



# **OPERATION and MAINTENANCE MANUALS**

For

**BRISBANE CITY COUNCIL**

At

**BRISBANE WATER**

**SEWAGE PUMP STATION**

**SP174 JESMOND ROAD**

Manuals Prepared by:

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**REVISION B: July 2003**

**OPERATION and MAINTENANCE MANUALS**

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Prepared by: Jim Pringle

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Reviewed  
Project Manager: \_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_



## **OPERATION and MAINTENANCE MANUALS**

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### **TABLE OF CONTENTS**

**Section 1. Instructions for use**

**Section 2. John Deere Operation Manual**

**Section 3. John Deere Spare Parts Catalogue**

**Section 4. Stamford Installation, Service & Maintenance Manual**

**Section 5. PLC – GE Fanuc**

**Section 6. Functional Description**

**Section 7. Drawings**

**Section 8. Test Reports**



## OPERATION and MAINTENANCE MANUALS

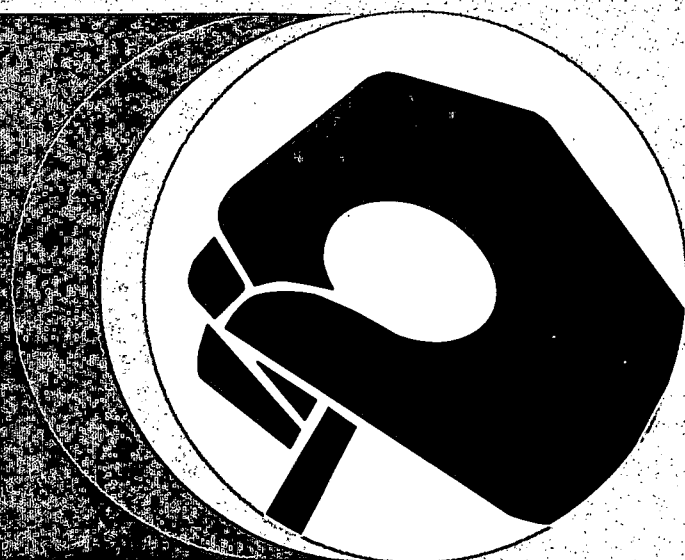
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### INSTRUCTIONS FOR USE

1. Units placed on site using "Hook Truck" (Cleanaway Type) over cable pit.
2. Cable pit to be under switchboard section of unit (rear).
3. Attach hold down / anti-theft chains to location points at rear of unit (beside switchboard).
4. Check engine lube oil level.
5. Check engine coolant level.
6. Check the battery is connected and the electrolyte level is correct.
7. Connect cables to plugs via colour-coded sequence.
8. Connect power inlet socket (240V).
9. Connect communication socket.
10. Connect pump station control socket.
11. Check fuel level (mechanical gauge beside fill point).
12. Refer to section 6, Functional Description for start/run and connection procedure.
13. Remember **SAFETY** is important **ALWAYS** wear your Personal Protection Equipment (PPE)

**POWER Units for  
Gensets (Saran)  
2.9L/4039/4.5/6.8L  
(128/008/158/258)**

**OPERATOR'S  
MANUAL**



**John Deere Usine de Saran  
OMCD16564 (03JAN00)**

Printed in Germany  
ENGLISH



# Introduction

THIS MANUAL COVERS the following engines for generator sets:

| ENGINE FAMILY | ENGINE MODEL |
|---------------|--------------|
| 300-SERIES    | CD3029DF128  |
|               | CD4039DF008  |
|               | CD4039TF008  |
| POWERTECH®    | CD4045DF158  |
|               | CD4045HF158  |
|               | CD4045TF158  |
|               | CD4045TF258  |
|               | CD6068HF158  |
|               | CD6068TF158  |
|               | CD6068TF258  |

READ THIS MANUAL carefully to learn how to operate and service your engine correctly. Failure to do so could result in personal injury or equipment damage.

THIS MANUAL SHOULD BE CONSIDERED a permanent part of your engine and should remain with the engine when you sell it.

MEASUREMENTS IN THIS MANUAL are given in metric. Use only correct replacement parts and fasteners. Metric and inch fasteners may require a specific metric or inch wrench.

WRITE ENGINE SERIAL NUMBERS and option codes in the spaces indicated in the Record Keeping Section. Accurately record all the numbers. Your dealer also needs these numbers when you order parts. File the identification numbers in a secure place off the engine or machine.

RIGHT-HAND AND LEFT-HAND sides are determined by standing at the drive or flywheel end (rear) of the engine and facing toward the front of the engine.

SETTING FUEL DELIVERY beyond published factory specifications or otherwise overpowering will result in loss of warranty protection for this engine.

## Information relative to emissions regulations

Depending on final destination, this engine can meet the emissions regulations according to the US Environmental Protection Agency (EPA), California Air Resources Board (CARB) and for Europe, the Directive 97/68/EC relating the measures against the emissions of gaseous and particulates pollutants from internal combustion engines. In this case an emission label is stuck on the engine.

Emission regulations prohibit tampering with the emission-related components listed below which would render that component inoperative or to make any adjustment on the engine beyond published specifications. It is also illegal to install a part or component where the principal effect of that component is to bypass, defeat, or render inoperative any engine component or device which would affect the engine conformance to the emissions regulations. To summarize, it is illegal to do anything except return the engine to its original published specifications.

List of emission-related components:

- Fuel injection pump
- Intake manifold
- Turbocharger
- Charge air cooling system
- Piston

CALIFORNIA PROPOSITION 65 WARNING  
Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects and other reproductive harm.

# Contents

|   | Page  |   | Page |
|---|-------|---|------|
| <b>Identification Views</b>                   |       | <b>Diesel Engine Coolant</b> .....                                    | 10-4 |
| Identification views .....                    | 01-1  | <b>Operating in Warm Temperature Climates</b> .....                   | 10-5 |
| <b>Maintenance Records</b>                    |       | <b>Operating the Engine</b>   |      |
| Using maintenance records .....               | 02-1  | Break-in period .....   | 15-1 |
| 100 Hours of operation .....                  | 02-1  | Starting the engine .....   | 15-1 |
| 500 Hours of operation .....                  | 02-2  | Cold weather operation .....  | 15-1 |
| 1000 Hours of operation .....                 | 02-2  | Using a booster battery or charger .....                              | 15-3 |
| 1500 Hours of operation .....                 | 02-3  | Engine operation .....  | 15-4 |
| 2000 Hours of operation .....                 | 02-3  | Standby power units .....   | 15-4 |
| 2500 Hours of operation .....                 | 02-4  | Stopping the engine .....   | 15-5 |
| 3000 Hours of operation .....                 | 02-4  | <b>Maintenance</b>  |      |
| 3500 Hours of operation .....                 | 02-5  | Observe service intervals .....                                       | 20-1 |
| 4000 Hours of operation .....                 | 02-5  | Use correct fuels, lubricants and coolant .....                       | 20-1 |
| 4500 Hours of operation .....                 | 02-6  | Maintenance interval chart .....                                      | 20-2 |
| 5000 Hours of operation .....                 | 02-6  | <b>Maintenance/Daily or every 10 hours</b>                            |      |
| 5500 Hours of operation .....                 | 02-7  | Daily prestarting checks .....  | 25-1 |
| 6000 Hours of operation .....                 | 02-7  | <b>Maintenance/500 hours</b>  |      |
| 6500 Hours of operation .....                 | 02-8  | Changing engine oil and filter .....                                  | 30-1 |
| 7000 Hours of operation .....                 | 02-8  | Replacing fuel filter element .....                                   | 30-3 |
| 7500 Hours of operation .....                 | 02-9  | Checking belt (300-SERIES ENGINES) .....                              | 30-4 |
| 8000 Hours of operation .....                 | 02-9  | Checking belt (POWERTech ENGINES with<br>manual tensioner) .....      | 30-5 |
| 8500 Hours of operation .....                 | 02-10 | <b>Maintenance/1000 hours/1 year</b>                                  |      |
| 9000 Hours of operation .....                 | 02-10 | Cleaning crankcase vent tube .....                                    | 35-1 |
| 9500 Hours of operation .....                 | 02-11 | Checking air intake system .....                                      | 35-1 |
| 10000 Hours of operation .....                | 02-11 | Checking automatic belt tensioner<br>(POWERTech ENGINES) .....        | 35-2 |
| <b>Record Keeping</b>                         |       | Check and adjust engine valve clearance<br>(300-SERIES ENGINES) ..... | 35-3 |
| POWERTech® medallion .....                    | 03-1  | <b>Maintenance/2000 hours/2 years</b>                                 |      |
| Engine serial number plate .....              | 03-1  | Check and adjust engine valve clearance<br>(POWERTech ENGINE) .....   | 40-1 |
| Record engine serial number .....             | 03-2  | Checking engine speed .....   | 40-3 |
| Engine option codes .....                     | 03-3  | Adjust speed droop governor .....                                     | 40-3 |
| Record fuel injection pump model number ..... | 03-5  |   |      |
| <b>Safety</b> .....                           | 05-1  |   |      |
| <b>Fuels, Lubricants and Coolant</b>          |       |   |      |
| Diesel Fuel .....                             | 10-1  |   |      |
| Handling and Storing Diesel Fuel .....        | 10-1  |   |      |
| Engine Break-In Oil .....                     | 10-2  |   |      |
| Diesel Engine Oil .....                       | 10-3  |   |      |
| Lubricant Storage .....                       | 10-3  |   |      |
| Mixing of Lubricants .....                    | 10-4  |   |      |

Continued on next page

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A John Deere ILLUSTRATION® Manual

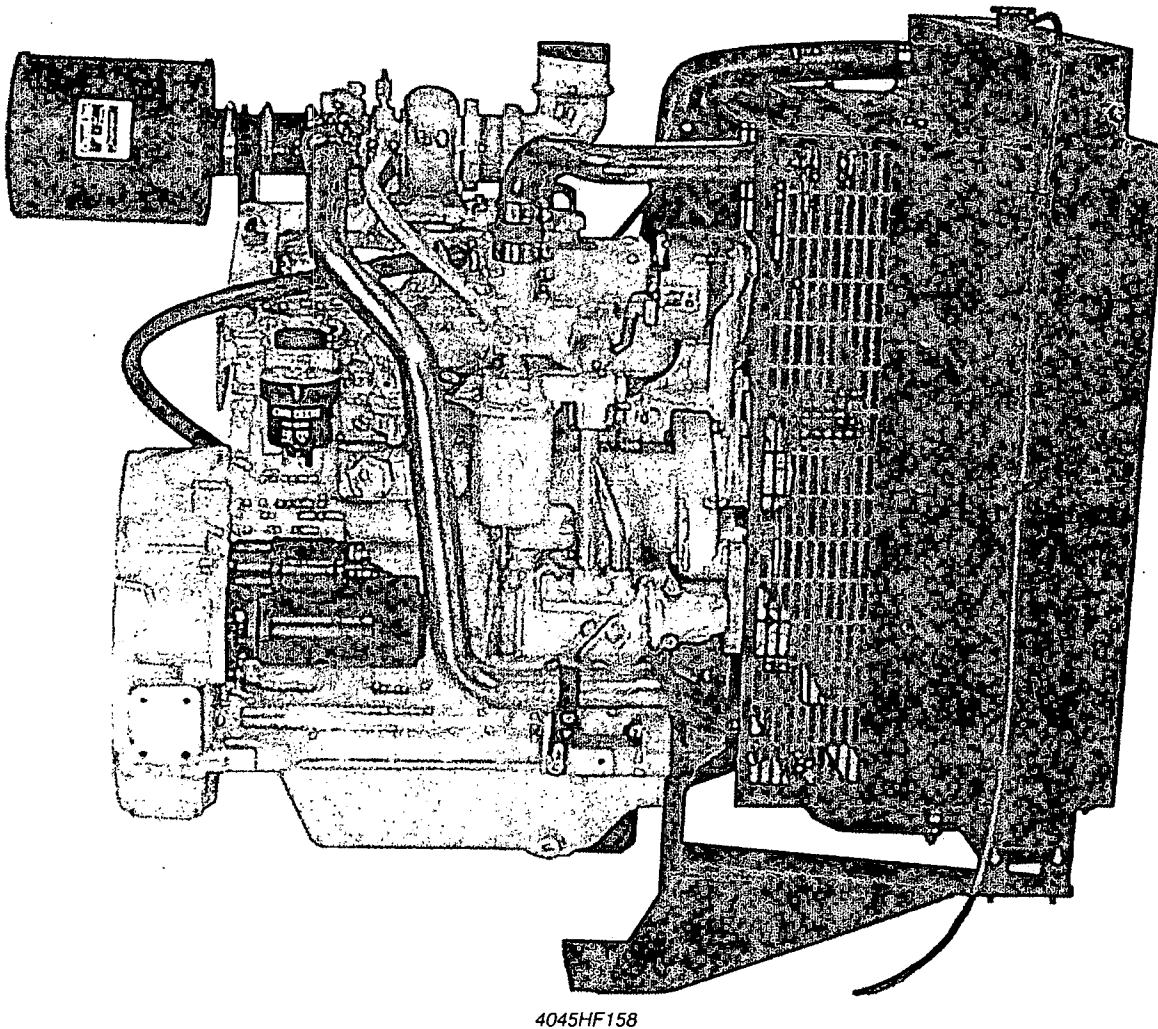
## Contents

|  | Page |
|--|------|
| Checking crankshaft vibration damper<br>(6-CYLINDER ENGINE ONLY) ..... | 40-4 |
| <br><b>Maintenance/2500 hours/3 years</b>                              |      |
| Drain and flush cooling system .....                                   | 45-1 |
| <br><b>Maintenance/As required</b>                                     |      |
| Additional service information .....                                   | 50-1 |
| Do not modify fuel system .....  | 50-1 |
| Clean or replace air filter (one-piece) .....                          | 50-2 |
| Clean or replace air filter element .....                              | 50-3 |
| Replacing fan and alternator belt<br>(POWERTech ENGINES) .....         | 50-4 |
| Checking fuel filter .....   | 50-5 |
| Bleeding the fuel system .....   | 50-6 |
| <br><b>Troubleshooting</b>   |      |
| Engine troubleshooting .....   | 55-1 |
| Electrical troubleshooting .....                                       | 55-6 |
| <br><b>Storage</b>   |      |
| Engine storage guidelines .....  | 60-1 |
| Use AR41785 engine storage kit .....                                   | 60-1 |
| Preparing engine for long term storage .....                           | 60-2 |
| Removing engine from long term storage .....                           | 60-3 |
| <br><b>Specifications</b>  |      |
| General engine specifications .....                                    | 65-1 |
| Unified Inch Bolt and Cap Screw Torque<br>Values .....                 | 65-4 |
| Metric Bolt and Cap Screw Torque Values .....                          | 65-5 |



# Identification Views

## IDENTIFICATION VIEWS



CD30744 -UN-23AUG99

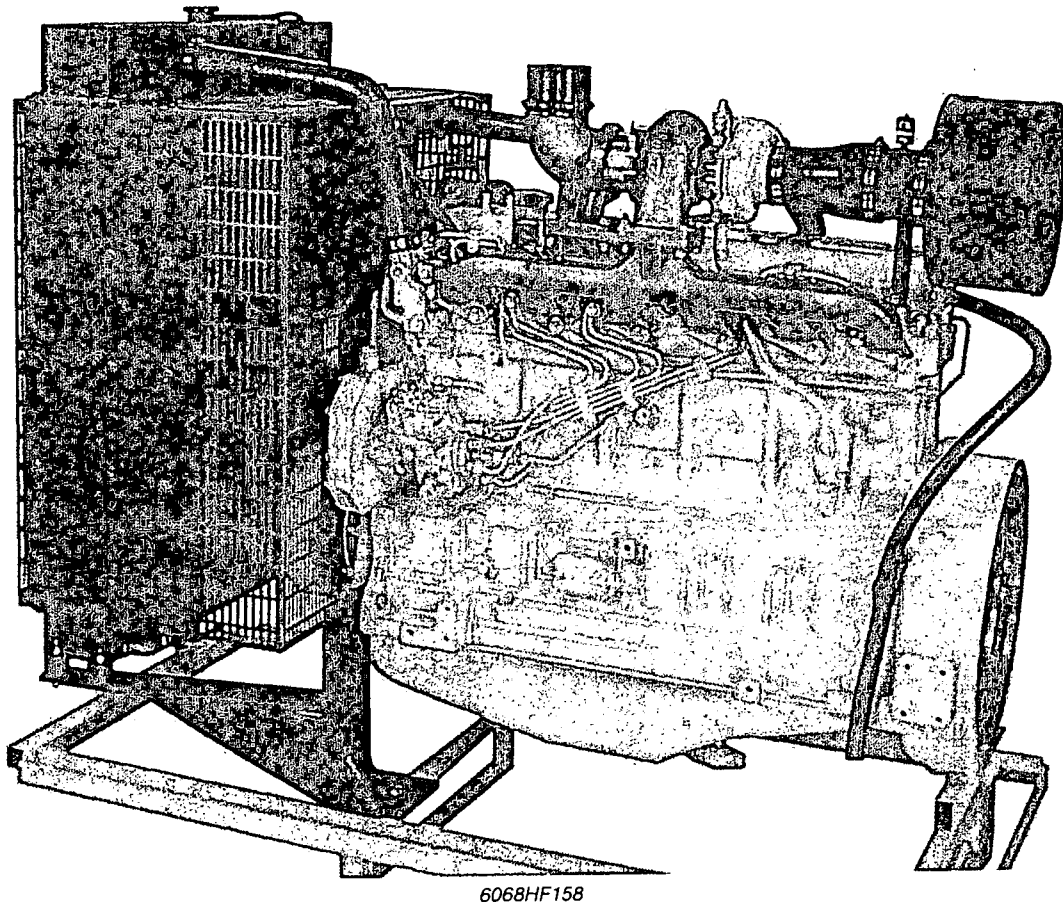
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DPSG,CD03523.3 -19-05JUL99-1/2

01-1

112699  
PN=5

Identification Views



CD30745 -UN-23AUG99

DPSG,CD03523.3 -19-05JUL99-2/2

01-2

112599  
PN=6

# Maintenance Records

## USING MAINTENANCE RECORDS

To obtain the best performance, economy and service life from your engine, ensure service is carried out according to this present manual and recorded in the following pages. It is recommended that your engine Distributor or your Dealer carry out this service work and stamp the appropriate case.

Keeping an accurate account of all service performed on your engine will give more value to the machine when you resell it.

John Deere oils and coolants have been formulated to give maximum protection and performance to your engine. We recommend only genuine John Deere service products and replacement parts.

To protect your rights under the warranty ensure all scheduled services are carried out and recorded. If your engine is covered by extended warranty, it is important to maintain this record for the duration of the warranty.

DPSG.CD03523,6 -19-05JUL99-1/1

## 100 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Hose connections, check

|                  |           |                             |
|------------------|-----------|-----------------------------|
| Number of hours: | Comments: | Dealer or distributor stamp |
| Date:            |           |                             |
| Job done by:     |           |                             |

DPSG.CD03523,7 -19-05JUL99-1/1

### Maintenance Records

#### 500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
  
- ☐ Fuel filter, replace
  
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
  
- ☐ Valve clearance, adjust (300-Series)

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523.8 -19-05JUL99-1/1

#### 1000 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace<br><br><input type="checkbox"/> Engine oil filter, replace<br><br><input type="checkbox"/> Fuel filter, replace<br><br><input type="checkbox"/> Check belt and tensioning system<br><br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Air intake system, check |
|--|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523.9 -19-05JUL99-1/1

02-2

112699  
PN=8

### Maintenance Records

#### 1500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523.10 -19-05JUL99-1/1

#### 2000 HOURS OF OPERATION

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li><input type="checkbox"/> Engine oil, replace</li> <li><input type="checkbox"/> Engine oil filter, replace</li> <li><input type="checkbox"/> Fuel filter, replace</li> <li><input type="checkbox"/> Check belt and tensioning system</li> <li>Crankcase vent tube, clean</li> </ul> | <ul style="list-style-type: none"> <li><input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is not used)</li> <li><input type="checkbox"/> Valve clearance, adjust (POWERTech)</li> <li><input type="checkbox"/> Air intake system, check</li> <li><input type="checkbox"/> Vibration damper, check</li> </ul> |
|---|--|

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523.59 -19-16AUG99-1/1

02-3

112699  
PN=9

### Maintenance Records

#### 2500 HOURS OF OPERATION

- |   |   |
|---|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Belt, check tension and wear (300-Series and POWERTech with manual tensioner)<br><input type="checkbox"/> Valve clearance, adjust (300-Series) | <input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is used) |
|---|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG.CD03523.60 -19-16AUG99-1/1

#### 3000 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Check belt and tensioning system<br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Air intake system, check |
|--|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG.CD03523.61 -19-16AUG99-1/1

02-4

112699  
PN=10

## Maintenance Records

## 3500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG.CD03523.62 -19-16AUG99-1/1

## 4000 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Check belt and tensioning system
- Crankcase vent tube, clean
- ☐ Cooling system, drain and flush (if COOL-GARD is not used)
- ☐ Valve clearance, adjust (POWERTech)
- ☐ Air intake system, check
- ☐ Vibration damper, check

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG.CD03523.63 -19-16AUG99-1/1

02-5

112699  
PN=11

### Maintenance Records

#### 4500 HOURS OF OPERATION

- |   |   |
|---|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Belt, check tension and wear (300-Series and POWERTech with manual tensioner)<br><input type="checkbox"/> Valve clearance, adjust (300-Series) | <input type="checkbox"/> Vibration damper, replace (6 cyl.) |
|---|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523,64 -19-16AUG99-1/1

#### 5000 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Check belt and tensioning system<br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Injection nozzles, replace<br><input type="checkbox"/> Air intake system, check<br><input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is used) |
|--|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523,65 -19-16AUG99-1/1

02-6

112699  
PN=12



### Maintenance Records

#### 5500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523.66 -19-16AUG99-1/1

#### 6000 HOURS OF OPERATION

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li><input type="checkbox"/> Engine oil, replace</li> <li><input type="checkbox"/> Engine oil filter, replace</li> <li><input type="checkbox"/> Fuel filter, replace</li> <li><input type="checkbox"/> Check belt and tensioning system</li> <li><input type="checkbox"/> Crankcase vent tube, clean</li> </ul> | <ul style="list-style-type: none"> <li><input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is not used)</li> <li><input type="checkbox"/> Valve clearance, adjust (POWERTech)</li> <li><input type="checkbox"/> Air intake system, check</li> <li><input type="checkbox"/> Vibration damper, check</li> </ul> |
|--|--|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523.67 -19-16AUG99-1/1

02-7

112699  
PN=13

### Maintenance Records

#### 6500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523,68 -19-16AUG99-1/1

#### 7000 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Check belt and tensioning system<br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Air intake system, check |
|--|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523,69 -19-16AUG99-1/1

02-8

112599  
PN=14

## Maintenance Records

## 7500 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace   | <input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is used) |
| <input type="checkbox"/> Engine oil filter, replace  |   |
| <input type="checkbox"/> Fuel filter, replace  |   |
| <input type="checkbox"/> Belt, check tension and wear (300-Series and POWERTech with manual tensioner) |   |
| <input type="checkbox"/> Valve clearance, adjust (300-Series)  |   |

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG.CD03523,70 -19-16AUG99-1/1

## 8000 HOURS OF OPERATION

- |   |   |
|---|---|
| <input type="checkbox"/> Engine oil, replace              | <input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is not used) |
| <input type="checkbox"/> Engine oil filter, replace       | <input type="checkbox"/> Valve clearance, adjust (POWERTech)                        |
| <input type="checkbox"/> Fuel filter, replace             | <input type="checkbox"/> Air intake system, check                                   |
| <input type="checkbox"/> Check belt and tensioning system | <input type="checkbox"/> Vibration damper, check                                    |
| <input type="checkbox"/> Crankcase vent tube, clean       |   |

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG.CD03523,71 -19-16AUG99-1/1

*Maintenance Records***8500 HOURS OF OPERATION**

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

|                  |           |                             |
|------------------|-----------|-----------------------------|
| Number of hours: | Comments: | Dealer or distributor stamp |
| Date:            |           |                             |
| Job done by:     |           |                             |

DPSG,CD03523,72 -19-16AUG99-1/1

**9000 HOURS OF OPERATION**

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Check belt and tensioning system
- ☐ Crankcase vent tube, clean
- ☐ Air intake system, check
- ☐ Vibration damper, replace (6 cyl.)

|                  |           |                             |
|------------------|-----------|-----------------------------|
| Number of hours: | Comments: | Dealer or distributor stamp |
| Date:            |           |                             |
| Job done by:     |           |                             |

DPSG,CD03523,73 -19-16AUG99-1/1

**02-10**112699  
PN=16

## Maintenance Records

## 9500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523,74 -19-16AUG99-1/1

## 10000 HOURS OF OPERATION

- |   |  |
|---|--|
| <input type="checkbox"/> Engine oil, replace              | <input type="checkbox"/> Cooling system, drain and flush     |
| <input type="checkbox"/> Engine oil filter, replace       | <input type="checkbox"/> Valve clearance, adjust (POWERTech) |
| <input type="checkbox"/> Fuel filter, replace             | <input type="checkbox"/> Thermostat, replace                 |
| <input type="checkbox"/> Check belt and tensioning system | <input type="checkbox"/> Vibration damper, check             |
| Crankcase vent tube, clean                                | <input type="checkbox"/> Injection nozzles, replace          |
| <input type="checkbox"/> Air intake system, check         |  |

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523,75 -19-16AUG99-1/1

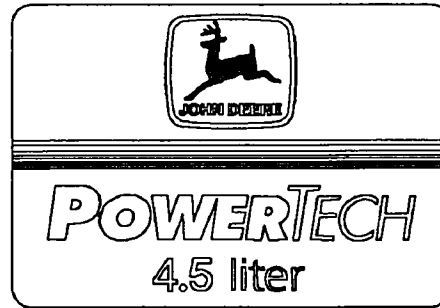
02-11

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PN=17

# Record Keeping

## POWERTECH® MEDALLION

A medallion is located on the rocker arm cover which identifies each engine as a John Deere POWERTECH® engine.

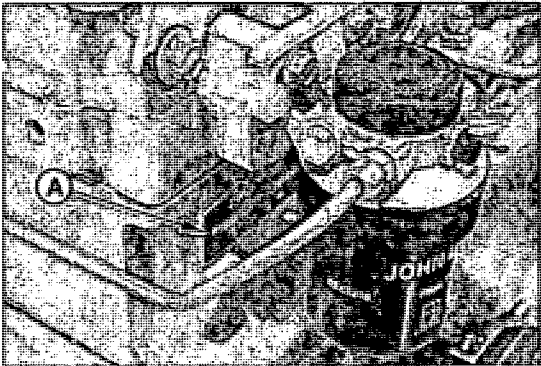


RG8041 -UN-15JAN99

POWERTECH is a trademark of Deere & Company

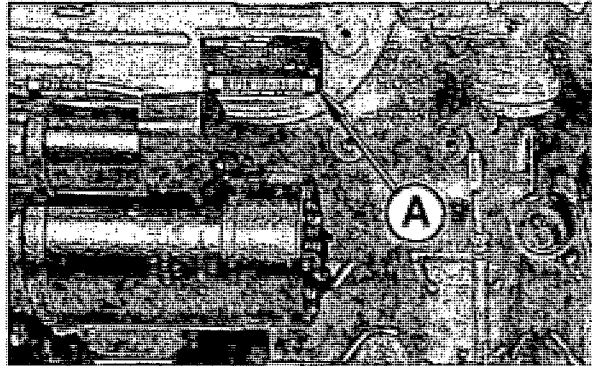
DPSG.CD03523.11 -19-05JUL99-1/1

## ENGINE SERIAL NUMBER PLATE



RG8007 -UN-15JAN99

POWERTECH engine



CD30746 -UN-24SEP99

300-Series engine

Each engine has a 13-digit John Deere serial number. The first two digits identify the factory that produced the engine:

"CD" indicates the engine was built in Saran, France.

Your engine's serial number plate (A) is located on the right-hand side of cylinder block behind the fuel filter for POWERTECH engines and near the fuel supply pump on 300-Series engines.

DPSG.CD03523.12 -19-05JUL99-1/1

## Record Keeping

**RECORD ENGINE SERIAL NUMBER**

Record all of the numbers and letters found on your engine serial number plate in the spaces provided below.

This information is very important for repair parts or warranty information.

Engine Serial Number (B)

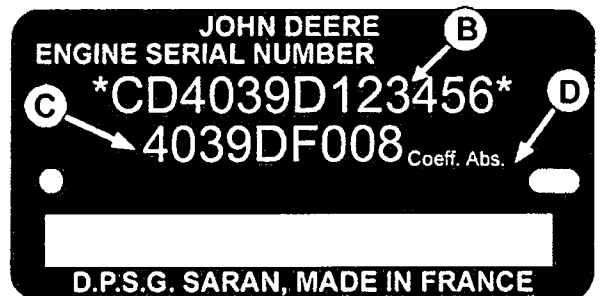
\_\_\_\_\_

Engine Model Number (C)

\_\_\_\_\_

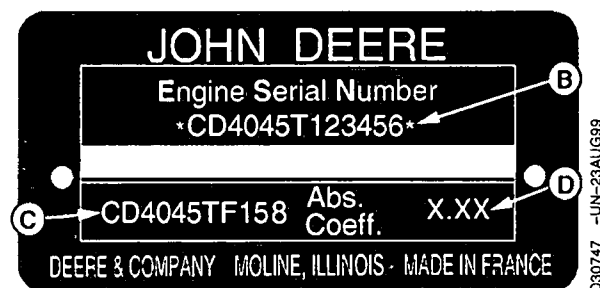
Coefficient of Absorption Value (D)

\_\_\_\_\_



CD30705B -UN-24AUG99

300-Series engine plate



CD30747 -UN-23AUG99

POWERTech engine plate

DPSG,CD03523,13 -19-05JUL99-1/1

## Record Keeping

## ENGINE OPTION CODES



Engine option code label

In addition to the serial number plate, OEM engines have an engine option code label affixed to the rocker arm cover. These codes indicate which of the engine options were installed on your engine at the factory. When in need of parts or service, furnish your authorized servicing dealer or engine distributor with these numbers.

An additional sticker may be also delivered (in a plastic bag attached to the engine or inserted in the machine documentation). It is recommended to stick this option code list sticker either:

- On this page of your Operator's manual below this section.
- or
- On the "Engine Owner's Warranty" booklet under the title OPTION CODES (Engine manufacturing configuration).

**NOTE:** The Machine Manufacturer may have already stuck it at a specific accessible place (inside the enclosure or close to a maintenance area).

The engine option code label includes an engine base code (A). This base code must also be recorded along with the option codes. At times it will be necessary to furnish this base code to differentiate two identical option codes for the same engine model.

The first two digits of each code identify a specific group, such as alternators. The last two digits of each code identify one specific option provided on your engine, such as a 12-volt, 55-amp alternator.

**NOTE:** These option codes are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

If an engine is ordered without a particular component, the last two digits of that functional group option code will be 99, 00, or XX. The list on the next page shows only the first two digits of the code numbers. For future reference such as ordering repair parts, it is important to have these code numbers available. To ensure this availability, enter the third and fourth digits shown on your engine option code label in the spaces provided on the following page.

**NOTE:** Your engine option code label may not contain all option codes if an option has been added after the engine left the producing factory.

If option code label is lost or destroyed, consult your servicing dealer or engine distributor selling the engine for a replacement.

Continued on next page

DPSG.CD03523.14 -19-05JUL99-1/2

03-3

112699  
PN=20



## Record Keeping

| Option Codes            | Description                       | Option Codes | Description                                 |
|-------------------------|-----------------------------------|--------------|---|
| Engine Base Code: _____ |                                   |              |   |
| 11 _____                | Rocker Arm Cover                  | 45 _____     | Balancer Shaft                              |
| 12 _____                | Oil Filler Neck                   | 46 _____     | Cylinder Block With Liners and Camshaft     |
| 13 _____                | Crankshaft Pulley                 | 47 _____     | Crankshaft and Bearings                     |
| 14 _____                | Flywheel Housing                  | 48 _____     | Connecting Rods and Pistons                 |
| 15 _____                | Flywheel                          | 49 _____     | Valve Actuating Mechanisms                  |
| 16 _____                | Fuel Injection Pump               | 50 _____     | Oil Pump                                    |
| 17 _____                | Air inlet                         | 51 _____     | Cylinder Head With Valves                   |
| 18 _____                | Air cleaner                       | 52 _____     | Auxiliary Gear Drive                        |
| 19 _____                | Oil pan                           | 54 _____     | Oil heater                                  |
| 20 _____                | Coolant pump                      | 55 _____     | Shipping stand                              |
| 21 _____                | Thermostat Cover                  | 56 _____     | Paint Option                                |
| 22 _____                | Thermostat                        | 57 _____     | Coolant Inlet                               |
| 23 _____                | Fan Drive                         | 59 _____     | Oil Cooler                                  |
| 24 _____                | Fan Belt                          | 60 _____     | Add-on Auxiliary Drive Pulley               |
| 25 _____                | Fan                               | 62 _____     | Alternator Mounting                         |
| 26 _____                | Engine Coolant Heater             | 64 _____     | Exhaust Elbow                               |
| 27 _____                | Radiator                          | 65 _____     | Turbocharger                                |
| 28 _____                | Exhaust Manifold                  | 66 _____     | Temperature Switch                          |
| 29 _____                | Ventilator System                 | 67 _____     | Electronic Tachometer Sensor                |
| 30 _____                | Starting Motor                    | 68 _____     | Damper                                      |
| 31 _____                | Alternator                        | 69 _____     | Engine Serial Number Plate                  |
| 32 _____                | Instrument Panel                  | 74 _____     | Air Conditioning System Compressor Mounting |
| 35 _____                | Fuel Filter                       | 75 _____     | Air Restriction Indicator                   |
| 36 _____                | Front Plate                       | 76 _____     | Oil Pressure Switch                         |
| 37 _____                | Fuel Transfer Pump                | 86 _____     | Fan Pulley                                  |
| 39 _____                | Thermostat Housing                | 87 _____     | Automatic Belt Tensioner                    |
| 40 _____                | Oil Dipstick                      | 88 _____     | Oil Filter                                  |
| 41 _____                | Belt Driven Front Auxiliary Drive | 91 _____     | Special Equipment (Factory Installed)       |
| 43 _____                | Starting Aid                      | 97 _____     | Special Equipment (Field Installed)         |
| 44 _____                | Timing Gear Cover with Gears      | 98 _____     | Shipping                                    |

DPSG.CD03523,14 -19-05JUL99-2/2

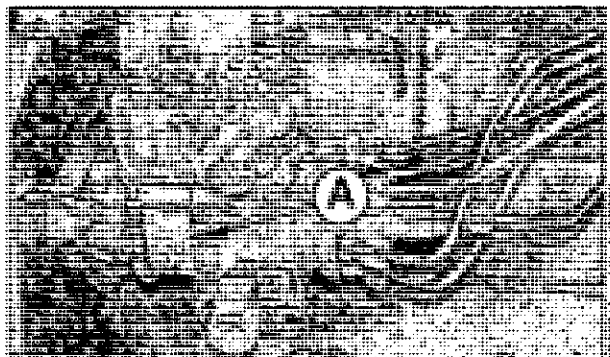
*Record Keeping***RECORD FUEL INJECTION PUMP MODEL NUMBER**

Record the fuel injection pump model and serial information found on the serial number plate (A).

Model No. \_\_\_\_\_ RPM \_\_\_\_\_

Manufacturer's No. \_\_\_\_\_

Serial No. \_\_\_\_\_



DPSG.CD03523,15 -19-07JUL99-1/1

# Safety

## RECOGNIZE SAFETY INFORMATION

This is a safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

Follow recommended precautions and safe operating practices.



T81389 -UN-07DEC88

DX,ALERT -19-29SEP98-1/1

## UNDERSTAND SIGNAL WORDS

A signal word—DANGER, WARNING, or CAUTION—is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

**⚠ DANGER**

**⚠ WARNING**

**⚠ CAUTION**

TS187 -19-30SEP88

DX,SIGNAL -19-03MAR93-1/1

## Safety

## ENGINE LIFTING PROCEDURE

**CAUTION:** The only recommended method for lifting the engine is with JDG23 Engine Lifting Sling (A) and safety approved lifting straps (B) that come with engine. Use extreme caution when lifting and NEVER permit any part of the body to be positioned under an engine being lifted or suspended.

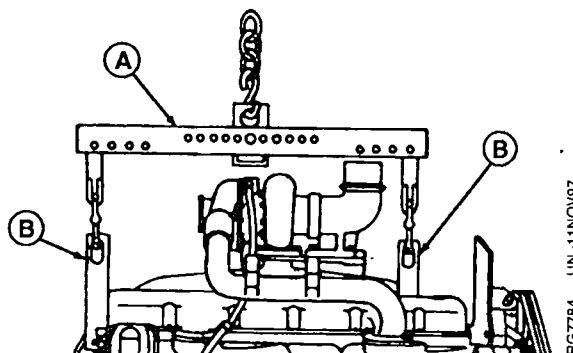
Lift engine with longitudinal loading on lifting sling and lifting straps only. Angular loading greatly reduces lifting capacity of sling and straps.

**NOTE:** If engine does not have lifting straps, universal straps can be procured through service parts under part numbers JD-244-1 and JD-244-2.

1. If not equipped, install lifting straps and torque to 200 N•m (145 lb-ft).
2. Attach JDG23 Engine Lifting Sling (A) to engine lifting straps (B) and overhead hoist.

**IMPORTANT:** Lifting straps are designed to lift the engine and accessories such as radiator, air filter and other small components. If larger components, such as power take-off, transmission, generator air compressor... etc, are attached to engine, the lifting straps provided with engine or through parts channel are not intended for this purpose. Technician is responsible for providing adequate lifting devices under these situations. See machine manuals for additional information on removing engine from machine.

3. Carefully move engine to desired location.



RG7784 -UN-11NOV97

DPSG.CD03523.95 -19-06OCT99-1/1

05-2

112699  
PN=24

## Safety

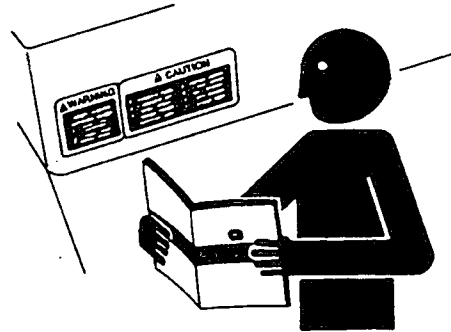
### FOLLOW SAFETY INSTRUCTIONS

Carefully read all safety messages in this manual and on your machine safety signs. Keep safety signs in good condition. Replace missing or damaged safety signs. Be sure new equipment components and repair parts include the current safety signs. Replacement safety signs are available from your John Deere dealer.

Learn how to operate the machine and how to use controls properly. Do not let anyone operate without instruction.

Keep your machine in proper working condition. Unauthorized modifications to the machine may impair the function and/or safety and affect machine life.

If you do not understand any part of this manual and need assistance, contact your John Deere dealer.



TS201 -UN-23AUG88

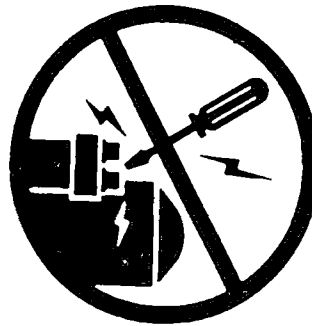
DX,READ -19-03MAR93-1/1

### PREVENT MACHINE RUNAWAY

Avoid possible injury or death from machinery runaway.

Do not start engine by shorting across starter terminals. Machine will start in gear if normal circuitry is bypassed.

NEVER start engine while standing on ground. Start engine only from operator's seat, with transmission in neutral or park.



TS177 -UN-11JAN89

DX,BYPAS1 -19-29SEP98-1/1

## Safety

### HANDLE FUEL SAFELY—AVOID FIRES

Handle fuel with care: it is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks.

Always stop engine before refueling machine. Fill fuel tank outdoors.

Prevent fires by keeping machine clean of accumulated trash, grease, and debris. Always clean up spilled fuel.



TS202 -UN-23AUG88

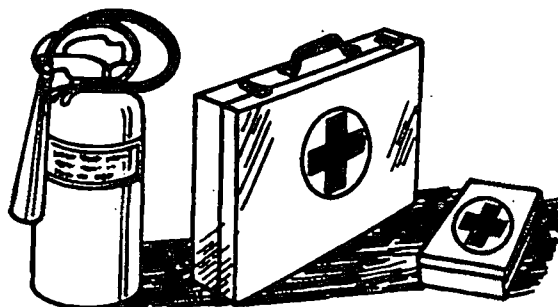
DX,FIRE1 -19-03MAR93-1/1

### PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



TS291 -UN-23AUG88

DX,FIRE2 -19-03MAR93-1/1

### HANDLE STARTING FLUID SAFELY

Starting fluid is highly flammable.

Keep all sparks and flame away when using it. Keep starting fluid away from batteries and cables.

To prevent accidental discharge when storing the pressurized can, keep the cap on the container, and store in a cool, protected location.

Do not incinerate or puncture a starting fluid container.



TS1356 -UN-18MAR92

DX,FIRE3 -19-16APR92-1/1

## Safety

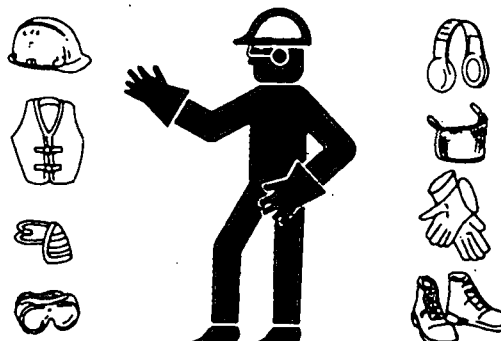
**WEAR PROTECTIVE CLOTHING**

Wear close fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.



TS206 -UN-23AUG88

DX,WEAR -19-10SEP90-1/1

**PROTECT AGAINST NOISE**

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



TS207 -UN-23AUG88

DX,NOISE -19-03MAR93-1/1

## Safety

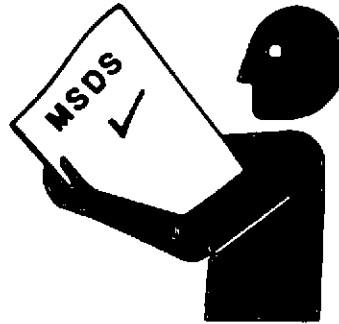
### HANDLE CHEMICAL PRODUCTS SAFELY

Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques.

Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and recommended equipment.

(See your John Deere dealer for MSDS's on chemical products used with John Deere equipment.)



TS1132 -JUN-26NOV90

DX,MSDS,NA -19-03MAR93-1/1

### STAY CLEAR OF ROTATING DRIVELINES

Entanglement in rotating driveline can cause serious injury or death.

Keep master shield and driveline shields in place at all times. Make sure rotating shields turn freely.

Wear close fitting clothing. Stop the engine and be sure the PTO driveline is stopped before making adjustments or performing any type service on the engine or PTO-driven equipment.



TS1644 -JUN-22AUG95

CO,PTO -19-12SEP95-1/1



## Safety

### PRACTICE SAFE MAINTENANCE

Understand service procedure before doing work. Keep area clean and dry.

Never lubricate, service, or adjust machine while it is moving. Keep hands, feet, and clothing from power-driven parts. Disengage all power and operate controls to relieve pressure. Lower equipment to the ground. Stop the engine. Remove the key. Allow machine to cool.

Securely support any machine elements that must be raised for service work.

Keep all parts in good condition and properly installed. Fix damage immediately. Replace worn or broken parts. move any buildup of grease, oil, or debris.

On self-propelled equipment, disconnect battery ground cable (-) before making adjustments on electrical systems or welding on machine.

On towed implements, disconnect wiring harnesses from tractor before servicing electrical system components or welding on machine.



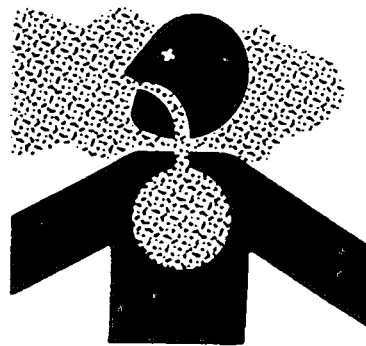
TS218 -UN-23AUG88

DX.SERV -19-17FEB99-1/1

### WORK IN VENTILATED AREA

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area



TS220 -UN-23AUG88

DX.AIR -19-17FEB99-1/1

## Safety

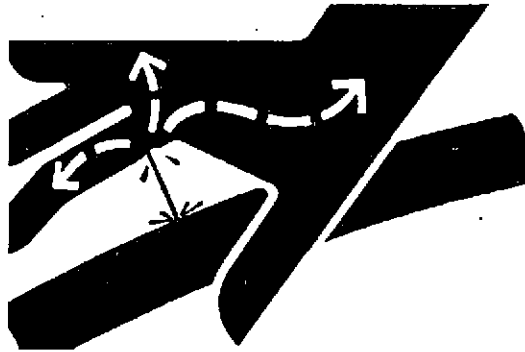
### AVOID HIGH-PRESSURE FLUIDS

Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.



X9811 -UN-23AUG88

DX,FLUID -19-03MAR93-1/1

### AVOID HEATING NEAR PRESSURIZED FLUID LINES

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.



TS953 -UN-15MAY90

DX,TORCH -19-03MAR93-1/1

## Safety

### REMOVE PAINT BEFORE WELDING OR HEATING

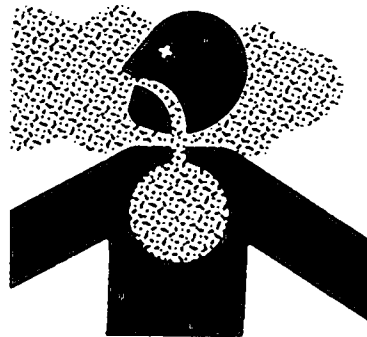
Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.



TS220 -UN-23AUG88

DX,PAINT -19-03MAR93-1/1

### SERVICE COOLING SYSTEM SAFELY

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.



TS281 -UN-23AUG88

DX,RCAP -19-04JUN90-1/1

## Safety

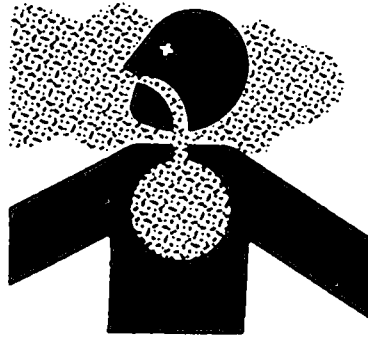
### AVOID HARMFUL ASBESTOS DUST

Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos.

Keep bystanders away from the area.



TS220 -UN-23AUG88

DX,DUST -19-15MAR91-1/1

### DISPOSE OF WASTE PROPERLY

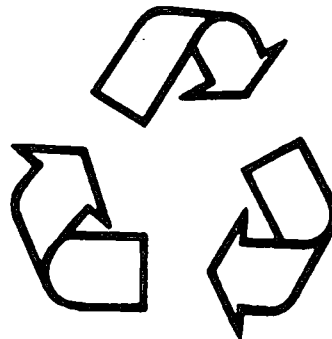
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Air conditioning refrigerants escaping into the air can damage the Earth's atmosphere. Government regulations may require a certified air conditioning service center to recover and recycle used air conditioning refrigerants.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.



TS1133 -UN-26NOV90

DX,DRAIN -19-03MAR93-1/1

## 05-10

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# Fuels, Lubricants and Coolant

## DIESEL FUEL

Consult your local fuel distributor for properties of the diesel fuel available in your area.

In general, diesel fuels are blended to satisfy the low temperature requirements of the geographical area in which they are marketed.

Diesel fuels specified to EN 590 or ASTM D975 are recommended.

In all cases, the fuel shall meet the following properties:

**Cetane number of 40 minimum.** Cetane number greater than 50 is preferred, especially for temperatures below -20°C (-4°F) or elevations above 1,000 m (5,000 ft).

**Cold Filter Plugging Point (CFPP)** below the expected low temperature OR **Cloud Point** at least 5°C (9°F) below the expected low temperature.

**Fuel lubricity** should pass a minimum of 3100 gram load level as measured by the BOCLE scuffing test.

### Sulfur content:

- Sulfur content should not exceed 0.5%. Sulfur content less than 0.05% is preferred.
- If diesel fuel with sulfur content greater than 0.5% sulfur content is used, reduce the service interval for engine oil and filter by 50%.
- DO NOT use diesel fuel with sulfur content greater than 1.0%.

Bio-diesel fuels may be used ONLY if the fuel properties meet DIN 51606 or equivalent specification.

DO NOT mix used engine oil or any other type of lubricant with diesel fuel.

DX,FUEL1 -19-17FEB99-1/1

## HANDLING AND STORING DIESEL FUEL



**CAUTION:** Handle fuel carefully. Do not fill the fuel tank when engine is running.

**DO NOT** smoke while you fill the fuel tank or service the fuel system.

Fill the fuel tank at the end of each day's operation to prevent condensation and freezing during cold weather.

**IMPORTANT:** The fuel tank is vented through the filler cap. If a new filler cap is required, always replace it with an original vented cap.

When fuel is stored for an extended period or if there is a slow turnover of fuel, add a fuel conditioner to stabilize the fuel and prevent water condensation. Contact your fuel supplier for recommendations.

DX,FUEL4 -19-18MAR96-1/1

## Fuels, Lubricants and Coolant

### ENGINE BREAK-IN OIL

New engines are filled at the factory with John Deere ENGINE BREAK-IN OIL. During the break-in period, add John Deere ENGINE BREAK-IN OIL as needed to maintain the specified oil level.

Change the oil and filter after the first 100 hours of operation of a new or rebuilt engine.

After engine overhaul, fill the engine with John Deere ENGINE BREAK-IN OIL.

If John Deere ENGINE BREAK-IN OIL is not available, use a diesel engine oil meeting one of the following during the first 100 hours of operation:

- API Service Classification CE

- ACEA Specification E1

After the break-in period, use John Deere PLUS-50® or other diesel engine oil as recommended in this manual.

**IMPORTANT:** Do not use PLUS-50 oil or engine oils meeting API CG4, API CF4, ACEA E3, or ACEA E2 performance levels during the first 100 hours of operation of a new or rebuilt engine. These oils will not allow the engine to break-in properly.

*PLUS-50 is a registered trademark of Deere & Company.*

DX,ENOIL4 -19-10OCT97-1/1

## Fuels, Lubricants and Coolant

### DIESEL ENGINE OIL

Use oil viscosity based on the expected air temperature range during the period between oil changes.

The following oil is preferred:

- John Deere PLUS-50®

The following oil is also recommended:

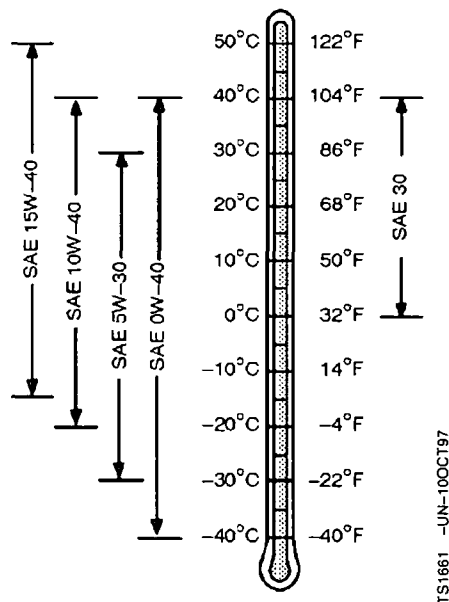
- John Deere TORQ-GARD SUPREME TORQ-GARD SUPREME®

Other oils may be used if they meet one or more of the following:

- API Service Classification CG-4
- API Service Classification CF-4
- ACEA Specification E3
- ACEA Specification E2

**Multi-viscosity diesel engine oils are preferred.**

If diesel fuel with sulfur content greater than 0.5% is used, reduce the service interval by 50%.



*PLUS-50 is a registered trademark of Deere & Company.  
TORQ-GARD SUPREME is a trademark of Deere & Company*

CD.ENOIL -19-10OCT97-1/1

### LUBRICANT STORAGE

Our equipment can operate at top efficiency only when clean lubricants are used.

Use clean containers to handle all lubricants.

Whenever possible, store lubricants and containers in an area protected from dust, moisture, and other contamination. Store containers on their side to avoid water and dirt accumulation.

Make certain that all containers are properly marked to identify their contents.

Properly dispose of all old containers and any residual lubricant they may contain.

DX.LUBST -19-18MAR96-1/1

## Fuels, Lubricants and Coolant

### MIXING OF LUBRICANTS

In general, avoid mixing different brands or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements.

Consult your John Deere dealer to obtain specific information and recommendations.

Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

DX,LUBMIX -19-18MAR96-1/1

### DIESEL ENGINE COOLANT

The engine cooling system is filled to provide year-round protection against corrosion and cylinder liner pitting, and winter freeze protection to -37°C (-34°F).

**John Deere COOL-GARD is preferred for service.**

If John Deere COOL-GARD is not available, use a low silicate ethylene glycol base coolant concentrate in a 50% mixture of concentrate with quality water.

The coolant concentrate shall be of a quality that provides cavitation protection to cast iron and aluminum parts in the cooling system. John Deere COOL-GARD meets this requirement.

A 50% mixture of ethylene glycol engine coolant in water provides freeze protection to -37°C (-34°F). If protection at lower temperatures is required, consult your John Deere dealer for recommendations.

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized

water is recommended for mixing with ethylene glycol base engine coolant concentrate.

**IMPORTANT: Do not use cooling system sealing additives or antifreeze that contains sealing additives.**

#### COOLANT DRAIN INTERVALS

Drain the factory fill engine coolant, flush the cooling system, and refill with new coolant after the first 3 years or 3000 hours of operation. Subsequent drain intervals are determined by the coolant used for service. At each interval, drain the coolant, flush the cooling system, and refill with new coolant.

When John Deere COOL-GARD is used, the coolant drain interval is 3 years or 3000 hours of operation.

If COOL-GARD is not used, the drain interval is reduced to 2 years or 2000 hours of operation.

DX,COOL8 -19-12FEB99-1/1



*Fuels, Lubricants and Coolant***OPERATING IN WARM TEMPERATURE CLIMATES**

John Deere engines are designed to operate using glycol base engine coolants.

Always use a recommended glycol base engine coolant, even when operating in geographical areas where freeze protection is not required.

**IMPORTANT:** *Water may be used as coolant in emergency situations only.*

**Foaming, hot surface aluminum and iron corrosion, scaling, and cavitation will occur when water is used as the coolant, even when coolant conditioners are added.**

**Drain cooling system and refill with recommended glycol base engine coolant as soon as possible.**

DX.COOL6 -19-18MAR96-1/1

# Operating the Engine

## BREAK-IN PERIOD

### Within first 100 hours of operation

During the first 100 hours of operation, avoid overloading, excessive idling and no-load operation.

See ENGINE BREAK-IN OIL for eventual addition of oil.

**NOTE:** *During the break-in period a higher-than-usual oil consumption should be considered as normal.*

### After first 100 hours of operation

After the first 100 hours, drain the crankcase and

change the oil filter (see CHANGING ENGINE OIL AND FILTER). Fill crankcase with seasonal viscosity grade oil (see DIESEL ENGINE OIL).

Check tension of alternator belt.

Check connections of air intake hoses.

Check for proper tightening of cap screws all around the engine.

DPSG.CD03523.17 -19-09JUL99-1/1

## STARTING THE ENGINE



**CAUTION:** Before starting engine in a confined building, install proper outlet exhaust ventilation equipment. Always use safety approved fuel storage and piping.

**NOTE:** *If temperature is below 0°C (32°F), it may be necessary to use cold weather starting aids (See COLD WEATHER OPERATION).*

1. Perform all prestarting checks outlined in Maintenance/Daily Section.

2. Open the fuel supply shut-off valve, if equipped.

3. Activate the starter motor switch to crank the engine and release it as soon as engine starts.

**NOTE:** *Do not operate the starter motor more than 20 seconds at a time.*

DPSG.CD03523.18 -19-09JUL99-1/4

## COLD WEATHER OPERATION

Depending on equipment, various cold weather starting aids are available to assist in starting the engine at temperatures below 0°C (32°F).

Continued on next page

DPSG.CD03523.19 -19-09JUL99-1/4

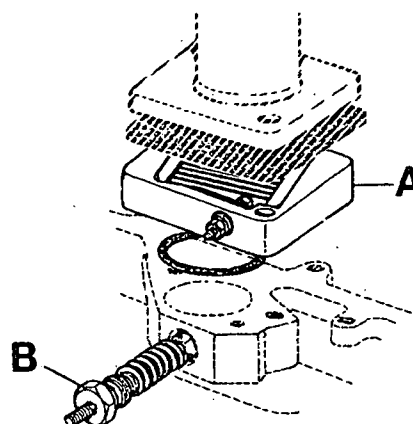
## Operating the Engine

### Air intake heater

Air intake heater is either a grid-type (A) for POWERTech engines or a glow plug-type (B) for 300-Series engines installed in the air intake channel.

**CAUTION:** NEVER use Ether Starting Fluid when air intake heater is used to start the engine.

Activate the heating element (preheater position) for 30 seconds maximum then start the engine.



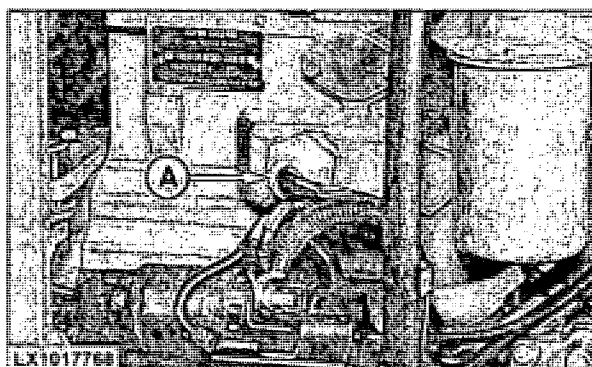
CD30750 -UN-03SEP99

DPSG,CD03523,19 -19-09JUL99-2/4

### Coolant heater

Connect plug of coolant heater (A) to a power source (110 or 220 V).

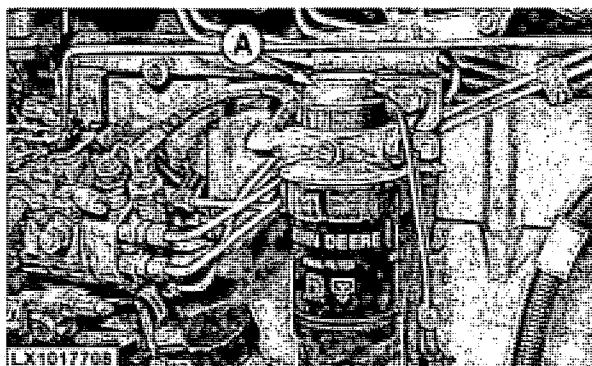
At an ambient temperature of  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ), the heating process takes approximately 2 hours. Extend heating period if ambient temperature is lower.



DPSG,CD03523,19 -19-09JUL99-3/4

### Fuel preheater

Fuel preheater (A) switches ON and OFF automatically in relation to the ambient temperature.



DPSG,CD03523,19 -19-09JUL99-4/4

## Operating the Engine

## USING A BOOSTER BATTERY OR CHARGER

A 12-volt booster battery can be connected in parallel with battery(ies) on the unit to aid in cold weather starting. ALWAYS use heavy duty jumper cables.

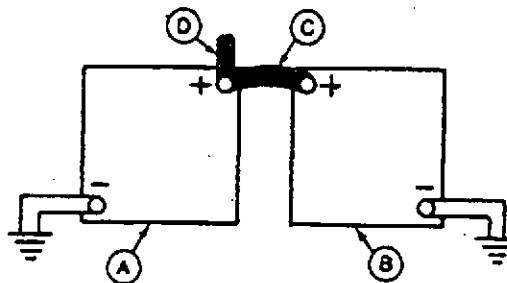
**CAUTION:** Gas given off by batteries is explosive. Keep sparks and flames away from batteries. Before connecting or disconnecting a battery charger, turn charger off. Make last connection and first disconnection at a point away from battery. Always connect **NEGATIVE (-)** cable last and disconnect this cable first.

**IMPORTANT:** Be sure polarity is correct before making connections. Reversed polarity will damage electrical system. Always connect positive to positive and negative to ground. Always use 12-volt booster battery for 12-volt electrical systems and 24-volt booster battery/batteries for 24-volt electrical systems.

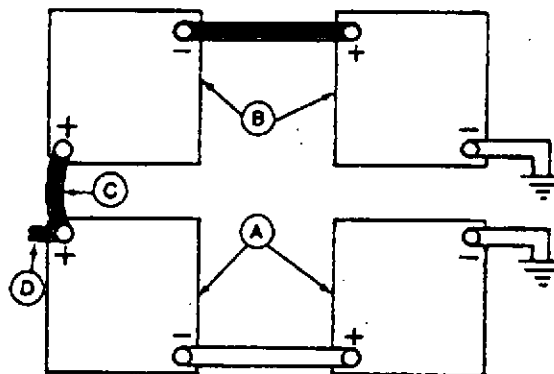
1. Connect booster battery or batteries to produce the required system voltage for your engine application.

**NOTE:** To avoid sparks, **DO NOT** allow the free ends of jumper cables to touch the engine.

2. Connect one end of jumper cable to the **POSITIVE (+)** post of the booster battery.
3. Connect the other end of the jumper cable to the **POSITIVE (+)** post of battery connected to starter.
4. Connect one end of the other jumper cable to the **NEGATIVE (-)** post of the booster battery.
5. **ALWAYS** complete the hookup by making the last connection of the **NEGATIVE (-)** cable to a good ground on the engine frame and away from the battery(ies).
6. Start the engine. Disconnect jumper cables immediately after engine starts. Disconnect **NEGATIVE (-)** cable first.



12-Volt System



24-Volts System

A—12-Volt Machine battery/batteries  
B—12-Volt Booster battery/batteries  
C—Booster cable  
D—Cable to starter motor

TS204 -UN-23AUG88

RG4678 -UN-14DEC88

RG4698 -UN-14DEC88

DPSG.CD03523.20 -19-09JUL99-1/1

## Operating the Engine

### ENGINE OPERATION

#### Warming engine

Operate engine at high idle for 1 to 2 minutes before applying the load.

**NOTE:** *This procedure does not apply to standby generator sets where the engine is loaded immediately upon reaching rated speed.*

#### Normal engine operation

Compare engine coolant temperature and engine oil pressure with specifications below:

##### Minimum oil pressure at full load rated speed<sup>1</sup>—Specification

Pressure..... 275 kPa (2.75 bar; 40 psi)

##### Coolant temperature range—Specification

Temperature ..... 82°—94°C (180°—202°F)

Stop engine immediately if coolant temperature is above or oil pressure below specifications or if there are any signs of part failure. Symptoms that may be early signs of engine problems could be:

- Sudden loss of power

- Unusual noise or vibration
- Excessive black exhaust fumes
- Excessive fuel consumption
- Excessive oil consumption
- Fluid leaks

#### Recommendation for turbocharger engines

Should the engine stall when operating under load, IMMEDIATELY restart it to prevent overheating of turbocharger components.

#### Idling engine

Avoid excessive engine idling. Prolonged idling may cause the engine coolant temperature to fall below its normal range. This, in turn, causes crankcase oil dilution, due to incomplete fuel combustion, and permits formation of gummy deposits on valves, pistons and piston rings. It also promotes rapid accumulation of engine sludge and unburned fuel in the exhaust system. If an engine will be idling for more than 5 minutes, stop and restart later.

**NOTE:** *Generator set applications have the governor locked at a specified speed and do not have a slow idle function. These engines idle at no load governed speed (fast idle).*

<sup>1</sup>Oil at normal operating temperature of 115°C (240°F).

DPSG,CD03523,21 -19-09JUL99-1/1

### STANDBY POWER UNITS

To assure that your engine will deliver efficient standby operation when needed, start engine and run at rated speed (with 50%—70% load) for 30 minutes every

2 weeks. DO NOT allow engine to run an extended period of time with no load.

DPSG,CD03523,22 -19-09JUL99-1/1

## *Operating the Engine*

### **STOPPING THE ENGINE**

1. Before stopping, run engine for at least 2 minutes at fast idle and no load.
2. Stop the engine.

DPSG,CD03523,23 -19-09JUL99-1/1

# Maintenance

## OBSERVE SERVICE INTERVALS

Using hour meter as a guide, perform all services at the hourly intervals indicated on following pages. At each scheduled maintenance interval, perform all previous maintenance operations in addition to the ones specified. Keep a record of hourly intervals and services performed using charts provided in Maintenance Records Section.

**IMPORTANT:** Recommended service intervals are for normal operating conditions. Service **MORE OFTEN** if engine is operated under adverse conditions. Neglecting maintenance can result in failures or permanent damage to the engine.

DPSG,CD03523,24 -19-09JUL99-1/1

## USE CORRECT FUELS, LUBRICANTS AND COOLANT

**PORTANT:** Use only fuels, lubricants, and coolants meeting specifications outlined in Fuels, Lubricants, and Coolant Section when servicing your John Deere Engine.

Consult your John Deere engine distributor, servicing dealer or your nearest John Deere Parts Network for recommended fuels, lubricants, and coolant. Also available are necessary additives for use when operating engines in tropical, arctic, or any other adverse conditions.



TS100 -UN-23AUG88

DPSG,CD03523,25 -19-09JUL99-1/1

## Maintenance

## MAINTENANCE INTERVAL CHART

| Item   | 10 H /<br>daily | 500 H | 1000 H /<br>1 year | 2000 H /<br>2 years | 2500 H /<br>3 years | As<br>required |
|--|-----------------|-------|--------------------|---------------------|---------------------|----------------|
| Check engine oil and coolant level                                   | •               |       |                    |                     |                     |                |
| Check air filter restriction indicator <sup>a</sup>                  | •               |       |                    |                     |                     |                |
| Change engine oil and filter <sup>b</sup>                            |                 | •     |                    |                     |                     |                |
| Replace fuel filter element  |                 | •     |                    |                     |                     |                |
| Check belt tension and automatic tensioner <sup>c</sup>              |                 | •     | •                  |                     |                     |                |
| Check and adjust valve clearance <sup>d</sup>                        |                 |       | •                  | •                   |                     |                |
| Clean crankcase vent tube  |                 |       | •                  |                     |                     |                |
| Check air intake hoses, connections and system                       |                 |       | •                  |                     |                     |                |
| Check vibration damper (6 cyl.) <sup>e</sup>                         |                 |       |                    | •                   |                     |                |
| Check engine speed and speed droop governor                          |                 |       |                    | •                   |                     |                |
| Drain and flush cooling system <sup>f</sup>                          |                 |       |                    | •                   | •                   |                |
| Drain water and sediment from fuel filter                            |                 |       |                    |                     |                     | •              |
| Clean filter element (see note a)                                    |                 |       |                    |                     |                     | •              |
| Test thermostat and injection nozzles (see your dealer) <sup>g</sup> |                 |       |                    |                     |                     | •              |

<sup>a</sup>Clean air filter element when restriction indicator is red. Replace filter element after 6 cleanings or once a year.

<sup>b</sup>Change oil and filter after the first 100 hours of operation, then every 500 hours thereafter. Change oil and filter at least once a year.

<sup>c</sup>Check belt tension every 500 hours on 300-Series engines and on POWERTech engines with manual tensioner. Check automatic belt tensioner every 1000 hours/1 year on POWERTech engines when equipped.

<sup>d</sup>Have your authorized servicing dealer or engine distributor adjust valve clearance as follows. After the first 500 hours of operation then every 1000 hours thereafter on 300-Series engines. Every 2000 hours on POWERTech engines.

<sup>e</sup>Have your authorized dealer or engine distributor replace the vibration damper every 4500 hours/5 years.

<sup>f</sup>Drain and flush cooling system every 2500 hours/3 years when John Deere COOL-GARD coolant is used. Otherwise every 2000 hours/2 years.

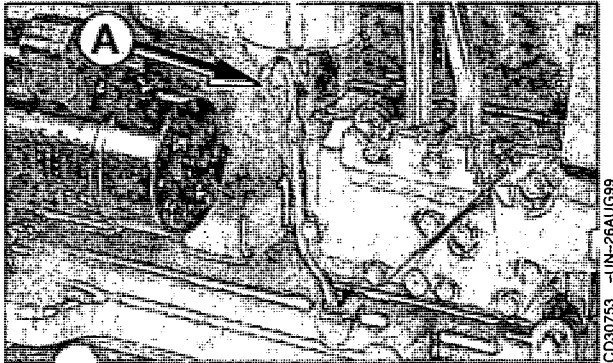
<sup>g</sup>Contact your dealer when thermostat or injection nozzles are suspected to be defective. Replace injection nozzles every 5000 hours and thermostat every 10000 hours.

DPSG,CD03523,26 -19-09JUL99-1/1

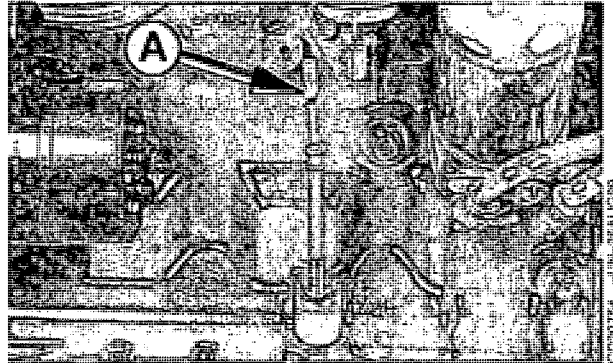


# Maintenance/Daily or every 10 hours

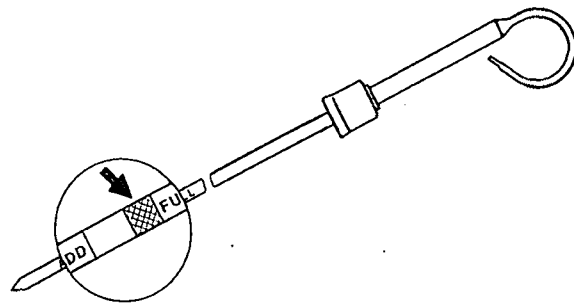
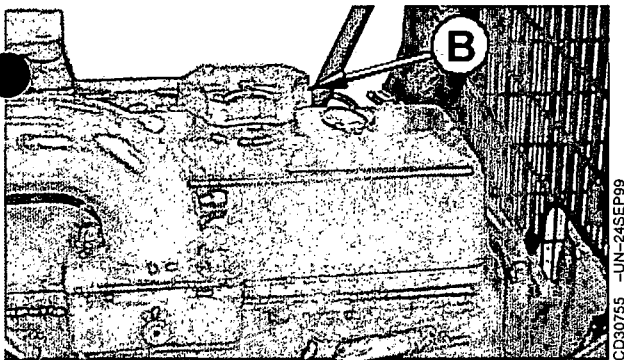
## DAILY PRESTARTING CHECKS



POWERTech engine



300-Series engine



FD000047

FD000047 -UN-13MAR96

Do the following BEFORE STARTING THE ENGINE for the first time each day:

**IMPORTANT: DO NOT** top up with fresh oil until the oil level is **BELOW** the add mark.

1. Check engine oil level on dipstick (A). Add as required, using seasonal viscosity grade oil. (See

DIESEL ENGINE OIL). Add oil at rocker arm cover filler cap (B).

**IMPORTANT: DO NOT** fill above the crosshatch area. Oil levels anywhere within crosshatch are considered in the acceptable operating range.

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DPSG,CD03523.27 -19-12JUL99-1/3

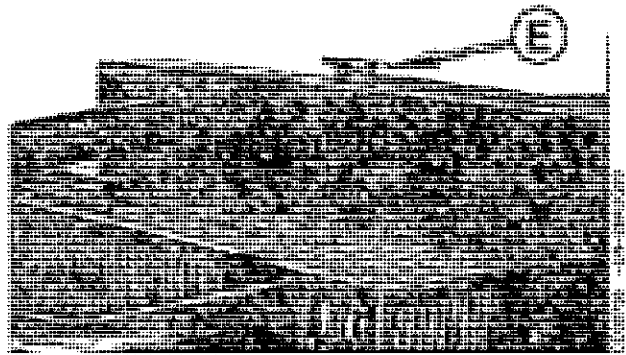
## Maintenance/Daily or every 10 hours



TS281 -UN-23AUG86

2. **CAUTION:** Explosive release of fluids from pressurized cooling system can cause serious burns.

Only remove filler cap when engine is cold or when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.



Remove radiator cap (E) and check coolant level which should be at bottom of filler neck. Fill radiator with proper coolant solution if level is low. (See DIESEL ENGINE COOLANT). Check overall cooling system for leaks.

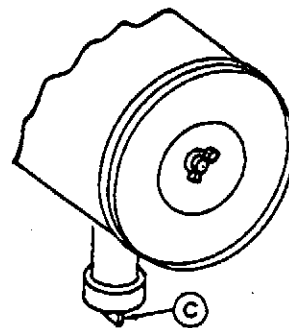
DPSG.CD03523.27 -19-12JUL99-2/3

3. If air filter has a dust unloading valve (C), squeeze valve tip to release any trapped dirt particles.
4. Check air intake restriction indicator (D). When indicator is red, air filter needs to be cleaned.

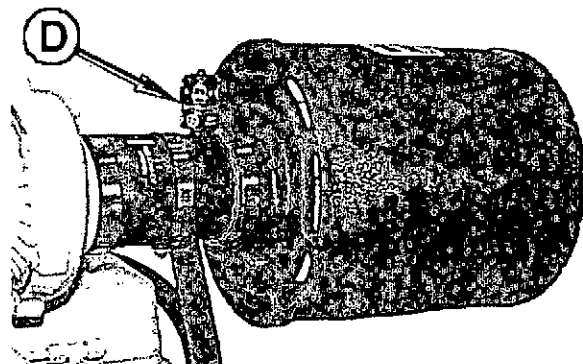
**IMPORTANT:** Maximum air intake restriction is 6.25 kPa (0.06 bar; 1.0 psi) (25 in. H<sub>2</sub>O). A clogged air cleaner element will cause excessive intake restriction and a reduced air supply to the engine.

5. Make a thorough inspection of the engine compartment.

**NOTE:** Wipe all fittings, caps and plugs before performing any maintenance to reduce the chance of system contamination.



RG4687 -UN-20DEC98



CD30757 -UN-26AUG99

DPSG.CD03523.27 -19-12JUL99-3/3

# Maintenance/500 hours

## CHANGING ENGINE OIL AND FILTER

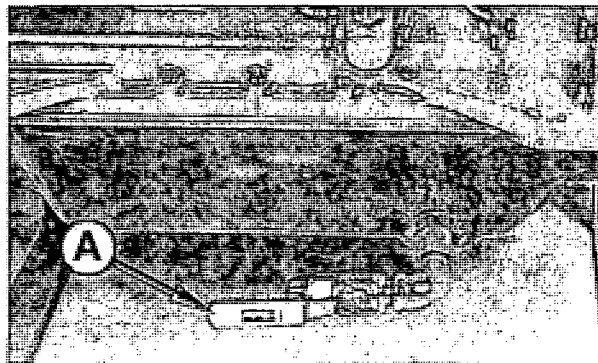
**NOTE:** Change engine oil and filter for the first time after 100 hours maximum of operation, then every 500 hours thereafter. Change oil and filter at least once a year.

1. Run engine approximately 5 minutes to warm up oil. Shut engine off.
2. Open oil pan drain valve (A).
3. Drain crankcase oil from engine while warm.
4. Remove and discard oil filter element (B) using a suitable filter wrench.

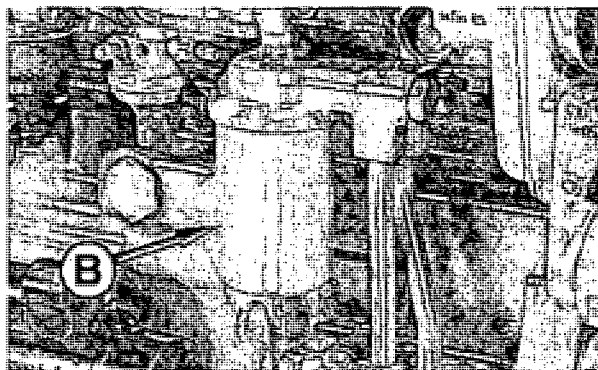
Remove oil filter packing and clean filter mounting pad.

**IMPORTANT:** Filtration of oils is critical to proper lubrication. Always change filter regularly. Use filters meeting John Deere performance specifications.

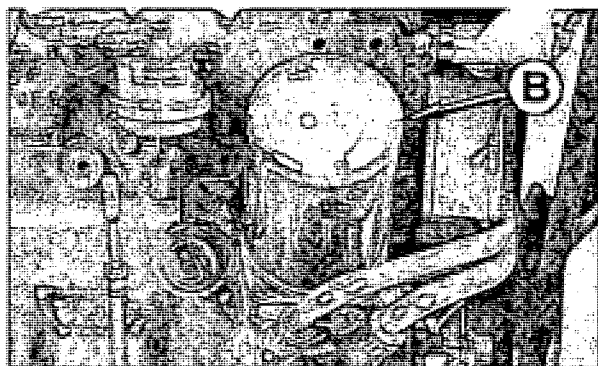
6. Oil the new packing and install a new filter element. Hand tighten element according to values printed on filter element. If values are not provided, tighten element approximately  $\frac{3}{4}$  —  $1\frac{1}{4}$  turn after packing contacts filter housing. DO NOT overtighten filter element.
7. Close oil pan drain valve.



CD30758 -UN-26AUG99



POWERTEch engine



300-Series engine

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DPSG,CD03523,29 -19-12JUL99-1/2

## Maintenance/500 hours

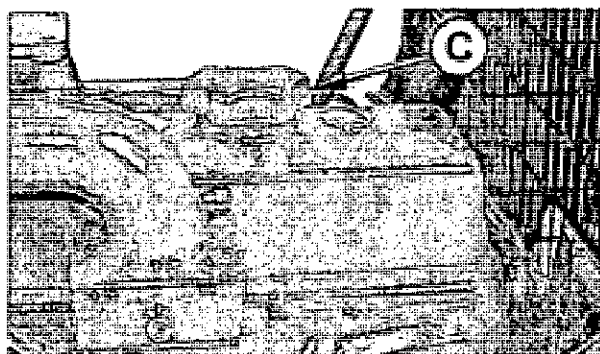
8. Fill engine crankcase with correct John Deere engine oil through rocker arm cover opening (C); see DIESEL ENGINE OIL.

To determine the correct oil fill quantity for your engine, see "Engine Oil Quantities" in Specifications Section.

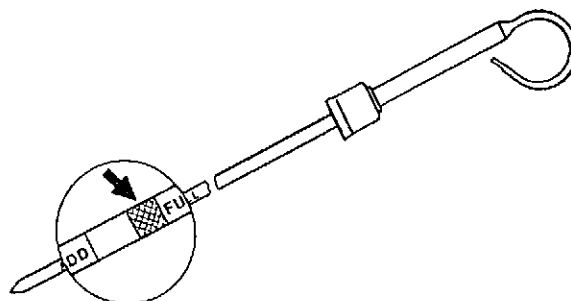
**NOTE:** Crankcase oil capacity may vary slightly. ALWAYS fill crankcase to full mark or within crosshatch on dipstick, whichever is present. DO NOT overfill.

**IMPORTANT:** Immediately after completing any oil change, crank engine for 30 seconds without permitting engine to start. This will help insure adequate lubrication to engine components before engine starts.

9. Start engine and run to check for possible leaks.
10. Stop engine and check oil level after 10 minutes. If necessary, top up.



CD00761 -UN-24SEP93



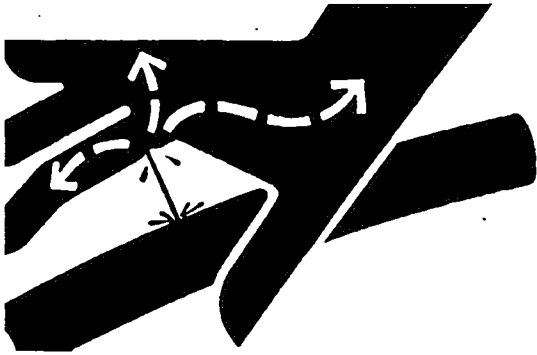
FD000047

FD000047 -UN-13MAR96

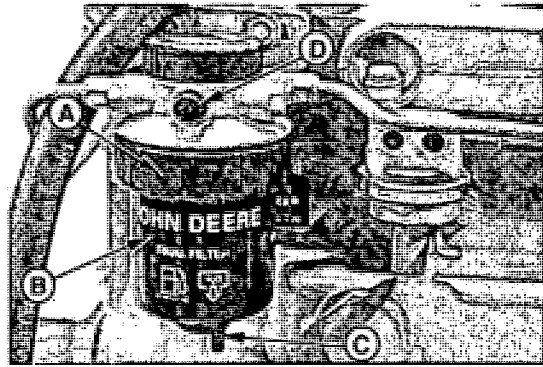
DPSG,CD003523,29 -19-12JUL99-2/2

Maintenance/500 hours

## REPLACING FUEL FILTER ELEMENT



X3811 -UN-23AUG88



FG7721 -UN-15JAN93

A—Retaining ring

B—Filter element

C—Drain plug

D—Bleed plug

**CAUTION: CAUTION:** Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

1. Thoroughly clean fuel filter assembly and surrounding area.
2. Loosen drain plug (C) and drain fuel into a suitable container.

**NOTE:** Lifting up on retaining ring as it is rotated helps to get it past raised locators.

3. Firmly grasp the retaining ring (A) and rotate it clockwise 1/4 turn. Remove ring with filter element (B).

**IMPORTANT:** Do not dump the old fuel into the new filter element. This could cause fuel injection problem.

A plug is provided with the new element for plugging the used element.

4. Inspect filter mounting base for cleanliness. Clean as required.

**NOTE:** Raised locators on fuel filter canister must be indexed properly with slots in mounting base for correct installation.

5. Install new filter element dry onto mounting base. Be sure element is properly indexed and firmly seated on base. It may be necessary to rotate filter for correct alignment.

6. Install retaining ring onto mounting base making certain dust seal is in place on filter base. Hand tighten ring (about 1/3 turn) until it "snaps" into the detent. DO NOT overtighten retaining ring.

**NOTE:** The proper installation is indicated when a "click" is heard and a release of the retaining ring is felt.

7. Bleed the fuel system.

DPSG,CD03523,30 -19-12JUL99-1/1

30-3

112699  
PN=49

## Maintenance/500 hours

**CHECKING BELT (300-SERIES ENGINES)**

1. Inspect belt for cracks, fraying, or stretched out areas. Replace as necessary.
2. Check belt tension using one of following methods:

- a) **Use of JDG529 Tension Gauge (A)**

**Belt tension—Specification**

|                 |                              |
|-----------------|------------------------------|
| New belt.....   | 578—622 N (130—140 lb-force) |
| Used belt ..... | 378—423 N (85—94 lb-force)   |

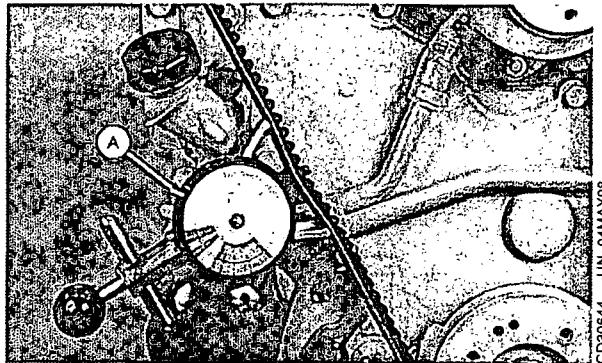
**NOTE:** Belt is considered used after 10 minutes of operation.

- b) **Use of tension tester (B) and straight edge (C)**  
A 89 N (20 lb) force applied halfway between pulleys should deflect belt by 19 mm (0.75 in.).

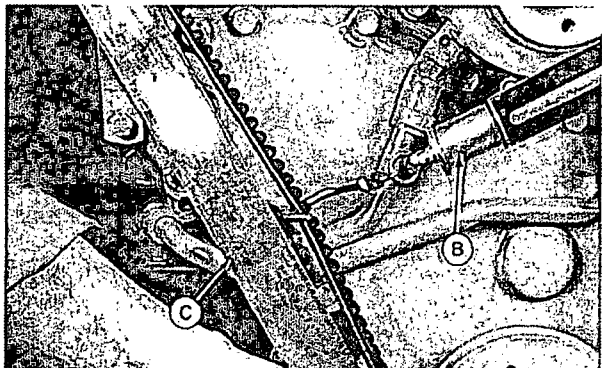
3. If adjustment is necessary, loosen alternator nuts (D) and (E). Pull alternator frame outward until belt is correctly tensioned.

**IMPORTANT:** Do not pry against the alternator rear frame. Do not tighten or loosen belts while they are hot.

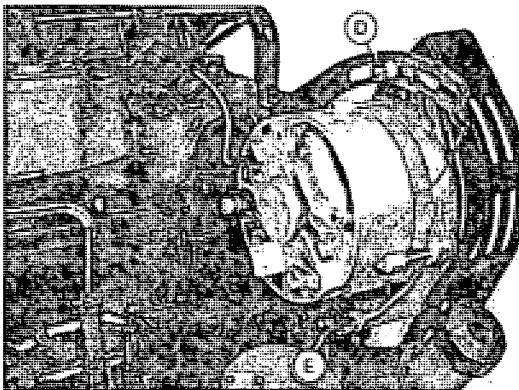
4. Tighten alternator bracket nuts firmly.
5. Run engine for 10 minutes then recheck belt tension.



CD30644 -UN-04MAY98



CD30645 -UN-04MAY98



CD30646 -UN-04MAY98

DPSG.CD03523,31 -19-12JUL99-1/1

## Maintenance/500 hours

**CHECKING BELT (POWERTECH ENGINES WITH MANUAL TENSIONER)**

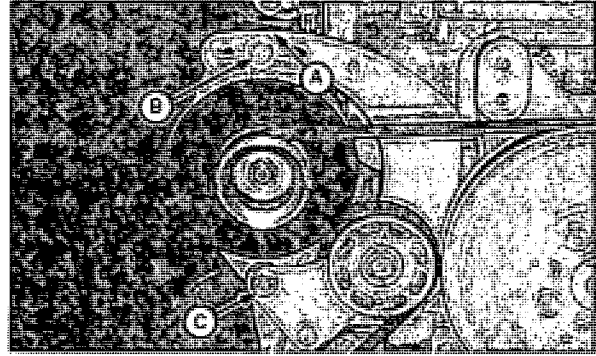
Inspect belt for cracks, fraying, or stretched out areas. Replace if necessary.

**NOTE:** *Belt adjustment is measured using a gauge stamped on the top edge of the alternator bracket.*

1. Loosen cap screws (B) and (C).
2. Slide alternator in slot by hand to remove all excess slack in belt.

**IMPORTANT:** Do not pry against alternator rear frame.

3. Using the gauge (A) on the alternator bracket, stretch belt by prying outward on alternator front frame. Stretch the belt 1 gauge unit for a used belt and 1.5 gauge units for a new belt.
4. Tighten cap screws (B) and (C).



A—Belt gauge  
B—Cap screw  
C—Cap screw

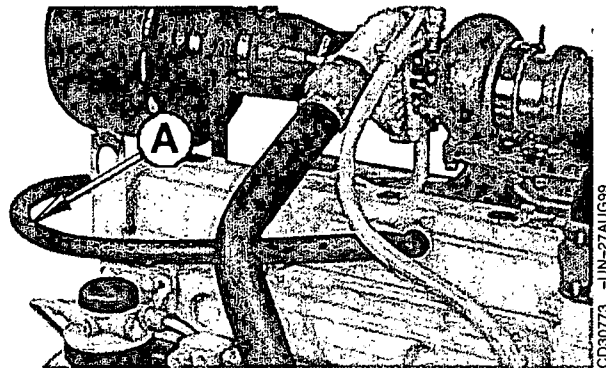
DPSG,CD03523.57 -19-16AUG99-1/1

# Maintenance/1000 hours/1 year

## CLEANING CRANKCASE VENT TUBE

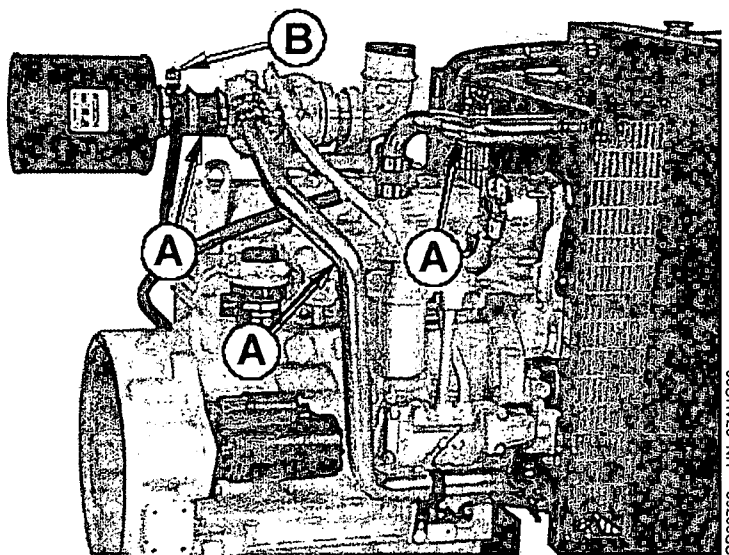
If you operate the engine in dusty conditions, clean the tube at shorter intervals.

1. Remove and clean crankcase vent tube (A).
2. Install the vent tube. Be sure the O-ring fits correctly in the rocker arm cover bore for elbow adapter. Tighten hose clamp securely.



DPSG,CD03523,32 -19-12JUL99-1/1

## CHECKING AIR INTAKE SYSTEM



**IMPORTANT:** The air intake system must not leak. Any leak, no matter how small, may result in engine failure due to abrasive dirt and dust entering the intake system.

1. Inspect all intake hoses (piping) for cracks. Replace as necessary.

2. Check clamps on piping (A) which connect the air filter, engine and, if present, turbocharger and air-to-air radiator. Tighten clamps as necessary.
3. Test air restriction indicator (B) for proper operation. Replace indicator as necessary.

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DPSG,CD03523,33 -19-12JUL99-1/2

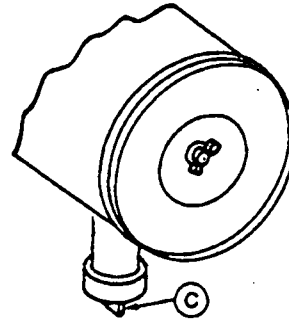
35-1

112699  
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## Maintenance/1000 hours/1 year

4. If engine has a rubber dust unloading valve (C), inspect the valve on bottom of air filter for cracks or plugging. Replace as necessary.
5. Service air filter as necessary.



RG4687 -UN-20DEC88

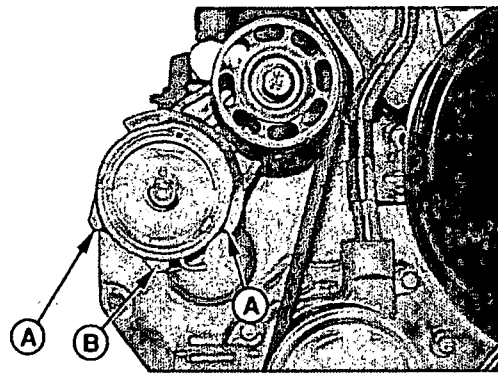
DPSG.CD03523.33 -19-12JUL99-2/2

### CHECKING AUTOMATIC BELT TENSIONER (POWERTECH ENGINES)

It drive systems equipped with automatic (spring) belt tensioners cannot be adjusted or repaired. The automatic belt tensioner is designed to maintain proper belt tension over the life of the belt. If tensioner spring tension is not within specification, replace tensioner assembly.

- **Checking belt wear**

The belt tensioner is designed to operate within the limit of arm movement provided by the cast stops (A) and (B) when correct belt length and geometry is used. If the tensioner stop on swing arm (A) is hitting the fixed stop (B), check mounting brackets (alternator, belt tensioner, idler pulley, etc.) and the belt length. Replace belt as needed (see REPLACING FAN AND ALTERNATOR BELTS).



RG8098 -UN-18NOV97

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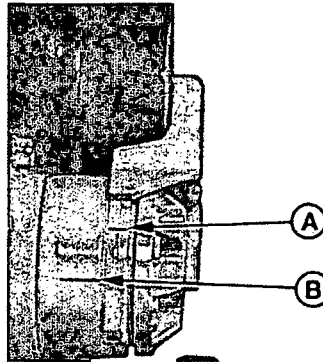
DPSG.CD03523.34 -19-13JUL99-1/2

## Maintenance/1000 hours/1 year

### • Checking tensioner spring tension

A belt tension gauge will not give an accurate measure of the belt tension when automatic spring tensioner is used. Measure tensioner spring tension using a torque wrench and procedure outlined below:

- Release tension on belt using a breaker bar and socket on tension arm. Remove belt from pulleys.
- Release tension on tension arm and remove breaker bar.
- Put a mark (A) on swing arm of tensioner as shown.
- Measure 21 mm (0.83 in.) from (A) and put a mark (B) on tensioner mounting base.
- Rotate the swing arm using a torque wrench until marks (A) and (B) are aligned.
- Record torque wrench measurement and compare with specification below. Replace tensioner assembly as required.



RG7977 -UN-14NOV97

#### Spring—Specification

Force..... 18—22 N•m (13—16 lb-ft)

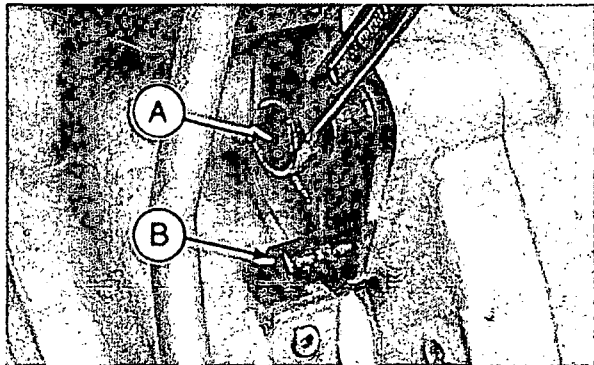
DPSG.CD03523.34 -19-13JUL99-2/2

## CHECK AND ADJUST ENGINE VALVE CLEARANCE (300-SERIES ENGINES)

**NOTE:** Valve clearance must be adjusted after the first 500 hours of operation, then every 1000 hours thereafter.

Adjust engine valve clearance as follows or have your authorized servicing dealer or engine distributor adjust the engine valve clearance.

- Remove rocker arm cover and crankcase vent tube.
- Using JDE83 or JDG820 Flywheel Turning Tool (A), rotate engine flywheel in running direction (clockwise viewed from water pump) until No.1 piston (front) has reached top dead center (TDC) on compression stroke. Insert timing pin JDE81-4 (B) into flywheel bore.



CD30544 -UN-19MAY98

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DPSG.CD03523.35 -19-13JUL99-1/4

## Maintenance/1000 hours/1 year

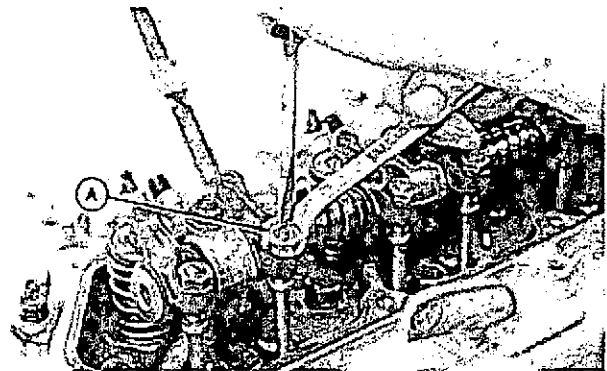
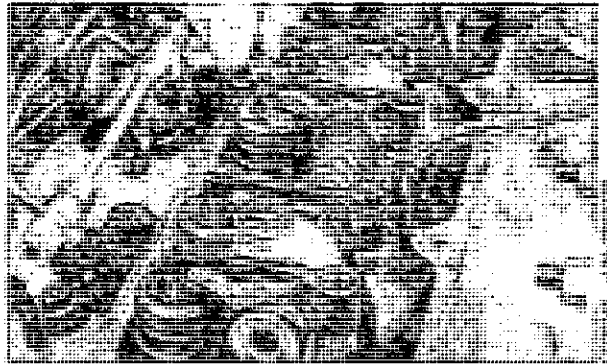
3. Check and adjust valve clearance to specifications according to following procedures.

## Valve clearance (engine cold)—Specification

|              |                     |
|--------------|---------------------|
| Intake.....  | 0.35 mm (0.014 in.) |
| Exhaust..... | 0.45 mm (0.018 in.) |

**NOTE:** If rocker arm is equipped with adjusting screw and lock nut (A), tighten lock nut to 27 N·m (20 lb-ft) after adjusting valve clearance.

4. Reinstall rocker arm cover and crankcase vent tube.

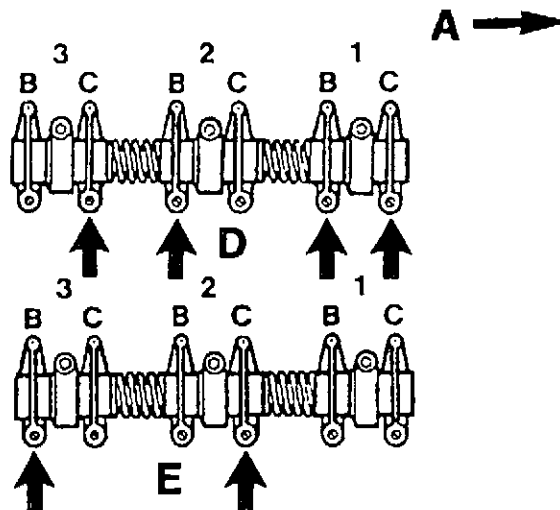


DPSG.CO03523.35 -19-13JUL99-2/4

• **3-Cylinder Engine:**

**NOTE:** Firing order is 1-2-3.

- Lock No. 1 piston at TDC compression stroke (D).
- Adjust valve clearance on No. 1 and 2 exhaust valves and No. 1 and 3 intake valves.
- Rotate flywheel 360°. Lock No. 1 piston at TDC exhaust stroke (E).
- Adjust valve clearance on No. 3 exhaust valve and No. 2 intake valve.



A—Front of engine  
 B—Exhaust valve  
 C—Intake valve  
 D—No.1 Piston at TDC compression stroke  
 E—No.1 Piston at TDC exhaust stroke

CD30549 -UN-16JUN98

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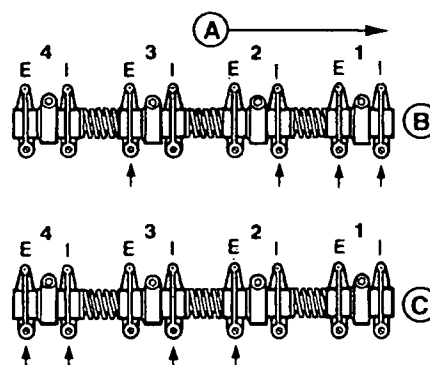
DPSG.CO03523.35 -19-13JUL99-3/4

## Maintenance/1000 hours/1 year

## • 4-Cylinder Engine:

NOTE: Firing order is 1-3-4-2.

- Lock No. 1 piston at TDC compression stroke (B).
- Adjust valve clearance on No. 1 and 3 exhaust valves and No.1 and 2 intake valves.
- Rotate flywheel 360°. Lock No. 4 piston at TDC compression stroke (C).
- Adjust valve clearance on No. 2 and 4 exhaust valves and No. 3 and 4 intake valves.



A—Front of engine  
 B—No.1 Piston at TDC compression stroke  
 C—No.4 Piston at TDC compression stroke  
 E—Exhaust valve  
 I—Intake valve

RG4776 -UN-31OCT97

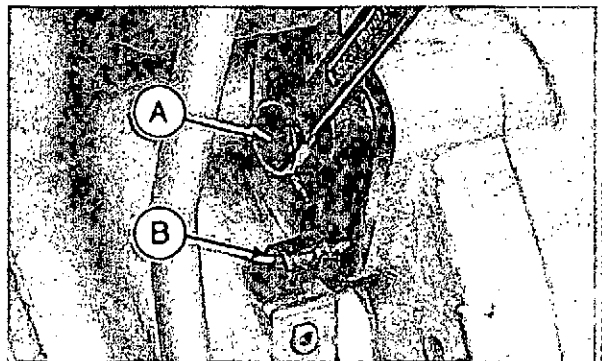
DPSG.CD03523.35 -19-13JUL99-4/4

# Maintenance/2000 hours/2 years

## CHECK AND ADJUST ENGINE VALVE CLEARANCE (POWERTECH ENGINE)

Adjust engine valve clearance as follows or have your authorized servicing dealer or engine distributor adjust the engine valve clearance.

1. Remove rocker arm cover and crankcase vent tube.
2. Using JDE83 or JDG820 Flywheel Turning Tool (A), rotate engine flywheel in running direction (clockwise viewed from water pump) until No.1 piston (front) has reached top dead center (TDC) on compression stroke. Insert timing pin JDE81-4 (B) into flywheel bore.



CD30544 -UN-19MAY98

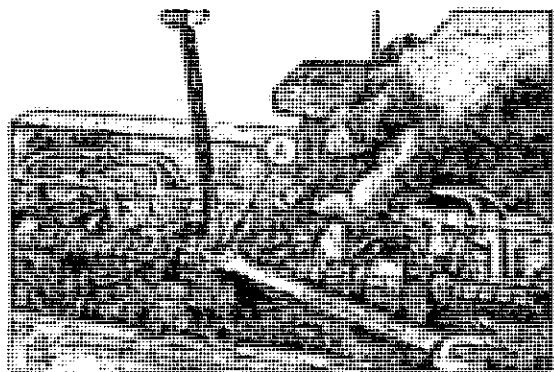
DPSG.CO03523,36 -19-13JUL99-1/4

3. Check and adjust valve clearance to specifications according to following procedures.

### Valve clearance (engine cold)—Specification

|               |                     |
|---------------|---------------------|
| Intake .....  | 0.35 mm (0.014 in.) |
| Exhaust ..... | 0.45 mm (0.018 in.) |

4. If valves need adjusting, loosen the lock nut on rocker arm adjusting screw. Turn adjusting screw until feeler gauge slips with a slight drag. Hold the adjusting screw from turning with screwdriver and tighten lock nut to 27 N•m (20 lb-ft). Recheck clearance again after tightening lock nut. Readjust clearance as necessary.
5. Reinstall rocker arm cover and crankcase vent tube.



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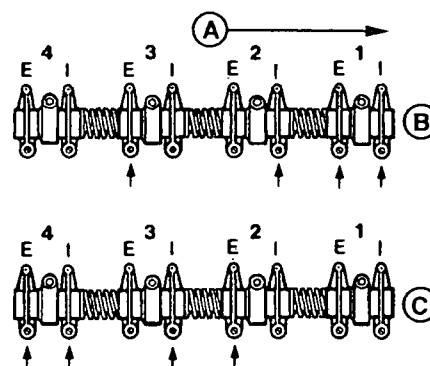
DPSG.CO03523,36 -19-13JUL99-2/4

## Maintenance/2000 hours/2 years

## • 4-Cylinder Engine:

NOTE: Firing order is 1-3-4-2.

- Lock No. 1 piston at TDC compression stroke (B).
- Adjust valve clearance on No. 1 and 3 exhaust valves and No.1 and 2 intake valves.
- Rotate flywheel 360°. Lock No. 4 piston at TDC compression stroke (C).
- Adjust valve clearance on No. 2 and 4 exhaust valves and No. 3 and 4 intake valves.



A—Front of engine  
 B—No.1 Piston at TDC compression stroke  
 C—No.4 Piston at TDC compression stroke  
 E—Exhaust valve  
 I—Intake valve

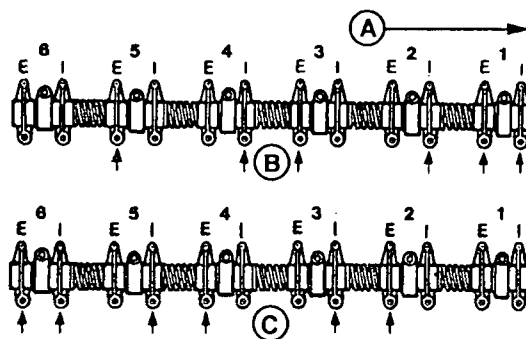
RG4776 -UN-31OCT97

DPSG,CD03523,36 -19-13JUL99-3/4

## • 6-Cylinder Engine:

NOTE: Firing order is 1-5-3-6-2-4.

- Lock No. 1 piston at TDC compression stroke (B).
- Adjust valve clearance on No. 1, 3, and 5 exhaust valves and No. 1, 2, and 4 intake valves.
- Rotate flywheel 360°. Lock No. 6 piston at TDC compression stroke (C).
- Adjust valve clearance on No. 2, 4, and 6 exhaust valves and No. 3, 5, and 6 intake valves.



A—Front of engine  
 B—No.1 Piston at TDC compression stroke  
 C—No.6 Piston at TDC compression stroke  
 E—Exhaust valve  
 I—Intake valve

RG4777 -UN-31OCT97

DPSG,CD03523,36 -19-13JUL99-4/4

## Maintenance/2000 hours/2 years

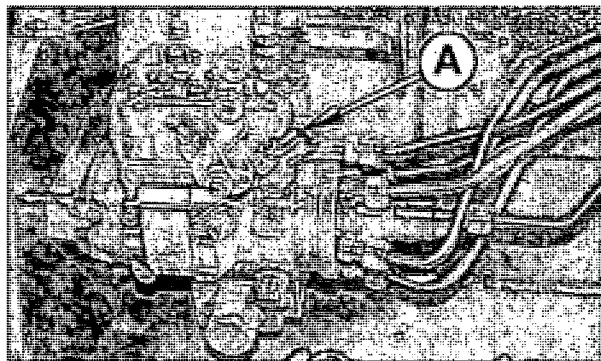
**CHECKING ENGINE SPEED**

**NOTE:** Most engines for generator set application (1500 rpm for 50 Hz or 1800 rpm for 60 Hz) run only at fast idle and therefore they do not have slow idle.

**Fast idle—Specification**

|                          |               |
|--------------------------|---------------|
| 50 Hz Generator set..... | 1550—1580 rpm |
| 60 Hz Generator set..... | 1865—1890 rpm |

**NOTE:** Fast idle is settled by the factory then the idle adjusting screw (A) is sealed to prevent from tampering. Fast idle adjustment can only be done by an authorized fuel system agent.

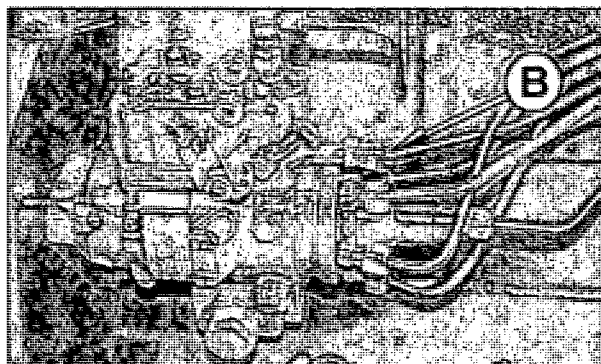


DPSG,CD03523,38 -19-13JUL99-1/1

**ADJUST SPEED DROOP GOVERNOR**

1. Warm engine to normal operating temperature.
2. Run engine at fast idle.
3. Apply full load.
4. If specified power cannot be obtained, turn screw (B) to adjust droop until the requested power is reached.

**NOTE:** If surging exists upon removing the load, turn screw (B) clockwise to eliminate.



DPSG,CD03523,39 -19-13JUL99-1/1

Maintenance/2000 hours/2 years

## CHECKING CRANKSHAFT VIBRATION DAMPER (6-CYLINDER ENGINE ONLY)

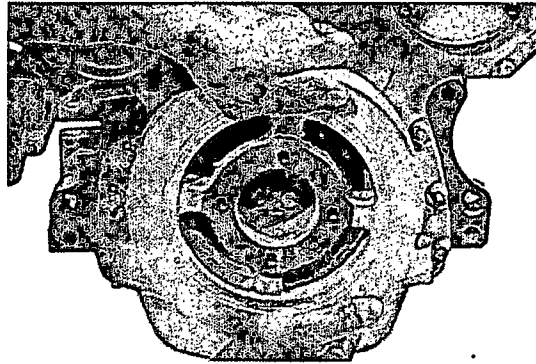
1. Remove belts (shown removed).
2. Grasp vibration damper with both hands and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced.

**IMPORTANT:** The vibration damper assembly is not repairable and should be replaced every 4500 hours or 5 years, whichever occurs first.

3. Check vibration damper radial runout by positioning a dial indicator so probe contacts damper outer circumference.
4. With engine at operating temperature, rotate crankshaft using JDG820 or JDE83 Flywheel Turning Tool.
5. Note dial indicator reading. If runout exceeds specifications given below, replace vibration damper.

### Damper—Specification

Maximum radial runout..... 1.50 mm (0.060 in.)



RG8018 -UN-15JAN99



RG7508 -UN-23NOV97

DPSG,CD03523,40 -19-13JUL99-1/1



# Maintenance/2500 hours/3 years

## DRAIN AND FLUSH COOLING SYSTEM

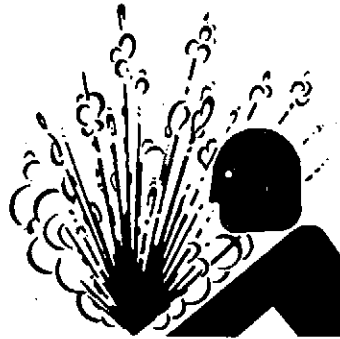
**NOTE:** Drain and flush cooling system every 2500 hours/3 years when John Deere COOL-GARD coolant is used. Otherwise every 2000 hours/2 years.

**CAUTION:** Explosive release of fluids from pressurized cooling system can cause serious burns.

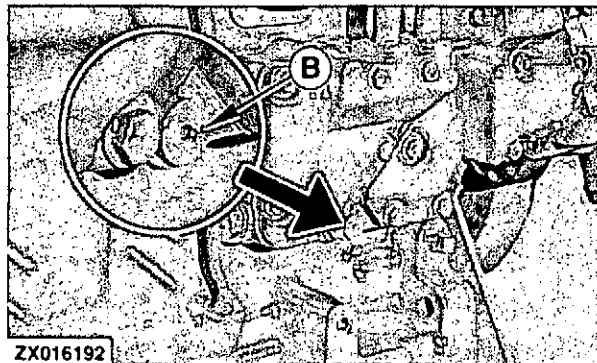
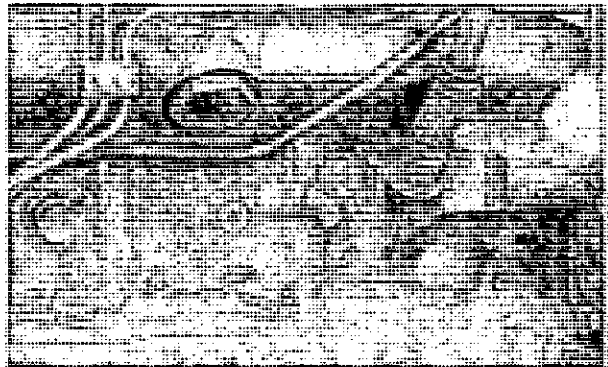
Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

Slowly open the radiator cap.

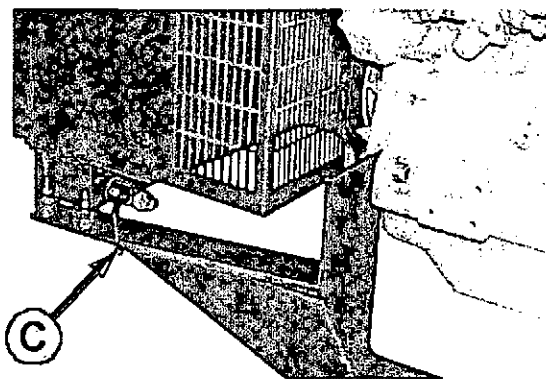
2. Remove engine block drain plug (A).
3. On POWERTech engines, remove oil cooler housing drain plug (B).
4. Open radiator drain valve (C). Drain all coolant from radiator.
5. Close all drain orifices after coolant has drained.
6. Fill the cooling system with clean water. Run engine until water passes through the thermostat to stir up possible rust or sediment.
7. Stop engine and immediately drain the water from system before rust and sediment settle.
8. After draining water, close all drain orifices and fill the cooling system with clean water and TY15979 John Deere Heavy Duty Cooling System Cleaner or equivalent cleaner. Follow manufacturer's directions on label.
9. After cleaning the cooling system, drain cleaner and fill with water to flush the system. Run engine until water passes through the thermostat, then drain out flushing water.



TS281 -UN-23AUG88



ZX016192 -UN-11JAN99



CD30765 -UN-27AUG99

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DPSG,CD03523,41 -19-13JUL99-1/3

*Maintenance/2500 hours/3 years*

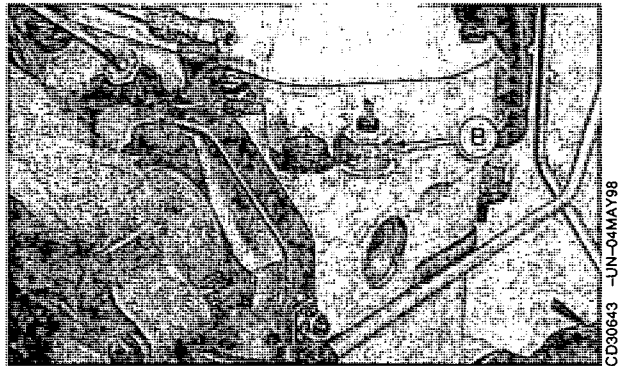
10. Check cooling system hoses for proper condition.  
Replace as necessary.
11. Close all drain orifices and fill the cooling system with  
specified coolant (see DIESEL ENGINE COOLANT).

**Cooling system capacity—Specification**

|                  |                  |
|------------------|------------------|
| CD3029DF128..... | 14.5 L (15.5 qt) |
| CD4039DF008..... | 16.5 L (17.5 qt) |
| CD4039TF008..... | 16.5 L (17.5 qt) |
| CD4045DF158..... | 20 L (21 qt)     |
| CD4045HF158..... | 25 L (26.5 qt)   |
| CD4045TF158..... | 25 L (26.5 qt)   |
| CD4045TF258..... | 25 L (26.5 qt)   |
| CD6068HF158..... | 29 L (30.5 qt)   |
| CD6068TF158..... | 26 L (27.5 qt)   |
| CD6068TF258..... | 26 L (27.5 qt)   |

DPSG,CD03523,41 -19-13JUL99-2/3

12. When refilling cooling system, loosen temperature  
sensor (B) or plug at the rear of cylinder head to  
allow air to escape.
13. Run engine until it reaches operating temperature  
then check coolant level and entire cooling system for  
leaks.



CD30643 -UN-04MAY98

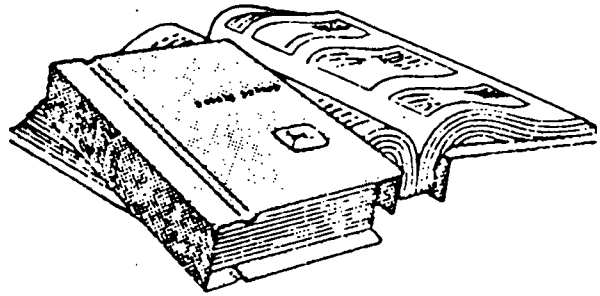
DPSG,CD03523,41 -19-13JUL99-3/3

# Maintenance/As required

## ADDITIONAL SERVICE INFORMATION

This manual does not allow a complete repair of your engine. If you want more detailed service information the following publications are available from your regular parts channel.

- PC2451 — Parts Catalog
- CTM3274 — Component Technical Manual for 300-Series engines (English)
- CTM104 — Component Technical Manual for POWERTech engines (English)
- CTM67 — Component Technical Manual for OEM Engine accessories (English only)
- CTM77 — Component Technical Manual for Alternators and Starter Motors (English only)



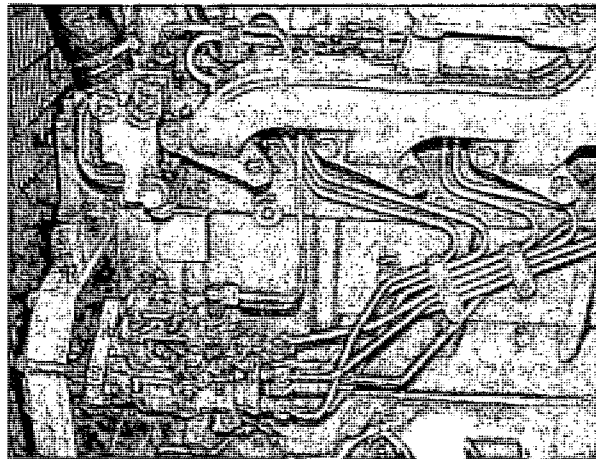
RG4624 -UN-15DEC88

DPSG.CD03523.42 -19-15JUL99-1/1

## DO NOT MODIFY FUEL SYSTEM

**IMPORTANT:** Modification or alteration of the injection pump, the injection pump timing, or the fuel injectors in ways not recommended by the manufacturer will terminate the warranty obligation to the purchaser.

Do not attempt to service injection pump or fuel injectors yourself. Special training and special tools are required (see your authorized servicing dealer or engine distributor).



112699 -UN-15JUL99-1/1

DPSG.CD03523.43 -19-15JUL99-1/1

Maintenance/As required

**CLEAN OR REPLACE AIR FILTER  
(ONE-PIECE)**

Clean air filter when restriction indicator (A) is red. Air filter can be cleaned up to six times. Thereafter, or at least once a year, it must be replaced.

Proceed as follows:

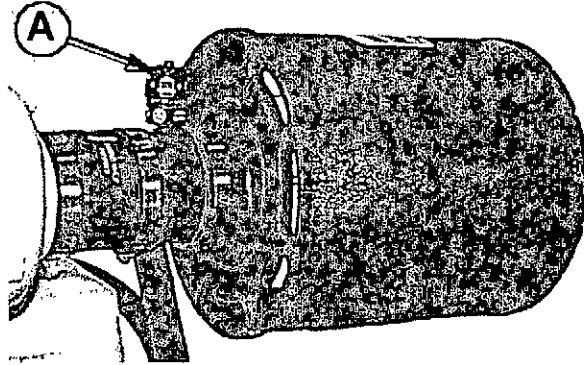
1. Thoroughly clean all dirt around air filter area.
2. Loosen clamp (B) then remove air filter.

**IMPORTANT:** Never reinstall an air filter which shows evidence of bad condition (punched, dented...) allowing no filtered air to enter the engine.

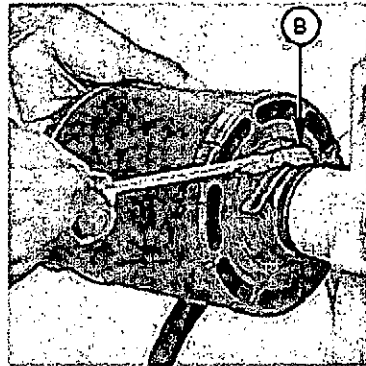
3. Clean air filter with compressed air working from "clean" to "dirty" side.

**NOTE:** Compressed air must not exceed 600 kPa (6 bar; 88 psi).

4. Mark air filter to keep track of each cleaning operation.
5. Fully depress air restriction indicator reset button and release to reset indicator.
6. Check air system entirely for proper condition (see CHECKING AIR INTAKE SYSTEM).



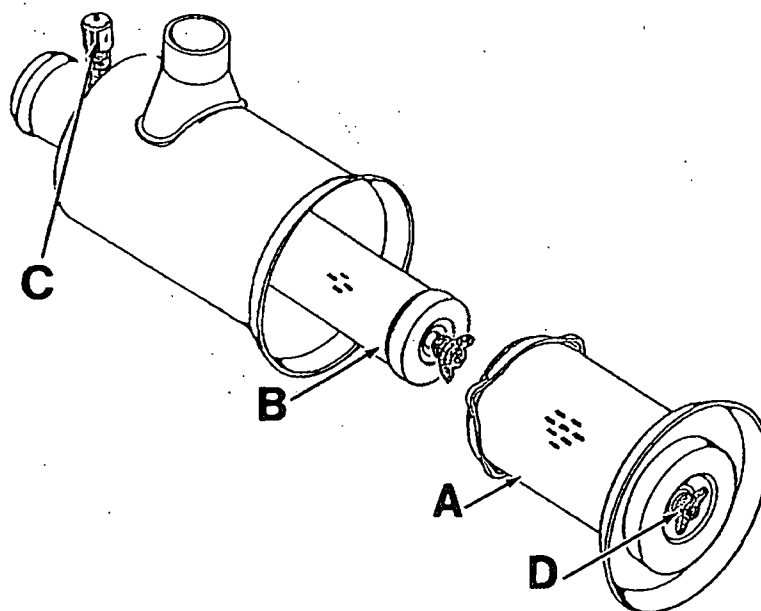
CD30766 -UN-Q5SEP89



RG9912 -UN-23FEB89

DP5G,CD03523,44 -19-15JUL99-1/1

Maintenance/As required

**CLEAN OR REPLACE AIR FILTER ELEMENT**

CD30772 -UN-27AUG99

- A—Primary element  
 B—Secondary (safety) element  
 C—Air restriction indicator  
 D—Wing nut

Clean air filter when restriction indicator (C) is red. Replace both primary (A) and secondary (B) filter elements every 6 primary element cleaning or at least once a year.

Proceed as follows:

1. Thoroughly clean all dirt around air filter area.
2. Remove wing nut (D) and remove primary element (A) from canister.

**IMPORTANT:** Do not attempt to clean the secondary (safety) element (B). It must be only replaced as recommended.

3. Thoroughly clean all dirt from inside canister.

**IMPORTANT:** If primary element shows evidence of bad condition (punched,

dented...), replace both the primary and the secondary elements.

4. Clean primary element with compressed air working from "clean" to "dirty" side.

**NOTE:** Compressed air must not exceed 600 kPa (6 bar; 88 psi).

5. Mark air filter to keep track of each cleaning operation.
6. Fully depress air restriction indicator reset button and release to reset indicator.
7. Check air system entirely for proper condition (see CHECKING AIR INTAKE SYSTEM).

DPSG,CD03523,58 -19-16AUG99-1/1

Maintenance/As required

## REPLACING FAN AND ALTERNATOR BELT (POWERTECH ENGINES)

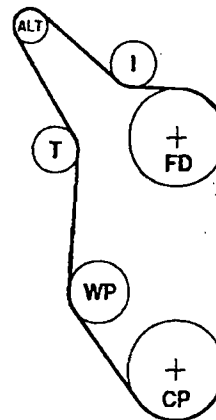
**NOTE:** Refer to *CHECKING BELT TENSIONER SPRING TENSION AND BELT WEAR* for additional information on the belt tensioner.

1. Inspect belts for cracks, fraying, or stretched out areas. Replace if necessary.

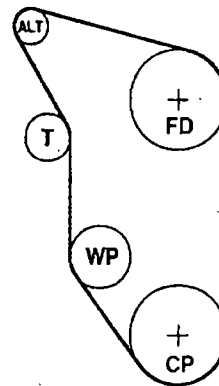
2. On engines with automatic belt tensioner, release tension on belt using a breaker bar and socket on tension arm.

On engines with manual tensioner, loosen cap screws holding the alternator.

3. Remove poly-vee belt from pulleys and discard belt.
4. Install new belt, making sure belt is correctly seated in all pulley grooves. Refer to belt routing at right for your application.
5. Apply tension to belt (see *CHECKING BELT*).
6. Start engine and check belt alignment.



Installation on 4 cyl. engines



Installation on 6 cyl. engines

ALT—Alternator  
CP—Crankshaft Pulley  
FD—Fan Drive  
I—Idler Pulley  
T—Tensioner  
WP—Water Pump

CD30769 -UN-01SEP99

CD30770 -UN-01SEP99

DPSG,CD03523,45 -19-15JUL99-1/1

## Maintenance/As required

**CHECKING FUEL FILTER**

Periodically the fuel filter should be checked for water or debris.

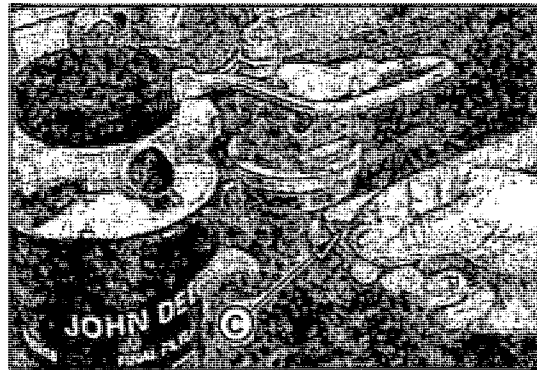
**IMPORTANT:** Drain water into a suitable container and dispose of properly.

1. Loosen drain plug (B) at bottom of fuel filter two or three turns.
2. Loosen air bleed plug two full turns (A) on fuel filter base and drain water from bottom until fuel starts to drain out.
3. When fuel starts to drain out, tighten drain plug securely.
4. After draining water from the fuel filter, the filter must be primed by bleeding all air from the fuel system. Operate primer lever of the fuel supply pump (C) until fuel flow is free from air bubbles.
5. Tighten bleed plug securely, continue operating hand primer until pumping action is not felt. Push hand primer inward (toward engine) as far as it will go.

If the fuel system needs further bleeding of air, see **BLEEDING THE FUEL SYSTEM**.



RG9888 -UN-15JAN99



RG8013B -UN-15JAN99

DPSG.CD03523.28 -19-12JUL99-1/1

Maintenance/As required

**BLEEDING THE FUEL SYSTEM**

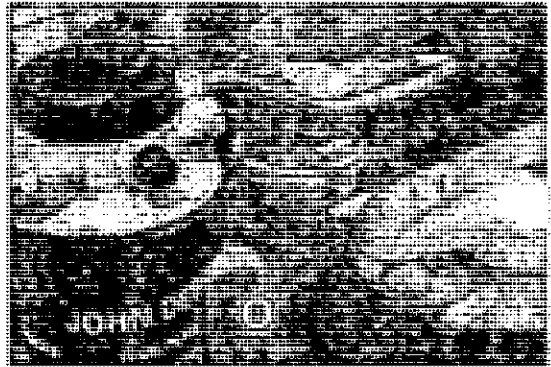
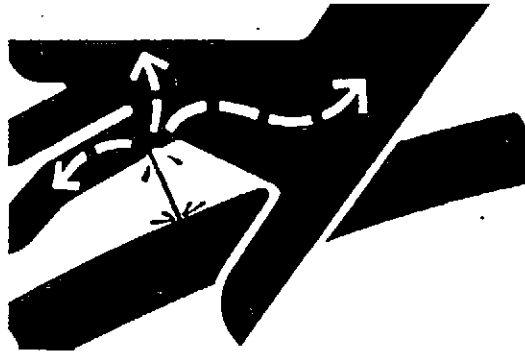
**CAUTION:** Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Whenever the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system.

1. Loosen the air bleed screw (A) two full turns by hand on fuel filter base.
2. Operate supply pump primer lever (B) until fuel flow is free from air bubbles.
3. Tighten bleed plug securely, continue operating hand primer until pumping action is not felt. Push hand primer inward (toward engine) as far as it will go.
4. Start engine and check for leaks.

If engine will not start, it may be necessary to bleed air from fuel system at fuel injection pump or injection nozzles as explained next.



X9811 -UN-23AUG88

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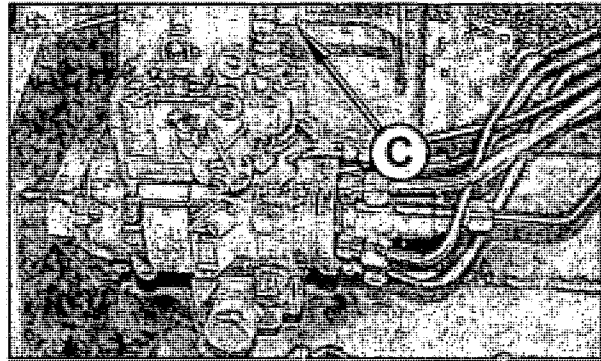
DPSG.CD03523.46 -19-10AUG99-1/2



*Maintenance/As required*

- **At Fuel Injection Pump:**

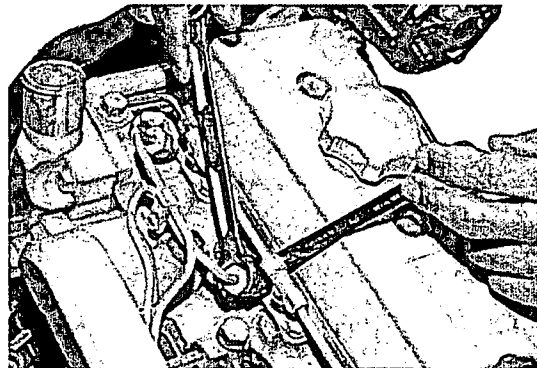
- Slightly loosen fuel return line connector (C) at fuel injection pump.
- Operate fuel supply pump primer lever until fuel, without air bubbles, flows from fuel return line connection.
- Tighten return line connector to 16 N•m (12 lb-ft).
- Leave hand primer in the inward position toward cylinder block.



CD30771 -UN-24SEP98

- **At Fuel Injection Nozzles:**

- Using two open-end wrenches, loosen fuel line connection at injection nozzle.
- Crank engine over with starting motor (but do not start engine), until fuel free from bubbles flows out of loosened connection. Retighten connection to 27 N•m (20 lb-ft).
- Repeat procedure for remaining injection nozzles (if necessary) until all air has been removed from fuel system.



RG7725 -UN-08JAN97

If engine still will not start, see your authorized servicing dealer or engine distributor.

DPSG,CD03523,46 -19-10AUG99-2/2

# Troubleshooting

## ENGINE TROUBLESHOOTING

| Symptom                                       | Problem  | Solution  |
|---|--|---|
| <b>Engine cranks but will not start</b>       | Incorrect starting procedure.                          | Verify correct starting procedure.                                      |
|   | No fuel.   | Check fuel in tank and manual shut-off valve.                           |
|   | Exhaust restricted.                                    | Check and correct exhaust restriction.                                  |
|   | Fuel filter plugged or full of water.                  | Replace fuel filter or drain water from filter.                         |
|   | Injection pump not getting fuel or air in fuel system. | Check fuel flow at supply pump or bleed fuel system.                    |
|   | Faulty injection pump or nozzles.                      | Consult authorized diesel repair station for repair or replacement.     |
| <b>Engine hard to start or will not start</b> | Engine starting under load.                            | Remove load.  |
|   | Improper starting procedure.                           | Review starting procedure.  |
|   | No fuel.   | Check fuel tank.  |
|   | Air in fuel line.                                      | Bleed fuel line.  |
|   | Cold weather.  | Use cold weather starting aids.   |
|   | Slow starter speed.                                    | See "Starter Cranks Slowly".  |
|   | Crankcase oil too heavy.                               | Use oil of correct viscosity.   |
|   | Improper type of fuel.                                 | Consult fuel supplier; use proper type fuel for operating conditions.   |
|   | Water, dirt or air in fuel system.                     | Drain, flush, fill and bleed system.                                    |
|   | Clogged fuel filter.                                   | Replace filter element.   |
|   | Dirty or faulty injection nozzles.                     | Have authorized servicing dealer or engine distributor check injectors. |

Continued on next page

DPSG,CD03523.49 -19-10AUG99-1/5

55-1

112699  
PN=70

### Troubleshooting

| Symptom   | Problem                                | Solution  |
|---|--|---|
| <b>Engine knocks</b>                                | Injection pump shut-off not reset.     | Turn key switch to "OFF" then to "ON".                                  |
|   | Low engine oil level.                  | Add oil to engine crankcase.  |
|   | Injection pump out of time.            | See your authorized servicing dealer or engine distributor.             |
|   | Low coolant temperature.               | Remove and check thermostat.  |
| <b>Engine runs irregularly or stalls frequently</b> | Engine overheating.                    | See "Engine Overheats".   |
|   | Low coolant temperature.               | Remove and check thermostat.  |
|   | Clogged fuel filter.                   | Replace fuel filter element.  |
|   | Water, dirt or air in fuel system.     | Drain, flush, fill and bleed system.                                    |
| <b>Below normal engine temperature</b>              | Dirty or faulty injection nozzles.     | Have authorized servicing dealer or engine distributor check injectors. |
|   | Defective thermostat.                  | Remove and check thermostat.  |
|   | Defective temperature gauge or sender. | Check gauge, sender and connections.                                    |
| <b>Lack of power</b>                                | Engine overloaded.                     | Reduce load.  |
|   | Intake air restriction.                | Service air cleaner.  |
|   | Clogged fuel filter.                   | Replace filter element.   |
|   | Improper type of fuel.                 | Use proper fuel.  |
|   | Overheated engine.                     | See "Engine Overheats".   |
|   | Below normal engine temperature.       | Remove and check thermostat.  |
|   | Improper valve clearance.              | See your authorized servicing dealer or engine distributor.             |
|   | Dirty or faulty injection nozzles.     | Have authorized servicing dealer or engine distributor check injectors. |
|   |  |   |

Continued on next page

DPSG,CD03523,49 -19-10AUG99-2/5

### Troubleshooting

| Symptom                         | Problem                          | Solution   |
|---------------------------------|----------------------------------|--|
|                                 | Injection pump out of time.      | See your authorized servicing dealer or engine distributor.        |
|                                 | Turbocharger not functioning.    | See your authorized servicing dealer or engine distributor.        |
|                                 | Leaking exhaust manifold gasket. | See your authorized servicing dealer or engine distributor.        |
|                                 | Defective aneroid control line.  | See your authorized servicing dealer or engine distributor.        |
|                                 | Restricted fuel hose.            | Clean or replace fuel hose.  |
|                                 | Low fast idle speed.             | See your authorized servicing dealer or engine distributor.        |
| <b>Low oil pressure</b>         | Low oil level.                   | Add oil.   |
|                                 | Improper type of oil.            | Drain and fill crankcase with oil of proper viscosity and quality. |
| <b>High oil consumption</b>     | Crankcase oil too light.         | Use oil of correct viscosity.                                      |
|                                 | Oil leaks.                       | Check for leaks in lines, gaskets, and drain plug.                 |
|                                 | Restricted crankcase vent tube.  | Clean vent tube.   |
|                                 | Defective turbocharger.          | See your authorized servicing dealer or engine distributor.        |
| <b>Engine emits white smoke</b> | Improper type of fuel.           | Use proper fuel.   |
|                                 | Low engine temperature.          | Warm up engine to normal operating temperature.                    |
|                                 | Defective thermostat.            | Remove and check thermostat.                                       |
|                                 | Defective injection nozzles.     | See your authorized servicing dealer or engine distributor.        |
|                                 | Engine out of time.              | See your authorized servicing dealer or engine distributor.        |

Continued on next page

DPSG.CD03523.49 -19-10AUG99-3/5

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### Troubleshooting

| Symptom   | Problem  | Solution  |
|---|--|---|
| <b>Engine emits black or grey exhaust smoke</b> | Improper type of fuel.                               | Use proper fuel.  |
|   | Clogged or dirty air cleaner.                        | Service air cleaner.  |
|   | Engine overloaded.                                   | Reduce load.  |
|   | Injection nozzles dirty.                             | See your authorized servicing dealer or engine distributor.                             |
|   | Engine out of time.                                  | See your authorized servicing dealer or engine distributor.                             |
|   | Turbocharger not functioning.                        | See your authorized servicing dealer or engine distributor.                             |
| <b>Engine overheats</b>                         | Engine overloaded.                                   | Reduce load.  |
|   | Low coolant level.                                   | Fill radiator to proper level, check radiator and hoses for loose connections or leaks. |
|   | Faulty radiator cap.                                 | Have serviceman check.  |
|   | Stretched poly-vee belt or defective belt tensioner. | Check automatic belt tensioner and check belts for stretching. Replace as required.     |
|   | Low engine oil level.                                | Check oil level. Add oil as required.   |
|   | Cooling system needs flushing.                       | Flush cooling system.   |
|   | Defective thermostat.                                | Remove and check thermostat.  |
|   | Defective temperature gauge or sender.               | Check coolant temperature with thermometer and replace, if necessary.                   |
| <b>High fuel consumption</b>                    | Incorrect grade of fuel.                             | Use correct grade of fuel.  |
|   | Improper type of fuel.                               | Use proper type of fuel.  |
|   | Clogged or dirty air cleaner.                        | Service air cleaner.  |

Continued on next page

DPSG,CD03523,49 -19-10AUG99-4/5

*Troubleshooting*

| Symptom | Problem                   | Solution  |
|---------|---------------------------|---|
|         | Engine overloaded.        | Reduce load.  |
|         | Improper valve clearance. | See your authorized servicing dealer or engine distributor. |
|         | Injection nozzles dirty.  | See your authorized servicing dealer or engine distributor. |
|         | Engine out of time.       | See your authorized servicing dealer or engine distributor. |
|         | Defective turbocharger.   | See your authorized servicing dealer or engine distributor. |
|         | Low engine temperature.   | Check thermostat.   |

DPSG,CD03523,49 -19-10AUG99-5/5

## Troubleshooting

### ELECTRICAL TROUBLESHOOTING

| Symptom                            | Problem  | Solution  |
|------------------------------------|--|---|
| <b>Undercharged system</b>         | Excessive electrical load from added accessories.                            | Remove accessories or install higher output alternator.     |
|                                    | Excessive engine idling.   | Increase engine rpm when heavy electrical load is used.     |
|                                    | Poor electrical connections on battery, ground strap, starter or alternator. | Inspect and clean as necessary.                             |
|                                    | Defective battery.   | Test battery.   |
|                                    | Defective alternator.  | Test charging system.                                       |
| <b>Battery uses too much water</b> | Cracked battery case.  | Check for moisture and replace as necessary.                |
|                                    | Defective battery.   | Test battery.   |
|                                    | Battery charging rate too high.  | Test charging system.                                       |
| <b>Battery will not charge</b>     | Loose or corroded connections.   | Clean and tighten connections.                              |
|                                    | Sulfated or worn-out battery.  | See your authorized servicing dealer or engine distributor. |
|                                    | Stretched poly-vee belt or defective belt tensioner.                         | Adjust belt tension or replace belts.                       |
| <b>Starter will not crank</b>      | Engine under load  | Remove load   |
|                                    | Loose or corroded connections.   | Clean and tighten loose connections.                        |
|                                    | Low battery output voltage.  | See your authorized servicing dealer or engine distributor. |
|                                    | Faulty start circuit relay.  | See your authorized servicing dealer or engine distributor. |
|                                    | Blown fuse.  | Replace fuse.   |

Continued on next page

DPSG,CD03523,50 -19-10AUG99-1/2

*Troubleshooting*

| Symptom                         | Problem                        | Solution  |
|---------------------------------|--------------------------------|---|
| <b>Starter cranks slowly</b>    | Low battery output.            | See your authorized servicing dealer or engine distributor. |
|                                 | Crankcase oil too heavy.       | Use proper viscosity oil.                                   |
|                                 | Loose or corroded connections. | Clean and tighten loose connections.                        |
| <b>Entire electrical system</b> | Faulty battery connection.     | Clean and tighten connections.                              |
|                                 | Sulfated or worn-out battery.  | See your authorized servicing dealer or engine distributor. |
|                                 | Blown fuse.                    | Replace fuse.   |

DPSG,CD03523,50 -19-10AUG99-2/2



# Storage

## ENGINE STORAGE GUIDELINES

1. John Deere engines can be stored outside for up to three (3) months with no long term preparation IF COVERED BY WATERPROOF COVERING.
2. John Deere engines can be stored in a standard overseas shipping container for up to three (3) months with no long term preparation.
3. John Deere engines can be stored inside, warehoused, for up to six (6) months with no long term preparation.
4. John Deere engines expected to be stored more than six (6) months, long term storage preparation

**MUST BE taken.** (See PREPARING ENGINE FOR LONG TERM STORAGE).

5. For John Deere engines not yet installed in machines, run a line from a container of AR41937 Nucle Oil (from AR41785 Engine Storage Kit) to the fuel transfer pump intake, and another line from the fuel return manifold to the tank, so that Nucle Oil is circulated through the injection system during cranking.

DPSG,CD03523,51 -19-10AUG99-1/1

## USE AR41785 ENGINE STORAGE KIT

See your John Deere servicing dealer or engine distributor for an AR41785 Engine Storage Kit. Closely follow instructions provided with this kit.

**IMPORTANT:** Inhibitors can easily change to gas.  
Seal or tape each opening immediately after adding inhibitor.



DPSG,CD03523,52 -19-10AUG99-1/1

## Storage

### PREPARING ENGINE FOR LONG TERM STORAGE

The following storage preparations are good for long term engine storage up to one year. After that, the engine should be started, warmed up, and retreated for an extended storage period.

**IMPORTANT:** Any time your engine will not be used for over six (6) months, the following recommendations for storing it and removing it from storage will help to minimize corrosion and deterioration. Use the AR41785 Engine Storage Kit. Follow recommended service procedure included with storage kit.

1. Change engine oil and replace filter. Used oil will not give adequate protection. (See CHANGING ENGINE OIL AND FILTER).
2. Service air cleaner. (See CLEAN OR REPLACE AIR FILTER).
3. Draining and flushing of cooling system is not necessary if engine is to be stored only for several months. However, for extended storage periods of a year or longer, it is recommended that the cooling system be drained, flushed, and refilled. Refill with appropriate coolant. (See DIESEL ENGINE COOLANT).
4. Drain fuel tank and add 30 ml (1 oz) of inhibitor to the fuel tank for each 15 L (4 U.S. gal) of tank capacity. Completely drain fuel filter and close fuel valve, if equipped.
5. Add 30 ml (1 oz) of inhibitor to the engine crankcase for each 0.95 L (1 qt) of crankcase oil.
6. Disconnect air intake piping from the manifold. Pour 90 ml (3 oz) of inhibitor into intake system and reconnect the piping.
7. Crank the engine several revolutions with starter (do not allow the engine to start).
8. Remove fan/alternator belt, if desired.
9. Remove and clean battery. Store them in a cool, dry place and keep them fully charged.
10. Clean the exterior of the engine with salt-free water and touchup any scratched or chipped painted surfaces with a good quality paint.
11. Coat all exposed (machined) metal surfaces with grease or corrosion inhibitor if not feasible to paint.
12. Seal all openings on engine with plastic bags and tape supplied in storage kit. Follow instructions supplied in kit.
13. Store the engine in a dry protected place. If engine must be stored outside, cover it with a waterproof canvas or other suitable protective material and use a strong waterproof tape.

DPSG,CD03523,53 -19-10AUG99-1/1

*Storage***REMOVING ENGINE FROM LONG TERM STORAGE**

Refer to the appropriate section for detailed services listed below or have your authorized servicing dealer or engine distributor perform services that you may not be familiar with.

**IMPORTANT: DO NOT operate starter more than 30 seconds at a time. Wait at least 2 minutes for starter to cool before trying again.**

1. Remove all protective coverings from engine. Unseal all openings in engine and remove covering from electrical systems.
2. Remove the battery from storage. Install battery (fully charged) and connect the terminals.
3. Install fan/alternator belt if removed.
4. Fill fuel tank.
5. Perform all appropriate prestarting checks. (See DAILY PRESTARTING CHECKS).
6. Crank engine for 20 seconds with starter (do not allow the engine to start). Wait 2 minutes and crank engine an additional 20 seconds to assure bearing surfaces are adequately lubricated.
7. Start engine and run at no load for several minutes. Warm up carefully and check all gauges before placing engine under load.
8. On the first day of operation after storage, check overall engine for leaks and check all gauges for correct operation.

DPSG.CD03523,54 -19-10AUG99-1/1

# Specifications

## GENERAL ENGINE SPECIFICATIONS

| ITEM                           | UNIT OF MEASURE | 3029DF128 | 4039DF008 | 4039TF008 |
|--------------------------------|-----------------|-----------|-----------|-----------|
| Number of Cylinders            |                 | 3         | 4         | 4         |
| Fuel                           |                 | Diesel    | Diesel    | Diesel    |
| Bore                           | mm              | 106.5     | 106.5     | 106.5     |
| Stroke                         | mm              | 110       | 110       | 110       |
| Displacement                   | L               | 2.9       | 3.9       | 3.9       |
| Compression Ratio              |                 | 17.8:1    | 17.8:1    | 17.8:1    |
| POWER* @<br>1500 rpm (Prime)   | kW (hp)         | 26 (35)   | 35 (48)   | 55 (75)   |
| POWER* @<br>1500 rpm (Standby) | kW (hp)         | 30 (41)   | 38 (52)   | 61 (83)   |
| POWER* @<br>1800 rpm (Prime)   | kW (hp)         | 30 (41)   | 41 (56)   | 67 (91)   |
| POWER* @<br>1800 rpm (Standby) | kW (hp)         | 34 (46)   | 47 (64)   | 73 (99)   |
| Width (overall)                | mm              | 582       | 588       | 588       |
| Length (overall)               | mm              | 888       | 1016      | 1016      |
| Height (overall)               | mm              | 931       | 960       | 979       |
| Weight (dry) <sup>b</sup>      | kg              | 345       | 410       | 455       |
| Engine oil quantity            | L               | 6         | 12        | 12        |
| Engine coolant<br>quantity     | L               | 14.5      | 16.5      | 16.5      |

\*With Fan

<sup>b</sup>Approximate

Continued on next page

DPSG,CD03523.55 -19-10AUG99-1/3

## Specifications

| ITEM                           | UNIT OF MEASURE | 4045HF158 | 4045TF158 | 4045TF258 | 4045DF158 |
|--------------------------------|-----------------|-----------|-----------|-----------|-----------|
| Number of Cylinders            |                 | 4         | 4         | 4         | 4         |
| Fuel                           |                 | Diesel    | Diesel    | Diesel    | Diesel    |
| Bore                           | mm              | 106.5     | 106.5     | 106.5     | 106.5     |
| Stroke                         | mm              | 127       | 127       | 127       | 127       |
| Displacement                   | L               | 4.5       | 4.5       | 4.5       | 4.5       |
| Compression Ratio              |                 | 17.0:1    | 17.0:1    | 17.0:1    | 17.6:1    |
| POWER* @<br>1500 rpm (Prime)   | kW (hp)         | 88 (120)  | 61 (83)   | 72 (98)   | 41 (56)   |
| POWER* @<br>1500 rpm (Standby) | kW (hp)         | 96 (131)  | 68 (92)   | 80 (109)  | 42 (57)   |
| POWER* @<br>300 rpm (Prime)    | kW (hp)         | 108 (147) | 72 (98)   | 80 (109)  | 48 (65)   |
| POWER* @<br>1800 rpm (Standby) | kW (hp)         | 120 (163) | 79 (107)  | 88 (120)  | 51 (69)   |
| Width (overall)                | mm              | 798       | 668       | 668       | 668       |
| Length (overall)               | mm              | 1356      | 1219      | 1219      | 1219      |
| Height (overall)               | mm              | 1136      | 1010      | 1010      | 1010      |
| Weight (dry) <sup>b</sup>      | kg              | 446       | 436       | 436       | 391       |
| Engine oil quantity            | L               | 12        | 12        | 12        | 8         |
| Engine coolant<br>quantity     | L               | 25        | 25        | 25        | 20        |
| *With Fan                      |                 |           |           |           |           |
| <sup>b</sup> Approximate       |                 |           |           |           |           |

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DPSG,CD03523,55 -19-10AUG99-2/3











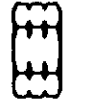
### Specifications

| ITEM  | UNIT OF MEASURE | 6068HF158 | 6068TF158 | 6068TF258 |
|---|-----------------|-----------|-----------|-----------|
| Number of Cylinders                               |                 | 6         | 6         | 6         |
| Fuel  |                 | Diesel    | Diesel    | Diesel    |
| Bore  | mm              | 106.5     | 106.5     | 106.5     |
| Stroke  | mm              | 127       | 127       | 127       |
| Displacement                                      | L               | 6.8       | 6.8       | 6.8       |
| Compression Ratio                                 |                 | 17.0:1    | 17.0:1    | 17.0:1    |
| POWER <sup>a</sup> @ 1500 rpm (Prime)             | kW (hp)         | 134 (182) | 92 (125)  | 105 (143) |
| POWER <sup>a</sup> @ 1500 rpm (Standby)           | kW (hp)         | 148 (201) | 101 (137) | 116 (158) |
| POWER <sup>a</sup> @ 1800 rpm (Prime)             | kW (hp)         | 164 (223) | 108 (147) | 124 (169) |
| POWER <sup>a</sup> @ 1800 rpm (Standby)           | kW (hp)         | 187 (254) | 119 (162) | 137 (186) |
| Width (overall)                                   | mm              | 798       | 668       | 668       |
| Length (overall)                                  | mm              | 1476      | 1383      | 1383      |
| Height (overall)                                  | mm              | 1136      | 1032      | 1032      |
| Weight (dry) <sup>b</sup>                         | kg              | 613       | 593       | 593       |
| Engine oil quantity                               | L               | 19.5      | 19.5      | 19.5      |
| Engine coolant quantity                           | L               | 29        | 26        | 26        |
| <sup>a</sup> With Fan<br><sup>b</sup> Approximate |                 |           |           |           |

DPSG,CD03523,55 -19-10AUG99-3/3

## Specifications

## UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES

|                             |  |  |  |   |  |  |
|-----------------------------|--|--|--|---|--|--|
| SAE Grade and Head Markings | 1 or 2 <sup>b</sup><br> | 5<br> | 5.1<br> | 5.2<br> | 8<br> | 8.2<br> |
| SAE Grade and Nut Markings  | 2<br>                   | 5<br> |        |   | 8<br> |         |

| Size  | Grade 1                 |       |                  |       | Grade 2 <sup>b</sup>    |       |                  |       | Grade 5, 5.1, or 5.2    |       |                  |       | Grade 8 or 8.2          |       |                  |       |
|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|
|       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       |
|       | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft |
| 1/4   | 3.7                     | 2.8   | 4.7              | 3.5   | 6                       | 4.5   | 7.5              | 5.5   | 9.5                     | 7     | 12               | 9     | 13.5                    | 10    | 17               | 12.5  |
| 5/16  | 7.7                     | 5.5   | 10               | 7     | 12                      | 9     | 15               | 11    | 20                      | 15    | 25               | 18    | 28                      | 21    | 35               | 26    |
| 3/8   | 14                      | 10    | 17               | 13    | 22                      | 16    | 27               | 20    | 35                      | 26    | 44               | 33    | 50                      | 36    | 63               | 46    |
| 7/16  | 22                      | 16    | 28               | 20    | 35                      | 26    | 44               | 32    | 55                      | 41    | 70               | 52    | 80                      | 58    | 100              | 75    |
| 1/2   | 33                      | 25    | 42               | 31    | 53                      | 39    | 67               | 50    | 85                      | 63    | 110              | 80    | 120                     | 90    | 150              | 115   |
| 9/16  | 48                      | 36    | 60               | 45    | 75                      | 56    | 95               | 70    | 125                     | 90    | 155              | 115   | 175                     | 130   | 225              | 160   |
| 5/8   | 67                      | 50    | 85               | 62    | 105                     | 78    | 135              | 100   | 170                     | 125   | 215              | 160   | 240                     | 175   | 300              | 225   |
| 3/4   | 120                     | 87    | 150              | 110   | 190                     | 140   | 240              | 175   | 300                     | 225   | 375              | 280   | 425                     | 310   | 550              | 400   |
| 7/8   | 190                     | 140   | 240              | 175   | 190                     | 140   | 240              | 175   | 490                     | 360   | 625              | 450   | 700                     | 500   | 875              | 650   |
| 1     | 290                     | 210   | 360              | 270   | 290                     | 210   | 360              | 270   | 725                     | 540   | 925              | 675   | 1050                    | 750   | 1300             | 975   |
| 1-1/8 | 400                     | 300   | 510              | 375   | 400                     | 300   | 510              | 375   | 900                     | 675   | 1150             | 850   | 1450                    | 1075  | 1850             | 1350  |
| 1-1/4 | 570                     | 425   | 725              | 530   | 570                     | 425   | 725              | 530   | 1300                    | 950   | 1650             | 1200  | 2050                    | 1500  | 2600             | 1950  |
| 1-3/8 | 750                     | 550   | 950              | 700   | 750                     | 550   | 950              | 700   | 1700                    | 1250  | 2150             | 1550  | 2700                    | 2000  | 3400             | 2550  |
| 1-1/2 | 1000                    | 725   | 1250             | 925   | 990                     | 725   | 1250             | 930   | 2250                    | 1650  | 2850             | 2100  | 3600                    | 2650  | 4550             | 3350  |

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

<sup>a</sup> "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

<sup>b</sup> Grade 2 applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. Grade 1 applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.

Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original.





















Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

DX.TORQ1 -19-20JUL94-1/1

## Specifications

## METRIC BOLT AND CAP SCREW TORQUE VALUES

|                                  |   |   |   |   |   |  |   |   |   |   |
|----------------------------------|---|---|---|---|---|--|---|---|---|---|
| Property Class and Head Markings | 4.8   |   | 8.8   |   | 9.8   |  | 10.9  |   | 12.9  |   |
|                                  |  |  |  |  |  |  |  |  |  |  |
| Property Class and Nut Markings  | 5   |   | 10  |   | 10  |  | 10  |   | 12  |   |
|                                  |  |  |  |  |  |   |   |  |  |  |

| Size | Class 4.8               |       |                  |       | Class 8.8 or 9.8        |       |                  |       | Class 10.9              |       |                  |       | Class 12.9              |       |                  |       |
|------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|
|      | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       |
|      | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft |
| M6   | 4.8                     | 3.5   | 6                | 4.5   | 9                       | 6.5   | 11               | 8.5   | 13                      | 9.5   | 17               | 12    | 15                      | 11.5  | 19               | 14.5  |
| M8   | 12                      | 8.5   | 15               | 11    | 22                      | 16    | 28               | 20    | 32                      | 24    | 40               | 30    | 37                      | 28    | 47               | 35    |
| M10  | 23                      | 17    | 29               | 21    | 43                      | 32    | 55               | 40    | 63                      | 47    | 80               | 60    | 75                      | 55    | 95               | 70    |
| M12  | 40                      | 29    | 50               | 37    | 75                      | 55    | 95               | 70    | 110                     | 80    | 140              | 105   | 130                     | 95    | 165              | 120   |
| M14  | 63                      | 47    | 80               | 60    | 120                     | 88    | 150              | 110   | 175                     | 130   | 225              | 165   | 205                     | 150   | 260              | 190   |
| M16  | 100                     | 73    | 125              | 92    | 190                     | 140   | 240              | 175   | 275                     | 200   | 350              | 255   | 320                     | 240   | 400              | 300   |
| M18  | 135                     | 100   | 175              | 125   | 260                     | 195   | 330              | 250   | 375                     | 275   | 475              | 350   | 440                     | 325   | 560              | 410   |
| M20  | 190                     | 140   | 240              | 180   | 375                     | 275   | 475              | 350   | 530                     | 400   | 675              | 500   | 625                     | 460   | 800              | 580   |
| M22  | 260                     | 190   | 330              | 250   | 510                     | 375   | 650              | 475   | 725                     | 540   | 925              | 675   | 850                     | 625   | 1075             | 800   |
| M24  | 330                     | 250   | 425              | 310   | 650                     | 475   | 825              | 600   | 925                     | 675   | 1150             | 850   | 1075                    | 800   | 1350             | 1000  |
| M27  | 490                     | 360   | 625              | 450   | 950                     | 700   | 1200             | 875   | 1350                    | 1000  | 1700             | 1250  | 1600                    | 1150  | 2000             | 1500  |
| M30  | 675                     | 490   | 850              | 625   | 1300                    | 950   | 1650             | 1200  | 1850                    | 1350  | 2300             | 1700  | 2150                    | 1600  | 2700             | 2000  |
| M33  | 900                     | 675   | 1150             | 850   | 1750                    | 1300  | 2200             | 1650  | 2500                    | 1850  | 3150             | 2350  | 2900                    | 2150  | 3700             | 2750  |
| M36  | 1150                    | 850   | 1450             | 1075  | 2250                    | 1650  | 2850             | 2100  | 3200                    | 2350  | 4050             | 3000  | 3750                    | 2750  | 4750             | 3500  |

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class.

Fasteners should be replaced with the same or higher property class. If higher property class fasteners are used, these should only be tightened to the strength of the original.

<sup>a</sup> "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

DX.TORQ2 -19-20JUL94-1/1

TS1657 -19-02APR97



# Index

|                                | Page       |   | Page       |
|--------------------------------|------------|---|------------|
| <b>A</b>                       |            | Fuel system                             |            |
| Air filter                     |            | Bleeding                                | 50-6       |
| Clean or replace (one-piece)   | 50-2       | Fuel                                    |            |
| Clean or replace element       | 50-3       | Diesel                                  | 10-1       |
| Air intake system              |            | Handling and storing                    | 10-1       |
| Checking                       | 35-1       |   |            |
| <b>B</b>                       |            | <b>I</b>                                |            |
| Belt                           |            | Identification views                    | 01-1       |
| Check automatic tensioner      | 35-2       | Inch torque values                      | 65-4       |
| Check tension                  | 30-4       |   |            |
| Replace (POWERTech)            | 50-4       | <b>L</b>                                |            |
| Break-in engine oil            | 10-2       | Lubricant                               |            |
| <b>C</b>                       |            | Mixing                                  | 10-4       |
| Coolant                        |            | Storage                                 | 10-3       |
| Diesel engine                  | 10-4       | <b>M</b>                                |            |
| Drain and flush cooling system | 45-1       | Maintenance records                     | 02-1       |
| Warm temperature climates      | 10-5       | Maintenance                             |            |
| Crankcase vent tube            |            | 1000 hours/1 year                       |            |
| Cleaning                       | 03-1, 35-1 | Check and adjust valve clearance        |            |
| <b>D</b>                       |            | (300-Series)                            | 35-3       |
| Damper                         | 40-4       | Checking air intake system              | 35-1       |
| Diesel engine oil              | 10-3       | Checking automatic belt tensioner       |            |
| Diesel fuel                    | 10-1       | (POWERTech)                             | 35-2       |
| <b>E</b>                       |            | Cleaning crankcase vent tube            | 03-1, 35-1 |
| Engine oil                     |            | 2000 hours/2 years                      |            |
| Break-In                       | 10-2       | Adjust speed droop governor             | 40-3       |
| Diesel                         | 10-3       | Adjust valve clearance (POWERTech)      | 40-1       |
| Draining                       | 30-1       | Check engine speed                      | 40-3       |
| Engine speed                   | 40-3       | Damper check                            | 40-4       |
| <b>F</b>                       |            | 2500 hours/3 years                      |            |
| Fuel filter                    |            | Drain and flush cooling system          | 45-1       |
| Replacement                    | 30-3       | 50 hours/2 weeks                        |            |
|                                |            | Checking fuel filter                    | 50-5       |
|                                |            | 500 hours                               |            |
|                                |            | Changing engine oil and filter          | 30-1       |
|                                |            | Checking belt                           | 30-4       |
|                                |            | Replace fuel filter                     | 30-3       |
|                                |            | As required                             |            |
|                                |            | Additional service information          | 50-1       |
|                                |            | Clean or replace air filter (one-piece) | 50-2       |
|                                |            | Clean or replace air filter element     | 50-3       |
|                                |            | Do not modify fuel system               | 50-1       |

## Index

|   | Page |                               | Page |
|---|------|-------------------------------|------|
|   |      | <b>V</b>                      |      |
| Replace fan and alternator belts<br>(POWERTech) . . . . . | 50-4 | Valve clearance               |      |
| Daily or every 10 hours . . . . .                         | 25-1 | Adjust (300-Series) . . . . . | 35-3 |
| Observe service intervals . . . . .                       | 20-1 | Adjust (POWERTech) . . . . .  | 40-1 |
| Use correct fuel, lubricant and coolant . . . . .         | 20-1 |                               |      |
| Metric torque values . . . . .                            | 65-5 |                               |      |
| Mixing lubricants . . . . .                               | 10-4 |                               |      |
|   |      |                               |      |
| <b>O</b>  |      |                               |      |
| Operating the engine                                      |      |                               |      |
| Break-in period . . . . .                                 | 15-1 |                               |      |
| Engine operation . . . . .                                | 15-4 |                               |      |
| Standby power units . . . . .                             | 15-4 |                               |      |
| Starting the engine . . . . .                             | 15-1 |                               |      |
| Stopping the engine . . . . .                             | 15-5 |                               |      |
| Using a booster battery or charger . . . . .              | 15-3 |                               |      |
|   |      |                               |      |
| <b>R</b>  |      |                               |      |
| Record keeping  |      |                               |      |
| Engine option codes . . . . .                             | 03-3 |                               |      |
| Engine serial number plate . . . . .                      | 03-1 |                               |      |
| POWERTech medallion . . . . .                             | 03-1 |                               |      |
| Record engine serial number . . . . .                     | 03-2 |                               |      |
| Record fuel injection pump model number . . . . .         | 03-5 |                               |      |
|   |      |                               |      |
| <b>S</b>  |      |                               |      |
| Specifications  |      |                               |      |
| Engine . . . . .  | 65-1 |                               |      |
| Storage   |      |                               |      |
| Engine . . . . .  | 60-1 |                               |      |
| Storing fuel . . . . .                                    | 10-1 |                               |      |
| Storing lubricants . . . . .                              | 10-3 |                               |      |
|   |      |                               |      |
| <b>T</b>  |      |                               |      |
| Torque values   |      |                               |      |
| Inch . . . . .  | 65-4 |                               |      |
| Metric . . . . .  | 65-5 |                               |      |
| Troubleshooting   |      |                               |      |
| Electrical . . . . .                                      | 55-6 |                               |      |
| Engine . . . . .  | 55-1 |                               |      |

## Index-2

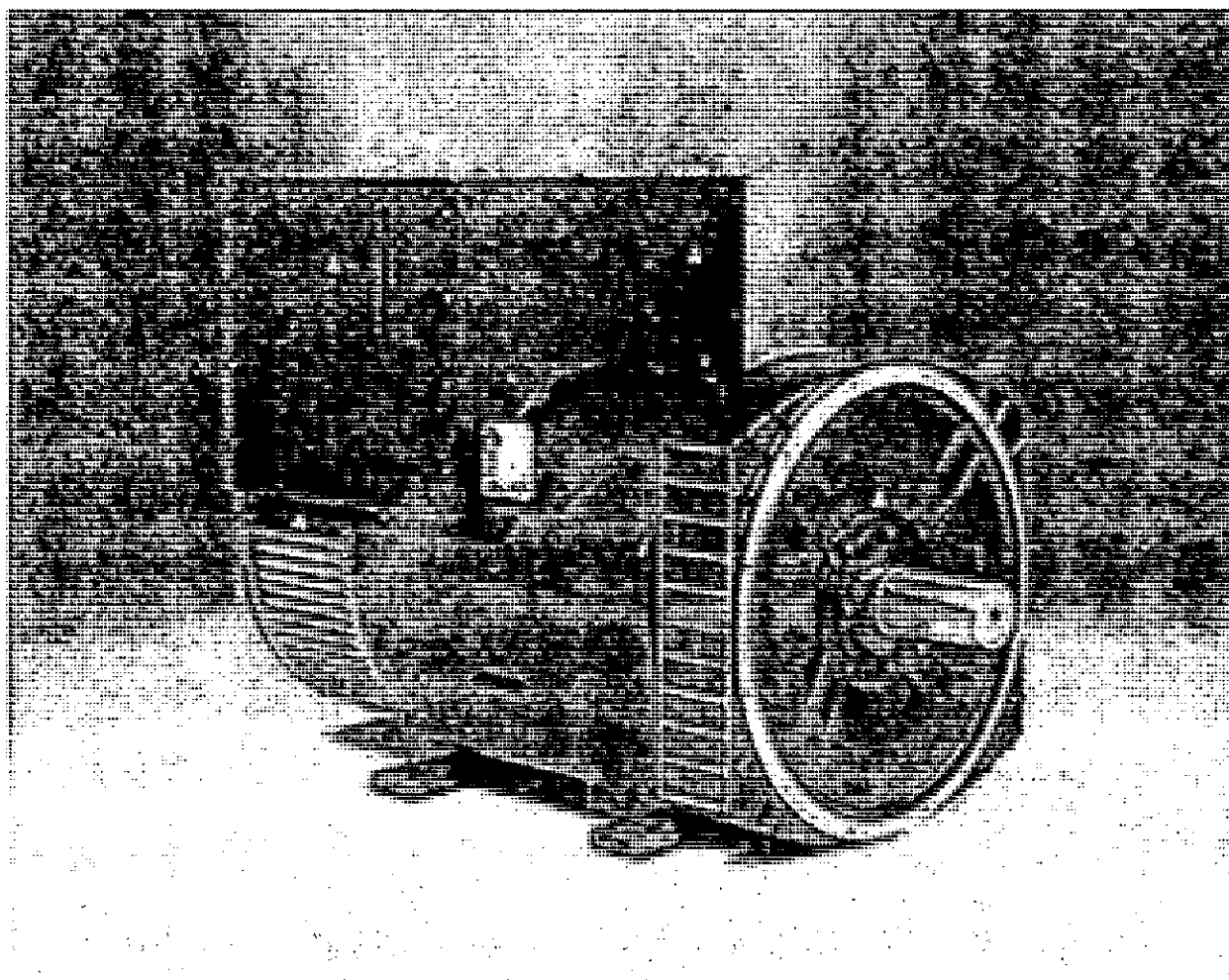
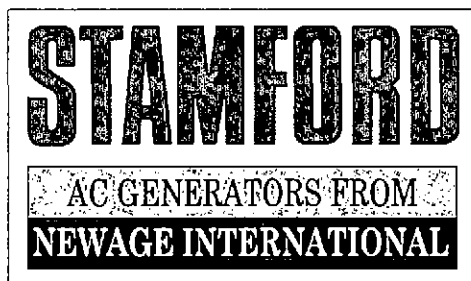
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## **SPARE PARTS**

The spare parts catalogue is too extensive for hard copy presentation.

Please refer to copy on enclosed CD.



## **Installation, Service & Maintenance Manual**

**for AC generators with the following prefixes:**

**HCI; HCM; HCK 4,5,6,7.**

## ***SAFETY PRECAUTIONS***

Before operating the generating set, read the generating set operation manual and this generator manual and become familiar with it and the equipment.

**SAFE AND EFFICIENT OPERATION CAN ONLY BE ACHIEVED IF THE EQUIPMENT IS CORRECTLY OPERATED AND MAINTAINED.**

Many accidents occur because of failure to follow fundamental rules and precautions.

**ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.**

Observe all **WARNING/CAUTION** notices.

- Ensure installation meets all applicable safety and local electrical codes. Have all installations performed by a qualified electrician.
- Do not operate the generator with protective covers, access covers or terminal box covers removed.
- Disable engine starting circuits before carrying out maintenance.
- Disable closing circuits and/or place warning notices on any circuit breakers normally used for connection to the mains or other generators, to avoid accidental closure.

Observe all **IMPORTANT, CAUTION, WARNING, and DANGER** notices, defined as:

**Important !** Important refers to hazard or unsafe method or practice which can result in product damage or related equipment damage.

**Caution !** Caution refers to hazard or unsafe method or practice which can result in product damage or personal injury.



**Warning !**

Warning refers to a hazard or unsafe method or practice which **CAN** result in severe personal injury or possible death.



**Danger !**

Danger refers to immediate hazards which **WILL** result in severe personal injury or death.

Due to our policy of continuous improvement, details in this manual which were correct at time of printing, may now be due for amendment. Information included must therefore not be regarded as binding.

### **Front Cover Photograph**

This photograph is representative only. Several variations are available within the range of generators covered by this manual.

## FOREWORD

The function of this book is to provide the user of the Stamford generator with an understanding of the principles of operation, the criteria for which the generator has been designed, and the installation and maintenance procedures. Specific areas where the lack of care or use of incorrect procedures could lead to equipment damage and/or personal injury are highlighted, with **WARNING** and/or **CAUTION** notes, and it is important that the contents of this book are read and understood before proceeding to fit or use the generator.

The Service, Sales and technical staff of Newage International are always ready to assist and reference to the company for advice is welcomed.




**Warning !**

**Incorrect installation, operation, servicing or replacement of parts can result in severe personal injury or death, and/or equipment damage.**  
**Service personnel must be qualified to perform electrical and mechanical service.**

### EC DECLARATION OF INCORPORATION

All Stamford generators are supplied with a declaration of incorporation for the relevant EC legislation, typically in the form of a label as below.

|  |                           |
|--|---------------------------|
| <br><b>EC DECLARATION OF INCORPORATION</b>  |                           |
| <small>IN ACCORDANCE WITH THE SUPPLY OF MACHINERY (SAFETY) REGULATIONS 1992<br/> AND THE SUPPLY OF MACHINERY (SAFETY) (AMENDMENT) REGULATIONS 1994<br/> IMPLEMENTING THE EC MACHINERY DIRECTIVE 89/392/EEC AS AMENDED BY 91/368/EEC.</small>                                       |                           |
| <small>THIS STAMFORD A.C. GENERATOR WAS<br/> MANUFACTURED BY OR ON BEHALF OF<br/> <b>NEWAGE INTERNATIONAL LTD</b><br/> BARNACK ROAD STAMFORD LINCOLNSHIRE ENGLAND.</small>   |                           |
| <small>THIS COMPONENT MACHINERY MUST NOT BE PUT INTO SERVICE UNTIL THE<br/> MACHINERY INTO WHICH IT IS TO BE INCORPORATED HAS BEEN DECLARED IN<br/> CONFORMITY WITH THE PROVISIONS OF THE SUPPLY OF MACHINERY (SAFETY)<br/> REGULATIONS 1995/MACHINERY DIRECTIVE.</small>          |                           |
| <small>FOR AND ON BEHALF OF NEWAGE INTERNATIONAL LIMITED</small>   |                           |
| <b>NAME:</b>   | <b>LAWRENCE HAYDOCK</b>   |
| <b>POSITION:</b>   | <b>TECHNICAL DIRECTOR</b> |
| <b>SIGNATURE:</b>  |                           |
| <small>THIS COMPONENT MACHINERY CARRIES THE CE MARK FOR COMPLIANCE WITH THE STATUTORY<br/> REQUIREMENTS FOR THE IMPLEMENTATION OF THE FOLLOWING DIRECTIVES</small>   |                           |
| <small>The EMC Directive 89/336/EEC<br/> This Component Machinery shall not be used in the Residential, Commercial and<br/> <b>WARNING!</b> Light Industrial environment unless it also conforms to the relevant standard<br/> (EN 50081 - 1) REFER TO FACTORY FOR DETAILS</small> |                           |
| <small>ii) The Low Voltage Directive 73/23/EEC as amended by 93/68/EEC</small>   |                           |



## ELECTROMAGNETIC COMPATIBILITY

### Additional Information

#### European Union

#### Council Directive 89/336/EEC

For installations within the European Union, electrical products must meet the requirements of the above directive, and Newage ac generators are supplied on the basis that:

- They are to be used for power-generation or related function.
- They are to be applied in one of the following environments:

Portable (open construction - temporary site supply)  
Portable (enclosed - temporary site supply)  
Containerised (temporary or permanent site supply)  
Ship-borne below decks (marine auxiliary power)  
Commercial vehicle (road transport / refrigeration etc)  
Rail transport (auxiliary power)  
Industrial vehicle (earthmoving, cranes etc)  
Fixed installation (industrial - factory / process plant)  
Fixed installation (residential, commercial and light industrial - home / office / health)  
Energy management (Combined heat and power and/or peak lopping)  
Alternative energy schemes

- The standard generators are designed to meet the 'industrial' emissions and immunity standards. Where the generator is required to meet the residential, commercial and light industrial emissions and immunity standards reference should be made to Newage document reference N4/X/011, as additional equipment may be required.
- The installation earthing scheme involves connection of the generator frame to the site protective earth conductor using a minimum practical lead length.
- Maintenance and servicing with anything other than factory supplied or authorised parts will invalidate any Newage liability for EMC compliance.
- Installation, maintenance and servicing is carried out by adequately trained personnel fully aware of the requirements of the relevant EC directives

# **CONTENTS**

|                    |  |     |
|--------------------|--|-----|
| SAFETY PRECAUTIONS |  | IFC |
| FOREWORD           |  | 1   |
| CONTENTS           |  | 2&3 |
| SECTION 1          | INTRODUCTION   | 4   |
| 1.1                | INTRODUCTION   | 4   |
| 1.2                | DESIGNATION  | 4   |
| 1.3                | SERIAL NUMBER LOCATION   | 4   |
| 1.4                | RATING PLATE AND CE MARK   | 4   |
| SECTION 2          | PRINCIPLE OF OPERATION   | 5   |
| 2.1                | SELF-EXCITED AVR CONTROLLED GENERATORS                                       | 5   |
| 2.2                | PERMANENT MAGNET GENERATOR (PMG) EXCITED - AVR CONTROLLED GENERATORS         | 5   |
| 2.3                | AVR ACCESSORIES  | 5   |
| SECTION 3          | APPLICATION OF THE GENERATOR   | 6   |
| 3.1                | VIBRATION  | 7   |
| SECTION 4          | INSTALLATION - PART 1  | 8   |
| 4.1                | LIFTING  | 8   |
| 4.2                | ENGINE TO GENERATOR COUPLING ASSEMBLY  | 8   |
| 4.2.1              | TWO BEARING GENERATORS   | 8   |
| 4.2.2              | SINGLE BEARING GENERATORS TYPES HC & HCK                                     | 8   |
| 4.3                | EARTHING   | 9   |
| 4.4                | PRE-RUNNING CHECKS   | 9   |
| 4.4.1              | INSULATION CHECK   | 9   |
| 4.4.2              | DIRECTION OF ROTATION  | 9   |
| 4.4.2.1            | FAN TYPES  | 9   |
| 4.4.2.2            | DIRECTION OF ROTATION  | 9   |
| 4.4.3              | VOLTAGE AND FREQUENCY  | 9   |
| 4.4.4              | AVR SETTINGS   | 9   |
| 4.4.4.1            | TYPE SX440 AVR   | 10  |
| 4.4.4.2            | TYPE SX421 AVR   | 10  |
| 4.4.4.3            | TYPE MX341 AVR   | 10  |
| 4.4.4.4            | TYPE MX321 AVR   | 11  |
| 4.5                | GENERATOR SET TESTING  | 11  |
| 4.5.1              | TEST METERING/CABLING  | 11  |
| 4.6                | INITIAL START-UP   | 11  |
| 4.7                | LOAD TESTING   | 12  |
| 4.7.1              | AVR ADJUSTMENTS  | 12  |
| 4.7.1.1            | UFRO (Under Frequency Roll Off)<br>(AVR Types SX440, SX421, MX341 and MX321) | 13  |
| 4.7.1.2            | EXC TRIP (Excitation Trip)   | 13  |
| 4.7.1.3            | OVER/V (Over Voltage)  | 13  |
| 4.7.1.4            | TRANSIENT LOAD SWITCHING ADJUSTMENTS   | 13  |
| 4.7.1.5            | RAMP   | 14  |
| 4.8                | ACCESSORIES  | 14  |
| SECTION 5          | INSTALLATION - PART 2  | 14  |
| 5.1                | GENERAL  | 14  |
| 5.2                | GLANDING   | 14  |
| 5.3                | MAXIMUM TORQUE SETTINGS FOR<br>CUSTOMER TERMINAL CONNECTIONS                 | 14  |
| 5.4                | EARTHING   | 14  |
| 5.5                | PROTECTION   | 14  |
| 5.6                | COMMISSIONING  | 14  |

# CONTENTS

|                  |         |   |           |
|------------------|---------|---|-----------|
| <b>SECTION 6</b> |         | <b>ACCESSORIES</b>  | <b>15</b> |
|                  | 6.1     | REMOTE VOLTAGE ADJUST (ALL AVR TYPES)                                       | 15        |
|                  | 6.2     | PARALLEL OPERATION  | 15        |
|                  | 6.2.1   | DROOP   | 15        |
|                  | 6.2.1.1 | SETTING PROCEDURE   | 16        |
|                  | 6.2.2   | ASTATIC CONTROL   | 16        |
|                  | 6.3     | MANUAL VOLTAGE REGULATOR (MVR) -<br>MX341 and MX321 AVR                     | 16        |
|                  | 6.4     | OVERVOLTAGE DE-EXCITATION BREAKER<br>SX421 and MX321 AVR                    | 16        |
|                  | 6.4.1   | RESETTING THE EXCITATION BREAKER  | 17        |
|                  | 6.5     | CURRENT LIMIT - MX321 AVR   | 17        |
|                  | 6.5.1   | SETTING PROCEDURE   | 17        |
|                  | 6.6     | POWER FACTOR CONTROLLER (PFC3)  | 17        |
| <b>SECTION 7</b> |         | <b>SERVICE AND MAINTENANCE</b>  | <b>18</b> |
|                  | 7.1     | WINDING CONDITION   | 18        |
|                  | 7.1.1   | WINDING CONDITION ASSESSMENT  | 18        |
|                  | 7.1.2   | METHODS OF DRYING OUT GENERATORS  | 18        |
|                  | 7.2     | BEARINGS  | 19        |
|                  | 7.3     | AIR FILTERS   | 21        |
|                  | 7.3.1   | CLEANING PROCEDURE  | 21        |
|                  | 7.3.2   | RECHARGING (CHARGING)   | 21        |
|                  | 7.4     | FAULT FINDING   | 21        |
|                  | 7.4.1   | SX440 AVR - FAULT FINDING   | 21        |
|                  | 7.4.2   | SX421 AVR - FAULT FINDING   | 21        |
|                  | 7.4.3   | MX341 AVR - FAULT FINDING   | 22        |
|                  | 7.4.4   | MX321 AVR - FAULT FINDING   | 22        |
|                  | 7.4.5   | RESIDUAL VOLTAGE CHECK  | 22        |
|                  | 7.4.6   | 'REFLASHING' TO RESTORE RESIDUAL  | 22        |
|                  | 7.5     | SEPARATE EXCITATION TEST PROCEDURE  | 23        |
|                  | 7.5.1   | GENERATOR WINDINGS, ROTATING DIODES and<br>PERMANENT MAGNET GENERATOR (PMG) | 23        |
|                  | 7.5.1.1 | BALANCED MAIN TERMINAL VOLTAGES   | 23        |
|                  | 7.5.1.2 | UNBALANCED MAIN TERMINAL VOLTAGES   | 24        |
|                  | 7.5.2   | EXCITATION CONTROL TEST   | 25        |
|                  | 7.5.2.1 | AVR FUNCTION TEST   | 25        |
|                  | 7.5.3   | REMOVAL AND REPLACEMENT OF COMPONENT<br>ASSEMBLIES                          | 25        |
|                  | 7.5.3.1 | ANTI-CONDENSATION HEATERS   | 25        |
|                  | 7.5.3.2 | REMOVAL OF PERMANENT MAGNET GENERATOR (PMG)                                 | 25        |
|                  | 7.5.3.3 | REMOVAL OF BEARINGS   | 25        |
|                  | 7.5.3.4 | MAIN ROTOR ASSEMBLY   | 29        |
|                  | 7.6     | RETURNING TO SERVICE  | 30        |
|                  | 7.7     | MAINTENANCE OF REGREASABLE BEARINGS   | 30        |
| <b>SECTION 8</b> |         | <b>SPARES AND AFTER SALES SERVICE</b>                                       | <b>31</b> |
|                  | 8.1     | RECOMMENDED SPARES  | 31        |
|                  | 8.2     | AFTER SALES SERVICE   | 31        |



# SECTION 1

## INTRODUCTION

### 1.1 INTRODUCTION

The HC range of generators is of brushless rotating field design, available up to 660V at 50 Hz or 60 Hz and built to meet BS5000 Part 3 and international standards.

1500 rpm (50Hz) or 1800 rpm (60Hz) 4 pole generators are available from 200kW to 2000kW in four frame sizes - HC4, HC5, HC6 and HC7.

1000 rpm (50Hz) or 1200 rpm (60Hz) 6 pole generators are available from 224kW to 1300kW in two frame sizes - HC6 and HC7.

Frame sizes HC4 and HC5 may be provided with a stator fed excitation system using SX440 or SX421 AVR, or with the permanent magnet generator (PMG) powered excitation system, using the MX341 or MX321 AVR.

Frames HC6 and HC7 are fitted with the PMG system using the MX321 AVR.

### 1.2 DESIGNATION

|   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|
| H | C | . | I | 4 | 4 | 4 | C | 1 |
| H | C | . | M | 5 | 3 | 4 | C | 2 |
| H | C | . | I | 6 | 3 | 4 | G | 1 |
| H | C | . | I | 6 | 3 | 6 | G | 2 |
| H | C | . | M | 7 | 3 | 4 | G | 2 |

|                                      |  |
|--------------------------------------|--|
| GENERATOR TYPE                       | HC   |
| SPECIFIC TYPE                        | K = VOLUTED ADAPTOR<br>AND UNI-DIRECTIONAL FAN |
| INDUSTRIAL = (I) OR MARINE = (M)     |  |
| FRAME SIZE AND CONTROL TYPE ON HC/MV |  |
| NUMBER OF POLES 4, OR 6              |  |
| CORE LENGTH                          |  |
| NUMBER OF BEARINGS 1 OR 2            |  |

### 1.3 SERIAL NUMBER LOCATION

Each generator has its unique serial number stamped in to the upper section of the drive end frame end-ring.

Inside the terminal box two adhesive rectangular labels have been fixed, each carrying the generators unique identity number. One label has been fixed to the inside of the terminal box sheet metal work, and the second label fixed to the main frame of the generator.

### 1.4 RATING PLATE AND CE MARK

The generator has been supplied with a self adhesive rating plate label to enable fitting after final assembly and painting. It is intended that this label will be stuck to the outside of the non drive end of the terminal box.

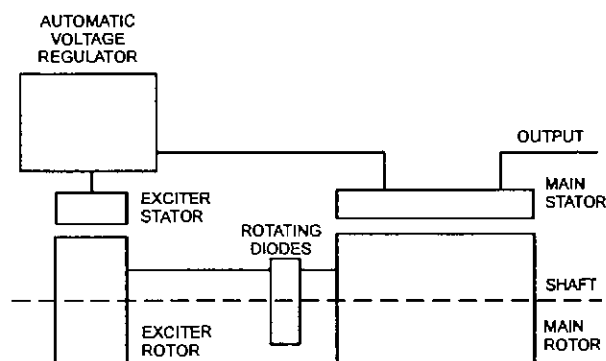
A CE Mark label is also supplied loose for fitment after final assembly and painting. This should be attached to an external surface of the Generator at a suitable location where it will not be obscured by the customer's wiring or other fittings. Before fitting the CE Mark label the genset builder must address the requirements of the relevant EC legislation to ensure the compliance of the genset as a whole. CE compliance will also need to be addressed when installed on site.

The surface in the area where a label is to be stuck must be flat, clean, and any paint finish be fully dry before attempting to attach label. Recommended method for attaching label is peel and fold back sufficient of the backing paper to expose some 20 mm of label adhesive along the edge which is to be located against the sheet metal protrusions. Once this first section of label has been carefully located and stuck into position the backing paper can be progressively removed, as the label is pressed down into position. The adhesive will achieve a permanent bond in 24 hours.

## SECTION 2

### PRINCIPLE OF OPERATION

#### 2.1 SELF-EXCITED AVR CONTROLLED GENERATORS



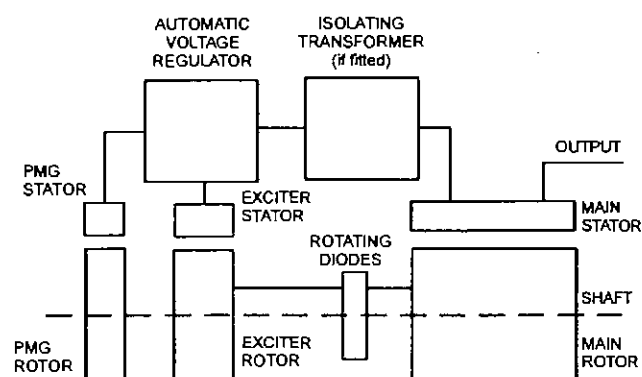
**Fig. 1**

The main stator provides power for excitation of the exciter field via the SX440 (or SX421) AVR which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage sensing signal derived from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature.

The SX440 AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine.

The SX421 AVR in addition to the SX440 features has three phase rms sensing and also provides for over voltage protection when used in conjunction with an external circuit breaker (switchboard mounted).

#### 2.2 PERMANENT MAGNET GENERATOR (PMG) EXCITED - AVR CONTROLLED GENERATORS



**Fig. 2**

The permanent magnet generator (PMG) provides power for excitation of the exciter field via the AVR MX341 (or MX321) which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage sensing signal derived, via an isolating transformer in the case of MX321 AVR,

from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature.

The PMG system provides a constant source of excitation power irrespective of main stator loading and provides high motor starting capability as well as immunity to waveform distortion on the main stator output created by non linear loads, e.g. thyristor controlled dc motor.

The MX341 AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides an adjustable voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine. It also provides over-excitation protection which acts following a time delay, to de-excite the generator in the event of excessive exciter field voltage.

The MX321 provides the protection and engine relief features of the MX341 and additionally incorporates 3 phase rms sensing and over-voltage protection.

The detailed function of all the AVR circuits is covered in the load testing section (subsection 4.7).

#### 2.3 AVR ACCESSORIES

The SX440, SX421, MX341 and MX321 AVRs incorporate circuits which, when used in conjunction with accessories, can provide for parallel operation either with 'droop' or 'astatic' control, VAR/ PF control and in the case of the MX321 AVR, short circuit current limiting.

Function and adjustment of the accessories which can be fitted inside the generator terminal box are covered in the accessories section of this book.

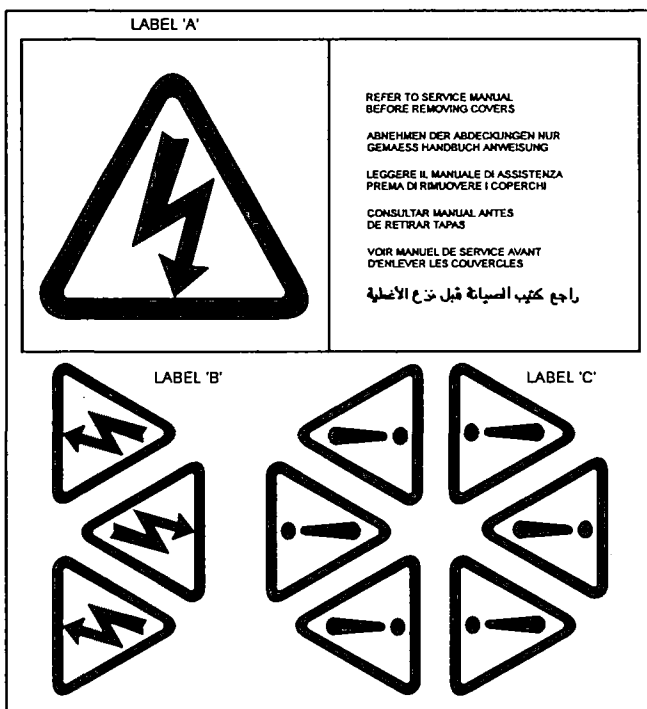
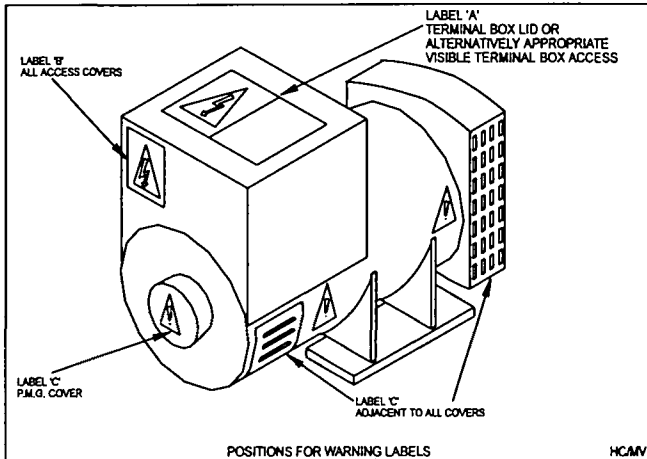
Separate instructions are provided with other accessories available for control panel mounting.

## SECTION 3

### APPLICATION OF THE GENERATOR

The generator is supplied as a component part for installation in a generating set. It is not, therefore, practicable to fit all the necessary warning/hazard labels during generator manufacture. The additional labels required are packaged with this Manual, together with a drawing identifying their locations. (see below).

It is the responsibility of the generating set manufacturer to ensure that the correct labels are fitted, and are clearly visible.



The generators have been designed for use in a maximum ambient temperature of 40°C, and altitude less than 1000 metres above sea level in accordance with BS5000.

Ambients in excess of 40°C, and altitudes above 1000 metres can be tolerated with reduced ratings - refer to the generator nameplate for rating and ambient.

In the event that the generator is required to operate in an ambient in excess of the nameplate value or at altitudes in excess of 1000 metres above sea level, refer to the factory.

The generators are of air-ventilated screen protected drip-proof design and are not suitable for mounting outdoors unless

adequately protected by the use of canopies. Anti-condensation heaters are recommended during storage and for standby duty to ensure winding insulation is maintained in good condition.

When installed in a closed canopy it must be ensured that the ambient temperature of the cooling air to the generator does not exceed that for which the generator has been rated.

The canopy should be designed such that the engine air intake to the canopy is separated from the generator intake, particularly where the radiator cooling fan is required to draw air into the canopy. In addition the generator air intake to the canopy should be designed such that the ingress of moisture is prohibited, preferably by use of a two stage filter.

The air intake/outlet must be suitable for the air flow given in the following table with additional pressure drops less than or equal to those given below:

| Frame | Air Flow             |                      | Additional<br>(intake/outlet)<br>Pressure Drop |
|-------|----------------------|----------------------|--|
|       | 50Hz<br>1500 Rev/Min | 60Hz<br>1800 Rev/Min |  |
| HC4   | 0.48m³/sec           | 0.58m³/sec           | 6mm water gauge                                |
|       | 1030cfm              | 1240cfm              | (0.25")  |
| HCK4  | 0.68m³/sec           | 0.83m³/sec           | 6mm water gauge                                |
|       | 1450cfm              | 1760cfm              | (0.25")  |
| HC5   | 1.04m³/sec           | 1.31m³/sec           | 6mm water gauge                                |
|       | 2202cfm              | 2708cfm              | (0.25")  |
| HCK5  | 1.23m³/sec           | 1.59m³/sec           | 6mm water gauge                                |
|       | 2615cfm              | 3366cfm              | (0.25")  |
| HC6   | 1.62m³/sec           | 1.96m³/sec           | 6mm water gauge                                |
|       | 3420cfm              | 4156cfm              | (0.25")  |
| HC7   | 2.64m³/sec           | 3.17m³/sec           | 6mm water gauge                                |
|       | 5600cfm              | 6720cfm              | (0.25")  |
| HCK7  | 3.0m³/sec            | 3.70m³/sec           | 6mm water gauge                                |
|       | 6550cfm              | 7860cfm              | (0.25")  |

**Table 1**

If specified at the time of ordering, HC6 and HC7 generators may be fitted with air filters. Air filters can be supplied factory fitted or as parts for up-fit for the HC4 and HC5 generators. These are oil charged gauze filters and require charging during installation.

**Important !** Reduction in cooling air flow or inadequate protection to the generator can result in damage and/or failure of windings.

Dynamic balancing of the generator rotor assembly has been carried out during manufacture in accordance with BS 6861 Part 1 Grade 2.5 to ensure vibration limits of the generator are in accordance with BS 4999 Part 142.

The main vibration frequencies produced by the component generator are as follows:-

|        |          |         |
|--------|----------|---------|
| 4 pole | 1500 rpm | 25 Hz   |
|        | 1800 rpm | 30 Hz   |
| 6 pole | 1000 rpm | 16.7 Hz |
|        | 1200 rpm | 20 Hz   |

### 3.1 VIBRATION

Vibrations generated by the engine are complex and contain harmonics of 1.5, 3, 5 or more times the fundamental frequency of vibration. The generator will be subjected to this vibration, which will result in the generator being subjected to vibration levels higher than those derived from the generator itself.

Newage generators are designed to withstand the vibration levels encountered on generating sets built to meet the requirements of ISO 8528-9 and BS5000-3. (Where ISO 8528 is taken to be broad band measurements and BS5000 refers to the predominant frequency of any vibrations on the generating set.)

#### DEFINITION OF BS5000 - 3

Generators shall be capable of continuously withstanding linear vibration levels with amplitudes of 0.25mm between 5Hz and 8Hz and velocities of 9.0mm/s rms between 8 Hz and 200 Hz when measured at any point directly on the carcass or main frame of the machine. These limits refer only to the predominant frequency of vibration of any complex waveform.

#### DEFINITION OF ISO 8528 - 9

ISO 8528-9 refers to a broad band of frequencies, the broad band is taken to be between 2 Hertz and 300 Hertz. The table below is an example from ISO 8528 - 9 (value 1). This simplified table lists the vibration limits by kVA range and speed for acceptable genset operation.

| VIBRATION LEVELS AS MEASURED ON THE GENERATOR |                        |                                       |                                     |   |
|---|------------------------|---------------------------------------|-------------------------------------|---|
| Engine Speed<br>Min -1                        | SET<br>OUTPUT<br>kVA   | VIBRATION<br>DISPLACEMENT<br>mm (rms) | VIBRATION<br>VELOCITY<br>mm/s (rms) | VIBRATION<br>ACCELERATION<br>m/s <sup>2</sup> (rms) |
| 4 POLE<br>1500 rpm 50 Hz<br>1800 rpm 60 HZ    | ≤ 10 kVA               | -                                     | -                                   | -   |
|   | > 10 but<br>≤ 50 Kva   | 0.64                                  | 40                                  | 25  |
|   | > 50 but<br>≤ 125 kVA  | 0.4                                   | 25                                  | 16  |
|   | > 125 but<br>≤ 250 kVA | 0.4                                   | 25                                  | 16  |
|   | > 250 kVA              | 0.32                                  | 20                                  | 13  |
| 6 POLE<br>1000 rpm 50 Hz<br>1200 rpm 60 HZ    | ≥ 250 but<br>≤ 1250    | 0.32                                  | 20                                  | 13  |
|   | > 1250                 | 0.29                                  | 18                                  | 11  |
| The 'Broad band' is taken as 2 Hz - 300 Hz.   |                        |                                       |                                     |   |

**Table 2**

It is the responsibility of the generating set designer to ensure the alignment of the genset, stiffness of the bedframe and mountings are such that the vibration limits as defined above are met.

If the vibration levels of the generating set are not within the parameters quoted above :-

1. Consult the genset builder. The genset builder should address the genset design to reduce the vibration levels as much as possible.
2. Discuss, with Newage, the impact of not meeting the above levels on both bearing and generator life expectancy.

**Important !** Exceeding either of the above specifications will have a detrimental effect on the generating set and in particular on the life of the bearings. (See section on bearings). This will invalidate the generator warranty. If you are in any doubt, contact Newage International Limited.

In standby applications where the running time is limited and reduced life expectancy is accepted, higher levels than specified in BS5000 can be tolerated, up to a maximum of 18mm/sec.

Two bearing generators require a substantial bedplate with engine/generator mounting pads to ensure a good base for accurate alignment. Close coupling of engine to generator can increase the overall rigidity of the set. A flexible coupling, designed to suit the specific engine/generator combination, is recommended to minimise torsional effects.

Alignment of single bearing generators is critical and vibration can occur due to the flexing of the flanges between the engine and generator. A substantial bedplate with engine/generator mounting pads is required.

For the purposes of establishing set design the bending moment at the engine flywheel housing to generator adaptor interface should not exceed that given in the table below:-

| FRAME | BENDING MOMENT         |
|-------|------------------------|
| 4/5   | 140 kgm. (1000ft.lbs.) |
| 6/7   | 275 kgm. (2000ft.lbs.) |

The maximum bending moment of the engine flange must be checked with the engine manufacturer.

Torsional vibrations occur in all engine-driven shaft systems and may be of a magnitude to cause damage at certain critical speeds. It is therefore necessary to consider the torsional vibration effect on the generator shaft and couplings.

It is the responsibility of the generator set manufacturer to ensure compatibility, and for this purpose drawings showing the shaft dimensions and rotor inertias are available for customers to forward to the engine supplier. In the case of single bearing generators coupling details are included.

**Important !** Torsional incompatibility and/or excessive vibration levels can cause damage or failure of generator and/or engine components.

The standard terminal box is arranged for cable entry on the right hand side looking from the non drive end of the generator. If specified at the time of order cable entry may be arranged on the opposite side.

The terminal box is constructed with removable panels for easy adaptation to suit specific glanding requirements. Within the terminal box there are insulated terminals for line and neutral connections and provision for earthing. Additional earthing points are provided on the generator feet.



**Warning !**

No earth connections are made on the generator and reference to site regulations for earthing must be made. Incorrect earthing or protection arrangements can result in personal injury or death.

The neutral is NOT connected to the frame.

Fault current curves (decrement curves), together with generator reactance data, are available on request to assist the system designer to select circuit breakers, calculate fault currents and ensure discrimination within the load network.



**Warning !**

Incorrect installation, service or replacement of parts can result in severe personal injury or death, and/or equipment damage. Service personnel must be qualified to perform electrical and mechanical service.

## SECTION 4

### INSTALLATION - PART 1

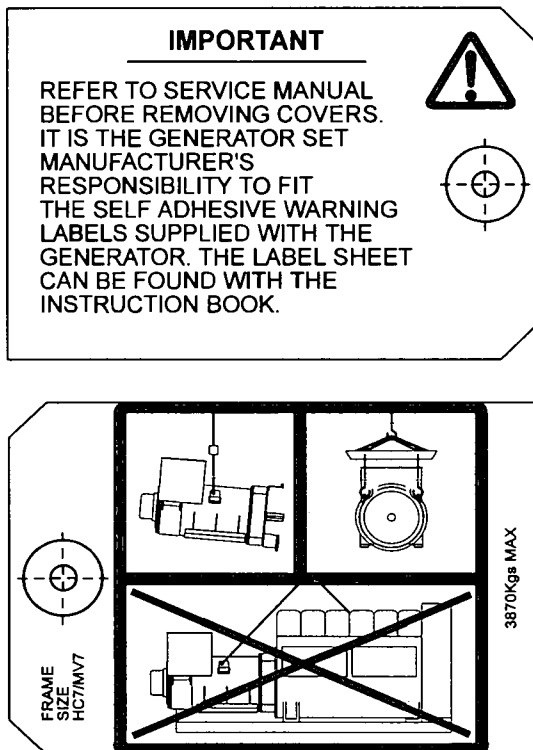
#### 4.1 LIFTING



**Warning !**

Incorrect lifting or inadequate lifting capacity can result in severe personal injury or equipment damage. **MINIMUM LIFTING CAPACITY REQUIRED IS AS INDICATED ON THE LIFTING LABEL.** Generator lifting lugs should not be used for lifting the complete generating set.

Two lifting lugs are provided for use with a shackle and pin type lifting aid. A spreader with chains to ensure that the lift is vertical of suitable length and lifting capacity must be used. Lifting points are designed to position the craneage point as close to the centre of gravity of the generator as possible, but due to design restrictions it is not possible to guarantee that the generator frame will remain horizontal while lifting. Care is therefore needed to avoid personal injury or equipment damage. The correct lifting arrangement is shown on the label attached to the lifting lug. (See sample below).



**Fig. 3**

Single bearing generators are supplied fitted with a rotor retaining bar at the drive end of the shaft. Single bearing generators are also fitted with wooden wedges supporting the fan for transit purposes.

Once the bar is removed to couple the rotor to engine, the rotor is free to move in the frame, and care is needed during coupling and alignment to ensure the frame is kept in the horizontal plane.

#### 4.2 ENGINE TO GENERATOR COUPLING ASSEMBLY

During the assembly of the Generator to the Engine it will be necessary to firstly carefully align, then rotate, the combined Generator rotor - Engine crankshaft assembly, as part of the construction process, to allow location, insertion and tightening of the coupling bolts. This requirement to rotate the combined assemblies exists for both single and two bearing units.

During the construction of single bearing units it is necessary to align the generator's coupling holes with the engine flywheel holes: it is suggested that two diametrically opposite location dowel pins are fitted to the engine flywheel, over which the generator coupling can slide into final location into the engine flywheel spigot recess. The dowels must be removed and replaced by coupling bolts before the final bolt tightening sequence.

While fitting and tightening the coupling bolts it will be necessary to rotate the Engine crankshaft - Generator rotor assembly. Care should be taken to ensure that rotation is carried out in an approved manner that ensures safe working practice when reaching inside the machine to insert or tighten coupling bolts, and that no component of the assembly is damaged by non-approved methods of assembly rotation.

Engine Manufacturers have available a proprietary tool designed to enable manual rotation of the crankshaft assembly. This tool must always be used, having been engineered as an approved method of assembly rotation, by engaging the manually driven pinion with the engine flywheel starter ring-gear.



**Danger !**

Before working inside the generator, during the aligning and fitting of coupling bolts, care should be taken to lock the assembly to ensure there is no possibility of assembly rotational movement.

#### 4.2.1 TWO BEARING GENERATORS

A flexible coupling should be fitted and aligned in accordance with the coupling manufacturer's instruction.

If a close coupling adaptor is used the alignment of machined faces must be checked by offering the generator up to the engine. Shim the generator feet if necessary. Ensure adaptor guards are fitted after generator/engine assembly is complete. Open coupled sets require a suitable guard, to be provided by the set builder.

Axial loading of the generator bearings should be avoided. Should it be unavoidable contact the factory for advice.

**Caution !** Incorrect guarding and/or generator alignment can result in personal injury and/or equipment damage.

#### 4.2.2 SINGLE BEARING GENERATORS TYPES HC & HCK

For transit and storage purposes the generator frame spigot and rotor coupling plates have been coated with a rust preventative. This **MUST BE** removed before assembly to engine.

A practical method for removal of this coating is to clean the mating surface areas with a de-greasing agent based on a petroleum solvent.

**Caution !** Care should be taken not to allow any cleaning agent to come into prolonged contact with skin.

Alignment of single bearing generators is critical. If necessary shim the generator feet to ensure alignment of the machined surfaces.

The sequence of assembly to the engine should generally be as follows:

1. On the engine check the distance from the coupling mating face on the flywheel to the flywheel housing mating face. This should be within 0.5mm of nominal dimension. This is necessary to ensure that a thrust is not applied to the ac generator bearing or engine bearing.
2. Check that the bolts securing the flexible plates to the coupling hub are tight and locked into position. Refer to Section 7, subsection 7.5.3.4 for tightening torques.
3. Remove covers from the drive end of the generator to gain access to coupling and adaptor bolts. Check coupling joint interfaces are clean and lubricant free.

#### 4. TYPE HC GENERATORS

Check that coupling discs are concentric with adaptor spigot. This can be adjusted by the use of tapered wooden wedges between the fan and adaptor. Alternatively the rotor can be suspended by means of a rope sling through the adaptor opening.

Offer the generator to engine and engage both coupling discs and housing spigots at same time, pushing generator towards engine until coupling discs are against flywheel face, and housing spigots located.

#### TYPE HCK GENERATORS

Screw the two supplied location studs into diametrically opposite engine flywheel tapped holes, about the horizontal centre line. Offer the generator to engine, locating rotor coupling discs over the location studs, pushing generator towards engine until housing spigots locate and coupling discs are against flywheel face.

5. Fit housing and coupling bolts taking care to use heavy gauge washers between coupling bolt head and coupling disc. Tighten bolts evenly around assembly sufficiently to ensure correct alignment.

#### TYPE HCK GENERATORS

Remove location studs and replace with coupling-flywheel bolts.

6. Tighten housing bolts.
7. Tighten coupling disc to flywheel bolts. Refer to engine manufacturers manual for correct tightening torque.

#### 8. TYPE HC GENERATORS

Remove rotor aligning aids, either wooden wedges, or the two M10 set screws and sheet metal wear plates.

**Caution ! Incorrect guarding and/or generator alignment can result in personal injury and/or equipment damage.**

### 4.3 EARTHING

The generator frame should be solidly bonded to the generating set bedplate. If antivibration mounts are fitted between the generator frame and its bedplate a suitably rated earth conductor (normally one half of the cross sectional area of the main line cables) should bridge across the antivibration mount.



**Warning !**

**Refer to local regulations to ensure that the correct earthing procedure has been followed.**

### 4.4 PRE-RUNNING CHECKS

#### 4.4.1 INSULATION CHECK

Insulation tests should be carried out before running the generating set, both after assembly and after installation on site. (see Section 7.1).

**Important !** The windings have been H.V. tested during manufacture and further H.V. testing may degrade the insulation with consequent reduction in operating life. Should it be necessary to demonstrate H.V. testing, for customer acceptance, the tests must be carried out at reduced voltage levels i.e. Test Voltage= 0.8 (2 X Rated Voltage + 1000)

#### 4.4.2 DIRECTION OF ROTATION

##### 4.4.2.1 FAN TYPES.

##### TYPE HC 4 & 5 GENERATORS.

These machines are fitted with a radial bladed bi-directional fan, operating within a conventional full height air outlet grills.

##### TYPE HC 6 & 7 GENERATORS.

These machines are fitted with an inclined bladed fan, operating within a conventional full height air outlet grills.

##### TYPE HCK 4, 5, & 7 GENERATORS.

These machines are fitted with a inclined bladed fan, operating within a voluted drive end adaptor with outlet grills half the machine height. Designed to optimise the fans performance.

##### 4.4.2.2 DIRECTION OF ROTATION

##### TYPE HCK GENERATORS.

These machines have been designed with an improved cooling fan system, incorporating the voluted fan housing. Therefore these machines are suitable only for clockwise rotation, as viewed from the drive end.

##### TYPE HC GENERATORS.

These machines can be operated in either direction of rotation.

##### Phase Rotation

HC generators can rotate efficiently in either direction. However phase rotation is fixed for clockwise rotation as viewed from the drive end. If the generator is to be rotated in a counter-clockwise direction it will be necessary for the customers to adjust their cabling to the output terminals accordingly. Refer to the factory for a reverse wiring diagram.

#### 4.4.3 VOLTAGE AND FREQUENCY

Check that the voltage and frequency levels required for the generating set application are as indicated on the generator nameplate.

HC4/5 generators normally have a 12 ends out reconnectable winding. If it is necessary to reconnect the stator for the voltage required, refer to diagrams in the back of this manual.

#### 4.4.4 AVR SETTINGS

To make AVR selections and adjustments remove the AVR cover and refer to 4.4.4.1, 4.4.4.2, 4.4.4.3 or 4.4.4.4 depending upon type of AVR fitted. Reference to the generator nameplate will indicate AVR type (SX440, SX421, MX341 or MX321).

Most of the AVR adjustments are factory set in positions which will give satisfactory performance during initial running tests. Subsequent adjustment may be required to achieve optimum performance of the set under operating conditions. Refer to 'Load Testing' section for details.

#### 4.4.4.1 TYPE SX440 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 4a for location of selection links.

##### 1. Frequency selection terminals

|                |           |
|----------------|-----------|
| 50Hz operation | LINK C-50 |
| 60Hz operation | LINK C-60 |

##### 2. Stability selection terminals

|             |          |
|-------------|----------|
| Frame HC4/5 | LINK B-C |
| Frame HC6/7 | LINK A-B |

##### 3. Sensing selection terminals

|          |
|----------|
| LINK 2-3 |
| LINK 4-5 |
| LINK 6-7 |

##### 4. Excitation Interruption Link

LINK K1-K2

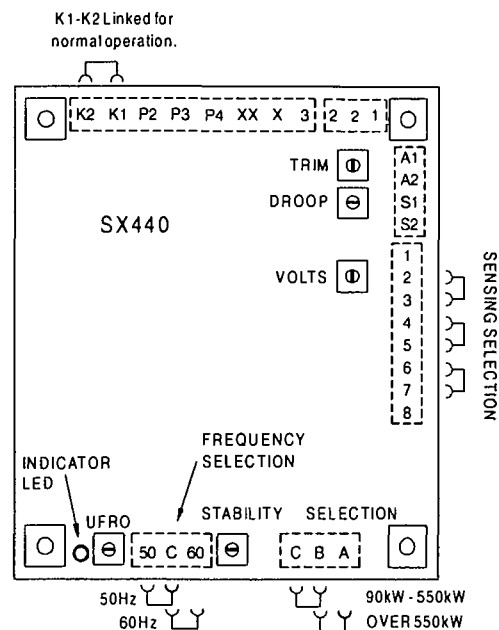


Fig. 4a

#### 4.4.4.2 TYPE SX421 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 4b for location of selection links.

##### 1. Frequency selection terminals

|                |           |
|----------------|-----------|
| 50Hz operation | LINK C-50 |
| 60Hz operation | LINK C-60 |

##### 2. Stability selection terminals

|             |          |
|-------------|----------|
| Frame HC4/5 | LINK B-C |
| Frame HC6/7 | LINK A-B |

##### 3. Excitation Interruption Link

Linked at auxiliary terminal block. K1-K2

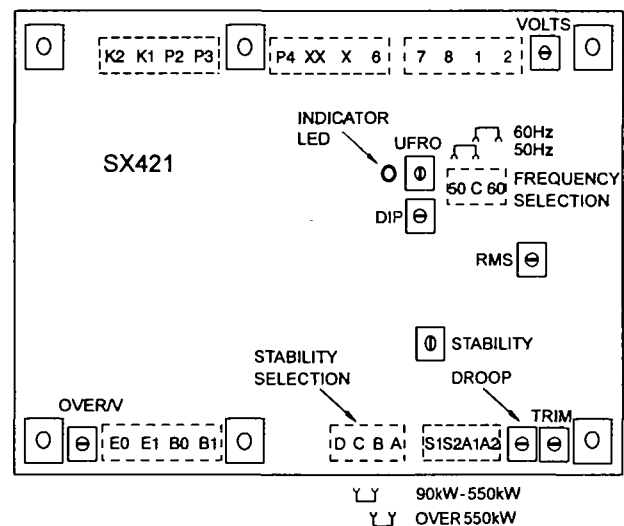


Fig. 4b

#### 4.4.4.3 TYPE MX341 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 4c for location of selection links.

|        |                |          |
|--------|----------------|----------|
| 4 pole | 50Hz operation | LINK 2-3 |
| 4 pole | 60Hz operation | LINK 1-3 |
| 6 pole | 50Hz operation | NO LINK  |
| 6 pole | 60Hz operation | LINK 1-2 |

##### 2. Stability selection terminals

|             |          |
|-------------|----------|
| Frame HC4/5 | LINK B-C |
| Frame HC6/7 | LINK A-B |

##### 3. Sensing selection terminals

|          |
|----------|
| LINK 2-3 |
| LINK 4-5 |
| LINK 6-7 |

##### 4. Excitation Interruption Link

LINK K1-K2

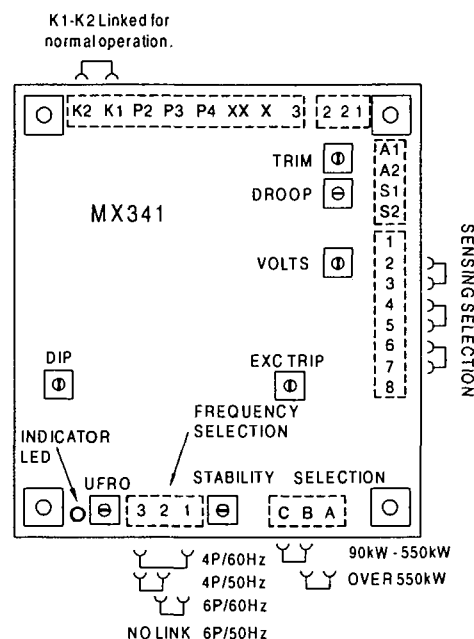


Fig. 4c

#### 4.4.4.4 TYPE MX321 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 4d for location of selection links.

##### 1. Frequency selection terminals

|        |                |          |
|--------|----------------|----------|
| 4 pole | 50Hz operation | LINK 2-3 |
| 4 pole | 60Hz operation | LINK 1-3 |
| 6 pole | 50Hz operation | NO LINK  |
| 6 pole | 60Hz operation | LINK 1-2 |

##### 2. Stability selection terminals

|             |          |
|-------------|----------|
| Frame HC4/5 | LINK B-C |
| Frame HC6/7 | LINK A-B |

##### 3. Excitation Interruption Link

Linked at auxiliary terminal block. K1-K2

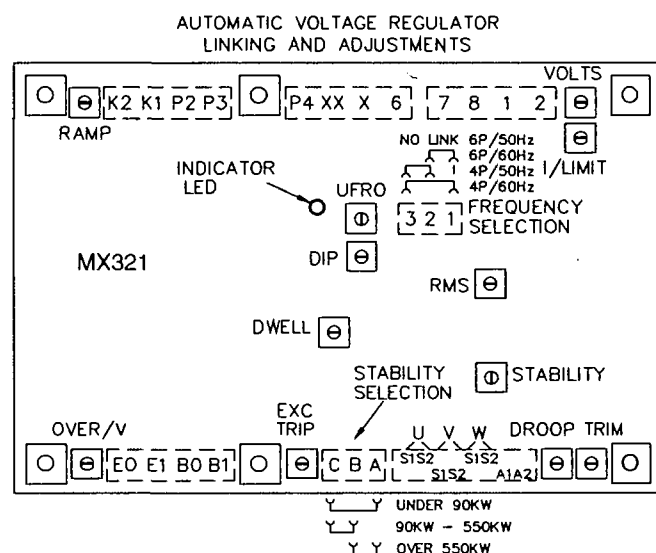


Fig. 4d

#### 4.5 GENERATOR SET TESTING



**Warning !**

During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments.

##### 4.5.1 TEST METERING/CABLING

Connect any instrument wiring and cabling required for initial test purposes with permanent or spring-clip type connectors.

Minimum instrumentation for testing should be line - line or line to neutral voltmeter, Hz meter, load current metering and kW meter. If reactive load is used a power factor meter is desirable.

**Important !** When fitting power cables for load testing purposes, ensure cable voltage rating is at least equal to the generator rated voltage. The load cable termination should be placed on top of the winding lead termination and clamped between the two nuts provided, on HC4/5 generators.

**Caution !** Check that all wiring terminations for internal or external wiring are secure, and fit all terminal box covers and guards. Failure to secure wiring and/or covers may result in personal injury and/or equipment failure.

#### 4.6 INITIAL START-UP



**Warning !**

During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments. Refit all access covers after adjustments are completed.

On completion of generating set assembly and before starting the generating set ensure that all engine manufacturer's pre-running procedures have been completed, and that adjustment of the engine governor is such that the generator will not be subjected to speeds in excess of 125% of the rated speed.

**Important !** Overspeeding of the generator during initial setting of the speed governor can result in damage to the generator rotating components.

In addition remove the AVR access cover and turn VOLTS control fully anti-clockwise. Start the generating set and run on no-load at nominal frequency. Slowly turn VOLTS control potentiometer clockwise until rated voltage is reached. Refer to Fig. 4a - 4d for control potentiometer location.

**Important !** Do not increase the voltage above the rated generator voltage shown on the generator nameplate.

The STABILITY control potentiometer will have been pre-set and should normally not require adjustment, but should this be required, usually identified by oscillation of the voltmeter, refer to Fig. 4a - 4d for control potentiometer location and proceed as follows:-

1. Run the generating set on no-load and check that speed is correct and stable.
2. Turn the STABILITY control potentiometer clockwise, then turn slowly anti-clockwise until the generator voltage starts to become unstable.

The correct setting is slightly clockwise from this position (i.e. where the machine volts are stable but close to the unstable region).



## 4.7 LOAD TESTING



**Warning !**

During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments. Refit all access covers after adjustments are completed.

### 4.7.1 AVR ADJUSTMENTS

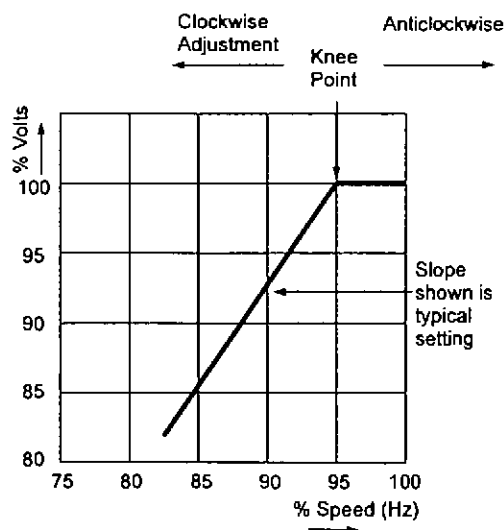
Refer to Fig. 4a - 4d for control potentiometer locations.

Having adjusted VOLTS and STABILITY during the initial start-up procedure, other AVR control functions should not normally need adjustment. If instability on load is experienced recheck stability setting. Refer to subsection 4.6.

If however, poor voltage regulation on-load or voltage collapse is experienced, refer to the following paragraphs on each function to a) check that the symptoms observed do indicate adjustment is necessary, and b) to make the adjustment correctly.

#### 4.7.1.1 UFRO (Under Frequency Roll Off) (AVR Types SX440, SX421, MX341 and MX321)

The AVR incorporates an underspeed protection circuit which gives a voltage/speed (Hz) characteristic as shown:



**Fig. 5**

The UFRO control potentiometer sets the "knee point".

Symptoms of incorrect setting are a) the light emitting diode (LED) indicator, just above the UFRO Control potentiometer, being permanently lit when the generator is on load, and b) poor voltage regulation on load, i.e. operation on the sloping part of the characteristic.

Clockwise adjustment lowers the frequency (speed) setting of the "knee point" and extinguishes the LED. For Optimum setting the LED should illuminate as the frequency falls just below nominal frequency, i.e. 47Hz on a 50Hz generator or 57Hz on a 60Hz generator.

**Important !** With AVR Types MX341 and MX321. If the LED is illuminated and no output voltage is present, refer to EXC TRIP and/or OVER/V sections below.

#### 4.7.1.2 EXC TRIP (Excitation Trip) AVR Types MX341 and MX321

An AVR supplied from a permanent magnet generator inherently delivers maximum excitation power on a line to line or line to neutral short circuit. In order to protect the generator windings the AVR incorporates an over excitation circuit which detects high excitation and removes it after a pre-determined time, i.e. 8-10 seconds.

Symptoms of incorrect setting are the generator output collapses on load or small overload, and the LED is permanently illuminated.

The correct setting is 70 volts +/- 5% between terminals X and XX.

#### 4.7.1.3 OVER/V (Over Voltage) AVR Types SX421 and MX321

Over voltage protection circuitry is included in the AVR to remove generator excitation in the event of loss of AVR sensing input.

The MX321 has both internal electronic de-excitation and provision of a signal to operate an external circuit breaker.

The SX421 only provides a signal to operate an external breaker, which MUST be fitted if over voltage protection is required.

Incorrect setting would cause the generator output voltage to collapse at no-load or on removal of load, and the LED to be illuminated.

The correct setting is 300 volts +/-5% across terminals E1, E0.

Clockwise adjustment of the OVER/V control potentiometer will increase the voltage at which the circuit operates.

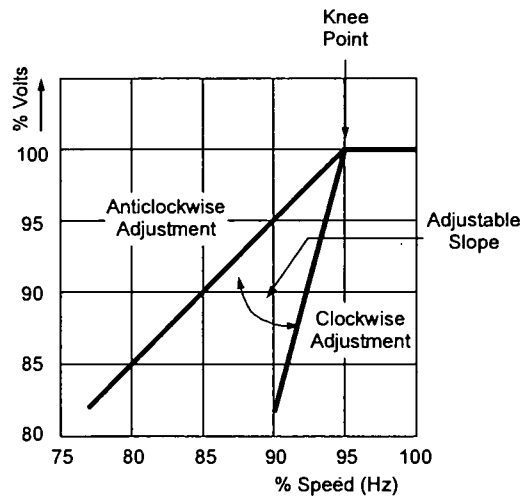
#### 4.7.1.4 TRANSIENT LOAD SWITCHING ADJUSTMENTS AVR Types SX421, MX341 and MX321

The additional function controls of DIP and DWELL are provided to enable the load acceptance capability of the generating set to be optimised. The overall generating set performance depends upon the engine capability and governor response, in conjunction with the generator characteristics.

It is not possible to adjust the level of voltage dip or recovery independently from the engine performance, and there will always be a 'trade off' between frequency dip and voltage dip.

## DIP-AVR Types SX421, MX341 and MX321

The dip function control potentiometer adjusts the slope of the voltage/speed (Hz) characteristic below the knee point as shown below:



**Fig. 6**

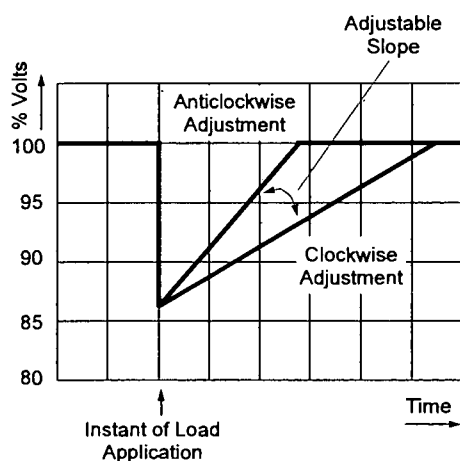
## DWELL-AVR Type MX321

The dwell function introduces a time delay between the recovery of voltage and recovery of speed.

The purpose of the time delay is to reduce the generator kW below the available engine kW during the recovery period, thus allowing an improved speed recovery.

Again this control is only functional below the "knee point", i.e. if the speed stays above the knee point during load switching there is no effect from the DWELL function setting.

Clockwise adjustment gives increased recovery time.



**Fig. 7**

The graphs shown above are representations only, since it is impossible to show the combined effects of voltage regulator and engine governor performance.



**Failure to refit covers can result in operator personal injury or death.**

**Warning !**

### 4.7.1.5 RAMP AVR Type MX321

The RAMP potentiometer enables adjustment of the time taken for the generator's initial build up to normal rated voltage during each start and run up to speed. The potentiometer is factory set to give a ramp time of three seconds, which is considered to be suitable for most applications. This time can be reduced to one second by turning the pot. fully counter clockwise, and increased to eight seconds by turning the pot. fully clockwise.

## 4.8 ACCESSORIES

Refer to the "ACCESSORIES" Section of this Manual for setting up procedures related to generator mounted accessories.

If there are accessories for control panel mounting supplied with the generator refer to the specific accessory fitting procedures inserted inside the back cover of this book.

Replace AVR access cover after all adjustments are completed.

## SECTION 5

### INSTALLATION - PART 2

#### 5.1 GENERAL

The extent of site installation will depend upon the generating set build, e.g. if the generator is installed in a canopied set with integral switchboards and circuit breaker, on site installation will be limited to connecting up the site load to the generating set output terminals. In this case reference should be made to the generating set manufacturer's instruction book and any pertinent local regulations.

If the generator has been installed on a set without switchboard or circuit breaker the following points relating to connecting up the generator should be noted.

#### 5.2 GLANDING

The terminal box is arranged for glanding on the right hand side (or if specifically ordered on the left hand side) viewed from the non drive end. Both panels are removable for drilling/punching to suit glands/or glanding boxes. If single core cables are taken through the terminal box side panel an insulated or non-magnetic gland plate should be fitted.

At entry to the terminal box incoming cables should be supported by a recognised glanding method such that minimum unsupported weight, and no axial force is transferred to the terminal assembly.

Incoming cables external to the terminal box should be supported at a sufficient distance from the centre line of the generating set so as to avoid a tight radius at the point of entry into the terminal box panel, and allow movement of the generator set on its anti-vibration mountings without excessive stress on the cable.

Before making final connections, test the insulation resistance of the windings. The AVR should be disconnected during this test and RTD leads grounded.

A 500V Megger or similar instrument should be used. Should the insulation resistance be less than 5M $\Omega$  the windings must be dried out as detailed in the Service and Maintenance section of this manual.

When making connections to the terminals of Frame 4 generators, the incoming cable termination lug should be placed on top of the winding lead termination lug(s) and then clamped with the nut provided.

**Important !** To avoid the possibility of swarf entering any electrical components in the terminal box, panels must be removed for drilling.

#### 5.3 TORQUE SETTINGS FOR TERMINAL CONNECTIONS

**Pre treatment:** Clean plated surfaces with a degreasing agent, then lightly abrade them to remove any tarnish. Don't score the surface.

The **generator torque settings** for all connections, links, CT's, accessories, cables, etc. is 45 Nm.

The **customer output cables** should be connected to the terminals using 8.8 grade steel bolts and associated anti-vibration hardware.

The following table is for your guidance.

| FRAME | HOLE SIZE | BOLT SIZE | TORQUE Nm |
|-------|-----------|-----------|-----------|
| 4     | -         | 12        | 45        |
| 5     | 13        | 12        | 50        |
| 6     | 17        | 14        | 70        |
| 7     | 17        | 16        | 90        |

**Table 3**

Carry out **periodic checks** to ensure the correct torque settings.

#### 5.4 EARTHING

The neutral of the generator is not bonded to the generator frame as supplied from the factory. An earth terminal is provided inside the terminal box adjacent to the main terminals. Should it be required to operate with the neutral earthed a substantial earth conductor (normally equivalent to one half of the section of the line conductors) must be connected between the neutral and the earth terminal inside the terminal box. It is the responsibility of the generating set builder to ensure the generating set bedplate and generator frame are all bonded to the main earth terminal in the terminal box.

**Caution !** Reference to local electricity regulations or safety rules should be made to ensure correct earthing procedures have been followed.

#### 5.5 PROTECTION

It is the responsibility of the end user and his contractors/sub-contractors to ensure that the overall system protection meets the needs of any inspectorate, local electricity authority or safety rules, pertaining to the site location.

To enable the system designer to achieve the necessary protection and/or discrimination, fault current curves are available on request from the factory, together with generator reactance values to enable fault current calculations to be made.



**Warning !**

Incorrect installation and/or protective systems can result in personal injury and/or equipment damage. Installers must be qualified to perform electrical installation work.

#### 5.6 COMMISSIONING

Ensure that all external cabling is correct and that all the generating set manufacturer's pre-running checks have been carried out before starting the set.

Generators fitted with air filters should have the filters charged with oil prior to commissioning. Refer to Service Section for charging procedure (subsection 7.3.2).

The generator AVR controls will have been adjusted during the generating set manufacturer's tests and should normally not require further adjustment.

Should malfunction occur during commissioning refer to Service and Maintenance section 'Fault Finding' procedure (subsection 7.4).

## SECTION 6

### ACCESSORIES

Generator control accessories may be fitted, as an option, in the generator terminal box. If fitted at the time of supply, the wiring diagram(s) in the back of this book shows the connections. When the options are supplied separately, fitting instructions are provided with the accessory.

The following table indicates availability of accessories with the differing AVRs.

| AVR Model | Paralleling Droop or Astatic | Manual Voltage Regulator | VAr/PF Control | Current Limit |
|-----------|------------------------------|--------------------------|----------------|---------------|
| SX440     | ✓                            | ✗                        | ✓              | ✗             |
| SX421     | ✓                            | ✗                        | ✓              | ✗             |
| MX341     | ✓                            | ✓                        | ✓              | ✗             |
| MX321     | ✓                            | ✓                        | ✓              | ✓             |

**Table 4**

#### 6.1 REMOTE VOLTAGE ADJUST (ALL AVR TYPES)

A remote voltage adjust (hand trimmer) can be fitted.

The remote voltage adjustment potentiometer is connected across AVR terminals 1-2.

These terminals are normally linked.

When the remote voltage adjust potentiometer is used the link across terminals 1-2 must be removed.

On AVR types SX440 and MX341 the link 1-2 is on an adjacent terminal block.

On AVR types SX421 and MX321 the link 1-2 is on the AVR terminals.

#### 6.2 PARALLEL OPERATION

Understanding of the following notes on parallel operation is useful before attempting the fitting or setting of the droop kit accessory. When operating in parallel with other generators or the mains, it is essential that the phase sequence of the incoming generator matches that of the busbar and also that all of the following conditions are met before the circuit breaker of the incoming generator is closed on to the busbar (or operational generator).

1. Frequency must match within close limits.
2. Voltages must match within close limits.
3. Phase angle of voltages must match within close limits.

A variety of techniques, varying from simple synchronising lamps to fully automatic synchronisers, can be used to ensure these conditions are met.

Once connected in parallel a minimum instrumentation level per generator of voltmeter, ammeter, wattmeter (measuring total power per generator), and frequency meter is required in order to adjust the engine and generator controls to share kW in relation to engine ratings and kVAr in relation to generator ratings.

**Important !** Failure to meet conditions 1, 2, and 3 when closing the circuit breaker, will generate excessive mechanical and electrical stresses, resulting in equipment damage.

It is important to recognise that

1. kW are derived from the engine, and speed governor characteristics determine the kW sharing between sets
- and
2. kVAr are derived from the generator, and excitation control characteristics determine the kVAr sharing.

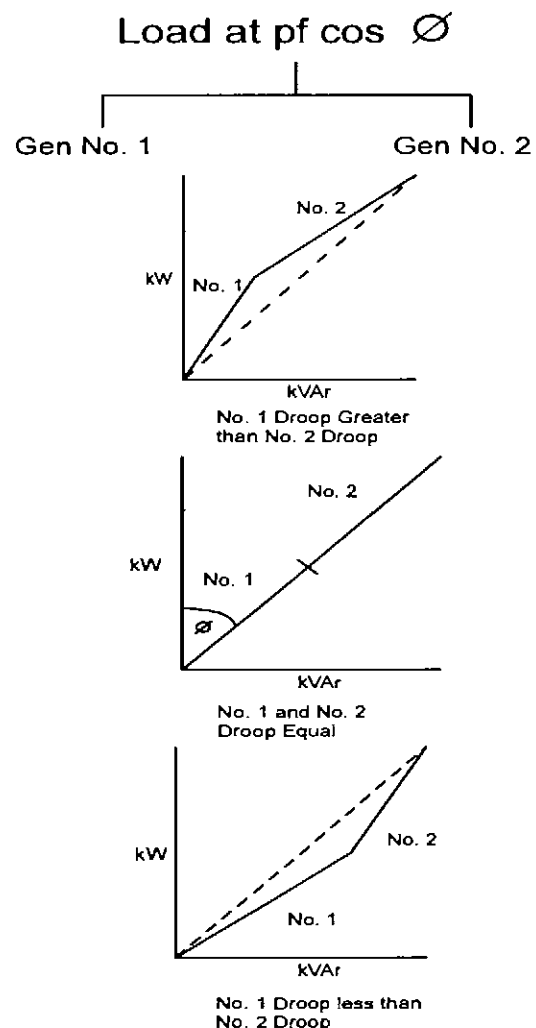
Reference should be made to the generating set manufacturer's instructions for setting the governor controls.

#### 6.2.1 DROOP

The most commonly used method of kVAr sharing is to create a generator voltage characteristic which falls with decreasing power factor (increasing kVAr). This is achieved with a current transformer (C.T.) which provides a signal dependent on current phase angle (i.e. power factor) to the AVR.

The current transformer has a burden resistor on the AVR board, and a percentage of the burden resistor voltage is summed into the AVR circuit. Increasing droop is obtained by turning the DROOP control potentiometer clockwise.

The diagrams below indicate the effect of droop in a simple two generator system:-



Generally 5% droop at full load current zero p.f. is sufficient to ensure kVAR sharing.

If the droop accessory has been supplied with the generator it will have been tested to ensure correct polarity and set to a nominal level of droop. The final level of droop will be set during generating set commissioning.

Although nominal droop setting may be factory set it is advisable to go through the setting procedure below.

### 6.2.1.1 SETTING PROCEDURE

Depending upon available load the following settings should be used - all are based on rated current level.

|                |                        |                 |
|----------------|------------------------|-----------------|
| 0.8 P.F. LOAD  | (at full load current) | SET DROOP TO 3% |
| Zero P.F. LOAD | (at full load current) | SET DROOP TO 5% |

Setting the droop with low power factor load is the most accurate.

Run each generator as a single unit at rated frequency or rated frequency + 4% depending upon type of governor and nominal voltage. Apply available load to rated current of the generator. Adjust 'DROOP' control potentiometer to give droop in line with above table. Clockwise rotation increases amount of droop. Refer to Fig. 4a - 4d for potentiometer locations.

Note 1)

Reverse polarity of the C.T. will raise the generator voltage with load. The polarities S1-S2 shown on the wiring diagrams are correct for clockwise rotation of the generator looking at the drive end. Reversed rotation requires S1-S2 to be reversed.

Note 2)

The most important aspect is to set all generators equal. The precise level of droop is less critical.

Note 3)

A generator operated as a single unit with a droop circuit set at rated load 0.8 power factor is unable to maintain the usual 0.5% regulation. A shorting switch can be connected across S1-S2 to restore regulation for single running.

**Important !** **LOSS OF FUEL** to an engine can cause its generator to motor with consequent damage to the generator windings. Reverse power relays should be fitted to trip main circuit breaker. **LOSS OF EXCITATION** to the generator can result in large current oscillations with consequent damage to generator windings. Excitation loss detection equipment should be fitted to trip main circuit breaker.

### 6.2.2 ASTATIC CONTROL

The 'droop' current transformer can be used in a connection arrangement which enables the normal regulation of the generator to be maintained when operating in parallel.

This feature is only supplied from the factory as a fitted droop kit, however, if requested at the time of order, the diagrams inside the back cover of this book will give the necessary site connections. The end user is required to provide a shorting switch for the droop current transformer secondary.

**Important !** When using this connection arrangement a shorting switch is required across each C.T. burden (terminals S1 and S2.) The switch must be closed a) when a generating set is not running and b) when a generating set is selected for single running.

Should the generator be required to be converted from standard droop to 'astatic' control, diagrams are available on request.

The setting procedure is exactly the same as for DROOP. (Subsection 6.2.1.1)

### 6.3 MANUAL VOLTAGE REGULATOR (MVR) - MX341 and MX321 AVR

This accessory is provided as an 'emergency' excitation system, in the event of an AVR failure.

Powered from a PMG output the unit is manually set, but automatically controls the excitation current, independent of generator voltage or frequency.

The unit is provided with 'MANUAL', 'OFF', 'AUTO' switching facility.

#### 'MANUAL'

- position connects the exciter field to the MVR output. Generator output is then controlled by the operator adjusting the excitation current.

#### 'OFF'

- disconnects the exciter field from both MVR and the normal AVR.

#### 'AUTO'

- connects the exciter field to the normal AVR and the generator output is controlled at the pre-set voltage under AVR control.

### 6.4 OVERVOLTAGE DE-EXCITATION BREAKER SX421 and MX321 AVR

This accessory provides positive interruption of the excitation power in the event of overvoltage due to loss of sensing or internal AVR faults including the output power device.

With the MX321 AVR this accessory is supplied loose for fitting in the control panel.

In the case of the SX421 the circuit breaker is always supplied and will normally be fitted in the generator.

**Important !** When the CB is supplied loose, terminals K1-K2 at the auxiliary terminal block are fitted with a link to enable operation of the AVR. When connecting the circuit breaker this link must be removed.

#### 6.4.1 RESETTING THE EXCITATION BREAKER

In the event of operation of the circuit breaker, indicated by loss of generator output voltage, manual resetting is required. When in the "tripped" state the circuit breaker switch lever shows "OFF". To reset move the switch lever to the position showing "ON".



**Danger !**

Terminals which are LIVE with the generating set running are exposed when the AVR access cover is removed. Resetting of the circuit breaker must be carried out with the generating set stationary, and engine starting circuits disabled.

When fitted in the generator, access to the breaker is gained by removal of the AVR access cover.

The circuit breaker is mounted on the AVR mounting bracket either to the left or to the right of the AVR depending upon AVR position. After resetting the circuit breaker replace the AVR access cover before restarting the generating set. Should resetting of the circuit breaker not restore the generator to normal operation, refer to subsection 7.5.

#### 6.5 CURRENT LIMIT - MX321 AVR

These accessories work in conjunction with the AVR circuits to provide an adjustment to the level of current delivered into a fault. One current transformer (CT) per phase is fitted to provide current limiting on any line to line or line to neutral fault.

Note: The W phase CT can also provide "DROOP". Refer to 6.2.1.1. for setting droop independent of current limit.

Adjustment means is provided with the "I/LIMIT" control potentiometer on the AVR. Refer to Fig. 4d for location. If current limit transformers are supplied with the generator the limit will be set in accordance with the level specified at the time of order, and no further adjustment will be necessary. However, should the level need to be adjusted, refer to the setting procedure given in 6.5.1.

##### 6.5.1 SETTING PROCEDURE

Run the generating set on no-load and check that engine governor is set to control nominal speed.

Stop the generating set. Remove the link between terminals K1-K2 at the auxiliary terminal block and connect a 5A switch across the terminals K1-K2.

Turn the "I/LIMIT" control potentiometer fully anticlockwise. Short circuit the stator winding with a bolted 3 phase short at the main terminals. An AC current clip-on ammeter is required to measure the winding lead current.

With the switch across K1-K2 open start the generating set.

Close the switch across K1-K2 and turn the "I/LIMIT" control potentiometer clockwise until required current level is observed on the clip-on ammeter. As soon as correct setting is achieved open the K1-K2 switch.

Should the current collapse during the setting procedure, the internal protective circuits of the AVR will have operated. In this event shut down the set and open the K1-K2 switch. Restart the set and run for 10 minutes with K1-K2 switch open, to cool the generator windings, before attempting to resume the setting procedure.

**Important !** Failure to carry out the correct COOLING procedure may cause overheating and consequent damage to the generator windings.

#### 6.6 POWER FACTOR CONTROLLER (PFC3)

This accessory is primarily designed for those generator applications where operation in parallel with the mains supply is required.

Protection against loss of mains voltage or generator excitation is not included in the unit and the system designer must incorporate suitable protection.

The electronic control unit requires both droop and kVAr current transformers. When supplied with the generator, wiring diagrams inside the back cover of this manual show the connections and the additional instruction leaflet provided gives details of setting procedures for the power factor controller (PFC3).

The unit monitors the power factor of the generator current and adjusts excitation to maintain the power factor constant.

This mode can also be used to control the power factor of the mains if the point of current monitoring is moved to the mains cables. Refer to the factory for appropriate details.

It is also possible to operate the unit to control kVAr of the generator if required. Refer to the factory for appropriate details.

## **SECTION 7**

### **SERVICE AND MAINTENANCE**

As part of routine maintenance procedures, periodic attention to winding condition (particularly when generators have been idle for a long period) and bearings is recommended. (Refer to subsections 7.1 and 7.2 respectively).

When generators are fitted with air filters regular inspection and filter maintenance is required. (Refer to subsection 7.3).

#### **7.1 WINDING CONDITION**



**Warning !**

**Service and fault finding procedures present hazards which can result in severe personal injury or death. Only personnel qualified to perform electrical and mechanical service should carry out these procedures. Ensure engine starting circuits are disabled before commencing service or maintenance procedures. Isolate any anti-condensation heater supply.**

#### **Guidance of Typical Insulation Resistance [IR] Values**

The following is offered as general information about IR values and is aimed at providing guidance about the typical IR values for generators from new through to the point of refurbishment.

##### **New Machines**

The generators Insulation Resistance, along with many other critical factors, will have been measured during the alternator manufacturing process. The generator will have been transported with an appropriate packaging suitable for the method of delivery to the Generating Set assemblers works. Where we expect it to be stored in a suitable location protected from adverse environmental conditions.

However, absolute assurance that the generator will arrive at the Gen-set production line with IR values still at the factory test levels of above 100 MΩ cannot be guaranteed.

##### **At Generating Set Manufacturers Works**

The generator should have been transported and stored such that it will be delivered to the assembly area in a clean dry condition. If held in appropriate storage conditions the generator IR value should typically be 25 MΩ.

If the unused/new generators IR values fall below 10 MΩ then a drying out procedure should be implemented by one of the processes outlined below before being despatched to the end customer's site. Some investigation should be undertaken into the storage conditions of the generator while on site.

##### **Generators in Service**

Whilst It is known that a generator will give reliable service with an IR value of just 1.0 MΩ. For a relatively new generator to be so low it must have been subjected to inappropriate operating or storage conditions.

Any temporarily reduction in IR values can be restored to expected values by following one of the drying out procedures.

#### **7.1.1 WINDING CONDITION ASSESSMENT**

**Caution ! The AVR should be disconnected and the Resistance Temperature Detector (R.T.D.) leads grounded during this test.**

The condition of the windings can be assessed by measurement of insulation resistance [IR] between phase to phase, and phase to earth.

Measurement of winding insulation should be carried out: -

1. As part of a periodic maintenance plan.
2. After prolonged periods of shutdown.
3. When low insulation is suspected, e.g. damp or wet windings.

Care should be taken when dealing with windings that are suspected of being excessively damp or dirty. The initial measurement of the [IR] Insulation Resistance should be established using a low voltage (500V) megger type instrument. If manually powered the handle should initially be turned slowly so that the full test voltage will not be applied, and only applied for long enough to very quickly assess the situation if low values are suspected or immediately indicated.

Full megger tests or any other form of high voltage test should not be applied until the windings have been dried out and if necessary cleaned.

#### **Procedure for Insulation Testing**

Disconnect all electronic components, AVR, electronic protection equipment etc. Ground the [RTD's] Resistance Temperature Detection devices if fitted. Short out the diodes on the rotating diode assembly. Be aware of all components connected to the system under test that could cause false readings or be damaged by the test voltage.

Carry out the insulation test in accordance with the 'operating instructions for the test equipment.

The measured value of insulation resistance for all windings to earth and phase to phase should be compared with the guidance given above for the various 'life stages' of a generator. The minimum acceptable value must be greater than 1.0 MΩ.

**If low winding insulation is confirmed use one or more of the methods, given below, for drying the winding should be carried out.**

#### **7.1.2 METHODS OF DRYING OUT GENERATORS**

##### **Cold Run**

Consider a good condition generator that has not been run for some time, and has been standing in damp, humid conditions. It is possible that simply running the gen set unexcited - AVR terminals K1 K2 open circuit - for a period of say 10 minutes will sufficiently dry the surface of the windings and raise the IR sufficiently, to greater than 1.0 MΩ, and so allow the unit to be put into service.

##### **Blown Air Drying**

Remove the covers from all apertures to allow the escape of the water-laden air. During drying, air must be able to flow freely through the generator in order to carry off the moisture.

Direct hot air from two electrical fan heaters of around 1 – 3 kW into the generator air inlet apertures. Ensure the heat source is at least 300mm away from the windings to avoid over heating and damage to the insulation.

Apply the heat and plot the insulation value at half hourly intervals. The process is complete when the parameters covered in the section entitled, 'Typical Drying Out Curve', are met.

Remove the heaters, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anti-condensation heaters are energised, and retest prior to running.

### Short Circuit Method

**NOTE:** This process should only be performed by a competent engineer familiar with safe operating practices within and around generator sets of the type in question.

Ensure the generator is safe to work on, initiate all mechanical and electrical safety procedures pertaining to the genset and the site.

Bolt a short circuit of adequate current carrying capacity, across the main terminals of the generator. The shorting link should be capable of taking full load current.

Disconnect the cables from terminals "X" and "XX" of the AVR.

Connect a variable dc supply to the "X" (positive) and "XX" (negative) field cables. The dc supply must be able to provide a current up to 2.0 Amp at 0 - 24 Volts.

Position a suitable ac ammeter to measure the shorting link current.

Set the dc supply voltage to zero and start the generating set. Slowly increase the dc voltage to pass current through the exciter field winding. As the excitation current increases, so the stator current in the shorting link will increase. This stator output current level must be monitored, and not allowed to exceed 80% of the generators rated output current.

After every 30 minutes of this exercise:

Stop the generator and switch off the separate excitation supply, and measure and record the stator winding IR values, and plot the results. The resulting graph should be compared with the classic shaped graph. This drying out procedure is complete when the parameters covered in the section entitled 'Typical Drying Out Curve' are met.

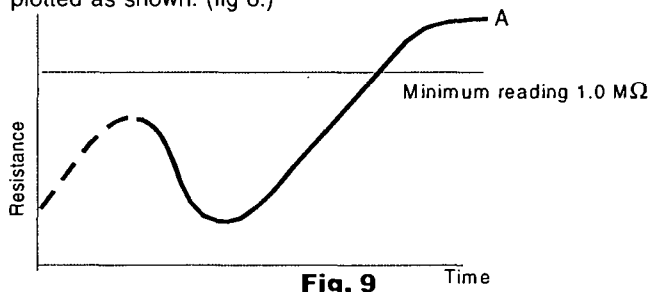
Once the Insulation Resistance is raised to an acceptable level - minimum value 1.0 MΩ – the dc supply may be removed and the exciter field leads "X" and "XX" re-connected to their terminals on the AVR.

Rebuild the genset, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anti-condensation heaters are energised, and retest the generator prior to running.

### TYPICAL DRYING OUT CURVE

Whichever method is used to dry out the generator the resistance should be measured every half-hour and a curve plotted as shown. (fig 6.)



The illustration shows a typical curve for a machine that has absorbed a considerable amount of moisture. The curve indicates a temporary increase in resistance, a fall and then a gradual rise to a steady state. Point 'A', the steady state, must be greater than 1.0 MΩ. (If the windings are only slightly damp the dotted portion of the curve may not appear).

For general guidance expect that the typical time to reach point 'A' will be:

- 1 hour for a BC16/18,
- 2 hours for a UC22/27
- 3 hours for an HC4,5,6&7

Drying should be continued after point "A" has been reached for at least one hour.

It should be noted that as winding temperature increases, values of insulation resistance may significantly reduce. Therefore, the reference values for insulation resistance can only be established with windings at a temperature of approximately 20°C.

If the IR value remains below 1.0 MΩ, even after the above drying methods have been properly conducted, then a Polarisation Index test [PI] should be carried out.

If the minimum value of 1.0 MΩ for all components cannot be achieved rewinding or refurbishment of the generator will be necessary.

**The generator must not be put into service until the minimum values can be achieved.**

**Important !** The short circuit must not be applied with the AVR connected in circuit. Current in excess of the rated generator current will cause damage to the windings.

After drying out, the insulation resistances should be rechecked to verify minimum resistances quoted above are achieved.

On re-testing it is recommended that the main stator insulation resistance is checked as follows:-

Separate the neutral leads

|                |                  |                   |
|----------------|------------------|-------------------|
| Ground V and W | phase and megger | U phase to ground |
| Ground U and W | phase and megger | V phase to ground |
| Ground U and V | phase and megger | W phase to ground |

If the minimum value of 1.0MΩ is not obtained, drying out must be continued and the test repeated.

### 7.2 BEARINGS

One of two bearing options will be fitted to generators covered by this manual.

| Bearing Options |               |                   |
|-----------------|---------------|-------------------|
| HC/HCK/HCM      | Regreasable*  | Sealed for life*† |
| 4               | Not available | Standard          |
| 5               | Optional      | Standard          |
| 6               | Optional      | Standard          |
| 7               | Standard      | Not available     |

**Table 5**

\*All bearings are supplied pre-packed with Kluber Asonic GHY 72 grease.

†Sealed for life bearings are fitted with integral seals and are not regreasable.

### BEARING LIFE

**Important !** The life of a bearing in service is subject to the working conditions and the environment.

**Important !** High levels of vibration from the engine or misalignment of the set will stress the bearing and reduce its service life. If the vibration limits set out in BS 5000-3 and ISO 8528-9 are exceeded bearing life will be reduced. Refer to 'Vibration' below.

**Important !** Long stationary periods in an environment where the generator is subject to vibration can cause false brinnelling, which puts flats on the ball and grooves on the races, leading to premature failure.



**Important !** Very humid atmospheric or wet conditions can emulsify the grease causing corrosion and deterioration of the grease, leading to premature failure of the bearings.

## HEALTH MONITORING OF THE BEARINGS

Newage recommends that the user checks the bearing condition, using monitoring equipment, to determine the state of the bearings. The 'best practice' is to take initial readings as a base line and periodically monitor the bearings to detect a deteriorating trend. It will then be possible to plan a bearing change at an appropriate generating set or engine service interval.

## VIBRATION

Newage generators are designed to withstand the vibration levels encountered on generating sets built to meet the requirements of ISO 8528-9 and BS5000-3. (Where ISO 8528 is taken to be broad band measurements and BS5000 refers to the predominant frequency of any vibrations on the generating set.)

### DEFINITION of BS5000 - 3

Generators shall be capable of continuously withstanding linear vibration levels with amplitudes of 0.25mm between 5Hz and 8Hz and velocities of 9.0mm/s rms between 8 Hz and 200 Hz when measured at any point directly on the carcass or main frame of the machine. These limits refer only to the predominant frequency of vibration of any complex waveform.

### DEFINITION of ISO 8528 - 9

ISO 8528-9 refers to a broad band of frequencies, the broad band is taken to be between 2 Hertz and 300 Hertz. The table below is an example from ISO 8528 - 9 (value 1). This simplified table lists the vibration limits by kVA range and speed for acceptable genset operation.

| VIBRATION LEVELS AS MEASURED ON THE GENERATOR |                        |                                       |                                     |   |
|---|------------------------|---------------------------------------|-------------------------------------|---|
| Engine Speed<br>Min -1                        | SET<br>OUTPUT<br>kVA   | VIBRATION<br>DISPLACEMENT<br>mm (rms) | VIBRATION<br>VELOCITY<br>mm/s (rms) | VIBRATION<br>ACCELERATION<br>m/s <sup>2</sup> (rms) |
| 4 POLE<br>1500 rpm 50 Hz<br>1800 rpm 60 Hz    | ≤ 10 kVA               | -                                     | -                                   | -   |
|   | > 10 but<br>≤ 50 Kva   | 0.64                                  | 40                                  | 25  |
|   | > 50 but<br>≤ 125 kVA  | 0.4                                   | 25                                  | 16  |
|   | > 125 but<br>≤ 250 kVA | 0.4                                   | 25                                  | 16  |
|   | > 250 kVA              | 0.32                                  | 20                                  | 13  |
| 6 POLE<br>1000 rpm 50 Hz<br>1200 rpm 60 Hz    | ≥ 250 but<br>≤ 1250    | 0.32                                  | 20                                  | 13  |
|   | > 1250                 | 0.29                                  | 18                                  | 11  |
| The 'Broad band' is taken as 2 Hz - 300 Hz.   |                        |                                       |                                     |   |

**Table 6**

**Important !** Exceeding either of the above specifications will have a detrimental effect on the life of the bearing. This will invalidate the generator warranty. If you are in any doubt, contact Newage International Limited.

If the vibration levels of the generating set are not within the parameters quoted above :-

1. Consult the genset builder. The genset builder should address the genset design to reduce the vibration levels as much as possible.
2. Discuss, with Newage, the impact of not meeting the above levels on both bearing and generator life expectancy.

Where requested, or deemed necessary, Newage will work with the genset builder in an attempt to find a satisfactory solution.

## BEARING 'SERVICE LIFE' EXPECTANCY

Bearing manufacturers recognise that the "service life" of their bearings is dependent upon many factors that are not in their control, they cannot therefore quote a "service life".

Although "service life" cannot be guaranteed, it can be maximised by attention to the generating set design. An understanding of the genset application will also help the user to maximise the service life expectancy of the bearings. Particular attention should be paid to the alignment, reduction of vibration levels, environmental protection, maintenance and monitoring procedures.

Newage does not quote life expectancy figures for bearings, but suggests practicable replacement intervals based on the L10 life of the bearing, the grease and the recommendations of the bearing and grease manufacturers.

For general-purpose applications, providing the vibration levels do not exceed the levels stated in ISO 8528-9\* and BS5000-3\* and the ambient temperature does not exceed 50°C the following approximations can be applied when planning bearing replacements.

\*(see section on vibration)

Sealed for Life Bearings. - Approximately 30,000 hours.

Re-greaseable bearings. - Approximately 40,000 hours.

(Provided the correct maintenance is carried out, and only Kluber Asonic GHY 72 grease is used in all bearings.)

It is important to note that bearings in service, under good operating conditions, can continue to run beyond the recommended replacement period. It should also be remembered that the risk of bearing failure increases with time.

If in doubt about any aspect of the 'bearing life' on generators supplied by Newage International, contact your nearest Newage subsidiary or contact the Stamford factory direct.

See the back cover for addresses.

### 7.3 AIR FILTERS

Air filters for the removal of airborne particulate matter (dust) are offered as an addition to the standard build option. Filters on Frame 6 and 7 need to be ordered with the generator but Frame 4 and 5 can have air filters fitted after the generator is built.

Air filters need to be changed with oil before the gen set is put to work (see 7.3.1).

The frequency of filter maintenance will depend upon the severity of the site conditions. Regular inspection of the elements will be required to establish when cleaning is necessary.



**Removal of filter elements enables access to LIVE parts.  
Only remove elements with the generator out of service.**

**Danger!**

#### 7.3.1 CLEANING PROCEDURE

Remove the filter elements from the filter frames. Immerse or flush the element with a suitable degreasing agent until the element is clean.

As an alternative procedure a high pressure water hose with a flat nozzle can be used. Sweep the water spray back and forth across the element from the clean side (fine mesh side of element) holding the nozzle firmly against the element surface. Cold water may be adequate depending upon type of contamination although hot water is preferable.

The element can be inspected for cleanliness by looking through the filter towards the light.

When thoroughly clean, no cloudy areas will be seen. Dry elements thoroughly before attempting to carry out the recharging procedure.

#### 7.3.2 RECHARGING (CHARGING)

Charging is best done by totally immersing the dry element into a dip tank containing "Filterkote Type K" or commercial lubricating oil SAE 20/50. Oils of higher or lower viscosity are not recommended.

Allow elements to completely drain before refitting the elements into the frames and putting into service.

### 7.4 FAULT FINDING

**Important ! Before commencing any fault finding procedures examine all wiring for broken or loose connections.**

Four types of excitation control system, involving four types of AVR, can be fitted to the range of generators covered by this manual. The systems can be identified by a combination of AVR type, where applicable, and the last digit of the generator frame size designation. Refer to the generator nameplate then proceed to the appropriate subsection as indicated below:-

| DIGIT | EXCITATION CONTROL | SUBSECTION |
|-------|--------------------|------------|
| 4     | SX440 AVR          | 7.4.1      |
| 4     | SX421 AVR          | 7.4.2      |
| 3     | MX341 AVR          | 7.4.3      |
| 3     | MX321 AVR          | 7.4.4      |

#### 7.4.1 SX440 AVR - FAULT FINDING

|   |   |
|---|---|
| No voltage build-up when starting set           | <ol style="list-style-type: none"> <li>1. Check link K1-K2.</li> <li>2. Check speed.</li> <li>3. Check residual voltage. Refer to subsection 7.4.5.</li> <li>4. Follow separate excitation test procedure to check generator and AVR. Refer to subsection 7.5.</li> </ol> |
| Unstable voltage either on no-load or with load | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check stability setting. Refer to subsection 4.6.</li> </ol>   |
| High voltage either on no-load or with load     | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check that generator load is not capacitive (leading power factor).</li> </ol>   |
| Low voltage no-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check link 1-2 or external hand trimmer leads for continuity.</li> </ol>   |
| Low voltage on-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check UFRO setting. Refer to subsection 4.7.1.1.</li> <li>3. Follow separate excitation procedure to check generator and AVR. Refer to subsection 7.5.</li> </ol>                                      |

**Table 7**

#### 7.4.2 SX421 AVR - FAULT FINDING

|   |  |
|---|--|
| No voltage build-up when starting set           | <ol style="list-style-type: none"> <li>1. Check circuit breaker ON. Refer to subsection 6.4.1.</li> <li>2. Check speed.</li> <li>3. Check residual voltage. Refer to subsection 7.4.5.</li> <li>4. Follow separate excitation test procedure to check generator and AVR. Refer to subsection 7.5.</li> </ol> |
| Unstable voltage either on no-load or with load | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check stability setting. Refer to subsection 4.6.</li> </ol>  |
| High voltage either on no-load or with load     | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check link 1-2 or external hand trimmer leads for continuity. Check continuity of leads 7-8 and P3-P2 for continuity.</li> <li>3. Check that generator load is not capacitive (leading power factor).</li> </ol>                          |
| Low voltage no-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check link 1-2 or external hand trimmer leads for continuity.</li> </ol>  |
| Low voltage on-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check UFRO setting. Refer to subsection 4.7.1.1.</li> <li>3. Follow separate excitation procedure to check generator and AVR. Refer to subsection 7.5.</li> </ol>   |
| Excessive voltage/speed dip on load switching   | <ol style="list-style-type: none"> <li>1. Check governor response.</li> <li>2. Refer to generating set manual. Check 'DIP' setting. Refer to subsection 4.7.1.4.</li> </ol>  |

**Table 8**

### 7.4.3 MX341 AVR - FAULT FINDING

|  |  |
|--|--|
| No voltage build-up when starting set            | <ol style="list-style-type: none"> <li>1. Check link K1-K2 on auxiliary terminals.</li> <li>2. Follow Separate Excitation Test Procedure to check machine and AVR. Refer to subsection 7.5.</li> </ol>     |
| Loss of voltage when set running                 | <ol style="list-style-type: none"> <li>1. First stop and re-start set. If no voltage or voltage collapses after short time, follow Separate Excitation Test Procedure. Refer to subsection 7.5.</li> </ol> |
| Generator voltage high followed by collapse      | <ol style="list-style-type: none"> <li>1. Check sensing leads to AVR.</li> <li>2. Refer to Separate Excitation Test Procedure. Refer to subsection 7.5.</li> </ol>   |
| Voltage unstable, either on no-load or with load | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check "STAB" setting. Refer to Load Testing section for procedure. Refer to subsection 4.6.</li> </ol>                        |
| Low voltage on-load                              | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. If correct check "UFRO" setting. Refer to subsection 4.7.1.1.</li> </ol>  |
| Excessive voltage/speed dip on load switching    | <ol style="list-style-type: none"> <li>1. Check governor response. Refer to generating set manual. Check "DIP" setting. Refer to subsection 4.7.1.4.</li> </ol>  |
| Sluggish recovery on load switching              | <ol style="list-style-type: none"> <li>1. Check governor response. Refer to generating set manual.</li> </ol>  |

**Table 9**

### 7.4.4 MX321 AVR - FAULT FINDING

|  |  |
|--|--|
| No voltage build-up when starting set            | <ol style="list-style-type: none"> <li>1. Check link K1-K2 on auxiliary terminals. Follow Separate Excitation Test Procedure to check machine and AVR. Refer to subsection 7.5.</li> </ol>                 |
| Voltage very slow to build up                    | <ol style="list-style-type: none"> <li>1. Check setting of ramp potentiometer. Refer to 4.7.1.5</li> </ol>   |
| Loss of voltage when set running                 | <ol style="list-style-type: none"> <li>1. First stop and re-start set. If no voltage or voltage collapses after short time, follow Separate Excitation Test Procedure. Refer to subsection 7.5.</li> </ol> |
| Generator voltage high followed by collapse      | <ol style="list-style-type: none"> <li>1. Check sensing leads to AVR.</li> <li>2. Refer to Separate Excitation Test Procedure. Refer to subsection 7.5.</li> </ol>   |
| Voltage unstable, either on no-load or with load | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check "STAB" setting. Refer to Load Testing section for procedure. Refer to subsection 4.6.</li> </ol>                        |
| Low voltage on-load                              | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. If correct check "UFRO" setting. Refer to subsection 4.7.1.1.</li> </ol>  |
| Excessive voltage/speed dip on load switching    | <ol style="list-style-type: none"> <li>1. Check governor response. Refer to generating set manual. Check "DIP" setting. Refer to subsection 4.7.1.4.</li> </ol>  |
| Sluggish recovery on load switching              | <ol style="list-style-type: none"> <li>1. Check governor response. Refer to generating set manual. Check "DWELL" setting. Refer to Load Testing section 4.7.1.4.</li> </ol>                                |

**Table 10**

### 7.4.5 RESIDUAL VOLTAGE CHECK

This procedure is applicable to generators with either SX460 or SX440 or SX421 AVR.

With the generator set stationary remove AVR access cover and disconnect leads X and XX from the AVR.

Start the set and measure voltage across AVR terminals P2-P3 on SX440 or SX421 AVR.

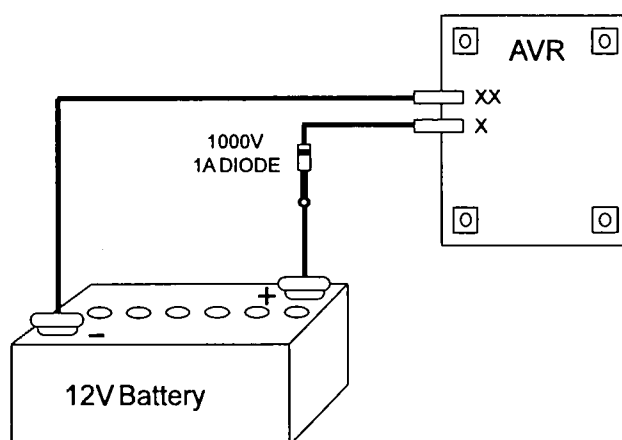
Stop the set, and replace leads X and XX on the AVR terminals. If the measured voltage was above 5V the generator should operate normally.

If the measured voltage was under 5V follow the procedure below.

### 7.4.6 'REFLASHING' TO RESTORE RESIDUAL

Using a 12 volt dc battery as a supply clip leads from battery negative to AVR terminal XX, and from battery positive through a diode to AVR terminal X. See Fig. 7.

**Important !** A diode must be used as shown below to ensure the AVR is not damaged.



**Fig. 7**

**Important !** If the generating set battery is used for field flashing, the generator main stator neutral must be disconnected from earth.

Restart the set and note output voltage from main stator, which should be approximately nominal voltage, or voltage at AVR terminals P2-P3 on SX440 or SX421 which should be between 170 and 250 volts.

Stop the set and unclip battery supply from terminals X and XX. Restart the set. The generator should now operate normally. If no voltage build-up is obtained it can be assumed a fault exists in either the generator or the AVR circuits. Follow the SEPARATE EXCITATION TEST PROCEDURE to check generator windings, rotating diodes and AVR. Refer to subsection 7.5.

## 7.5 SEPARATE EXCITATION TEST PROCEDURE

The generator windings, diode assembly and AVR can be checked using the appropriate following section.

### 7.5.1 GENERATOR WINDINGS, ROTATING DIODES and PERMANENT MAGNET GENERATOR (PMG)

#### 7.5.2 EXCITATION CONTROL TEST.

### 7.5.1 GENERATOR WINDINGS, ROTATING DIODES and PERMANENT MAGNET GENERATOR (PMG)

**Important !** The resistances quoted apply to a standard winding. For generators having windings or voltages other than those specified refer to factory for details. Ensure all disconnected leads are isolated and free from earth.

**Important !** Incorrect speed setting will give proportional error in voltage output.

#### CHECKING PMG

Start the set and run at rated speed.

Measure the voltages at the AVR terminals P2, P3 and P4. These should be balanced and within the following ranges:-

50Hz generators - 170-180 volts

60Hz generators - 200-216 volts

Should the voltages be unbalanced stop the set, remove the PMG sheet metal cover from the non drive endbracket and disconnect the multipin plug in the PMG output leads. Check leads P2, P3, P4 for continuity. Check the PMG stator resistances between output leads. These should be balanced and within

+/-10% of 2.3 ohms. If resistances are unbalanced and/or incorrect the PMG stator must be replaced. If the voltages are balanced but low and the PMG stator winding resistances are correct - the PMG rotor must be replaced.

#### CHECKING GENERATOR WINDINGS AND ROTATING DIODES

This procedure is carried out with leads X and XX disconnected at the AVR or transformer control rectifier bridge and using a 12 volt d.c. supply to leads X and XX.

Start the set and run at rated speed.

Measure the voltages at the main output terminals U, V and W. If voltages are balanced and within +/-10% of the generator nominal voltage, refer to 7.5.1.1.

Check voltages at AVR terminals 6, 7 and 8. These should be balanced and between 170-250 volts.

If voltages at main terminals are balanced but voltage at 6, 7 and 8 are unbalanced, check continuity of leads 6, 7 and 8. Where an isolating transformer is fitted (MX321 AVR) check transformer windings. If faulty the transformer unit must be replaced.

If voltages are unbalanced, refer to 7.5.1.2.

### 7.5.1.1 BALANCED MAIN TERMINAL VOLTAGES

If all voltages are balanced within 1% at the main terminals, it can be assumed that all exciter windings, main windings and main rotating diodes are in good order, and the fault is in the AVR or transformer control. Refer to subsection 7.5.2 for test procedure.

If voltages are balanced but low, there is a fault in the main excitation windings or rotating diode assembly. Proceed as follows to identify:-

#### Rectifier Diodes

The diodes on the main rectifier assembly can be checked with a multimeter. The flexible leads connected to each diode should be disconnected at the terminal end, and the forward and reverse resistance checked. A healthy diode will indicate a very high resistance (infinity) in the reverse direction, and a low resistance in the forward direction. A faulty diode will give a full deflection reading in both directions with the test meter on the 10,000 ohms scale, or an infinity reading in both directions.

On an electronic digital meter a healthy diode will give a low reading in one direction, and a high reading in the other.

#### Replacement of Faulty Diodes

The rectifier assembly is split into two plates, the positive and negative, and the main rotor is connected across these plates. Each plate carries 3 diodes, the negative plate carrying negative biased diodes and the positive plate carrying positive biased diodes. Care must be taken to ensure that the correct polarity diodes are fitted to each respective plate. When fitting the diodes to the plates they must be tight enough to ensure a good mechanical and electrical contact, but should not be overtightened. The recommended torque tightening is 4.06 - 4.74Nm (36-42lb in).

#### Surge Suppressor

The surge suppressor is a metal-oxide varistor connected across the two rectifier plates to prevent high transient reverse voltages in the field winding from damaging the diodes. This device is not polarised and will show a virtually infinite reading in both directions with an ordinary resistance meter. If defective this will be visible by inspection, since it will normally fail to short circuit and show signs of disintegration. Replace if faulty.

#### Main Excitation Windings

If after establishing and correcting any fault on the rectifier assembly the output is still low when separately excited, then the main rotor, exciter stator and exciter rotor winding resistances should be checked (see Resistance Charts), as the fault must be in one of these windings. The exciter stator resistance is measured across leads X and XX. The exciter rotor is connected to six studs which also carry the diode lead terminals. The main rotor winding is connected across the two rectifier plates. The respective leads must be disconnected before taking the readings.

Resistance values should be within +/-10% of the values given in the tables below:-

| 4 POLE GENERATORS |            |                |               |
|-------------------|------------|----------------|---------------|
| FRAME SIZE        | MAIN ROTOR | EXCITER STATOR | EXCITER ROTOR |
| 4 - 4C            | 0.91       | 18             | 0.136         |
| 4 - 4D            | 1.04       | 18             | 0.136         |
| 4 - 4E            | 1.17       | 18             | 0.136         |
| 4 - 4F            | 1.35       | 18             | 0.136         |
|                   |            |                |               |
| 5 - 4C            | 1.55       | 17             | 0.184         |
| 5 - 4D            | 1.77       | 17             | 0.184         |
| 5 - 4E            | 1.96       | 17             | 0.184         |
| 5 - 4F            | 2.16       | 17             | 0.184         |
|                   |            |                |               |
| 6 - 4G            | 1.75       | 17             | 0.158         |
| 6 - 4H            | 1.88       | 17             | 0.158         |
| 6 - 4J            | 2.09       | 17             | 0.158         |
| 6 - 4K            | 2.36       | 17             | 0.158         |
|                   |            |                |               |
| 7 - 4E            | 1.27       | 17             | 0.096         |
| 7 - 4F            | 1.41       | 17             | 0.096         |
| 7 - 4G            | 1.65       | 17             | 0.096         |
| 7 - 4H            | 1.77       | 17             | 0.096         |

**Table 11**

| 6 POLE GENERATORS |            |                |               |
|-------------------|------------|----------------|---------------|
| FRAME SIZE        | MAIN ROTOR | EXCITER STATOR | EXCITER ROTOR |
| 6 - 6G            | 1.12       | 17             | 0.2           |
| 6 - 6H            | 1.33       | 17             | 0.2           |
| 6 - 6J            | 1.5        | 17             | 0.2           |
| 6 - 6K            | 1.75       | 17             | 0.2           |
|                   |            |                |               |
| 7 - 6E            | 2.33       | 17             | 0.2           |
| 7 - 6F            | 2.83       | 17             | 0.2           |
| 7 - 6G            | 3.25       | 20             | 0.28          |

**Table 12**

### 7.5.1.2 UNBALANCED MAIN TERMINAL VOLTAGES

If voltages are unbalanced, this indicates a fault on the main stator winding or main cables to the circuit breaker. NOTE: Faults on the stator winding or cables may also cause noticeable load increase on the engine when excitation is applied. Disconnect the main cables and separate the winding leads U1-U2, (U5-U6), V1-V2, (V5-V6), W1-W2, (W5-W6) to isolate each winding section.

Note:- leads suffixed 5 and 6 apply to 12 wire windings only.

Measure each section resistance - values should be balanced and within +/-10% of the value given below:-

| MAIN STATOR SECTION RESISTANCES |                           |                   |                          |                   |
|---------------------------------|---------------------------|-------------------|--------------------------|-------------------|
| 4 POLE GENERATORS               |                           |                   |                          |                   |
| SECTION RESISTANCES             |                           |                   |                          |                   |
| FRAME SIZE                      | WINDING 311<br>1-2 OR 5-6 | WINDING 12<br>1-2 | WINDING 17<br>1-2 OR 5-6 | WINDING 07<br>1-2 |
| 4 - 4C                          | 0.0085                    | N/A               | 0.0115                   | N/A               |
| 4 - 4D                          | 0.006                     | N/A               | 0.01                     | N/A               |
| 4 - 4E                          | 0.0045                    | N/A               | 0.0075                   | N/A               |
| 4 - 4F                          | 0.0037                    | N/A               | 0.0055                   | N/A               |
|                                 |                           |                   |                          |                   |
| 5 - 4C                          | 0.0032                    | N/A               | 0.0053                   | N/A               |
| 5 - 4D                          | 0.0024                    | N/A               | 0.004                    | N/A               |
| 5 - 4E                          | 0.0022                    | N/A               | 0.0034                   | N/A               |
| 5 - 4F                          | 0.0019                    | N/A               | 0.0025                   | N/A               |
|                                 |                           |                   |                          |                   |
| 6 - 4G                          | 0.0017                    | 0.0034            | N/A                      | 0.0055            |
| 6 - 4H                          | 0.0013                    | 0.0025            | N/A                      | 0.0036            |
| 6 - 4J                          | 0.0011                    | 0.0022            | N/A                      | 0.003             |
| 6 - 4K                          | 0.0085                    | 0.0017            | N/A                      | 0.0026            |
|                                 |                           |                   |                          |                   |
| 7 - 4E                          | N/A                       | 0.0016            | N/A                      | 0.0026            |
| 7 - 4F                          | N/A                       | 0.0013            | N/A                      | 0.002             |
| 7 - 4G                          | N/A                       | 0.0009            | N/A                      | 0.0015            |
| 7 - 4H                          | N/A                       | 0.0008            | N/A                      | 0.0011            |

**Table 13**

| 6 POLE GENERATORS   |                           |                   |            |                   |
|---------------------|---------------------------|-------------------|------------|-------------------|
| SECTION RESISTANCES |                           |                   |            |                   |
| FRAME SIZE          | WINDING 311<br>1-2 OR 5-6 | WINDING 12<br>1-2 | WINDING 17 | WINDING 07<br>1-2 |
| 6 - 6G              | 0.0045                    | 0.009             | N/A        | 0.015             |
| 6 - 6H              | 0.0032                    | 0.0063            | N/A        | 0.01              |
| 6 - 6J              | N/A                       | 0.0049            | N/A        | 0.007             |
| 6 - 6K              | 0.002                     | 0.0039            | N/A        | 0.006             |
|                     |                           |                   |            |                   |
| 7 - 6E              | N/A                       | 0.0027            | N/A        | 0.0042            |
| 7 - 6F              | N/A                       | 0.0018            | N/A        | 0.0032            |
| 7 - 6G              | N/A                       | 0.0014            | N/A        | 0.002             |

**Table 14**

Measure insulation resistance between sections and each section to earth.

Unbalanced or incorrect winding resistances and/or low insulation resistances to earth indicate rewinding of the stator will be necessary. Refer to removal and replacement of component assemblies subsection 7.5.3.

## 7.5.2 EXCITATION CONTROL TEST

### 7.5.2.1 AVR FUNCTION TEST

All types of AVR's can be tested with this procedure:

1. Remove exciter field leads X & XX (F1 & F2) from the AVR terminals X & XX (F1 & F2).
2. Connect a 60W 240V household lamp to AVR terminals X & XX (F1 & F2).
3. Set the AVR VOLTS control potentiometer fully clockwise.
4. Connect a 12V, 1.0A DC supply to the exciter field leads X & XX (F1 & F2) with X (F1) to the positive.
5. Start the generating set and run at rated speed.
6. Check that the generator output voltage is within +/- 10% of rated voltage.

Voltages at AVR terminals 7-8 on SX460 AVR or P2-P3 on SX440 or SX421 AVR should be between 170 and 250 volts. If the generator output voltage is correct but the voltage on 7-8 (or P2-P3) is low, check auxiliary leads and connections to main terminals.

Voltages at P2, P3, P4 terminals on MX341 and MX321 should be as given in 7.5.1.

The lamp connected across X-XX should glow. In the case of the SX460, SX440 and SX421 AVRs the lamp should glow continuously. In the case of the MX341 and MX321 AVRs the lamp should glow for approximately 8 secs. and then turn off. Failure to turn off indicates faulty protection circuit and the AVR should be replaced. Turning the "VOLTS" control potentiometer fully anti-clockwise should turn off the lamp with all AVR types.

Should the lamp fail to light the AVR is faulty and should be replaced.

**Important !** After this test turn VOLTS control potentiometer fully anti-clockwise.

### 7.5.3 REMOVAL AND REPLACEMENT OF COMPONENT ASSEMBLIES

METRIC THREADS ARE USED THROUGHOUT

**Caution !** When lifting single bearing generators, care is needed to ensure the generator frame is kept in the horizontal plane. The rotor is free to move in the frame and can slide out if not correctly lifted. Incorrect lifting can cause serious injury to personnel.

#### 7.5.3.1 ANTI-CONDENSATION HEATERS



**Danger !**

The external mains electricity supply used to power the anti-condensation heater must be switched off and safely isolated before attempting any work adjacent to the heater, or removal of the non drive end endbracket on which the anti-con heater is mounted. Ensure that the engine is inhibited prior to work in generator.

#### 7.5.3.2 REMOVAL OF PERMANENT MAGNET GENERATOR (PMG)

1. Remove access cover.
2. Disconnect P2, P3, P4 at the multiway connector inside the access cover.

3. Remove the 4 screws and clamps retaining the stator housing (Frames 4, 5 and 6) or the stator pack (Frame 7).
4. Tap the stator pack or housing out of its spigot.

**NOTE:**

As the highly magnetic rotor will attract the stator core, care must be taken to avoid a contact which may damage the winding.

5. Remove the exciter rotor securing bolt and stow safely and firmly pull the complete rotor assembly from its location.

N.B. Keep the rotor clean and avoid contact with metal dust or particles - preferably place in plastic bag.

**Important !** The rotor assembly must not be dismantled.

Re-assembly is a reversal of the above procedure having due regard for the notes below:-

1. Ensure rotor magnet assembly is free of metal pieces or particles.
2. Care is needed to avoid winding damage when re-assembling the stator pack, due to strong magnetic attraction.

#### 7.5.3.3 REMOVAL OF BEARINGS

**Important !** Position the main rotor so that a full pole face of the main rotor core is at the bottom. Remove PMG of the stator bore if fitted.

The generators in this manual will be fitted with one of three different bearing arrangements. There may be two different arrangements on a two-bearing generator. (See table 14 & 15)

| BEARING OPTIONS FOR DRIVE-END BEARINGS |     |     |     |     |
|--|-----|-----|-----|-----|
|  | HC4 | HC5 | HC6 | HC7 |
| Regreasable bearings                   | N/A | OPT | OPT | STD |
| Sealed for life with a cartridge       | STD | STD | STD | N/A |
| Sealed for life without cartridge      | N/A | N/A | N/A | N/A |

**Table 15**

| BEARING OPTIONS FOR NON DRIVE-END BEARINGS |     |     |     |     |
|--|-----|-----|-----|-----|
|  | HC4 | HC5 | HC6 | HC7 |
| Regreasable bearings                       | N/A | OPT | OPT | STD |
| Sealed for life with a cartridge           | NA  | NA  | STD | N/A |
| Sealed for life without cartridge          | STD | STD | N/A | N/A |

**Table 16**

Removal of the bearings may be effected either after the rotor assembly has been removed or more simply by removal of endbracket(s).

**Be sure to note the location of all components during removal to assist during the assembly process.**

## BEARING REPLACEMENT

### Environment

Every effort must be made to establish a clean area around the generator when removing and replacing bearings. Contamination is a major cause of bearing failures.

### Equipment

Suitable cleaning solvent  
Bearing puller, two or three leg  
Thin protective gloves  
Lint free cleaning cloth  
Induction heater.

### Preparation

Remove PMG if fitted  
Remove the lubrication pipework if fitted  
Position the rotor so that the full pole face of the main rotor is at the bottom of the stator bore.  
Remove the end bracket, see 7.5.3.4 for procedure.

#### NOTES:

- It is not necessary to remove the rotor.
- Ensure that the bearing contact surfaces shows no sign of wear or corrosion prior to fitting the bearing.
- Never refit used bearings, wave washers or 'O'rings.
- Never refit used bearings, grease flingers, wave washer or 'O' rings.
- Only the outer race should be used to transmit load during assembly (NEVER use the inner race).

## REMOVAL OF REGREASABLE BEARINGS

The bearings are a press fit on the shaft and can be removed with standard tooling, i.e. 2 or 3 legged manual or hydraulic bearing pullers.

To remove bearings proceed as follows:

1. Remove 4 screws holding bearing cap.
2. Remove cap.
3. Non drive end - remove wave washer and circlip (single bearing only).
4. Remove bearing cartridge housing complete with bearing (and grease flinger if fitted).
5. Remove bearing from cartridge.
6. Discard the old bearing 'O' rings and wave washer where fitted.

The bearing cap(s) and cartridge(s) must be thoroughly flushed out with clean solvent and checked for wear or damage, before re-assembly. Damaged components should be replaced before refitting the bearing.

## ASSEMBLY OF REGREASABLE BEARINGS

NOTE: Gloves must be worn at all times when handling the bearings, grease and solvent.

1. Wipe clean the assembly surface, using cleaning solvent on lint free cloth.
2. Wipe clean: Bearing Cartridge, Wave Washer, Bearing Cap, grease flinger, all re-lubrication pipes and fittings (internal and external). Visually inspect all components after cleaning, for contamination.
3. Place all components on the clean assembly surface. Do not use an air line to blow off excess fluid.
4. Thoroughly clean the external surface of the grease gun nozzle using lint free cloth.

### Bearing preparation

1. Remove the bearing from its packaging.
2. Wipe off the preservative oil from the surface of the inner and outer rings - using lint free cloth only.
3. Place the bearing on the clean assembly surface, with the bearing designation marking facing down.

### Bearing Assembly ( Lubrication, see TABLE 17)

#### Cartridge:

1. Apply the specified cartridge grease fill quantity to the back face of the bearing housing.
2. Apply a small amount of grease to the grooved sealing surface in the cartridge.
3. Apply anti-fretting lubricant (MP14002 - Klüber Altemp Q NB 50) to the bearing housing circumference. Apply paste in a thin coherent layer by use of a lint free cloth (DO NOT rub in) (use clean protective gloves).
4. Non-drive end - fit new 'O' Rings into the 'O' Ring grooves in the bearing housing circumference.

#### Bearing:

1. Apply half the specified bearing grease fill quantity (see table 16) to the upper face of the bearing (opposite side to the bearing designation markings).
2. Thumb the applied grease into the bearing, ensuring good penetration into the raceways/balls (use clean protective gloves).

### Assemble Bearing into Cartridge

1. Heat the bearing cartridge to 25° C above ambient with an induction heater ( Do not exceed 100°C).
2. With greased face of the bearing facing the cartridge bore, assemble the bearing into the bearing housing. Ensure the bearing outer race contacts the location shoulder.

## Assemble Bearing onto Shaft

### Bearing Cartridge

1. Heat the Bearing and Cartridge assembly to 80°C above ambient with an induction heater. ( use induction heater, no other heat source is suitable)
2. Slide the Bearing and Cartridge assembly over the shaft, pushing it firmly against the bearing seating shoulder.
3. Rotate the assembly (including inner race) 45° in either direction, to provide correct alignment. The bearing must be held firmly in place until it is cool enough to positively self locate.

NOTE: Ensure cartridge is at ambient temp. before assembling bracket.

### Cap/Flinger:

Apply the specified cap grease fill quantity to the inside face of the cap (see table 16).

1. Fill the grease exhaust slot with grease.
2. Apply a small amount of grease to the grooved sealing surface in the cap.
3. Fit circlip. (single bearing only).
4. Heat flinger to 120°C and place on shaft up to the bearing inner race. Hold firmly until positively located.
5. Place wave washer in cap, fit cap to bearing cartridge.

### Re-lubrication pipe:

1. Fill pipe and grease nipple with grease.
2. Fit pipe work to machine.

| INITIAL LUBRICATION DETAILS, REGREASEABLE BEARINGS |                  |                 |       |                 |       |                 |       |
|--|------------------|-----------------|-------|-----------------|-------|-----------------|-------|
| FRAME  | BEARING POSITION | GREASE QUANTITY |       |                 |       |                 |       |
|  |                  | BEARINGS        |       | CARTRIDGE       |       | CAP             |       |
|  |                  | CM <sup>3</sup> | GRAMS | CM <sup>3</sup> | GRAMS | CM <sup>3</sup> | GRAMS |
| 5  | Non-Drive End    | 65              | 58    | 33              | 29    | 33              | 29    |
| 5  | Drive End        | 92              | 82    | 46              | 41    | 46              | 41    |
| 6  | Non-Drive End    | 121             | 111   | 63              | 56    | 63              | 56    |
| 6  | Drive End        | 156             | 139   | 78              | 69    | 78              | 69    |
| 7  | Non-Drive End    | 174             | 154   | 87              | 77    | 87              | 77    |
| 7  | Drive End        | 208             | 185   | 104             | 92    | 104             | 92    |

Lubricant: Kluber Asonic GHY 72

**Table 17**

## REMOVAL OF GREASED FOR LIFE BEARINGS WITH BEARING CARTRIDGE

The bearings are a press fit on the shaft and can be removed with standard tooling, i.e. 2 or 3 legged manual or hydraulic bearing pullers.

To remove bearings proceed as follows:

1. Remove 4 screws holding bearing cap.
2. Remove cap.
3. Non drive end - remove wave washer and circlip (single bearing only).
4. Remove bearing cartridge housing complete with bearing.
5. Remove bearing from cartridge.
6. Discard the old bearing, 'o' rings and wave washer where fitted.

The bearing cap(s) and cartridge(s) must be thoroughly flushed out with clean solvent and checked for wear or damage, before re-assembly. Damaged components should be replaced before refitting the bearing.

## ASSEMBLY OF SEALED FOR LIFE BEARINGS WITH CARTRIDGE

### Pre-assembly cleaning.

NOTE: Gloves must be worn at all times when handling the bearings, grease and solvent.

1. Wipe clean the assembly surface, using cleaning solvent on lint free cloth.
2. Wipe clean: Bearing Cartridge and Bearing Cap (internal and external). Visually inspect all components after cleaning, for contamination.
3. Place all components on a clean assembly surface. Do not use an air line to blow off excess fluid.
4. Thoroughly clean the external surface of the grease gun nozzle using lint free cloth.

### Bearing preparation:

1. Remove the bearing from its packaging.
2. Wipe off the preservative oil from the surface of the inner and outer rings - using lint free cloth only.
3. Place the bearing on the clean assembly surface, with the bearing designation marking facing down.



## Bearing Assembly

### Cartridge:

1. Apply anti-fretting lubricant (**MP14002 - Klüber Altemp Q NB 50**) to the bearing housing circumference. Apply paste in a thin coherent layer by use of a lint free cloth (**DO NOT rub in**) (use clean protective gloves).
2. Fit 'O' Rings into the 'O' Ring grooves in the bearing housing circumference.

### Assemble Bearing into Cartridge

1. Heat the bearing cartridge to 25° C above the ambient temperature (with an induction heater, do not exceed 100°C) and assemble the new bearing into the cartridge. Ensure that the bearing designation is visible after assembly.
2. With greased face of the bearing facing the cartridge bore, assemble the bearing into the bearing housing. Ensure the bearing outer race contacts the location shoulder.

NOTE: Only the outer race should be used to transmit load during assembly (NEVER use the inner race).

### Assemble Bearing and Cartridge onto the Shaft

1. Heat the Bearing and Cartridge assembly to 80°C above ambient.  
( use induction heater, no other heat source is suitable)
2. Slide the Bearing and Cartridge assembly over the shaft, pushing it firmly against the bearing seating shoulder.
3. Rotate the assembly (including inner race) 45° in either direction, to provide correct alignment. The bearing must be held firmly in place until it is cool enough to positively self locate.
4. Non drive end only - fit circlip (single bearing only) and wave washer.
5. Fit the bearing cap.
6. Rotate the bearing assembly on the shaft to check for free movement.

Note: Ensure cartridge is at ambient temp. before assembling bracket.

7. Refit the end bracket and PMG where fitted.

### SEALED FOR LIFE BEARINGS (WITHOUT CARTRIDGE)

NOTE: Prior to commencement of removal of end bracket ensure rotor is positioned with full pole face at the bottom of the stator bore.

## Preparation

1. Remove terminal box lid.
2. Cut cable ties and disconnect exciter leads.
3. Remove bolts from NDE terminal panel and place panel over terminal board with AVR still connected.
4. Remove Permanent Magnet Generator (if fitted) see 7.5.3.2.
5. Remove the rotor retaining circlip (Non drive end - single bearing only) and slack off remaining NDE bracket bolts.
6. Fit 2 off M10x60mm bolts into jacking locations on centre line and replace 2 bolts into end bracket for support as end bracket is removed (be aware of exciter lead and PMG lead, if fitted).
7. If alternator not connected to engine be aware of rotor pulling through stator, to avoid this, place wooden spacer between fan and frame each side at drive end.
8. Use available lifting equipment to remove the bracket.
9. Remove bearing circlip (Non drive end - single bearing only).

## BEARING REMOVAL

1. Fit pulley drawers and draw off bearing, ensuring to protect the threaded hole in the end of the main shaft.
2. Heat the Bearing to 80°C above ambient with an induction heater and fit to shaft. ( use induction heater, no other heat source is suitable do not exceed 100°C) (ensure shaft and bearing are clean prior to assembly)
3. Replace the bearing circlip (single bearing only).

## Replace the Endbracket

1. Remove jacking bolts from end bracket and lift end bracket into position and fit bracket onto bearing (heat bracket if required). Ensure exciter and PMG leads are pulled through and positioned.
2. Lift rotor to align exciter (use piece of wood as lever under shaft through NDE aperture) fit bolts and secure evenly around end bracket to ensure it is correctly aligned.
3. Replace rotor retaining circlip and permanent magnet assembly if fitted, and replace cover.
4. Connect exciter and re-tie all cables into position and re-assemble terminal box.

NOTE: Prior to re-fitting end bracket check exciter electrically and physically to ensure no damaged caused when dismantling.

### 7.5.3.4 MAIN ROTOR ASSEMBLY

#### SINGLE BEARING MACHINE

NOTE: On single bearing machines, before removal from, or re-assembly to the prime mover, position the rotor, if possible, such that a full pole face is at bottom dead centre.

1. Remove all access covers and terminal box lid.
2. Disconnect exciter leads X and XX and PMG leads P2-P3-P4 at the auxiliary terminals inside the terminal box.
3. Ensure that these leads are free to come away with the non drive end bracket when removed.
4. Remove the 8 bolts holding the drive end adaptor to the frame.
5. With a rope sling around drive end adaptor, tap adaptor out of its spigot location; guide over fan and remove.
6. If the generator is fitted with a cartridge. Remove the 4 bolts retaining the non drive end bearing cartridge in the non drive end endbracket (outer 4 bolts). (This includes all regreasable options).
7. Remove the 8 bolts securing the non drive end bracket to the frame.
8. Supporting the non drive end bracket with a hoist, insert two M10 bolts in the two holes provided for 'jacking' purposes (on the end bracket horizontal centre line). Screw in the bolts until the end bracket spigot is clear of the locating recess, lower the whole assembly until the main rotor is resting in the stator bore. Still supporting the non drive end bracket, tap the bracket off the non drive end bearing cartridge (taking care that the exciter stator does not foul exciter rotor windings) and remove.
9. To withdraw the rotor from the stator the rotor must be supported by a rope at the drive end and eased out of the stator core until half the main rotor is protruding out of the stator. At this point it is safe to release the weight from the rope sling.
10. Tightly bind a rope sling around the rotor core, and supporting the non drive end of the rotor, guide it clear of the stator.



**Warning!**

The rope sling may not be at the centre of gravity of the rotor and guidance at the ends of the rotor is essential. THE FULL WEIGHT OF THE ROTOR GIVEN IN THE TABLE BELOW MUST BE SUPPORTED BY THE CRANE AND SLING. If the rotor core is allowed to drop more than a few millimetres at this point, it will make contact with the stator windings and may damage them.

#### MINIMUM ROTOR ASSEMBLY WEIGHTS

| FRAME      | WEIGHT   |
|------------|----------|
| 4 - 4 pole | 473 kgs  |
| 5 - 4 pole | 685 kgs  |
| 6 - 4 pole | 1093 kgs |
| 6 - 6 pole | 1050 kgs |
| 7 - 4 pole | 1592 kgs |
| 7 - 6 pole | 1790 kgs |

Re-assembly is a reversal of the above procedure.

Before assembly of a single bearing rotor into stator housing check that the drive discs are not damaged or cracked or showing any other signs of fatigue. Also check that holes in the discs for drive fixing screws are not elongated.

Damaged components must be replaced.

When refitting discs ensure that the number and thickness of discs, and the tightening torque of hub bolts is in accordance with the table below.

Refer to engine manual for torque setting of disc to flywheel bolts.

| FRAME | NO. OF DISCS | SINGLE DISC THICKNESS | TOTAL THICKNESS | TIGHTENING TORQUE |
|-------|--------------|-----------------------|-----------------|-------------------|
| 4     | 4            | 1.2                   | 4.8             | 48kgm             |
|       |              |                       |                 | 479Nm             |
| 5     | 4            | 1.2                   | 4.8             | 48kgm             |
|       |              |                       |                 | 479Nm             |
| 6     | 6            | 1.2                   | 7.2             | 84kgm             |
|       |              |                       |                 | 822Nm             |
| 7     | 6            | 1.2                   | 7.2             | 84kgm             |
|       |              |                       |                 | 822Nm             |

**Table 18**

#### TWO BEARING MACHINES

NOTE:

Position rotor, if possible, such that a full pole face is at bottom dead centre.

The procedure for removal of a two bearing rotor is similar to that outlined for single bearing machines with the exception of Steps 4 and 5 relating to the drive end adaptor.

For removal of this item proceed as follows:-

1. Remove the 8 bolts holding drive end adaptor to frame and 4 bolts retaining bearing cartridge in drive end bracket (outer 4 bolts), if fitted.
2. With rope sling around the shaft extension, supporting the rotor weight tap the drive end bracket spigot out of its locating recess and lower rotor assembly to rest in the stator bore.
3. Take the weight of the drive end bracket on the sling and tap the bracket off the drive end bearing cartridge, guide over the fan and remove.

Re-assembly is a reversal of the above procedure.

## 7.6 RETURNING TO SERVICE

After rectification of any faults found, remove all test connections and reconnect all control system leads.

Restart the set and adjust VOLTS control potentiometer on AVR by slowly turning clockwise until rated voltage is obtained.

Refit all terminal box covers/access covers and reconnect heater supply.

**Caution!** Failure to refit all guards, access covers and terminal box covers can result in personal injury or death.

## 7.7 MAINTENANCE

### Re-lubrication

1. Ensure grease gun nozzle and re-lubrication nipple are free from contaminants or abrasive material.
2. Apply the specified re-lubrication grease fill quantity (see table below) via the grease nipple.
3. Run the machine for 10 minutes to allow excess grease to exhaust.

Check inside the non-drive end PMG cover for expelled grease. Clean out as necessary.

| RELUBRICATION DETAILS FOR REGREASABLE BEARINGS |                  |                 |       |                      |
|--|------------------|-----------------|-------|----------------------|
| HCHCK  | BEARING POSITION | GREASE QUANTITY |       | RELUBRICATION PERIOD |
|  |                  | CMS             | GRAMS |                      |
| 5  | Non-Drive End    | 33              | 29    | 4,500 Hrs            |
| 5  | Drive End        | 46              | 41    | 4,500 Hrs            |
| 6  | Non-Drive End    | 60              | 53    | 4,500 Hrs            |
| 6  | Drive End        | 75              | 66    | 4,500 Hrs            |
| 7  | Non-Drive End    | 85              | 75    | 4,500 Hrs            |
| 7  | Drive End        | 100             | 89    | 4,500 Hrs            |

**Table 19**

## **SECTION 8**

### **SPARES AND AFTER SALES SERVICE**

#### **8.1 RECOMMENDED SPARES**

Service parts are conveniently packaged for easy identification. Genuine parts may be recognised by the Nupart name.

We recommend the following for Service and Maintenance. In critical applications a set of these service spares should be held with the generator.

1. **Diode Set (6 diodes with Surge Suppressors)**  
 HC4/5                                      **RSK5001**  
 HC6/7                                      **RSK6001**
2. **SX440 AVR**                                      **E000-24030**  
**SX421 AVR**                                      **E000-24210**  
**MX321 AVR**                                      **E000-23212**  
**MX341 AVR**                                      **E000-23412**
3. **Bearings**

| <b>PART NUMBERS NON DRIVE-END BEARINGS</b> |                  |                  |                  |                  |
|--|------------------|------------------|------------------|------------------|
|  | <b>HC4</b>       | <b>HC5</b>       | <b>HC6</b>       | <b>HC7</b>       |
| Regreasable bearings                       | N/A              | OPT<br>051-01068 | OPT<br>051-01065 | STD<br>051-01063 |
| Sealed for life with a cartridge           | N/A              | OPT<br>051-01068 | STD<br>051-01070 | N/A              |
| Sealed for life without cartridge          | STD<br>051-01072 | STD<br>051-01072 | N/A              | N/A              |

**Table 20**

| <b>PART NUMBERS FOR DRIVE-END BEARINGS</b> |                  |                  |                  |                  |
|--|------------------|------------------|------------------|------------------|
|  | <b>HC4</b>       | <b>HC5</b>       | <b>HC6</b>       | <b>HC7</b>       |
| Regreasable bearings                       | N/A              | OPT<br>051-01067 | OPT<br>051-01064 | STD<br>051-01062 |
| Sealed for life with a cartridge           | STD<br>051-01070 | STD<br>051-01071 | STD<br>051-01069 | N/A              |
| Sealed for life without cartridge          | N/A              | N/A              | N/A              | N/A              |

**Table 21**

When ordering parts the machine serial number or machine identity number and type should be quoted, together with the part description. For location of these numbers see paragraph 1.3.

Orders and enquiries for parts should be addressed to:

Newage International Ltd.,  
 Nupart Department,  
 P O Box 17, Barnack Road,  
 Stamford,  
 Lincolnshire  
 PE9 2NB  
 England.

Telephone: 44 (0) 1780 484000  
 Fax: 44 (0) 1780 766074

Website: [www.newagestamford.com](http://www.newagestamford.com)

or any of our subsidiary companies listed on the back cover.

#### **8.2 AFTER SALES SERVICE**

A full technical advice and on-site service facility is available from our Service Department at Stamford or through our subsidiary companies. A repair facility is also available at our Stamford Works.

This manual is available in the following languages on request:  
English, French, German, Italian and Spanish.

Denne manual er til rådighed på følgende sprog: engelsk, fransk, tysk, italiensk og spansk.

Denne håndboken er tilgjengelig på de følgende språkene: engelsk, fransk, tysk, italiensk og spansk.

Sur simple demande, ce manuel vous sera fourni dans l'une des langues suivantes: anglais, français, allemand, italien, espagnol.

Dieses Handbuch ist auf Anfrage in den folgenden Sprachen erhältlich: Englisch, Französisch, Deutsch, Italienisch, Spanisch.

Deze handleiding is op verzoek leverbaar in de volgende talen: Engels, Frans, Duits, Italiaans, Spaans.

Este manual pode também ser obtido nas seguintes línguas: inglês, francês, alemão, italiano e espanhol.

Tämä käsikirja on saatavissa pyynnöstä seuraavilla kielillä: Englanti, ranska, saksa, italia, espanja.

Il presente manuale è disponibile, su richiesta, nelle seguenti lingue: inglese, francese, tedesco, italiano e spagnolo.

Este manual también puede solicitarse en los siguientes idiomas: inglés, francés, alemán, italiano e español.

Αυτό το εγχειρίδιο οδηγιών χρήσεως διατίθεται στις ακόλουθες γλώσσες κατόπιν αιτήσεων: Αγγλικά, Γαλλικά, Γερμανικά, Ιταλικά, Ισπανικά.

## A.C. GENERATOR WARRANTY

### WARRANTY PERIOD

#### A.C. Generators

In respect of a.c. generators the Warranty Period is eighteen months from the date when the goods have been notified as ready for despatch by N.I. or twelve months from the date of first commissioning (whichever is the shorter period).

### DEFECTS AFTER DELIVERY

We will make good by repair or, at our option, by the supply of a replacement, any fault which under proper use appears in the goods within the period specified above, and is found on examination by us to be solely due to defective material and workmanship; provided that the defective part is promptly returned, carriage paid, with all identification numbers and marks intact, to our works or, if appropriate to the Dealer who supplied the goods.

Any part repaired or replaced, under warranty, will be returned by N.I. free of charge (via sea freight if outside the UK).

We shall not be liable for any expenses which may be incurred in removing or replacing any part sent to us for inspection or in fitting any replacement supplied by us. We shall be under no liability for defects in any goods which have not been properly installed in accordance with N.I. recommended installation practices as detailed in the publications 'N.I. Installation, Service and Maintenance Manual' and 'N.I. Application Guidelines', or which have been improperly stored or which have been repaired, adjusted or altered by any person except ourselves or our authorised agents, or in any second-hand goods, proprietary articles or goods not of our own manufacture although supplied by us, such articles and goods being covered by the warranty (if any) given by the separate manufacturers.

Any claim under this clause must contain fully particulars of the alleged defect, the description of the goods, the date of purchase, and the name and address of the Vendor, the Serial Number (as shown on the manufacturers identification plate) or for Spares the order reference under which the goods were supplied.

Our judgement in all cases of claims shall be final and conclusive and the claimant shall accept our decision on all questions as to defects and the exchange of a part or parts.

Our liability shall be fully discharged by either repair or replacement as above, and in any event shall not exceed the current list price of the defective goods.

Our liability under this clause shall be in lieu of any warranty or condition implied by law as to the quality or fitness for any particular purpose of the goods, and save as expressly provided in this clause we shall not be under any liability, whether in contract, tort or otherwise, in respect of defects in goods delivered or for any injury, damages or loss resulting from such defects or from any work undone in connection therewith.

### MACHINE SERIAL NUMBER

# NEWAGE INTERNATIONAL LIMITED

## REGISTERED OFFICE AND ADDRESS:

PO BOX 17  
BARNACK ROAD  
STAMFORD  
LINCOLNSHIRE  
PE9 2NB ENGLAND

Telephone: 44 (0) 1780 484000  
Fax: 44 (0) 1780 484100  
Web site: [www.newagestamford.com](http://www.newagestamford.com)

## SUBSIDIARY COMPANIES



**1 AUSTRALIA:** NEWAGE ENGINEERS PTY. LIMITED  
PO Box 6027, Baulkham Hills Business Centre,  
Baulkham Hills NSW 2153.  
Telephone: Sydney (61) 2 9680 2299  
Fax: (61) 2 9680 1545

**2 CHINA:** WUXI NEWAGE ALTERNATORS LIMITED  
Plot 49-A, Xiang Jiang Road  
Wuxi High - Technical Industrial Dev. Zone  
Wuxi, Jiangsu 214028  
PR of China  
Tel: (86) 510 5216212  
Fax: (86) 510 5217673

**3 GERMANY:** NEWAGE ENGINEERS G.m.b.H.  
Rotenbrückenweg 14, D-22113 Hamburg.  
Telephone: Hamburg (49) 40 714 8750  
Fax: (49) 40 714 87520

**4 INDIA:** C.G. NEWAGE ELECTRICAL LIMITED  
C33 Midc, Ahmednagar 414111, Maharashtra.  
Telephone: (91) 241 778224  
Fax: (91) 241 777494

**5 ITALY:** NEWAGE ITALIA S.r.l.  
Via Triboniano, 20156 Milan.  
Telephone: Milan (39) 02 380 00714  
Fax: (39) 02 380 03664

**6 JAPAN:** NEWAGE INTERNATIONAL JAPAN  
8 - 5 - 302 Kashima  
Hachioji-shi  
Tokyo, 192-03  
Telephone: (81) 426 77 2881  
Fax: (81) 426 77 2884

**7 NORWAY:** NEWAGE NORGE A/S  
Økern Naeringspark, Kabeigt. 5  
Postboks 28, Økern, 0508 Oslo  
Telephone: Oslo (47) 22 97 44 44  
Fax: (47) 22 97 44 45

**8 SINGAPORE:** NEWAGE ASIA PACIFIC PTE LIMITED  
10 Toh Guan Road #05-03  
TT International Tradepark  
Singapore 608838  
Telephone: Singapore (65) 794 3730  
Fax: (65) 898 9065  
Telex: RS 33404 NEWAGE

**9 SPAIN:** STAMFORD IBERICA S.A.  
Ctra. Fuenlabrada-Humanes, km.2  
Poligono Industrial "Los Linares"  
C/Pico de Almanzor, 2  
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Telephone: Madrid (34) 91 604 8987/8928  
Fax: (34) 91 604 81 66

**10 U.S.A.:** NEWAGE LIMITED  
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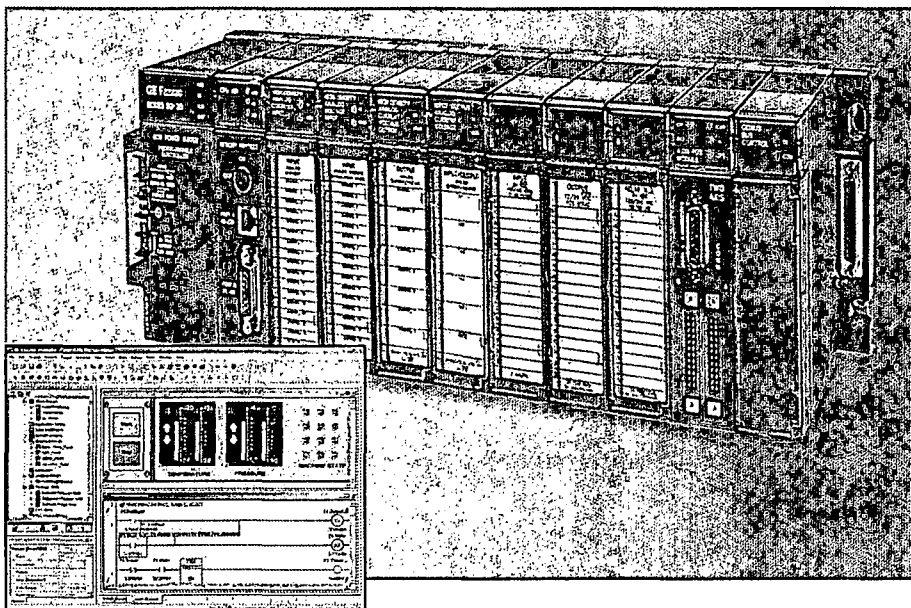


FANUC

## GE Fanuc Automation

### Series 90™-30 PLCs

The Series 90™-30 PLCs are a family of controllers, I/O systems and specialty modules designed to meet the demand for versatile industrial solutions. With its single overall control architecture, the Series 90-30 has been the PLC of record in over 200,000 applications, such as high-speed packaging, material handling, complex motion control, water treatment, continuous emissions monitoring, mining, food processing, elevator control, injection molding and many more.



Thanks to its modular design, the Series 90-30 offers unmatched versatility. Configure just the system you need, saving critical space and reducing cost.

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- Analog modules with varying degrees of resolution for flow, temperature or pressure applications
- Direct connect wiring or remote termination
- Local or remote I/O systems

**Series 90-30 Ethernet communications provide** a real-time link between the plant floor and the boardroom. You can begin with an Ethernet-enabled CPU, or at a later date, choose from our selection of rack-mounted Ethernet modules. The Series 90-30 Ethernet module supports both SRTP and Modbus TCP/IP application protocols.

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**Ease of programming is a strong suit of the Series 90-30.** Choose the programming options that meet your needs: Windows®-based IEC programming, advanced C or State Logic®. Floating point math, PID, indirect addressing, array moves and sequencing are just a few of the over 200 instructions available.

**The Series 90-30 stands out among small controls for offering redundancy options.** The Series 90-30 is the low-cost solution for high availability applications, with redundant CPUs and power supplies.

**Easy trouble shooting and machine setup using a handheld PDA.** CIMPLICITY® Machine Edition Logic Developer PDA software allows you to interface a Palm® handheld device to your Series 90-30 controller. With Logic Developer PDA, you can monitor/change data, view diagnostics, force ON/OFF, and configure machine setup — saving you time and increasing productivity.



## Ordering Information

| Description                            | Catalog Number | Description  | Catalog Number |   |
|--|----------------|--|----------------|---|
| Discrete Input Modules                 | IC693MDL230    | 120 VAC Isolated Input (8 Points)  | IC693MDL646    | 24 VDC Input, Neg/Pos Logic, 1 msec Filter (16 Points)  |
|  | IC693MDL231    | 240 VAC Isolated Input (8 Points)  | IC693MDL648    | 48 VDC Input, Neg/Pos Logic, 1 msec filter, Neg/Pos Logic (16 Points)   |
|  | IC693MDL240    | 120 VAC Input (16 Points)  | IC693MDL653    | 24 VDC Input, Neg/Pos Logic, 2msec Filter (32 Points)   |
|  | IC693MDL241    | 24 VAC/VDC Input (16 Points)   | IC693MDL654    | 5/12 VDC (TTL) Input, Neg/Pos Logic, (32 Points)  |
|  | IC693MDL632    | 125 VDC Input (8 Points)   | IC693MDL655    | 24 VDC Input, Neg/Pos Logic, 1 ms, (32 Points)  |
|  | IC693MDL634    | 24 VDC Input, Neg/Pos Logic (8 Points)   | IC693ACC300    | Input Simulator Module (8 Points)   |
|  | IC693MDL645    | 24 VDC Input, Neg/Pos Logic (16 Points)  |                |   |
| Discrete Output Modules                | IC693MDL310    | 120 VAC Output, 0.5 Amp (12 Points)  | IC693MDL740    | 12/24 VDC Output, 0.5 Amp, Positive Logic (16 Points)   |
|  | IC693MDL330    | 120/240 VAC Output, 2 Amp (8 Points)   | IC693MDL741    | 12/24 VDC Output, 0.5 Amp, Negative Logic (16 Points)   |
|  | IC693MDL340    | 120 VAC Output, 0.5 Amp (16 Points)  | IC693MDL742    | 12/24 VDC Output, 1 Amp, Positive Logic (16 Points), Fused  |
|  | IC693MDL390    | 120/240 VAC Isolated Output, 2 Amp (5 Points)  | IC693MDL748    | 48 VDC Output, 0.5 Amps, Positive Logic (8 Points)  |
|  | IC693MDL730    | 12/24 VDC Output, 2 Amp, Positive Logic (8 Points)   | IC693MDL750    | 12/24 VDC Output, Negative Logic (32 Points)  |
|  | IC693MDL731    | 12/24 VDC Output, 2 Amp, Negative Logic (8 Points)   | IC693MDL751    | 12/24 VDC Output, Positive Logic (32 Points)  |
|  | IC693MDL732    | 12/24 VDC Output, 0.5 Amp, Positive Logic (8 Points)   | IC693MDL752    | 5/12/24 VDC (TTL) Output, Negative Logic, (32 Points)   |
|  | IC693MDL733    | 12/24 VDC Output, 0.5 Amp, Negative Logic (8 Points)   | IC693MDL753    | 12/24 VDC Output, Positive Logic (32 Points)  |
|  | IC693MDL734    | 125 VDC Output, (6 Points)   |                |   |
|  | IC693MDL930    | Relay Output, Isolated, 4 Amp (8 Points)   | IC693MDL940    | Relay Output, 2 Amp (16 Points)   |
| Relay Output Module                    | IC693MDL931    | Relay Output, 8 Amp Form B/C contacts, Isolated in 2 Groups of 4 (8 Points)  |                |   |
| Mixed Discrete Module                  | IC693MDR390    | Mixed I/O, 24 VDC Input (8 points), Relay Output (8 points)  | IC693MAR590    | Mixed I/O, 120 VAC Input (8 Points), Relay Output (8 Points)  |
| Analog Input Modules                   | IC693ALG220    | Analog Input, Voltage/Current, 4 Channels  | IC693ALG222    | Analog Input, Voltage 16 Single/8 Differential Channels   |
|  | IC693ALG221    | Analog Input, Current, 4 Channels  | IC693ALG223    | Analog Input, Current, 16 Single Channels   |
|  | IC693ALG390    | Analog Output, Voltage, 2 Channels   | IC693ALG392    | High Density Analog Output (8 Channels)   |
|  | IC693ALG391    | Analog Output, Current, 2 Channels   |                |   |
| Mixed Analog Modules                   | IC693ALG442    | Analog Combo Module 4IN/2OUT   |                |   |
| Motion Modules                         | IC693APU300    | High Speed Counter (HSC)   | IC693APU305    | High Speed Counter with Gray Code Encoder or an A QUAD B Encoder Input  |
|  | IC693APU301    | Axis Positioning Module (APM), 1 Axis  | IC693DSM302    | Digital Servo Motion Controller, 2 Axis   |
| Specialty Modules                      | IC693APU302    | Axis Positioning Module (APM), 2 Axis  | IC693DSM314    | Digital Servo Motion Controller, 1-2 Axis of Digital Servo or 1-4 Axis Analog Servo   |
|  | IC693MDL750    | Solenoid Valve Output (11 Points)/24 VDC Output, 0.5 Amp, Positive Logic (5 Points)                                    | IC693PTM101    | Power Transducer Module, CT and PT Interface 120/240 VAC (1m cable)   |
|  | IC693PCM301    | Programmable Coprocessor Module, 192 KB (47 KB Basic or C Program), 2 Serial Ports                                     | IC693TCM302    | Temperature Control Module, (8) TC In and (8) 24 VDC Solid State Outputs  |
|  | IC693PCM311    | Programmable Coprocessor Module, 640 KB (640 KB Basic or C Program), 2 Serial Ports                                    | IC693TCM303    | Temperature Control Module Extended Temperature Range, (8) TC In and (8) 24 VDC Solid State Outputs   |
|  | IC693PTM100    | Power Transducer Module, CT and PT Interface 120/240 VAC (0.5m Cable)  |                |   |
|  | IC693BEM331    | Genius Bus Controller (Supports I/O and Datagrams)   | IC693PBM200    | Profibus DP Master Module   |
|  | IC693CAM302    | Communication Module, Genius (1 Kbyte) GCM+ (No Datagram Support)  | IC693PBM201    | Profibus DP Slave Module  |
| Communications Modules                 | IC693CAM311    | Communications Module, CCM, RTU, SNP, and SNPx Protocols   | IC693DNM200    | DeviceNet Master Module   |
|  | IC693CAM321    | Ethernet Interface TCP/IP Module, 10Mbps (Supports SRTP and Modbus TCP/IP, No EGD)                                     | IC693DNS201    | DeviceNet Slave Module  |
| Controllers                            | IC693CPU311    | 5-Slot Base with CPU in Base (6KBytes User Program), Not Expandable  | IC693CPU360    | CPU 360 Module (240KBytes Configurable User Memory, 4K I/O, 8 Racks), No Built-In Serial Ports, Logic Execution is .22msec/K  |
|  | IC693CPU313    | 5-Slot Base with Turbo CPU in Base (Logic Execution is .6 msec), 1K Registers, (12KBytes User Program), Not Expandable | IC693CPU363    | CPU 363 Module (240KBytes Configurable User Memory 4K I/O, 8 Racks), 2 Built-In Serial Ports, Logic Execution is .22msec/K  |
|  | IC693CPU323    | 10-Slot Base with Turbo CPU in Base (Logic Execution is .6 msec) 12Kbytes User Program, Not Expandable                 | IC693CPU364    | CPU 364 Module (240KBytes Configurable User Memory 4K I/O, 8 Racks), No Built-In Serial Ports, Built-In 10Mbps Ethernet, Supports SRTP, Channels and EGD, Logic Execution is .22msec/K                    |
|  | IC693CPU350    | CPU 350 Module (32KBytes User Memory, 4K I/O, 8 Racks), No Built-In Serial Ports, Logic Execution is .22msec/K         | IC693CPU374    | CPU 374 Module (240KBytes Configurable User Memory), No Built-In Serial Ports, Built-In 10/100Mbps with Built-In Switch, Ethernet Supports SRTP, EGD and No Channel Support, Logic Execution is .22msec/K |
|  |                |  |                |   |
| Backplanes                             | IC693CHS391    | Base, CPU, 10 Slots, Use with CPU331/CSE331 and above  | IC693CHS397    | Base, CPU, 5 Slots (use with CPU331/CSE331 and above)   |
|  | IC693CHS392    | Base, Expansion, 10 Slots  | IC693CHS398    | Base, Expansion, 5 Slots  |
|  | IC693CHS393    | Base, Remote Expansion, 10 Slots (700 ft.)   | IC693CHS399    | Base, Remote Expansion, 5 Slots (700 ft.)   |
| Power Supplies                         | IC693PWR321    | Power Supply, 120/240 VAC, 125 VDC, Standard, 30 Watts   | IC693PWR332    | Power Supply, 12 VDC, High Capacity, 30 Watts   |
|  | IC693PWR322    | Power Supply, 24/48 VDC, Standard, 30 Watts  | IC693ACC340    | Redundant Power Supply Base (RPSB) with 0.1 meter cable to connect to Power Supply Adapter Module   |
|  | IC693PWR328    | Power Supply, 48 VDC, Standard, 30 Watts   | IC693ACC341    | Redundant Power Supply Base with 0.5 meter cable to connect to Power Supply Adapter Module  |
|  | IC693PWR330    | Power Supply, 120/240 VAC, 125 VDC, High Capacity, 30 Watts  | IC693ACC350    | Redundant Power Supply Adapter (RPSA) Module. The RPSA replaces the power supply on a CPU base or expansion base and connects to a Redundant Power Supply Base.   |
|  | IC693PWR331    | Power Supply, 24 VDC, High Capacity, 30 Watts  |                |   |
| Accessories                            | IC693ACC301    | Replacement Battery, CPU & PCM (Qty. 2)  | IC693CBL301    | Rack to Rack Expansion Cable, 2 Meters  |
|  | IC693ACC302    | High Capacity Battery Pack   | IC693CBL302    | Rack to Rack Expansion Cable, 15 Meters   |
|  | IC200ACD003    | EZ Program Store Flash Device (for CPU374 only)  | IC693CBL312    | Rack to Rack Expansion Cable, 0.15 Meters, Shielded   |
|  | IC693ACC310    | Filler Module, Blank Slot  | IC693CBL313    | Rack to Rack Expansion Cable, 8 Meters  |
|  | IC693CBL300    | Rack to Rack Expansion Cable, 1 Meter  | IC693CBL314    | Rack to Rack Expansion Cable, 15 Meters, Shielded   |
| Programming and Trouble Shooting Tools | IC646MPP001    | Logic Developer - PLC Professional   | IC646MPH101    | Logic Developer PDA Software Tool with Cable Adapter  |
|  | IC646MPS001    | Logic Developer - PLC Standard   |                |   |



## GE Fanuc Automation

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### Additional Resources

For detailed technical specifications and product ordering information, please visit the GE Fanuc e-catalog at:

**www.gefanuc.com**

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# ***GE Fanuc Automation***

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## ***Programmable Control Products***

### ***Series 90™-30 PLC Installation and Hardware Manual***

GFK-0356Q

*August 2002*

GFL-002

## *Warnings, Cautions, and Notes as Used in this Publication*

### **Warning**

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

### **Caution**

Caution notices are used where equipment might be damaged if care is not taken.

### **Note**

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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| Alarm Master         | Field Control    | Modelmaster | Series 90    |
| CIMPLICITY           | GENet            | Motion Mate | Series One   |
| CIMPLICITY Control   | Genius           | PowerMotion | Series Six   |
| CIMPLICITY PowerTRAC | Genius PowerTRAC | ProLoop     | Series Three |
| CIMPLICITY 90-ADS    | Helpmate         | PROMACRO    | VuMaster     |
| CIMSTAR              | Logicmaster      | Series Five | Workmaster   |

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## *RFI Standards*

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The Series 90-30 PLC and its associated modules have been tested and found to meet or exceed the requirements of FCC Rule, Part 15, Subpart J. The Federal Communications Commission (FCC) requires the following note to be published according to FCC guidelines.

### **NOTE**

This equipment generates, uses, and can radiate radio frequency energy and if not installed in accordance with this instruction manual, may cause harmful interference to radio communications. It has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules, which are designed to provide reasonable protection against harmful interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

The following note is required to be published by the Canadian Department of Communications.

### **NOTE**

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the radio interference regulations of the Canadian Department of Communications.

The following statements are required to appear in the *Series 90\_-30 Installation Manual* and the *Series 90\_-30 I/O Specifications Manual* for Class I Div 2 Hazardous Locations.

- i. EQUIPMENT LABELED WITH REFERENCE TO CLASS I, GROUPS A, B, C, and D, DIV. 2 HAZARDOUS LOCATIONS IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A, B, C, D OR NON-HAZARDOUS LOCATIONS ONLY.
2. WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2:
3. WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
4. ALL UNUSED SLOTS IN ALL BASEPLATES MUST BE POPULATED WITH FILLER MODULES, IC693ACC310, OR EQUIVALENT.

## Preface

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This manual describes the GE Fanuc Series 90-30 Programmable Logic Controller (PLC). It contains a description of hardware components and provides basic hardware installation procedures. The Series 90-30 PLC is a member of the Series 90\_ family of Programmable Logic Controllers from GE Fanuc.

For a list of product standards, refer to data sheet GFK-0867B or later, *GE Fanuc Approvals, Standards, General Specifications* which lists all of the standards for GE Fanuc products. Installation instructions in this manual are provided for installations that do not require special procedures for noisy or hazardous environments. For installations that must conform to more stringent requirements (such as CE Mark), see GFK-1179, *Installation Requirements for Conformance to Standards*.

## What's New in This Manual

- Added the model 374 CPU, which supports connection to an Ethernet network through two built-in 10BaseT/100BaseTx auto-negotiating full-duplex Ethernet ports. Models 364 (release 9.10 and later) and 374 are the only Series 90-30 CPUs that support Ethernet Global Data. Note that the CPU374 is supported only by the Windows®-based programmers.
- Other corrections and clarifications as necessary.

## Related Publications

For more information on Series 90-30 products, refer to these publications. (For a publication to product catalog number cross-reference refer to Appendix G):

- GFK-0255 - Series 90™ PCM and Support Software User's Manual
- GFK-0256 - MegaBasic™ Programming Reference Manual
- GFK-0293 - Series 90™ -30 High Speed Counter User's Manual
- GFK-0401 - Workmaster® II PLC Programming Unit Guide to Operation
- GFK-0402 - Series 90™ -30 and 90-20 PLC Hand-Held Programmer User's Manual
- GFK-0412 - Genius® Communications Module User's Manual
- GFK-0466 - Logicmaster 90™ Series 90™ -30/20/Micro Programming Software User's Manual
- GFK-0467 - Series 90™ -30/20/Micro Programmable Controllers Reference Manual
- GFK-0487 - Series 90™ PCM Development Software (PCOP) User's Manual
- GFK-0499 - CIMPLICITY® 90-ADS Alphanumeric Display System User's Manual

GFK-0356Q

## *Preface*

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GFK-0582 - Series 90™ PLC Serial Communications User's Manual  
 GFK-0631 - Series 90™ -30 I/O LINK Interface User's Manual  
 GFK-0641 - CIMPLICITY® 90-ADS Alphanumeric Display System Reference Manual  
 GFK-0664 - Series 90™-30 PLC Axis Positioning Module Programmer's Manual  
 GFK-0685 - Series 90™ Programmable Controllers Flow Computer User's Manual  
 GFK-0695 - Series 90™-30 Enhanced Genius) Communications Module User's Manual  
 GFK-0726 - Series 90™-30 PLC State Logic Processor User's Guide  
 GFK-0732 - Series 90™-30 PLC ECLiPS User's Manual  
 GFK-0747 - Series 90™-30 PLC OnTOP User's Guide  
 GFK-0750 - OnTop for Series 90™-30 (State Logic) Program User's Manual  
 GFK-0781 - Motion Mate™ APM300 for Series 90™-30 PLC Follower Mode User's Manual  
 GFK-0823 - Series 90™ -30 I/O LINK Master Module User's Manual  
 GFK-0828 - Series 90™ -30 Diagnostic System User's Manual  
 GFK-0840 - Motion Mate™ APM300 for Series 90™ -30 PLC Standard Mode User's Manual  
 GFK-0867 - GE Fanuc Product Agency Approvals, Standards, General Specifications  
 GFK-0898 - Series 90™ -30 PLC I/O Module Specifications  
 GFK-1028 - Series 90™ -30 I/O Processor Module User's Manual  
 GFK-1034 - Series 90™ -30 Genius® Bus Controller User's Manual  
 GFK-1037 - Series 90™ -30 FIP Remote I/O Scanner User's Manual  
 GFK-1056 - Series 90™ -30 State Logic Control System User's Manual  
 GFK-1186 - TCP/IP Ethernet Communications for the Series 90\_-30 PLC Station Manager Manual  
 GFK-1179 - Series 90™ PLC Installation Requirements for Conformance to Standards  
 GFK-1464 - Motion Mate DSM302 for Series 90™-30 PLCs User's Manual  
 GFK-1466 - Temperature Control Module for the Series 90™-30 PLC User's Manual  
 GFK-1541 - TCP/IP Ethernet Communications for the Series 90™ PLC User's Manual

## *Contents*

|                  |   |            |
|------------------|---|------------|
| <b>Chapter 1</b> | <b>Overview of the Series 90-30 PLC .....</b>                                 | <b>1-1</b> |
|                  | The Basic Parts of a Series 90-30 PLC.....                                    | 1-1        |
|                  | Assembling a Basic Series 90-30 PLC System .....                              | 1-2        |
|                  | What else would be needed to make this basic system functional? .....         | 1-6        |
|                  | What if the application requires more than five modules? .....                | 1-6        |
|                  | What if the application requires more than ten modules? .....                 | 1-7        |
|                  | What is the Difference Between Expansion and Remote baseplates?.....          | 1-8        |
|                  | What if I need to cover more than 700 feet (213 meters)? .....                | 1-9        |
| <b>Chapter 2</b> | <b>Installation .....</b>   | <b>2-1</b> |
|                  | Receiving your Products - Visual Inspection .....                             | 2-1        |
|                  | Pre-installation Check .....  | 2-1        |
|                  | Warranty Claims.....  | 2-1        |
|                  | Working with Series 90-30 Modules.....  | 2-2        |
|                  | Module Features.....  | 2-2        |
|                  | Installing a Module.....  | 2-3        |
|                  | Removing a Module .....   | 2-4        |
|                  | Installing a Module's Terminal Board .....                                    | 2-5        |
|                  | Removing a Module's Terminal Board .....                                      | 2-6        |
|                  | I/O Module Terminal Board Posts .....   | 2-7        |
|                  | Installing and Removing Terminal Boards with Holding Screws .....             | 2-7        |
|                  | Baseplate Mounting.....   | 2-8        |
|                  | Mounting a Baseplate to a Panel .....   | 2-8        |
|                  | Mounting a Baseplate to a 19" Rack .....                                      | 2-8        |
|                  | Grounding Procedures .....  | 2-11       |
|                  | System Grounding Procedures .....   | 2-11       |
|                  | Ground Conductors .....   | 2-11       |
|                  | Series 90-30 PLC Equipment Grounding.....                                     | 2-12       |
|                  | Baseplate Safety Grounding.....   | 2-12       |
|                  | Grounding 19" Rack-Mounted Baseplates .....                                   | 2-13       |
|                  | Programmer Grounding.....   | 2-13       |
|                  | Module Shield Grounding.....  | 2-14       |
|                  | Shield Grounding Information for CPUs with External Port Connections.....     | 2-14       |
|                  | CPU351 and 352 Shield Grounding .....   | 2-14       |
|                  | CPU363, CPU364, and CPU374 Shield Grounding.....                              | 2-16       |
|                  | Additional Modules with Shield Grounding Requirements .....                   | 2-16       |
|                  | General Wiring Guidelines .....   | 2-17       |
|                  | Discrete I/O Module Connection Methods.....                                   | 2-18       |
|                  | Connections to I/O Module Terminal Boards .....                               | 2-18       |
|                  | Terminal Block Quick Connect Installation for 16-Point Discrete Modules ..... | 2-19       |
|                  | Installation of 32-Point Discrete, 50-Pin Connector Modules .....             | 2-19       |
|                  | Using Weidmuller #912263 Terminal Block .....                                 | 2-19       |
|                  | Using a Generic Terminal Block or Strip.....                                  | 2-20       |
|                  | Direct Method .....   | 2-20       |
|                  | Installation of Discrete 32-Point, Dual 24-Pin Connector Modules.....         | 2-20       |
|                  | Using a TBQC.....   | 2-20       |

## Contents

---

|   |            |
|---|------------|
| With a Generic Terminal Block/Strip.....                                      | 2-20       |
| Direct Method .....   | 2-21       |
| General Wiring Methods for Analog Modules.....                                | 2-21       |
| Analog Input Module Wiring Methods.....                                       | 2-21       |
| Using a Generic Terminal Block or Strip.....                                  | 2-21       |
| Direct Method .....   | 2-21       |
| TBQC not Recommended for Analog Modules .....                                 | 2-22       |
| Analog Output Module Wiring .....   | 2-22       |
| General .....   | 2-22       |
| Using a Generic Terminal Block or Strip.....                                  | 2-22       |
| Direct Method .....   | 2-22       |
| TBQC not Recommended for Analog Modules .....                                 | 2-22       |
| AC Power Source Connections.....  | 2-23       |
| AC Input Wiring to AC/DC Power Supplies .....                                 | 2-23       |
| Power Supply Overvoltage Protection Devices.....                              | 2-24       |
| Special Installation Instructions for Floating Neutral (IT) Systems .....     | 2-25       |
| Definition of Floating Neutral Systems.....                                   | 2-25       |
| Use These Special Installation Instructions for Floating Neutral Systems..... | 2-26       |
| DC Power Source Connections.....  | 2-27       |
| DC Input Wiring to AC/DC and DC-Only Power Supplies.....                      | 2-27       |
| +24 VDC Output (All Supplies).....  | 2-27       |
| Basic Installation Procedure .....  | 2-28       |
| <b>Chapter 3   Baseplates .....</b>   | <b>3-1</b> |
| Baseplate Types .....   | 3-1        |
| Common Baseplate Features .....   | 3-1        |
| Two Baseplate Sizes.....  | 3-2        |
| Baseplate Terms.....  | 3-3        |
| CPU Baseplates.....   | 3-4        |
| Embedded CPU Baseplates (Figures 3-2 and 3-3) .....                           | 3-4        |
| Modular CPU Baseplates (Figures 3-4 and 3-5) .....                            | 3-6        |
| Expansion Baseplates (Figures 3-6 and 3-7) .....                              | 3-7        |
| Remote Baseplates (Figures 3-8 and 3-9).....                                  | 3-8        |
| I/O Bus Expansion Cables.....   | 3-10       |
| Differences Between Remote and Expansion Racks.....                           | 3-11       |
| Mixing Expansion and Remote Baseplates in a System .....                      | 3-11       |
| Termination Requirement for Expansion or Remote System .....                  | 3-12       |
| Powering Down Individual Expansion or Remote Baseplates .....                 | 3-12       |
| Series 90-30 PLC Backplane .....  | 3-12       |
| Rack Number DIP Switch on Expansion and Remote Baseplates.....                | 3-13       |
| Expansion and Remote Baseplates Connection Example.....                       | 3-15       |
| Baseplate Mounting Dimensions .....   | 3-16       |
| Embedded CPU (311, 313, and 323) Baseplate Dimensions .....                   | 3-16       |
| Modular CPU, Expansion, and Remote Baseplate Dimensions.....                  | 3-18       |



## Contents

---

|                  |   |            |
|------------------|---|------------|
|                  | Load Ratings, Temperature, and Mounting Position .....                  | 3-19       |
|                  | Baseplate Adapter Brackets for 19" Rack Mounting.....                   | 3-20       |
|                  | Baseplate Comparison Table.....   | 3-22       |
| <b>Chapter 4</b> | <b>Power Supplies.....</b>  | <b>4-1</b> |
|                  | Power Supply Categories.....  | 4-1        |
|                  | Power Supply Feature Comparison.....                                    | 4-1        |
|                  | AC/DC Input Power Supplies .....  | 4-2        |
|                  | IC693PWR321 Standard Power Supply, 120/240 VAC or 125 VDC Input .....   | 4-2        |
|                  | IC693PWR330 High Capacity Power Supply, 120/240 VAC/125 VDC Input ..... | 4-4        |
|                  | Field Wiring Connections for the AC/DC Input Power Supplies.....        | 4-5        |
|                  | Isolated 24 VDC Supply Output Connections.....                          | 4-6        |
|                  | DC Input Only Power Supplies.....                                       | 4-7        |
|                  | IC693PWR322 Standard Power Supply, 24/48 VDC Input .....                | 4-7        |
|                  | Calculating Input Power Requirements for IC693PWR322 .....              | 4-8        |
|                  | IC693PWR328 Standard Power Supply, 48 VDC Input.....                    | 4-10       |
|                  | Calculating Input Power Requirements for IC693PWR328.....               | 4-11       |
|                  | Input Power/Current Calculation for IC693PWR328 Power Supply .....      | 4-12       |
|                  | IC693PWR331 High Capacity Power Supply, 24 VDC Input.....               | 4-13       |
|                  | Current Derating for Higher Temperatures .....                          | 4-14       |
|                  | Calculating Input Power Requirements for IC693PWR331.....               | 4-15       |
|                  | Field Wiring Connections to the DC Input-Only Power Supplies .....      | 4-15       |
|                  | Common Series 90-30 Power Supply Features.....                          | 4-16       |
|                  | Status Indicator Lights on all Power Supplies.....                      | 4-16       |
|                  | Input Overvoltage Protection Devices.....                               | 4-16       |
|                  | Output Voltage Connections to Backplane (All Supplies).....             | 4-17       |
|                  | Overcurrent Protection (all Supplies).....                              | 4-18       |
|                  | Timing Diagram .....  | 4-18       |
|                  | CPU Serial Port Connector on Power Supply (All Supplies).....           | 4-19       |
|                  | CPU Serial Port Information .....                                       | 4-19       |
|                  | Backup Battery for RAM Memory (All Supplies).....                       | 4-20       |
| <b>Chapter 5</b> | <b>CPUs .....</b>   | <b>5-1</b> |
|                  | CPU Types for Series 90-30 PLCs .....                                   | 5-1        |
|                  | Embedded CPUs.....  | 5-1        |
|                  | Modular CPUs.....   | 5-2        |
|                  | General CPU Features .....  | 5-3        |
|                  | Microprocessor.....   | 5-3        |
|                  | CPU Serial Port (Connector on Power Supply).....                        | 5-3        |
|                  | Memory Volatility.....  | 5-4        |
|                  | RAM Memory.....   | 5-5        |
|                  | RAM Memory Backup/Backup Battery Information .....                      | 5-5        |
|                  | Programmable Read-Only Memory (PROM) Types.....                         | 5-5        |
|                  | Uses of PROM devices in the 90-30 CPUs .....                            | 5-5        |

## Contents

---

|   |      |
|---|------|
| CPU Firmware.....   | 5-6  |
| Determining CPU Revision Levels (Versions) .....                        | 5-7  |
| EPROM and EEPROM User Program Storage Options.....                      | 5-8  |
| Comparing EPROM and EEPROM Features.....                                | 5-8  |
| Procedure for Creating an EPROM.....                                    | 5-9  |
| Flash Memory.....   | 5-9  |
| Series 90-30 CPU Capacities.....  | 5-10 |
| User Memory Addresses (References).....                                 | 5-10 |
| Difference Between a Memory Address and a Nickname.....                 | 5-10 |
| User Memory Reference Types.....  | 5-11 |
| Application Program Compatibility .....                                 | 5-12 |
| CPU Time-of-Day (TOD) Clock Accuracy.....                               | 5-12 |
| Breakfree SNP Protocol .....  | 5-13 |
| 350–374 CPUs.....   | 5-13 |
| Compatibility With Hand-Held Programmer (HHP) and Memory Card.....      | 5-13 |
| 350–374 CPU Advanced Features.....                                      | 5-14 |
| Details of 350 – 374 CPU Advanced Features .....                        | 5-14 |
| Hardware Features of the 350–364 CPUs.....                              | 5-18 |
| CPU350 and CPU360 Hardware Features .....                               | 5-18 |
| CPU Firmware Upgrade.....   | 5-18 |
| CPU351, CPU352, and CPU363 Hardware Features.....                       | 5-19 |
| CPU Firmware Upgrade.....   | 5-19 |
| Keyswitch.....  | 5-19 |
| Shield Ground Connection Tab.....                                       | 5-20 |
| Serial Ports .....  | 5-20 |
| Serial Port Front Panel Connectors .....                                | 5-20 |
| Serial Port Status LEDs.....  | 5-20 |
| Protocols Supported .....   | 5-21 |
| Pin Assignments for CPU351, CPU352, and CPU363 Serial Ports 1 & 2 ..... | 5-22 |
| CPU364 Hardware Features.....   | 5-23 |
| LED Indicators .....  | 5-23 |
| Ethernet Restart Pushbutton .....                                       | 5-23 |
| Keyswitch.....  | 5-24 |
| Front Panel Connectors .....  | 5-24 |
| Shield Ground Connection Tab.....                                       | 5-24 |
| Firmware Upgrade.....   | 5-24 |
| CPU374 Hardware Features.....   | 5-25 |
| LED Indicators .....  | 5-25 |
| Ethernet Restart Pushbutton .....                                       | 5-25 |
| Keyswitch.....  | 5-26 |
| Front Panel Connectors .....  | 5-26 |
| Shield Ground Connection Tab.....                                       | 5-26 |
| Firmware Upgrade.....   | 5-26 |
| CPU Data Sheets.....  | 5-27 |
| CPU311                      Catalog Number IC693CPU311 .....            | 5-28 |
| CPU313                      Catalog Number IC693CPU313 .....            | 5-29 |
| CPU323                      Catalog Number IC693CPU323 .....            | 5-30 |
| CPU331                      Catalog Number IC693CPU331 .....            | 5-31 |

## Contents

|                  |  |            |
|------------------|--|------------|
| CPU340           | Catalog Number IC693CPU340 .....                                 | 5-32       |
| CPU341           | Catalog Number IC693CPU341 .....                                 | 5-33       |
| CPU350           | Catalog Number IC693CPU350 .....                                 | 5-34       |
| CPU351           | Catalog Number IC693CPU351 .....                                 | 5-35       |
| CPU352           | Catalog Number IC693CPU352 .....                                 | 5-36       |
| CPU360           | Catalog Number IC693CPU360 .....                                 | 5-37       |
| CPU363           | Catalog Number IC693CPU363 .....                                 | 5-38       |
| CPU364           | Catalog Number IC693CPU364 .....                                 | 5-39       |
| CPU374           | Catalog Number IC693CPU374 .....                                 | 5-40       |
| <b>Chapter 6</b> | <b>Memory Backup/Battery Backup .....</b>                        | <b>6-1</b> |
|                  | Backup Battery for RAM Memory (All Supplies).....                | 6-1        |
|                  | Battery Replacement Instructions .....                           | 6-2        |
|                  | Battery Replacement/Memory Protection Factors .....              | 6-3        |
|                  | The Importance of Backing up Your Program.....                   | 6-3        |
|                  | Factors Affecting Battery Life .....                             | 6-4        |
|                  | Low Battery Warning Methods.....                                 | 6-4        |
|                  | Operating Without a Memory Backup Battery .....                  | 6-6        |
|                  | RAM Memory Battery Backup Connection Path .....                  | 6-8        |
|                  | Super Capacitor Memory Backup.....                               | 6-8        |
|                  | Maintaining RAM Memory During Storage or Shipment of a CPU.....  | 6-9        |
|                  | Modular CPUs.....  | 6-9        |
|                  | Embedded CPUs .....  | 6-9        |
|                  | Battery Accessory Kit (IC693ACC315).....                         | 6-9        |
|                  | Battery Accessory Kit Installation.....                          | 6-10       |
|                  | External Battery Module (IC693ACC302).....                       | 6-10       |
|                  | Batteries in Power Supplies on Expansion or Remote Racks .....   | 6-11       |
| <b>Chapter 7</b> | <b>Input/Output Modules .....</b>                                | <b>7-1</b> |
|                  | Basic I/O Module Types .....                                     | 7-1        |
|                  | Discrete I/O Modules .....                                       | 7-2        |
|                  | Discrete I/O Module Point Density .....                          | 7-2        |
|                  | Standard Density Discrete I/O Module Features.....               | 7-2        |
|                  | Wiring Standard Density (16-Point or Less) Discrete Modules..... | 7-4        |
|                  | Discrete Relay Output Module Protection .....                    | 7-4        |
|                  | High Density (32-Point) Discrete Module Features .....           | 7-4        |
|                  | Wiring Methods for 32-Point Discrete I/O Modules.....            | 7-6        |
|                  | Modules with Single 50-Pin Connector .....                       | 7-6        |
|                  | Modules with Dual 24-Pin Connectors .....                        | 7-7        |
|                  | Analog Module Features.....                                      | 7-8        |
|                  | Wiring Methods for Analog Modules .....                          | 7-9        |
|                  | Analog Input Module Wiring Methods .....                         | 7-9        |
|                  | Analog Output Module Wiring .....                                | 7-10       |
|                  | I/O Module Power Supply Current Draw .....                       | 7-10       |

## Contents

---

|   |            |
|---|------------|
| I/O Module Wire Routing .....                                   | 7-11       |
| Grouping Modules to Keep Wires Segregated .....                 | 7-11       |
| IC693DVM300 Digital Valve Driver Module .....                   | 7-12       |
| Indicator LEDs .....  | 7-12       |
| DVM Specifications .....  | 7-13       |
| Fuses .....   | 7-13       |
| <b>Chapter 8   Option Modules .....</b>                         | <b>8-1</b> |
| Third-Party Option Modules and the Accompany Program .....      | 8-1        |
| Option Modules Discussed in this Chapter .....                  | 8-1        |
| IC693CMM301 Genius Communications Module (GCM) .....            | 8-2        |
| Status LEDs .....   | 8-3        |
| GCM Documentation .....   | 8-3        |
| IC693CMM302 Enhanced Genius Communications Module (GCM+) .....  | 8-4        |
| Status LEDs .....   | 8-5        |
| GCM+ Documentation .....  | 8-5        |
| IC693BEM331 Genius Bus Controller (GBC) .....                   | 8-6        |
| Number of Genius Bus Controllers .....                          | 8-7        |
| Status LEDs .....   | 8-7        |
| Compatibility .....   | 8-7        |
| Series 90-30 PLC .....  | 8-7        |
| Series Six PLC .....  | 8-7        |
| Genius Hand-Held Monitor .....                                  | 8-8        |
| Hand-Held Programmer .....                                      | 8-8        |
| Genius I/O Blocks .....   | 8-8        |
| Genius Bus .....  | 8-8        |
| Diagnostics .....   | 8-8        |
| Datagrams .....   | 8-9        |
| Global Data .....   | 8-9        |
| Sending Global Data .....                                       | 8-9        |
| Receiving Global Data .....                                     | 8-9        |
| Genius Bus Controller Documentation .....                       | 8-9        |
| IC693BEM340 FIP Bus Controller (FBC) Module .....               | 8-10       |
| Status LEDs .....   | 8-11       |
| Serial Port .....   | 8-11       |
| FIP Bus Connectors .....  | 8-11       |
| IC693BEM330 FIP Remote I/O Scanner Module .....                 | 8-12       |
| Features of the Remote I/O Scanner .....                        | 8-12       |
| FIP Bus Interface .....   | 8-13       |
| Module Description .....  | 8-13       |
| Connectors .....  | 8-14       |
| LEDs .....  | 8-14       |
| FIP Remote I/O Scanner Documentation .....                      | 8-14       |
| IC693APU301/302 Motion Mate Axis Positioning Module (APM) ..... | 8-15       |

## Contents

|  |            |
|--|------------|
| APM Cables .....   | 8-16       |
| Motion Mate APM Module Documentation .....                     | 8-16       |
| IC693DSM302 Motion Mate Digital Servo Module (DSM302).....     | 8-17       |
| Features .....   | 8-18       |
| IC693DSM302 Documentation.....                                 | 8-18       |
| IC693DSM314 Motion Mate Digital Servo Module (DSM314).....     | 8-20       |
| Features .....   | 8-21       |
| IC693DSM314 Documentation.....                                 | 8-22       |
| IC693APU300 High Speed Counter (HSC) Module .....              | 8-23       |
| IC693BEM320 I/O LINK Interface (Slave) Module .....            | 8-24       |
| IC693BEM321 I/O LINK Master Module.....                        | 8-25       |
| Compatibility.....   | 8-26       |
| IC693APU305 I/O Processor Module .....                         | 8-27       |
| Module Features.....   | 8-28       |
| IC693CMM321 Ethernet Interface Module.....                     | 8-29       |
| IC693PCM300/301/311 Programmable Coprocessor Module (PCM)..... | 8-31       |
| IC693CMM311 Communications Coprocessor Module (CMM).....       | 8-34       |
| IC693ADC311 Alphanumeric Display Coprocessor (ADC).....        | 8-35       |
| IC693TCM302/303 Temperature Control Modules (TCM).....         | 8-37       |
| Connections.....   | 8-37       |
| LED Indicators .....   | 8-38       |
| Internal Fuse.....   | 8-38       |
| Automatic Data Transfers Between TCM and PLC .....             | 8-38       |
| Comparison of TCM302 and TCM303 Modules .....                  | 8-39       |
| IC693PTM100/101 Power Transducer (PTM) .....                   | 8-40       |
| Difference Between PTM100 and PTM101 .....                     | 8-40       |
| Capabilities .....   | 8-40       |
| Operating Modes .....  | 8-40       |
| Automatic Data Transfers Between PTMPM and PLC.....            | 8-41       |
| Compatibility .....  | 8-41       |
| Dimensions.....  | 8-42       |
| PTMPM Indicator LEDs .....                                     | 8-42       |
| General Mounting Information.....                              | 8-42       |
| Baseplate Type and Allowable Number of PTMPM Modules.....      | 8-43       |
| Power Supply Requirement.....                                  | 8-43       |
| Memory Requirement.....  | 8-43       |
| Configuration.....   | 8-43       |
| Ordering Information.....                                      | 8-43       |
| Documentation .....  | 8-43       |
| <b>Chapter 9 State Logic Products.....</b>                     | <b>9-1</b> |
| State Logic Overview .....                                     | 9-1        |
| State Logic Products .....                                     | 9-1        |
| Baseplates and Power Supply, I/O, and Option Modules.....      | 9-1        |

|   |             |
|---|-------------|
| AD693CMM301 State Logic Serial Communications Module (SCM).....           | 9-2         |
| Description .....   | 9-2         |
| OK LED .....  | 9-2         |
| Reset Button .....  | 9-2         |
| Serial Connector.....   | 9-3         |
| Cable Information.....  | 9-3         |
| State Logic SCM Documentation.....  | 9-3         |
| IC693SLP300 State Logic Processor Module .....                            | 9-4         |
| Description .....   | 9-4         |
| SLP Features.....   | 9-5         |
| Memory .....  | 9-5         |
| Installation.....   | 9-5         |
| Status Light.....   | 9-6         |
| Pushbutton .....  | 9-6         |
| Battery .....   | 9-7         |
| Cable Information.....  | 9-7         |
| Hardware Specifications.....  | 9-7         |
| State Logic Processor (SLP) Documentation .....                           | 9-7         |
| State Logic CPUs.....   | 9-8         |
| Features of State Logic CPUs.....   | 9-8         |
| Model CSE311, CSE313 and CSE323 Embedded CPU Baseplates .....             | 9-9         |
| Model CSE331 and CSE340 Modular CPUs.....                                 | 9-10        |
| CPU Serial Port Connector on Power Supply .....                           | 9-11        |
| Configuring the State Logic CPUs .....                                    | 9-11        |
| State Logic CPU Firmware and PROM Configurations .....                    | 9-13        |
| State Logic CPU Data Sheets .....   | 9-13        |
| CSE311                      Catalog Number IC693CSE311 .....              | 9-14        |
| CSE313                      Catalog Number IC693CSE313 .....              | 9-15        |
| CSE323                      Catalog Number IC693CSE323 .....              | 9-16        |
| CSE331                      Catalog Number IC693CSE331 .....              | 9-17        |
| CSE340                      Catalog Number IC693CSE340 .....              | 9-18        |
| <b>Chapter 10      Cables .....</b>                                       | <b>10-1</b> |
| Cable Data Sheets .....   | 10-7        |
| IC647CBL704 Workstation Interface to Series 90 CPU (SNP Port) Cable ..... | 10-8        |
| Function of cable.....  | 10-8        |
| IC690CBL701 PCM, ADC, CMM to Workmaster (PC-XT) Cable.....                | 10-12       |
| Function of cable.....  | 10-12       |
| Cable Specifications.....   | 10-12       |
| Wiring Diagram.....   | 10-12       |
| PCM to Programmer Cable Installation .....                                | 10-13       |
| IC690CBL702 PC-AT to PCM, ADC, CMM Cable .....                            | 10-14       |
| Function of cable.....  | 10-14       |
| Cable Specifications.....   | 10-14       |

## Contents

|  |       |
|--|-------|
| Wiring Diagram.....  | 10-14 |
| PCM to Programmer Cable Installation .....                               | 10-15 |
| IC690CBL705 Workmaster II (PS/2) to PCM, ADC, CMM Cable .....            | 10-16 |
| Function of cable.....   | 10-16 |
| Cable Specifications .....   | 10-16 |
| Wiring Diagram.....  | 10-16 |
| PCM to Programmer Cable Installation .....                               | 10-17 |
| IC690CBL714A Multidrop Cable .....                                       | 10-18 |
| Purpose .....  | 10-18 |
| Specifications .....   | 10-18 |
| IC690CBL714A Multi-Drop Cable Wiring Diagram.....                        | 10-19 |
| Connection Diagrams for IC690CBL714A Cable.....                          | 10-20 |
| IC693CBL300/301/302/312/313/314 I/O Bus Expansion Cables .....           | 10-22 |
| Description .....  | 10-22 |
| Cable Lengths.....   | 10-22 |
| Function of Cables .....   | 10-22 |
| Connecting the Cables.....   | 10-23 |
| Important Notes About I/O Bus Expansion Cables.....                      | 10-23 |
| Cable Application Suggestions.....                                       | 10-23 |
| Using Standard Cables .....  | 10-23 |
| Using Custom Built cables .....  | 10-24 |
| Building Custom Length I/O Bus Expansion Cables .....                    | 10-24 |
| Two Types of Custom Built Cables .....                                   | 10-24 |
| Components Needed to Build Custom Length I/O Bus Expansion Cables .....  | 10-24 |
| Expansion Port Pin Assignments.....                                      | 10-25 |
| I/O Expansion Bus Termination.....                                       | 10-25 |
| Shield Treatment .....   | 10-26 |
| Alert for Users of Early Remote Baseplate Versions .....                 | 10-26 |
| Making a 100% Shielded Cable .....                                       | 10-27 |
| Wiring Diagrams .....  | 10-28 |
| Application Examples .....   | 10-31 |
| Expansion System Cable Connections .....                                 | 10-31 |
| Remote and Expansion System Cable Connection Example.....                | 10-31 |
| IC693CBL303 Hand-Hand Programmer and Converter (IC690ACC900) Cable ..... | 10-33 |
| Function of cable.....   | 10-33 |
| Cable Specifications .....   | 10-33 |
| Wiring Diagram.....  | 10-34 |
| Connecting the Cable .....   | 10-34 |
| IC693CBL304/305 Port Expansion (WYE) Cables for PCM, ADC, and CMM.....   | 10-35 |
| Function of cable.....   | 10-35 |
| Cable Specifications .....   | 10-35 |
| Wiring Information.....  | 10-36 |
| IC693CBL306/307 Extension Cables (50-Pin) for 32 Point Modules.....      | 10-38 |
| Function of cable.....   | 10-38 |
| Cable Specifications .....   | 10-38 |
| IC693CBL308/309 I/O Cables (50-Pin) for 32 Point Modules .....           | 10-40 |
| Specifications .....   | 10-40 |
| Wiring Information.....  | 10-40 |

## Contents

---

|  |       |
|--|-------|
| IC693CBL310 I/O Interface Cable (24-Pin) for 32 Point Modules.....                                     | 10-42 |
| Function of cable.....   | 10-42 |
| Replacement/Obsolescence Information.....  | 10-43 |
| Connector Depth for Cable IC693CBL310.....   | 10-43 |
| IC693CBL311/317/319/320 I/O Interface Cables for Power Mate APM Modules.....                           | 10-45 |
| Function of cable.....   | 10-45 |
| Specifications.....  | 10-45 |
| Wiring Information.....  | 10-46 |
| IC693CBL315 I/O Interface Cable (24-Pin) for 32 Point Modules.....                                     | 10-49 |
| Function of cable.....   | 10-49 |
| Building Custom Length Cables for 24-Pin Connectors.....   | 10-49 |
| Replacement/Obsolescence Information.....  | 10-51 |
| Connector Depth for IC693CBL315.....   | 10-51 |
| IC693CBL316 Serial Cable, 9-Pin D-Shell to RJ-11 Connector.....  | 10-53 |
| Description.....   | 10-53 |
| Typical Applications.....  | 10-53 |
| IC693CBL321/322/323 I/O Faceplate Connector to Terminal Block Connector, 24-Pin.....                   | 10-54 |
| Function of cable.....   | 10-54 |
| Cable Specifications.....  | 10-54 |
| Connector Depth.....   | 10-55 |
| IC693CBL327/328 I/O Interface Cables with Right Angle 24-Pin Connector.....                            | 10-57 |
| Description.....   | 10-57 |
| Applications.....  | 10-57 |
| Specifications.....  | 10-58 |
| Connector Depth for Cables IC693CBL327/328.....  | 10-58 |
| Building Custom Length 24-pin Connector Cables.....  | 10-59 |
| Connector Depth for Custom Built Cables.....   | 10-60 |
| Possible Uses for These Cables (Factory or Custom Built).....  | 10-61 |
| IC693CBL329/330/331/332/333/334 Cables 24-Pin I/O Faceplate Connector to Terminal Block Connector..... | 10-62 |
| Description.....   | 10-62 |
| Connector Depth.....   | 10-63 |
| Applications.....  | 10-64 |
| IC693CBL340/341 PTM Interface Cables.....  | 10-65 |
| Documentation.....   | 10-67 |

## **Chapter 11 Programmer Hardware Products.....11-1**

|  |      |
|--|------|
| Products Discussed in this Chapter.....            | 11-1 |
| IC640WMI310/320 Work Station Interface Boards..... | 11-2 |
| Replacing Workmaster Computers.....                | 11-3 |
| IC690ACC900 RS-422/RS-485 to RS-232 Converter..... | 11-3 |
| IC690ACC901 Miniconverter Kit.....                 | 11-4 |
| IC693PRG300 Hand-Held Programmer (HHP).....        | 11-5 |
| HHP Features.....                                  | 11-6 |



## Contents

|  |             |
|--|-------------|
| HHP Memory Card (IC693ACC303).....                               | 11-6        |
| HHP Modes of Operation.....                                      | 11-6        |
| Documentation.....   | 11-6        |
| IC693PIF301/400 Personal Computer Interface (PCIF) Cards .....   | 11-7        |
| IC655CCM590 Isolated Repeater/Converter .....                    | 11-8        |
| IC690ACC903 Port Isolator .....                                  | 11-8        |
| <b>Chapter 12   System Design .....</b>                          | <b>12-1</b> |
| Introduction.....  | 12-1        |
| Step 1: Planning Your System.....                                | 12-1        |
| Step 2: Determining I/O Requirements .....                       | 12-1        |
| Additional I/O Module Selection Factors.....                     | 12-2        |
| Step 3: Selecting Option Modules.....                            | 12-2        |
| Step 4: Selecting a CPU .....                                    | 12-4        |
| Step 5: Selecting Baseplates.....                                | 12-5        |
| Step 6: Selecting Power Supplies .....                           | 12-6        |
| Reducing PLC Module Count by Using Other GE Fanuc Products ..... | 12-7        |
| Designing For Safety .....                                       | 12-8        |
| Protection From Electrical Shock.....                            | 12-8        |
| Fire Prevention .....  | 12-8        |
| Protection From Mechanical Hazards .....                         | 12-8        |
| Protection From Electrical Failure .....                         | 12-8        |
| Protection From Design Changes or Overrides.....                 | 12-9        |
| Safety Documentation .....                                       | 12-10       |
| Guarding Against Unauthorized Operation.....                     | 12-10       |
| Labeling, Guarding, and Lighting Issues.....                     | 12-10       |
| Equipment Accessibility Issues .....                             | 12-10       |
| Number of Modules Per Series 90-30 PLC System.....               | 12-11       |
| Calculating Power Supply Loading .....                           | 12-12       |
| Load Requirements for Hardware Components .....                  | 12-12       |
| Power Supply Loading Calculation Examples .....                  | 12-14       |
| Scan (Sweep) Time Calculation.....                               | 12-15       |
| Major Design Factors Affecting Scan Time.....                    | 12-16       |
| Where to Find Scan Time Information.....                         | 12-16       |
| Calculating PLC Heat Dissipation .....                           | 12-17       |
| System Layout Guidelines .....                                   | 12-17       |
| Benefits of a Good Layout - Safe, Reliable, and Accessible.....  | 12-17       |
| PLC Rack Location and Clearance Requirement.....                 | 12-17       |
| Location of Modules in the PLC Racks .....                       | 12-18       |
| Allowable Module Locations .....                                 | 12-19       |
| Series 90-30 PLC Layout Example.....                             | 12-20       |
| PLC Mounting Position .....                                      | 12-21       |
| Recommended Upright Mounting Orientation.....                    | 12-21       |
| Derated Horizontal Mounting Orientation .....                    | 12-21       |

## Contents

---

|                   |  |             |
|-------------------|--|-------------|
| <b>Chapter 13</b> | <b>Maintenance and Troubleshooting .....</b>                       | <b>13-1</b> |
|                   | Troubleshooting Features of Series 90-30 Hardware.....             | 13-1        |
|                   | Indicator Lights (LEDs) and Terminal Board .....                   | 13-1        |
|                   | Module LED Indicators .....  | 13-2        |
|                   | Troubleshooting Features of Programming Software .....             | 13-3        |
|                   | Ladder Screens .....   | 13-3        |
|                   | Configuration Screens .....  | 13-3        |
|                   | Fault Tables .....   | 13-3        |
|                   | System Status References.....                                      | 13-3        |
|                   | Reference Tables .....   | 13-4        |
|                   | Override feature.....  | 13-4        |
|                   | Sequential Event Recorder (SER), DOIO functional instruction ..... | 13-4        |
|                   | Replacing Modules .....  | 13-5        |
|                   | Series 90-30 Product Repair.....                                   | 13-5        |
|                   | Module Fuse List.....  | 13-6        |
|                   | Spare/Replacement Parts .....                                      | 13-7        |
|                   | Preventive Maintenance Suggestions.....                            | 13-8        |
|                   | Getting Additional Help and Information.....                       | 13-9        |
| <b>Appendix A</b> | <b>Serial Ports and Cables .....</b>                               | <b>A-1</b>  |
|                   | RS-422 Interface .....   | A-1         |
|                   | Cable and Connector Specifications.....                            | A-2         |
|                   | Series 90 PLC Serial Port.....                                     | A-3         |
|                   | Workmaster Serial Port.....  | A-4         |
|                   | RS-232/RS-485 Converter .....                                      | A-7         |
|                   | IC690ACC901 Miniconverter Kit.....                                 | A-7         |
|                   | IC690ACC900 Obsolete Converter.....                                | A-7         |
|                   | Serial Cable Diagrams .....  | A-8         |
|                   | RS-232 Point-to-Point Connections .....                            | A-8         |
|                   | RS-422 Point-to-Point Connection.....                              | A-10        |
|                   | Multidrop Connections .....  | A-10        |
| <b>Appendix B</b> | <b>IC690ACC900 Converter .....</b>                                 | <b>B-1</b>  |
|                   | Features .....   | B-1         |
|                   | Functions.....   | B-1         |
|                   | Location in System .....   | B-2         |
|                   | Installation.....  | B-2         |
|                   | Cable Description.....   | B-3         |
|                   | RS-232 Interface Pin Assignments.....                              | B-4         |
|                   | RS-422/RS-485 Interface Pin Assignments .....                      | B-5         |
|                   | Logic Diagram .....  | B-6         |
|                   | Jumper Configuration .....   | B-7         |

## Contents

---

|                   |  |            |
|-------------------|--|------------|
|                   | Example of Cable Configurations .....                        | B-9        |
| <b>Appendix C</b> | <b>IC655CCM690 Isolated Repeater/Converter .....</b>         | <b>C-1</b> |
|                   | Description of the Isolated Repeater/Converter .....         | C-1        |
|                   | Logic Diagram of the Isolated Repeater/Converter .....       | C-3        |
|                   | Pin Assignments for the Isolated Repeater/Converter .....    | C-4        |
|                   | System Configurations.....                                   | C-5        |
|                   | Simple Multidrop Configuration .....                         | C-6        |
|                   | Complex Multidrop Configuration.....                         | C-6        |
|                   | Rules for Using Repeater/Converters in Complex Networks..... | C-7        |
|                   | Cable Diagrams.....  | C-8        |
| <b>Appendix D</b> | <b>IC690ACC901 Miniconverter Kit.....</b>                    | <b>D-1</b> |
|                   | Description of Miniconverter.....                            | D-1        |
|                   | Pin Assignments.....   | D-2        |
|                   | Pin Assignments, RS-232 Port .....                           | D-2        |
|                   | Pin Assignments, RS-422 Port .....                           | D-2        |
|                   | System Configurations.....                                   | D-3        |
|                   | Cable Diagrams (Point-To-Point).....                         | D-3        |
| <b>Appendix E</b> | <b>IC690ACC903 Port Isolator .....</b>                       | <b>E-1</b> |
|                   | Connectors .....   | E-2        |
|                   | Logic Diagram .....  | E-3        |
|                   | Installation.....  | E-4        |
|                   | Specifications.....  | E-7        |
| <b>Appendix F</b> | <b>Calculating Series 90-30 Heat Dissipation .....</b>       | <b>F-1</b> |
|                   | Overview.....  | F-1        |
|                   | Information Required.....                                    | F-1        |
|                   | Procedure .....  | F-2        |
|                   | Step 1: Basic Method to Calculate Module Dissipation.....    | F-2        |
|                   | Step 2: Calculation for PLC Power Supplies.....              | F-3        |
|                   | Step 3: Output Calculations for Discrete Output Modules..... | F-3        |
|                   | Step 4: Input Calculations for Discrete Input Modules .....  | F-4        |
|                   | Step 5: Final Calculation.....                               | F-6        |
|                   | Other Information Related to Enclosure Sizing.....           | F-6        |
| <b>Appendix G</b> | <b>Catalog Number to Publication Cross-Reference .....</b>   | <b>G-1</b> |
|                   | General System Information.....                              | G-2        |
|                   | Analog I/O Modules .....                                     | G-2        |
|                   | Baseplates .....   | G-2        |
|                   | Communications Modules .....                                 | G-3        |

## Contents

---

|  |            |
|--|------------|
| CPU Modules, CPU311-CPU341 .....                                   | G-3        |
| CPU Modules, CPU350 - CPU374 .....                                 | G-4        |
| Digital Valve Driver Module .....                                  | G-5        |
| Discrete I/O Modules .....   | G-5        |
| Genius Modules .....   | G-6        |
| Motion Modules .....   | G-6        |
| Other Option Modules .....   | G-6        |
| Power Supply Modules .....   | G-7        |
| Programming Device .....   | G-7        |
| State Logic Products .....   | G-7        |
| Publication Revision Letters .....                                 | G-8        |
| Other Sources of Information .....                                 | G-8        |
| <b>Appendix H    Terminal Block Quick Connect Components .....</b> | <b>H-1</b> |
| Terminal Block Quick Connect Components for 16-Point Modules ..... | H-2        |
| Terminal Blocks .....  | H-2        |
| Cable Current Rating .....   | H-2        |
| Cable Selection and Cross-Reference .....                          | H-3        |
| I/O Face Plate for 16-Point Modules .....                          | H-3        |
| I/O Face Plate Installation .....                                  | H-3        |
| Module Wiring Information .....                                    | H-4        |
| Cable Information .....  | H-4        |
| Connector Pin Orientation and Connection to Module Terminal .....  | H-5        |
| Terminal Block Information .....                                   | H-5        |
| IC693ACC329 TBQC Terminal Block .....                              | H-6        |
| IC693ACC330 TBQC Terminal Block .....                              | H-7        |
| IC693ACC331 TBQC Terminal Block .....                              | H-8        |
| IC693ACC332 TBQC Terminal Block .....                              | H-9        |
| IC693ACC333 TBQC Terminal Block .....                              | H-10       |
| Terminal Block Quick Connect Components for 32-Point Modules ..... | H-11       |
| Terminal Block .....   | H-12       |
| Cable Selection and Cross-Reference .....                          | H-12       |
| Cable Current Rating .....   | H-12       |
| Cable Data .....   | H-13       |
| Terminal Block Data .....  | H-13       |
| IC693ACC337 TBQC Terminal Block .....                              | H-13       |
| <b>Appendix I    SNP Multidrop .....</b>                           | <b>I-1</b> |
| SNP Multidrop Overview .....                                       | I-1        |
| Multidrop Cables .....   | I-2        |
| Limitations .....  | I-2        |
| Cable and Connector Specifications .....                           | I-2        |
| MultiDrop Cable Wiring Diagram .....                               | I-3        |

## Contents

---

|                   |  |            |
|-------------------|--|------------|
|                   | SNP Multidrop Examples .....   | I-4        |
|                   | Configuring and Connecting a Programmer to a Multidrop Network .....       | I-5        |
|                   | Assigning a PLC SNP ID to a PLC with Logicmaster .....                     | I-6        |
|                   | Connecting your Logicmaster Programmer to a PLC on a Multidrop System..... | I-6        |
|                   | SNP Multidrop Troubleshooting.....   | I-7        |
| <b>Appendix J</b> | <b>Ethernet Transceivers .....</b>   | <b>J-1</b> |
|                   | IC649AEA102 Ethernet 10BASE-T Transceiver .....                            | J-1        |
|                   | Power Requirement .....  | J-1        |
|                   | LED Indicator Lights.....  | J-1        |
|                   | IC649AEA103 Ethernet 10BASE2 Transceiver.....                              | J-2        |
|                   | Power Requirement .....  | J-2        |
|                   | LED Indicator Light .....  | J-2        |
| <b>Appendix K</b> | <b>Tables and Formulas.....</b>  | <b>K-1</b> |
|                   | AWG to Metric Wire Size Conversion .....                                   | K-2        |
|                   | Temperature Conversion .....   | K-3        |
|                   | Formulas.....  | K-3        |
|                   | Conversion Information .....   | K-4        |
|                   | English and Metric Equivalents.....  | K-5        |
| <b>Appendix L</b> | <b>44A420084-001 EMI Line Filter.....</b>                                  | <b>L-1</b> |
|                   | 44A720084-001 Optional EMI Line Filter .....                               | L-1        |
|                   | 44A720084-001 Line Filter Mounting Dimensions.....                         | L-3        |

## Contents

---

|   |      |
|---|------|
| Figure 1-1. Five-Slot CPU Baseplate .....   | 1-3  |
| Figure 1-2. Power Supply Module.....  | 1-3  |
| Figure 1-3. CPU Module .....  | 1-4  |
| Figure 1-4. I/O Module.....   | 1-4  |
| Figure 1-5. Assembling the System.....  | 1-5  |
| Figure 1-6. A Basic System .....  | 1-6  |
| Figure 1-7. Ten-Slot Rack .....   | 1-6  |
| Figure 1-8. I/O Bus Expansion Cable.....  | 1-7  |
| Figure 1-9. Connecting Expansion and Remote Baseplates .....                            | 1-8  |
| Figure 1-10. Connecting PLCs Using GBC or CMM Modules .....                             | 1-9  |
| Figure 2-1. Features of Series 90-30 Module .....                                       | 2-2  |
| Figure 2-2. Installing a Module .....   | 2-3  |
| Figure 2-3. Removing a Module.....  | 2-4  |
| Figure 2-4. Installing an I/O Module's Terminal Board.....                              | 2-5  |
| Figure 2-5. Removing a Module's Terminal Board .....                                    | 2-6  |
| Figure 2-6. Terminal Board with Holding Screws .....                                    | 2-7  |
| Figure 2-7. IC693ACC308 Front Mount Adapter Bracket Installation.....                   | 2-9  |
| Figure 2-8. Dimensions for 19-inch Rack Mounting Using IC693ACC308 Adapter Bracket..... | 2-9  |
| Figure 2-9. IC693ACC313 Recessed Mount Adapter Bracket.....                             | 2-10 |
| Figure 2-10. Recommended System Grounding.....  | 2-11 |
| Figure 2-11. Baseplate Grounding.....   | 2-12 |
| Figure 2-12. CPU 351 or 352 - Attaching Shield Ground Wire .....                        | 2-14 |
| Figure 2-13. CPU 351 or 352 - Mounting the Shield Grounding Bracket and Wire .....      | 2-15 |
| Figure 2-14. CPU 363, CPU364, or CPU374 - Attaching Ground Wire.....                    | 2-16 |
| Figure 2-15. Power Supply Terminal Boards .....   | 2-24 |
| Figure 2-16. Overvoltage Protection Devices and Jumper Strap.....                       | 2-24 |
| Figure 3-1. Common Baseplate Features.....  | 3-2  |
| Figure 3-2. Models IC693CPU311 and IC693CPU313 (5-Slot) Embedded CPU Baseplates .....   | 3-5  |
| Figure 3-3. Model IC693CPU323 (10-slot) Embedded CPU Baseplate .....                    | 3-5  |
| Figure 3-4. IC693CHS397 5-Slot Modular CPU Baseplate .....                              | 3-6  |
| Figure 3-5. IC693CHS391 10-Slot Modular CPU Baseplate .....                             | 3-6  |
| Figure 3-6. IC693CHS398 5-Slot Expansion Baseplate.....                                 | 3-7  |
| Figure 3-7. IC693CHS392 10-Slot Expansion Baseplate.....                                | 3-8  |
| Figure 3-8. IC693CHS399 5-Slot Remote Baseplate .....                                   | 3-9  |
| Figure 3-9. IC693CHS393 10-Slot Remote Baseplate .....                                  | 3-9  |
| Figure 3-10. I/O Bus Expansion Cables .....   | 3-10 |

## Contents

|   |      |
|---|------|
| Figure 3-11. Rack Number Selection Switch (Shown with Rack 2 Selected).....                                 | 3-13 |
| Figure 3-12. Example of Connecting Expansion Baseplates.....  | 3-14 |
| Figure 3-13. Example of Connecting Expansion and Remote Baseplates.....                                     | 3-15 |
| Figure 3-14. Model 311 and 313 5-Slot Baseplate Dimensions and Spacing Requirements .....                   | 3-16 |
| Figure 3-15. Model 323 10-Slot Baseplate Dimensions and Spacing Requirements .....                          | 3-17 |
| Figure 3-16. Modular CPU, Expansion, and Remote 5-Slot Baseplate Dimensions and Spacing Requirements .....  | 3-18 |
| Figure 3-17. Modular CPU, Expansion, and Remote 10-Slot Baseplate Dimensions and Spacing Requirements ..... | 3-18 |
| Figure 3-18. IC693ACC308 Front Mount Adapter Bracket Installation.....                                      | 3-20 |
| Figure 3-19. Dimensions for 19" Rack Mounting Using IC693ACC308 Adapter Bracket.....                        | 3-21 |
| Figure 3-20. IC693ACC313 Recessed Mount Adapter Bracket.....  | 3-21 |
| Figure 4-1. Standard AC/DC Input Power Supply - IC693PWR321 .....   | 4-2  |
| Figure 4-2. High Capacity AC/DC Input Power Supply - IC693PWR330 .....                                      | 4-4  |
| Figure 4-3. Overvoltage Protection Devices and Jumper Strap.....  | 4-6  |
| Figure 4-4. Series 90-30 24/48 VDC Input Power Supply - IC693PWR322 .....                                   | 4-7  |
| Figure 4-5. Typical Efficiency Curve for 24/48 VDC Power Supply .....                                       | 4-8  |
| Figure 4-6. Series 90-30 48 VDC Input Power Supply - IC693PWR328 .....                                      | 4-10 |
| Figure 4-7. Typical Efficiency Curve for IC693PWR328 Power Supply .....                                     | 4-11 |
| Figure 4-8. Series 90-30 24 VDC Input High Capacity Power Supply - IC693PWR331 .....                        | 4-13 |
| Figure 4-9. 5 VDC Current Output Derating for Temperatures above 50°C (122°F).....                          | 4-14 |
| Figure 4-10. Overvoltage Protection Devices and Jumper Strap.....   | 4-17 |
| Figure 4-11. Interconnection of Power Supplies .....  | 4-17 |
| Figure 4-12. Timing Diagram for all Series 90-30 Power Supplies .....                                       | 4-18 |
| Figure 4-13. Serial Port Connector .....  | 4-19 |
| Figure 4-14. Backup Battery for RAM Memory .....  | 4-20 |
| Figure 5-1. Models 311 and 313 (5-Slot) Embedded CPU Baseplates.....  | 5-2  |
| Figure 5-2. IC693CHS397 5-Slot Modular CPU Baseplate.....   | 5-3  |
| Figure 5-3. CPU Serial Port Connector on Power Supply.....  | 5-4  |
| Figure 5-4. CPUs 351, 352, and 363 .....  | 5-19 |
| Figure 6-1. Backup Battery for RAM Memory .....   | 6-1  |
| Figure 6-2. Installing the Battery Accessory Kit .....  | 6-10 |
| Figure 7-1. Example of Series 90-30 Standard Density Discrete Output Module.....                            | 7-3  |
| Figure 7-2. Example of 32-Point I/O Module (IC693MDL654) With Dual Connectors .....                         | 7-5  |
| Figure 7-3. Example of 32-Point I/O Module (IC693MDL653) With Single Connector .....                        | 7-5  |
| Figure 7-4. 50-PIN, 32 Point I/O Module Connection Method.....  | 7-6  |
| Figure 7-5. Example of Series 90-30 Analog Current Output Module.....                                       | 7-9  |
| Figure 7-6. IC693DVM300 Digital Valve Driver Module.....  | 7-12 |

## Contents

---

|   |       |
|---|-------|
| Figure 8-1. The IC693CMM301 GCM Module .....  | 8-2   |
| Figure 8-2. Genius Bus Wiring Schematic .....   | 8-3   |
| Figure 8-3. Example of Genius Communications Network.....                                 | 8-3   |
| Figure 8-4. Enhanced Genius Communications Module.....                                    | 8-4   |
| Figure 8-5. Genius Bus Controller Module .....  | 8-6   |
| Figure 8-6. Example of FIP I/O System Configuration.....                                  | 8-10  |
| Figure 8-7. Series 90-30 FIP Bus Controller .....   | 8-11  |
| Figure 8-8. Example of FIP Remote I/O Scanner System Configuration.....                   | 8-12  |
| Figure 8-9. FIP Bus Interface Module .....  | 8-13  |
| Figure 8-10. Motion Mate APM Module .....   | 8-15  |
| Figure 8-11. Example of Motion Mate APM Servo System .....                                | 8-16  |
| Figure 8-12. Motion Mate DSM302 Module .....  | 8-17  |
| Figure 8-13. Motion Mate DSM314 Module .....  | 8-20  |
| Figure 8-14. High Speed Counter (HSC) .....   | 8-23  |
| Figure 8-15. Example of a Series 90-30 PLC in a Fanuc I/O LINK Configuration .....        | 8-24  |
| Figure 8-16. Example of I/O LINK Master System Configuration .....                        | 8-25  |
| Figure 8-17. I/O Processor Module .....   | 8-27  |
| Figure 8-18. Ethernet Interface Module .....  | 8-29  |
| Figure 8-19. Programmable Coprocessor Module (PCM).....                                   | 8-31  |
| Figure 8-20. Communications Control Module.....   | 8-34  |
| Figure 8-21. Alphanumeric Display Coprocessor Module (ADC).....                           | 8-35  |
| Figure 8-22. IC693TCM302/303 Temperature Control Module (TCM).....                        | 8-37  |
| Figure 8-23. IC693PTM100/101 Components .....   | 8-41  |
| Figure 8-24. IC693PTM100/101 Component Mounting.....                                      | 8-42  |
| Figure 9-1. AD693CMM301 State Logic Serial Communications Module.....                     | 9-2   |
| Figure 9-2. IC693CBL305 WYE Cable .....   | 9-3   |
| Figure 9-3. IC693SLP300 State Logic Processor Module for Series 90-30.....                | 9-4   |
| Figure 9-4. State Logic Processor Module User Details .....                               | 9-6   |
| Figure 9-5. Model CSE311 or CSE313 5-Slot Embedded CPU Baseplate .....                    | 9-9   |
| Figure 9-6. Model CSE323 10-Slot Embedded CPU Baseplate.....                              | 9-9   |
| Figure 9-7. CPU Models CSE 331 or CSE 340.....  | 9-10  |
| Figure 9-8. Serial Port Connector .....   | 9-11  |
| Figure 10-1. Serial Port to Work Station Interface Board Cable Connection .....           | 10-8  |
| Figure 10-2. Series 90 PLC to Workmaster II Serial Cable .....                            | 10-9  |
| Figure 10-3. Example of Multidrop Configuration with Converter .....                      | 10-10 |
| Figure 10-4. Series 90 PLC to Programmer 8-Wire Multidrop, Serial Data Configuration..... | 10-11 |
| Figure 10-5. PCM, ADC, or CMM to Workmaster or PC-XT Serial Cable .....                   | 10-12 |



## Contents

---

|  |       |
|--|-------|
| Figure 10-6. PCM to Workmaster Computer or PC-XT Personal Computer .....                               | 10-13 |
| Figure 10-7. PCM, ADC, or CMM to Workmaster or PC-AT Serial Cable .....                                | 10-14 |
| Figure 10-8. PCM to PC-AT Personal Computer .....  | 10-15 |
| Figure 10-9. PCM, ADC, or CMM to Workmaster II or PS/2 Serial Cable .....                              | 10-16 |
| Figure 10-10. PCM to Workmaster II Computer or PS/2 Computer .....                                     | 10-17 |
| Figure 10-11. Connecting Diagram for Multidrop Cable IC690CBL714A .....                                | 10-19 |
| Figure 10-12. Multidrop Arrangement for Series 90-30 Redundant System .....                            | 10-20 |
| Figure 10-13. Connecting CPU and APM to Programmer with IC690CBL714A Cable .....                       | 10-20 |
| Figure 10-14. Multidrop Arrangement for Series 90-70 TMR Redundant System .....                        | 10-21 |
| Figure 10-15. Detail of I/O Bus Expansion Cables .....   | 10-22 |
| Figure 10-16. How to use Split-Ring Ferrules for Foil and Braided Cable Shield .....                   | 10-26 |
| Figure 10-17. Point-To-Point Cable Wiring for Continuous Shield Custom Length Cables .....             | 10-28 |
| Figure 10-18. Point-To-Point Cable Wiring Diagram for Applications Requiring Less Noise Immunity ..... | 10-28 |
| Figure 10-19. Earlier Versions of Remote Baseplate Custom WYE Cable Wiring Diagram .....               | 10-29 |
| Figure 10-20. Current Remote baseplate (IC693CHS393/399) Custom Wye Cable Wiring Diagram ....          | 10-30 |
| Figure 10-21. Example of Connecting Expansion Baseplates .....   | 10-31 |
| Figure 10-22. Example of Connecting Expansion and Remote Baseplates .....                              | 10-32 |
| Figure 10-23. Wiring Connections for IC693CBL303 and Custom-Built Cables .....                         | 10-34 |
| Figure 10-24. Hand-Held Programmer Cable Connection to a Series 90-30 PLC .....                        | 10-34 |
| Figure 10-25. Wye Cable .....  | 10-35 |
| Figure 10-26. Wye Cable Connections .....  | 10-36 |
| Figure 10-27. 32 Point I/O Module to Weidmuller Terminal Block Assembly .....                          | 10-39 |
| Figure 10-28. IC693CBL310 Cable .....  | 10-42 |
| Figure 10-29. Dimensions for Depth of Connector in front of PLC .....                                  | 10-44 |
| Figure 10-30. I/O Connector Cable Specifications .....   | 10-45 |
| Figure 10-31. IC693CBL315 Cable .....  | 10-49 |
| Figure 10-32. Dimensions for Depth of Connector in front of PLC .....                                  | 10-52 |
| Figure 10-33. IC693CBL316A Serial Cable Illustration and Connector Pinouts .....                       | 10-53 |
| Figure 10-34. Connector Orientation on I/O Faceplate .....   | 10-55 |
| Figure 10-35. I/O Faceplate to Terminal Block Cable .....  | 10-55 |
| Figure 10-36. Dimensions for Depth of Connector in front of PLC .....                                  | 10-56 |
| Figure 10-37. C693CBL327/328 Cables .....  | 10-57 |
| Figure 10-38. Dimension for Depth of Connector for IC693CBL327/328 .....                               | 10-58 |
| Figure 10-39. Dimensions for Depth of Connector in front of PLC for Custom Built Cables .....          | 10-61 |
| Figure 10-40. IC693CBL329/330/331/332/333/334 Cables .....   | 10-62 |
| Figure 10-41. Dimension for Depth of Connector .....   | 10-63 |
| Figure 10-42. Figure IC693CBL340/341 PTM Interface Cables .....  | 10-65 |

## Contents

---

|  |       |
|--|-------|
| Figure 10-43. PTM Component Mounting and Cable Connection.....                           | 10-65 |
| Figure 11-1. WSI Board for the Workmaster II Computer.....                               | 11-2  |
| Figure 11-2. Location of WSI in a Series II 90-30 PLC System .....                       | 11-2  |
| Figure 11-3. Example of IC690ACC900 Converter Connection.....                            | 11-3  |
| Figure 11-4. IC690ACC901 Series 90 SNP Port to RS-232 Adapter.....                       | 11-4  |
| Figure 11-5. Hand-Held Programmer for the Series 90-30 PLC .....                         | 11-5  |
| Figure 11-6. Example of PCIF Interface to Series 90-30 I/O .....                         | 11-7  |
| Figure 12-1. Hard-Wired MCR Circuit Example .....  | 12-9  |
| Figure 12-2. Allowable Location of Modules .....   | 12-19 |
| Figure 12-3. Series 90-30 Example Layout.....  | 12-20 |
| Figure 12-4. Recommended PLC Mounting Orientation .....                                  | 12-21 |
| Figure 12-5. Derated PLC Mounting Orientation.....                                       | 12-21 |
| Figure 13-1. Relationship of Indicator Lights to Terminal Board Connections .....        | 13-1  |
| Figure A-1. Series 90 PLC, RS-422 Serial Port Connector Configuration .....              | A-3   |
| Figure A-2. Workmaster RS-232 Serial Port Connector Configuration.....                   | A-4   |
| Figure A-3. IBM-AT/XT Serial Port .....  | A-5   |
| Figure A-4. IBM-AT (compatibles) Personal Computer to Series 90 PLCs .....               | A-9   |
| Figure A-5. Workmaster or IBM-XT (compatibles) Personal Computer to Series 90 PLCs ..... | A-9   |
| Figure A-6. Typical RS-422, Host to PLC Connection, with Handshaking.....                | A-10  |
| Figure A-7. Workmaster II/Series 90 PLC Multidrop Connection.....                        | A-11  |
| Figure A-8. Workmaster/Series 90 PLC Multidrop Connection .....                          | A-12  |
| Figure A-9. IBM-AT/Series 90 PLC Multidrop Connection.....                               | A-12  |
| Figure A-10. IBM-XT/Series 90 PLC Multidrop Connection.....                              | A-13  |
| Figure B-1. Front and Rear View of Converter .....                                       | B-2   |
| Figure B-2. Typical Configuration with Series 90-70 PLC.....                             | B-3   |
| Figure B-3. Typical Configuration with Series 90-30 PLC.....                             | B-4   |
| Figure B-4. RS-422/RS-485 to RS-232 Converter Logic Diagram.....                         | B-6   |
| Figure B-5. Location of Jumpers for User Options .....                                   | B-7   |
| Figure C-1. Isolated/Repeater Converter .....  | C-2   |
| Figure C-2. RS-422 Isolated Repeater/RS-232 Converter Logic Diagram .....                | C-3   |
| Figure C-3. Example RS-422 Isolated Repeater/RS-232 Converter Connection.....            | C-5   |
| Figure C-4. Simple System Configuration Using the Isolated Repeater/Converter .....      | C-6   |
| Figure C-5. Complex System Configuration Using the Isolated Repeater/Converter.....      | C-6   |
| Figure C-6. Cable A; RS-232 CMM To Converter .....                                       | C-8   |
| Figure C-7. Cable B; RS-422 CMM To Converter .....                                       | C-8   |
| Figure C-8. Cable C; RS422 Twisted Pair.....   | C-9   |
| Figure C-9. Cable D; RS-422 Twisted Pair .....   | C-10  |

## Contents

|  |      |
|--|------|
| Figure C-10. Cable E; RS-232 Converter to CMM.....   | C-10 |
| Figure D-1. Series 90 SNP to RS-232 Miniconverter .....  | D-1  |
| Figure D-2. Miniconverter to PC-AT .....   | D-3  |
| Figure D-3. Miniconverter to Workmaster II, PC-XT, PS/2 .....                                  | D-3  |
| Figure D-4. Miniconverter to 9-Pin Workmaster or PC-XT Computer.....                           | D-4  |
| Figure E-2. IC690ACC903 Block Diagram .....  | E-3  |
| Figure E-3. RS-485 Port Isolator in PLC Network.....   | E-4  |
| Figure E-4. Mounting Port Isolator to Panel .....  | E-4  |
| Figure E-5. Multidrop Configuration Connecting Devices with 15-Pin Ports and 25-Pin Ports..... | E-5  |
| Figure E-6. Cable for Supplying External Power Through the Port Isolator.....                  | E-6  |
| Figure H-1. Typical TBQC Terminal Block.....   | H-1  |
| Figure H-2. TBQC Faceplate.....  | H-5  |
| Figure H-3. IC693ACC329 TBQC Terminal Block.....   | H-6  |
| Figure H-4. IC693ACC330 TBQC Terminal Block.....   | H-7  |
| Figure H-5. IC693ACC331 TBQC Terminal Block.....   | H-8  |
| Figure H-6. IC693ACC332 TBQC Terminal Block.....   | H-9  |
| Figure H-7. IC693ACC333 TBQC Terminal Block.....   | H-10 |
| Figure H-8. IC693MDL654 32-Point Module.....   | H-11 |
| Figure H-9. IC693ACC337 TBQC Terminal Block.....   | H-13 |
| Figure I-1. Series 90-30 Multidrop Example.....  | I-1  |
| Figure I-2. Multidrop Cable Wiring Diagram .....   | I-3  |
| Figure I-3. Connecting CPU and APM to Programmer with IC690CBL714A Cable.....                  | I-4  |
| Figure I-4. Multidrop Arrangement for Series 90-70 TMR Redundant System.....                   | I-4  |
| Figure I-5. Multidrop Arrangement for Series 90-30 Redundant System .....                      | I-5  |
| Figure J-1. IC649AEA102 Ethernet 10BASE-T Transceiver .....                                    | J-1  |
| Figure J-2. IC649AEA103 Ethernet 10BASE2 Transceiver .....                                     | J-2  |
| Figure L-1. 44A720084-001 Line Filter Connections to Series 90-30 Power Supply .....           | L-2  |
| Figure L-2. Equivalent Circuit for 44A720084-001 Line Filter .....                             | L-2  |
| Figure L-3. 44A720084-001 Line Filter Mounting Dimensions .....                                | L-3  |

## Contents

---

|   |       |
|---|-------|
| Table 3-1. Rack Number Selection Switch Settings.....                                 | 3-13  |
| Table 3-2. Series 90-30 Baseplate Comparison.....                                     | 3-22  |
| Table 4-1. Power Supply Comparison.....   | 4-1   |
| Table 4-2. IC693PWR321 Power Supply Capacities .....                                  | 4-2   |
| Table 4-3. Specifications for IC693PWR321 Standard AC/DC Input Power Supply.....      | 4-3   |
| Table 4-4. IC693PWR330 Power Supply Capacities .....                                  | 4-4   |
| Table 4-5. Specifications for IC693PWR330 High Capacity AC/DC Input Power Supply..... | 4-5   |
| Table 4-6. IC693PWR322 Power Supply Capacities .....                                  | 4-7   |
| Table 4-7. Specifications for IC693PWR322 Power Supply.....                           | 4-8   |
| Table 4-8. IC693PWR328 Power Supply Capacities .....                                  | 4-10  |
| Table 4-9. Specifications for IC693PWR328 Power Supply.....                           | 4-11  |
| Table 4-10. IC693PWR331 Power Supply Capacities .....                                 | 4-13  |
| Table 4-11. Specifications for IC693PWR331 Power Supply.....                          | 4-14  |
| Table 5-1. CPU Firmware and PROM Configurations.....                                  | 5-6   |
| Table 5-2. EPROM and EEPROM Catalog Numbers .....                                     | 5-9   |
| Table 5-3. Series 90-30 CPU Capacities .....  | 5-10  |
| Table 5-4. Range and Size of User References for CPU Models 311-341 .....             | 5-11  |
| Table 5-5. Range and Size of User References for CPU Models 350 through 374.....      | 5-12  |
| Table 5-6. Port 1 (RS-232) .....  | 5-22  |
| Table 5-7. Port 2 (RS-485) .....  | 5-22  |
| Table 7-1. IC693DVM300 Specifications.....  | 7-13  |
| Table 7-2. IC693DVM300 Connections.....   | 7-14  |
| Table 7-3. Series 90-30 Discrete I/O Modules .....                                    | 7-15  |
| Table 7-4. Series 90-30 Analog I/O Modules.....                                       | 7-16  |
| Table 8-1. Comparison of TCM302 and TCM303 .....                                      | 8-39  |
| Table 9-1. System Specifications for Series 90-30 State Logic CPUs .....              | 9-12  |
| Table 10-1. Series 90-30 Cable Cross-Reference.....                                   | 10-1  |
| Table 10-2. Expansion Port Pin Assignments .....                                      | 10-25 |
| Table 10-3. Wire List for 32 Point I/O Cables .....                                   | 10-40 |
| Table 10-4. Wire List for 24-Pin Connectors .....                                     | 10-43 |
| Table 10-5. Catalog Numbers for 24-Pin Connector Kits .....                           | 10-46 |
| Table 10-6. I/O Cable Wire Coding for IC693CBL311 and IC693CBL319.....                | 10-47 |
| Table 10-7. I/O Cable Wire Coding for IC693CBL317 and IC693CBL320.....                | 10-48 |
| Table 10-8. Catalog Numbers for 24-Pin Connector Kits .....                           | 10-50 |
| Table 10-9. Wire List for 24-Pin Connectors .....                                     | 10-51 |
| Table 10-10. Catalog Numbers for 24-Pin Connector Kits .....                          | 10-59 |

## *Contents*

---

|   |       |
|---|-------|
| Table 10-11. Wire List for 24-Pin Connectors .....  | 10-60 |
| Table 10-12. TBQC Cable Cross-Reference Table .....                                       | 10-63 |
| Table 11-1. Personal Computer Interface Card Comparison Table.....                        | 11-7  |
| Table 12-1. Power Supply Feature Comparison Table.....                                    | 12-6  |
| Table 12-2. Maximum Number of Modules Per System.....                                     | 12-11 |
| Table 12-3. Load Requirements (in milliamps).....   | 12-12 |
| Table 13-1. Fuse List for Series 90-30 Modules .....                                      | 13-6  |
| Table 13-2. Spare/Replacement Parts.....  | 13-7  |
| Table A-1. Connector/Cable Specifications .....   | A-2   |
| Table A-2. Series 90 PLC, RS-422 Serial Port Pin-out .....                                | A-4   |
| Table A-3. Workmaster RS-232 Serial Port Pins-out.....                                    | A-5   |
| Table A-4. IBM-AT/XT Serial Port Pins-out .....   | A-6   |
| Table B-1. RS-232 Interface for Converter .....   | B-4   |
| Table B-2. RS-422/RS-485 Interface for Converter.....                                     | B-5   |
| Table B-3. Jumper Configuration for RS-422/RS-485 to RS-232 Converter.....                | B-8   |
| Table B-4. Specifications for IC690ACC900 Converter.....                                  | B-9   |
| Table C-1. Isolated Repeater/Converter Pin Assignments .....                              | C-4   |
| Table D-1. Miniconverter RS-232 Port .....  | D-2   |
| Table D-2. Miniconverter RS-422 Port .....  | D-2   |
| Table D-3. Miniconverter Specifications .....   | D-4   |
| RS-485 Connectors.....  | E-2   |
| Table H-1. TBQC Terminal Block Selection Table .....                                      | H-2   |
| Table I-1. Connector and Cable Specifications .....                                       | I-2   |
| Table K-1. Standard ASCII (American Standard Code for Information Interchange) Codes..... | K-1   |
| Table K-2. AWG to Metric Wire Size Conversion .....                                       | K-2   |
| Table K-3. Celsius to Fahrenheit Conversion.....  | K-3   |
| Table K-4. General Conversions .....  | K-4   |
| Table K-5. Length Equivalents.....  | K-5   |
| Table K-6. Area Equivalents .....   | K-5   |
| Table K-7. Volume Equivalents I.....  | K-6   |
| Table K-8. Volume Equivalents II.....   | K-6   |

# Chapter 1

## Overview of the Series 90-30 PLC

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The Series 90™-30 Programmable Logic Controller (PLC) is a member of the GE Fanuc Series 90 PLC family.

### The Basic Parts of a Series 90-30 PLC

The Series 90-30 PLC is very versatile because (1) it is programmable, and (2) it is assembled from a wide variety of modular, plug-together components. Therefore, by choosing the correct components and developing an appropriate program, the PLC can be used for an almost unlimited variety of applications. Although there are many choices of individual hardware components to use in a system, there are just a few basic categories. Each of these component categories is covered in detail in a separate chapter in this manual. They are introduced in this chapter so you can see how they fit together:

- Baseplates
- Power Supplies
- CPUs
- I/O Modules
- Option Modules
- Cables

#### Baseplates

The baseplates are the foundation of the PLC system because most other components mount on them. As a basic minimum, every system has at least one baseplate, which usually contains the CPU (in which case, it is referred to as “the CPU Baseplate”). Many systems require more modules than can be mounted on one baseplate, so there are also Expansion and Remote baseplates that connect together. The three categories of baseplates, CPU, Expansion, and Remote, are available in two sizes, 5-slot and 10-slot, named according to the number of modules they can hold.

#### Power Supply Modules

Every baseplate must have its own power supply. The power supply always mounts in a baseplate’s left-most slot. There are several power supply models available to meet a variety of requirements.

## CPU's

The CPU is the manager of the PLC. Every PLC system must have one. A CPU uses the instructions in its firmware and application program to direct the PLC's operation and to monitor the system to make sure there are no basic faults. Some Series 90-30 CPU's are built into baseplates, but most are contained in plug-in modules. In some cases, the CPU resides in a Personal Computer using a Personal Computer Interface Card that interfaces to Series 90-30 Input, Output, and Option modules.

## Input and Output (I/O) Modules

These modules enable the PLC to interface with input and output field devices such as switches, sensors, relays, and solenoids. They are available in both discrete and analog types.

## Option Modules

These modules extend the capability of the PLC beyond the basic functions. These provide such things as communications and networking options, motion control, high speed counting, temperature control, interfacing to operator interface stations, etc.

## Cables

These connect the PLC components together or to other systems. Many standard prefabricated cables are available from GE Fanuc. They are primarily used to:

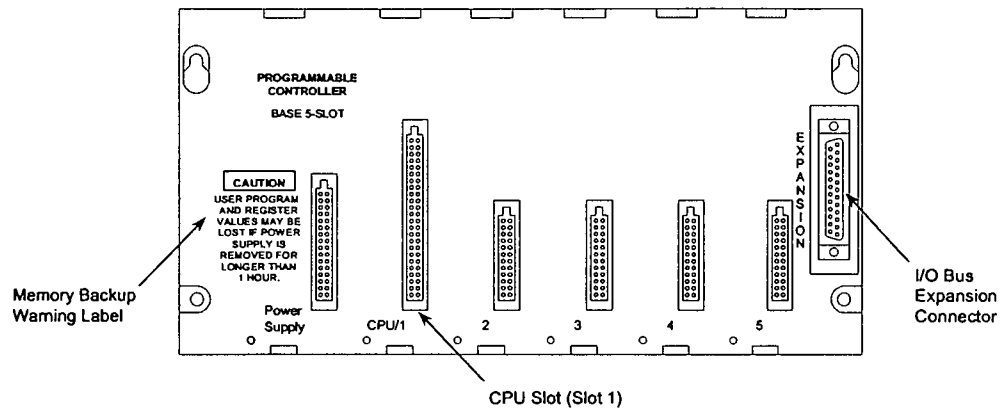
- Interconnect baseplates
- Connect a programmer to the CPU or to an option module
- Connect option modules to field devices or other systems.

## Assembling a Basic Series 90-30 PLC System

Let's assemble, on paper, a basic system using the following components:

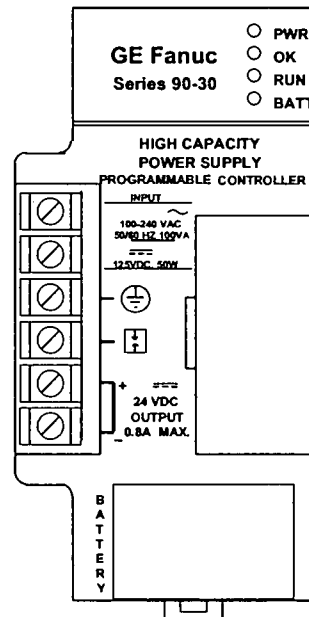
- Baseplate
- Power Supply module
- CPU module
- Some I/O modules

We'll start with the **baseplate**. To keep it simple, we'll use a 5-slot size. Note that a 5-slot baseplate actually has six slots, but the power supply slot is not numbered. Note also, that this baseplate has a CPU slot, which is slot number 1, and it has an expansion connector on the right end, which is used for connecting to another baseplate if the system has more than one baseplate.



**Figure 1-1. Five-Slot CPU Baseplate**

Next, we'll add a **power supply** module. It mounts in the unnumbered slot on the left end of the baseplate. This slot has a unique connector that will only fit a power supply module.



**Figure 1-2. Power Supply Module**



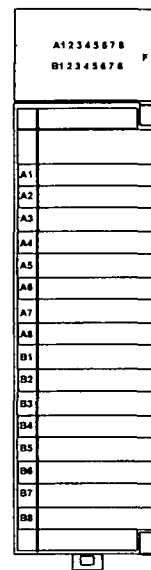
1

Then add a **CPU module**. A CPU module can only mount in baseplate slot 1, next to the power supply. Slot 1 has a unique connector that will only fit CPU or special Option modules.



**Figure 1-3. CPU Module**

To finish, we will add some **I/O modules** to baseplate slots 2 through 5.



**Figure 1-4. I/O Module**

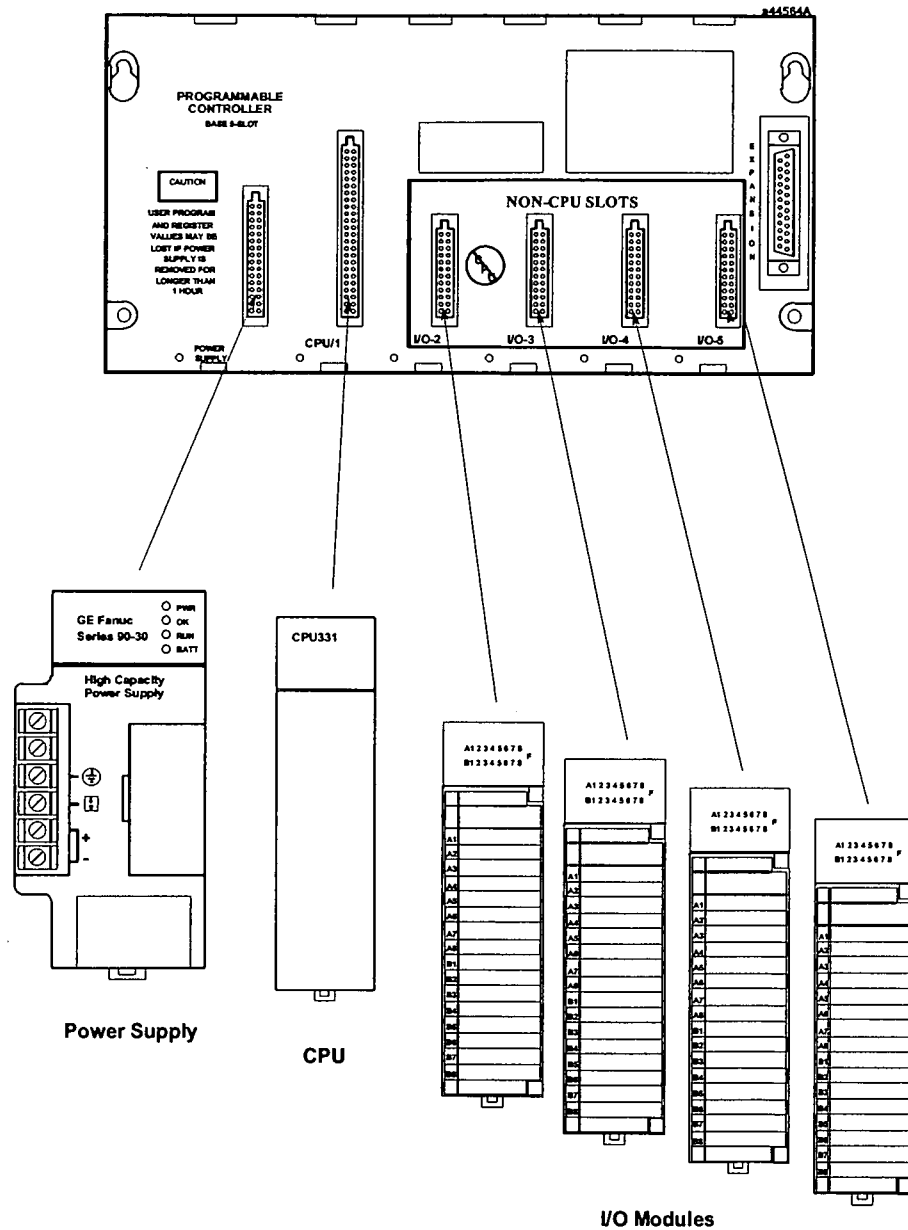


Figure 1-5. Assembling the System

1

When assembled, the system will look like this:

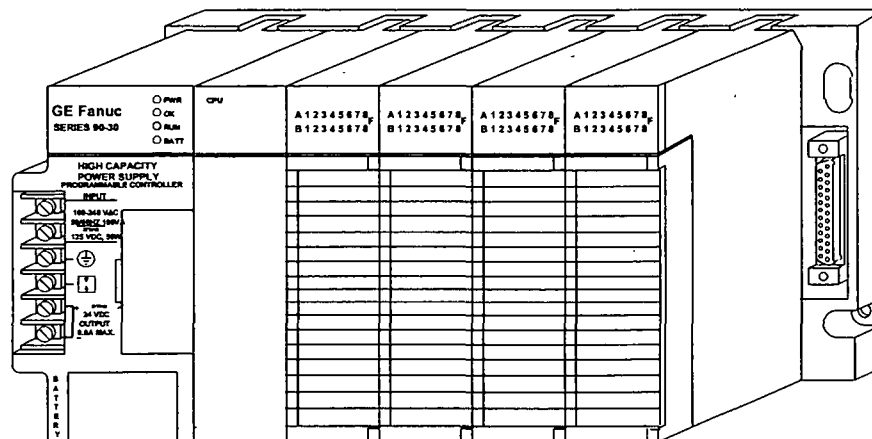


Figure 1-6. A Basic System

An assembly of baseplate and modules such as this one is called a "Rack."

What else would be needed to make this basic system functional?

To make this basic system functional, you would need:

- **Mounting.** Safe, secure mounting for the PLC in a protective enclosure.
- **Wiring.** This includes properly installed incoming power to the power supply, as well as wiring from the I/O modules to field devices such as switches, sensors, solenoids, relays, etc.
- **Program.** An application program for the PLC to run. This is developed with GE Fanuc PLC programming software.

What if the application requires more than five modules?

You could use a 10-slot baseplate, shown in the next picture:

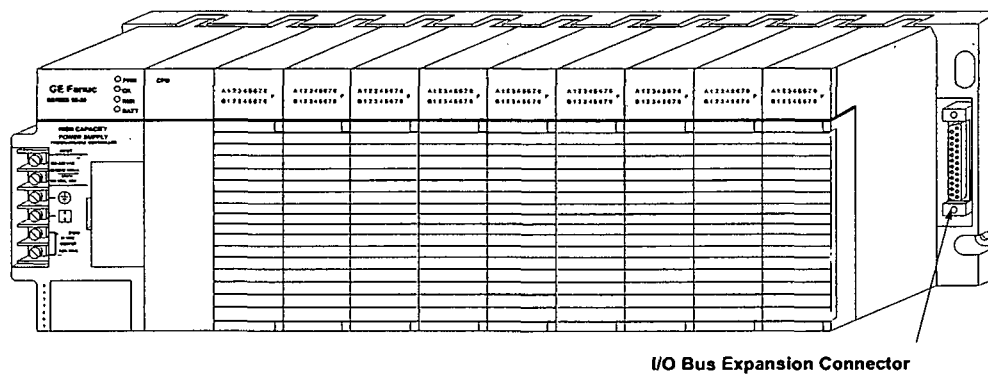


Figure 1-7. Ten-Slot Rack

## What if the application requires more than ten modules?

You can add one or more Expansion or Remote racks to this system. Some CPUs can support up to seven additional racks. If you added seven additional 10-slot racks, you could have 70 more modules.

Racks are interconnected in a “daisy-chain” cabling arrangement. This interconnection system is called the “I/O Expansion Bus.” The connections are made from one baseplate’s I/O Bus Expansion Connector (shown in the figure above) to the next one’s. The I/O Bus Expansion Cables, shown below, have a double connector on one end to facilitate these connections.

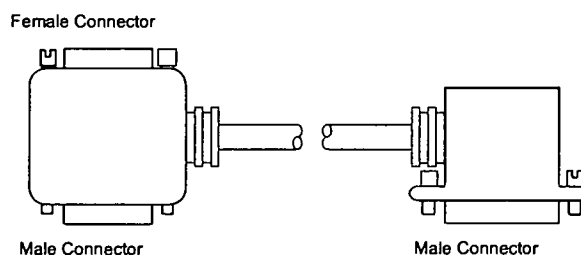


Figure 1-8. I/O Bus Expansion Cable

The next figure shows a system that has a CPU baseplate, one Expansion rack and three Remote racks. Notice that the last rack, the one at the end of the I/O Expansion Bus, must be terminated. A convenient way of terminating the bus is with an IC693ACC307 I/O Bus Terminator Plug, as shown.

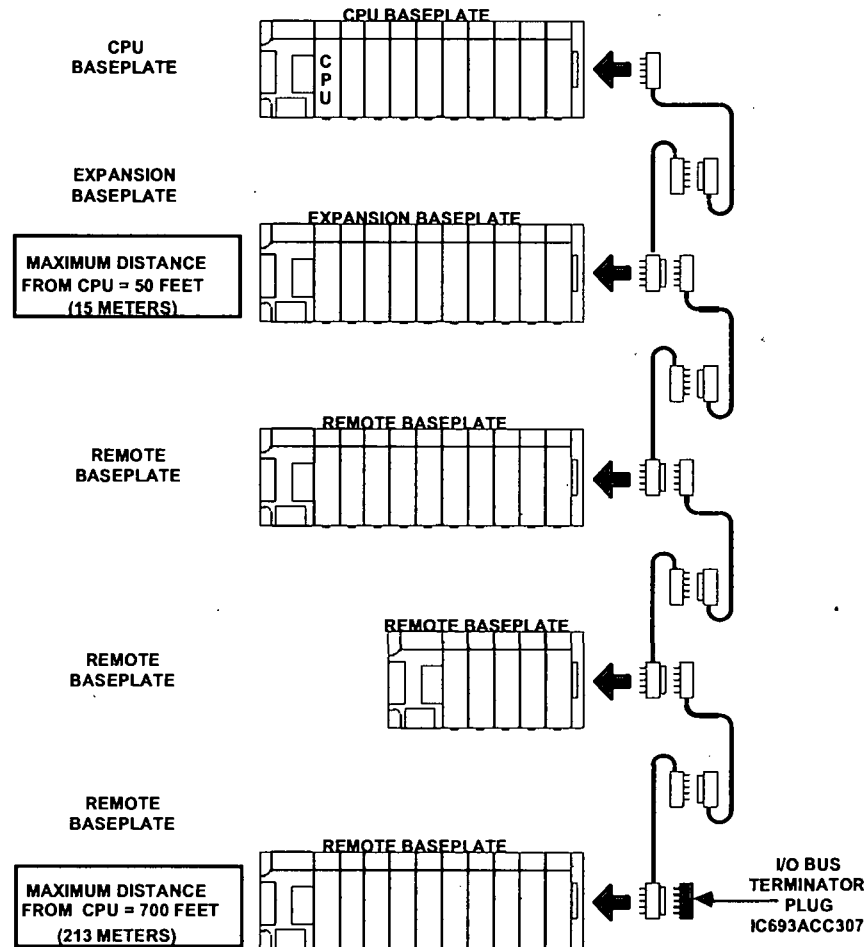


Figure 1-9. Connecting Expansion and Remote Baseplates

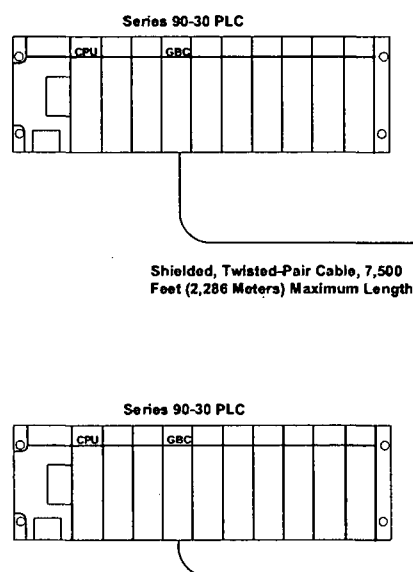
## What is the Difference Between Expansion and Remote baseplates?

The main factor to consider is distance. How far will the baseplate be from the CPU baseplate? If the cabling distance from the CPU baseplate is 50 feet (15 meters) or less, use an Expansion baseplate. The Expansion baseplate is preferable because of its higher communication speed with the CPU baseplate. However, if a baseplate must be located where it requires a cabling distance from the CPU rack in excess of 50 feet, an Expansion baseplate will not work - a Remote baseplate must be used. The limit for a Remote baseplate is a cabling distance of 700 feet (213 meters) from the CPU baseplate to the farthest Remote baseplate.

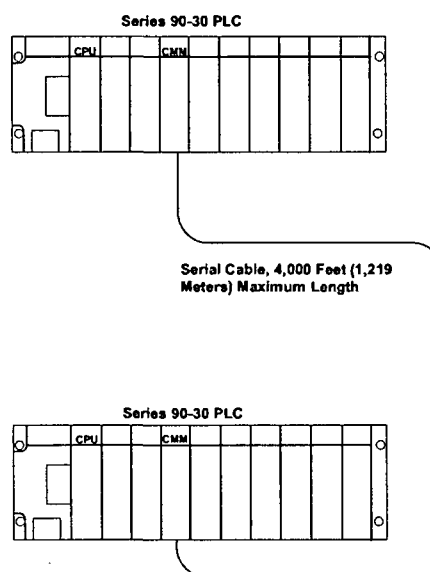
## What if I need to cover more than 700 feet (213 meters)?

You can cover much greater distances by using Series 90-30 communications option modules. For example, Genius Bus Controller Modules (GBC) can communicate at distances up to 7,500 feet (2,286 meters) over a shielded twisted-pair cable, as shown in Example 1 below. Or, serial communications with Communications Coprocessor Modules (CMM) using the RS-485 standard can cover up to 4,000 feet (1,219 meters), as shown in Example 2 below. And virtually unlimited communication distances can be attained with modems and telephone lines or radio transmitters. Also, there are numerous networking options available such as Ethernet or WorldFIP.

**Example 1 - GBC**



**Example 2 - CMM**



**Figure 1-10. Connecting PLCs Using GBC or CMM Modules**

## Chapter 2 Installation

This chapter discusses installation details only. Other information about the products such as hardware descriptions and specifications, is covered in the applicable chapters.

### Important Note

*Series 90-30 PLCs must be mounted in a protective enclosure.*

*The installation instructions described in this chapter apply to PLC installations that do not require special procedures for noisy or hazardous environments. For installations that must conform to more stringent requirements (such as CE Mark), see GFK-1179, **Installation Requirements for Conformance to Standards**. Also see GFK-0867, **GE Fanuc Product Agency Approvals, Standards, General Specifications**.*

### Receiving your Products - Visual Inspection

When you receive your Series 90-30 PLC system, carefully inspect all shipping containers for damage that may have occurred during shipping. If any part of the system is damaged, notify the carrier immediately. The damaged shipping container should be saved as evidence for inspection by the carrier.

As the consignee, it is your responsibility to register a claim with the carrier for damage incurred during shipment. However, GE Fanuc will fully cooperate with you if such action is necessary.

### Pre-installation Check

After unpacking Series 90-30 PLC racks, cables, modules, etc., **record all serial numbers**. Serial numbers are printed on the module packaging. Serial numbers are required to make a claim during the warranty period of the equipment. All software product registration cards should be completed and returned to GE Fanuc. See "Module Features" in this chapter for location of module serial numbers. See "Common Baseplate Features" in chapter 3 for location of baseplate serial numbers.

You should verify that all components of the system have been received and that they agree with your order. If the parts received do not agree with your order, call Programmable Control Customer Service at 1-800-432-7521. A Customer Service representative will provide further instructions.

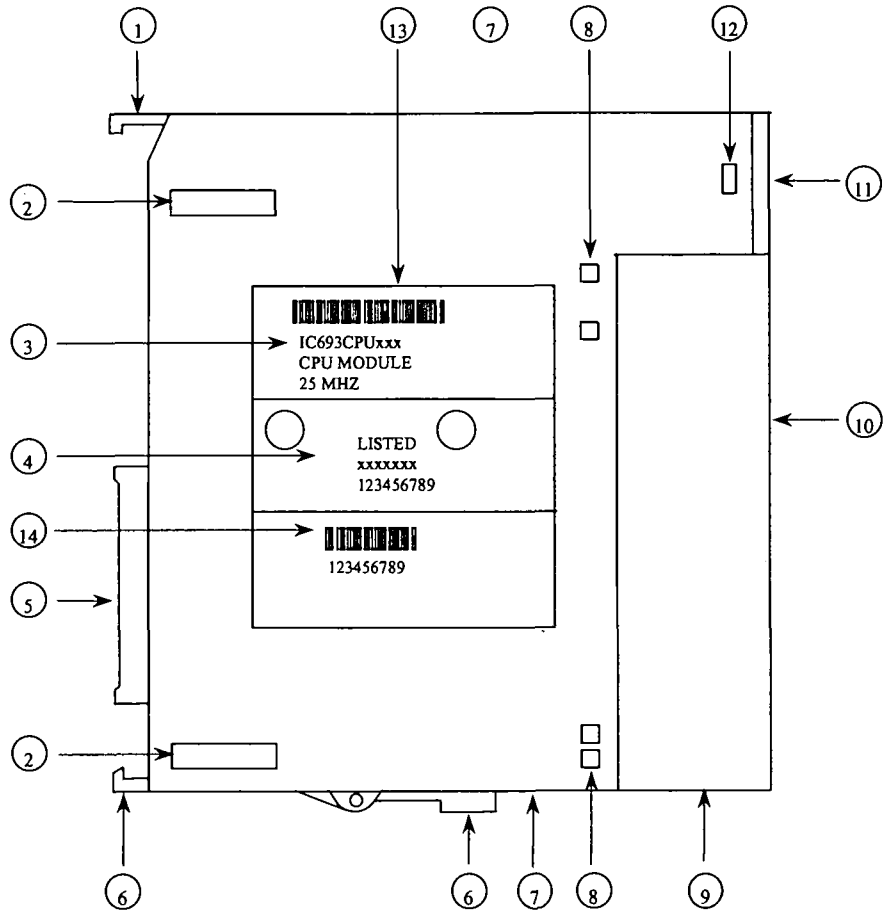
If you require assistance with your installation, GE Fanuc's Technical Support department offers expert help. Call the support number for your area from the list in Chapter 13, "Maintenance and Troubleshooting." The GE Fanuc web site support address is [www.gefanuc.com/support/plc](http://www.gefanuc.com/support/plc).

### Warranty Claims

Record the serial number of the defective item and contact your distributor for instructions.

## Working with Series 90-30 Modules

### Module Features



**Figure 2-1. Features of Series 90-30 Module**

1. Pivot hook
2. Circuit board holding tabs (two on each side of module)
3. Catalog number and description section of label (Includes MAC address for CPU374.)
4. Certification (UL, CE, etc.) section of label
5. Module connector - plugs into baseplate backplane connector
6. Release lever - spring loaded
7. Ventilation openings in module case (top and bottom)
8. Front cover holding tabs (two on each side of module)
9. Front cover (shown) or terminal board (for I/O modules).
10. Front cover faceplate or hinged cover for terminal board.
11. Lens cap (some modules do not have).
12. Lens cap holding tabs (one on each side of module)
13. Module label
14. Serial Number - used to determine module warranty status. (On some modules, the Serial Number may be on a small tag on the back of the module.)



## Installing a Module

### Warning

**Do not insert or remove modules with power applied. This could cause the PLC to stop or malfunction. Injury to personnel and damage to the module or baseplate may result. Also, attempts to force a module into an improper slot type will result in damage to the module and/or the baseplate. Modules will mount in the correct slot type easily, with a minimum of force.**

Use the following instructions as a guide when inserting a module into a baseplate slot.

- Check that module catalog number matches slot configuration. Each slot is, or will be, assigned a particular module type during configuration. A Power Supply module must be installed in the left end unnumbered slot only, and a CPU module and some special Option modules can only be installed in Slot 1 of a CPU baseplate. I/O Modules and most Option modules install in slots numbered 2 and higher.
- Grasp the module firmly with terminal board toward you and with rear pivot hook facing away from you.
- Align the module with the desired baseplate slot and connector. Tilt the module upwards so that top rear pivot hook of the module engages the baseplate's top module retainer.
- Swing the module downward until the module's connector engages the baseplate's backplane connector, and the release lever on the bottom of the module snaps into place in the baseplate's bottom module retainer.
- Visually inspect the module to be sure that it properly seated.

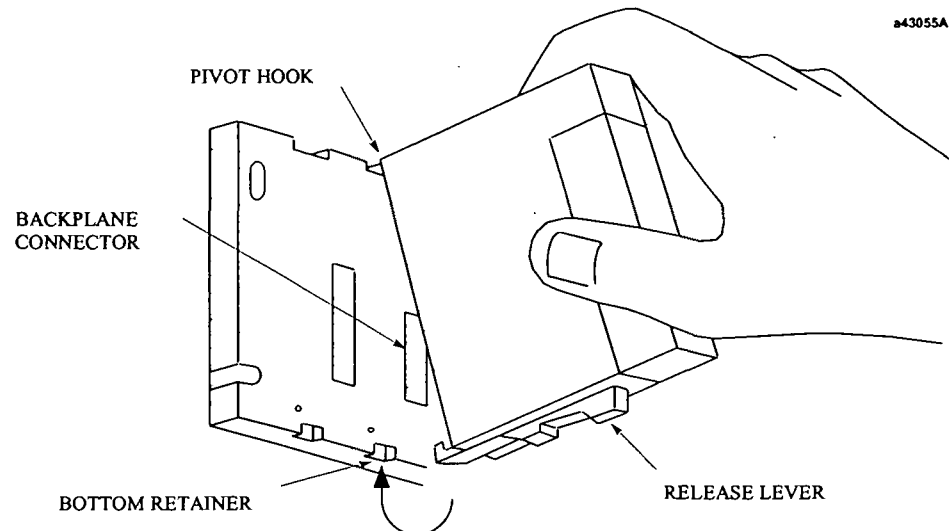


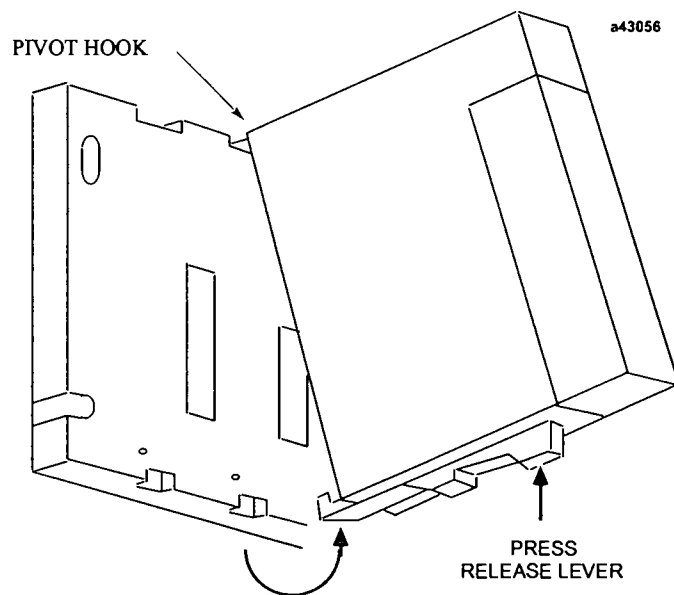
Figure 2-2. Installing a Module

## Removing a Module

### Warning

**Do not insert or remove modules with power applied. This could cause the PLC to stop or malfunction. Injury to personnel and damage to the module or baseplate may result. Also potentially dangerous voltages from user devices may be present on a module's screw terminals even though power to the rack is turned off. Care must be taken any time that you are handling the module's removable terminal board or any wires connected to it.**

- If the module has wiring, remove the module's terminal board (NOTE: You do not have to unwire the terminal board) or cables. The procedure for removing a terminal board is described later in this section.
- Locate the release lever at the bottom of the module and firmly press it up, towards the module.
- While holding the module firmly at its top and fully depressing release lever, swing (pivot) the module upward (release lever must be free of its retaining slot).
- Disengage pivot hook at the top rear of the module by moving the module up and away from the baseplate.



**Figure 2-3. Removing a Module**

### Note

Modules in expansion or remote baseplates can be added, removed, or replaced while the PLC is in RUN mode if power is first removed from the expansion or remote baseplate. I/O data to/from this baseplate will not be updated while power is removed.

## Installing a Module's Terminal Board

Note: Modules IC693MDL730F (and later) and IC693MDL731F (and later) have special terminal boards that are equipped with holding screws. For Installation and Removal instructions, please see the section "Installing and Removing Terminal Boards with Holding Screws" later in this chapter.

To install a terminal board (circled numbers refer to drawing below):

- Hook the pivot hook ①, located on the bottom of the terminal board, to the lower slot on the module.
- Push the terminal board toward the module ② until it snaps into place.
- Open the terminal board cover ③ and ensure that the latch on the module is securely holding the terminal board in place.

### Caution

Compare the module catalog number on the label on the back of the hinged door (see Figure 2-6) and the label on the side of the module (see below) to ensure that they match. If a wired terminal board is installed on the wrong module type, damage to the module may occur when the system is powered up.

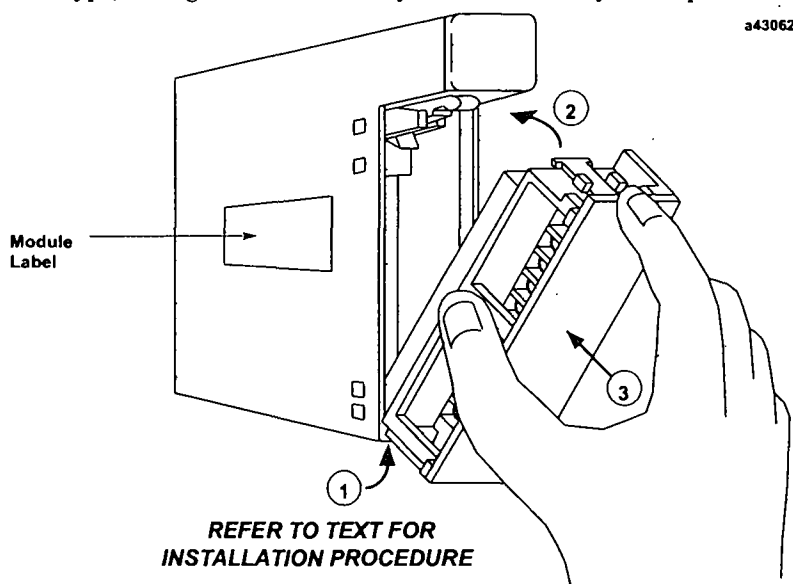
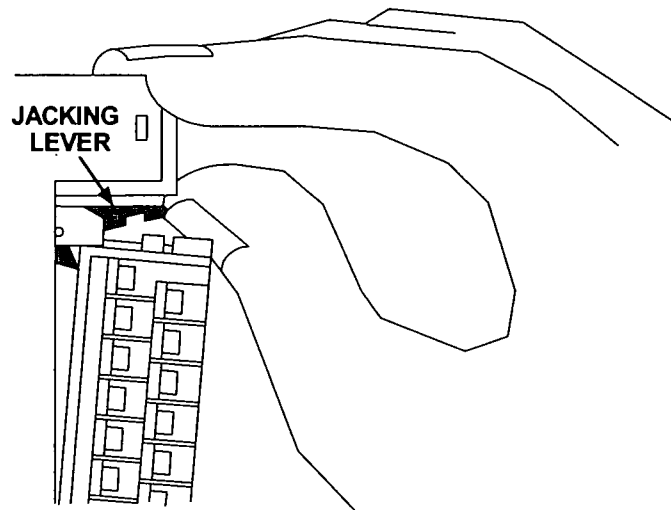


Figure 2-4. Installing an I/O Module's Terminal Board

## Removing a Module's Terminal Board

To remove a terminal board:

- Open the plastic terminal board cover.
- Push up on the jacking lever to release the terminal block.



- Grasp pull-tab and pull it towards you until contacts have separated from module housing and bottom pivot hook has disengaged.

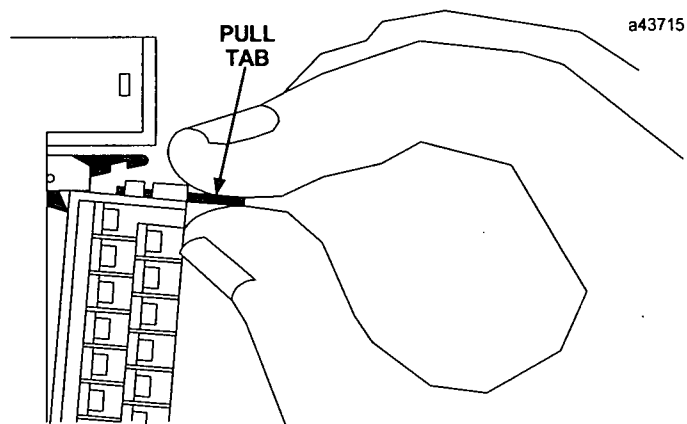


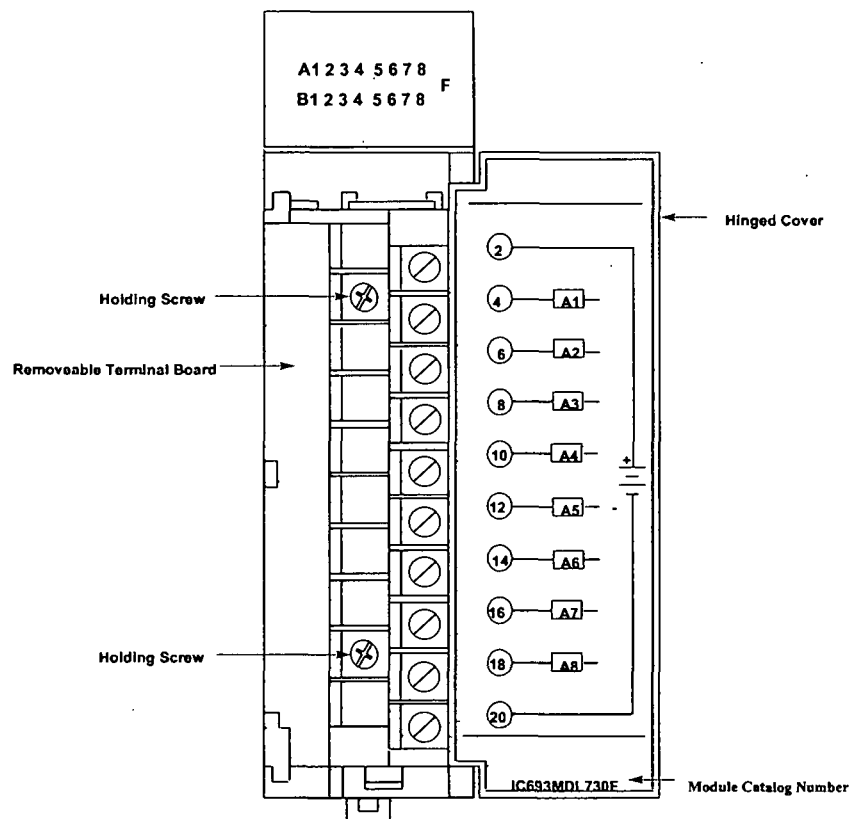
Figure 2-5. Removing a Module's Terminal Board

## I/O Module Terminal Board Posts

The terminal board has three posts on the left side. The top and bottom posts hold the terminal board cover in place. The middle post keeps the terminal board wiring in place. If you do not require it to hold the wiring in place, the middle post can be easily snapped off. (Be careful that you do not inadvertently snap it off if you need it to keep your wiring in place.)

## Installing and Removing Terminal Boards with Holding Screws

Discrete output modules IC693MDL730F (and later) and IC693MDL731F (and later) have a special terminal board that is equipped with holding screws, shown in the figure below. These screws prevent the terminal board-to-module connections from deteriorating in applications where the PLC is subjected to severe vibration.



**Figure 2-6. Terminal Board with Holding Screws**

- **Removing:** To Remove these terminal boards, first loosen the two holding screws on the front of the terminal board, then follow the standard removal instructions in the section "Removing an I/O Module's Terminal Board." The holding screws are held captive in the terminal board and do not have to be completely removed.
- **Installing:** To install these terminal boards, follow the standard installation instructions in the section "Installing an I/O Module's Terminal Board," then tighten the two holding screws to 8 to 10 inch-pounds (1 Newton-meter) of torque.

## Baseplate Mounting

### Warning

Be sure to follow baseplate grounding instructions in this chapter. Failure to properly ground the PLC can result in improper operation, damage to equipment, and injury to personnel.

### Mounting a Baseplate to a Panel

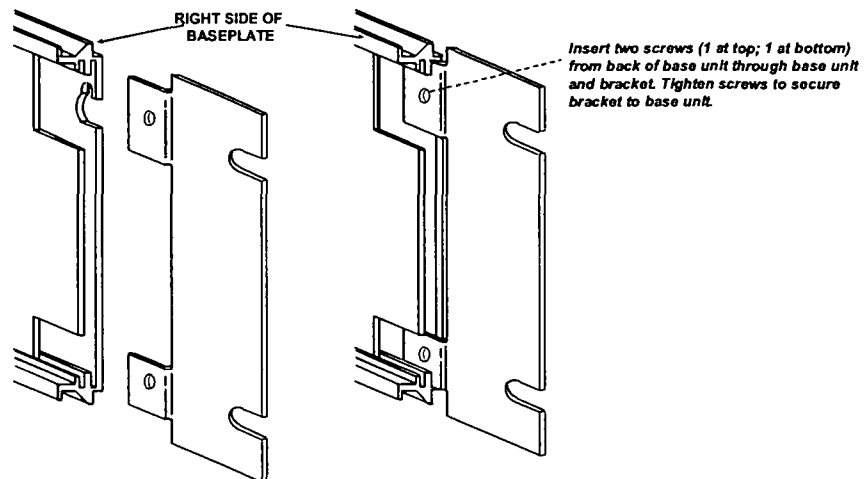
- Use four good-quality 8-32 x 1/2 (4 x 12mm) machine screws, lock washers and flat washers. Install the screws in four tapped holes. The “Baseplates” chapter has the applicable dimensions and mounting clearances. Alternately, 10-slot baseplates can be mounted in standard 19-inch racks by using the appropriate adapter. This is also discussed in the “Baseplates” chapter.
- A vertical mounting orientation is preferred for maximum heat dissipation. Other mounting orientations will require derating the Power Supply current capabilities. See Chapter 12, “System Design,” for details.
- All baseplates must be grounded. The “Baseplate Safety Grounding” section of this chapter has details.
- The Rack Number Selection switch must be set on each Expansion or Remote baseplate. A CPU baseplate does not require this switch. Rack numbers should be assigned by the system designer. Failure to set the Rack Number Selection switches properly will result in system malfunction. See the “Baseplates” chapter for details on setting these switches.

### Mounting a Baseplate to a 19" Rack

Two optional Baseplate Adapter Brackets allow a 10-slot baseplate to be mounted in a 19 inch rack. Each baseplate installation requires only one of the adapter brackets.

- **IC693ACC308 Front Mount Adapter Bracket.** Used to mount a baseplate to the front face of a 19" rack. Install the adapter bracket by inserting the tabs at the top and bottom of the adapter bracket into the corresponding slots at the top and bottom of the plastic baseplate cover. NOTE: Although Figure 2-7 shows the plastic baseplate cover removed, this is for illustration purposes only. It is not necessary to remove the cover to install the bracket. With the bracket in place, insert and tighten the two screws (included with the bracket) through the back of the baseplate holes into the threaded holes in the bracket.

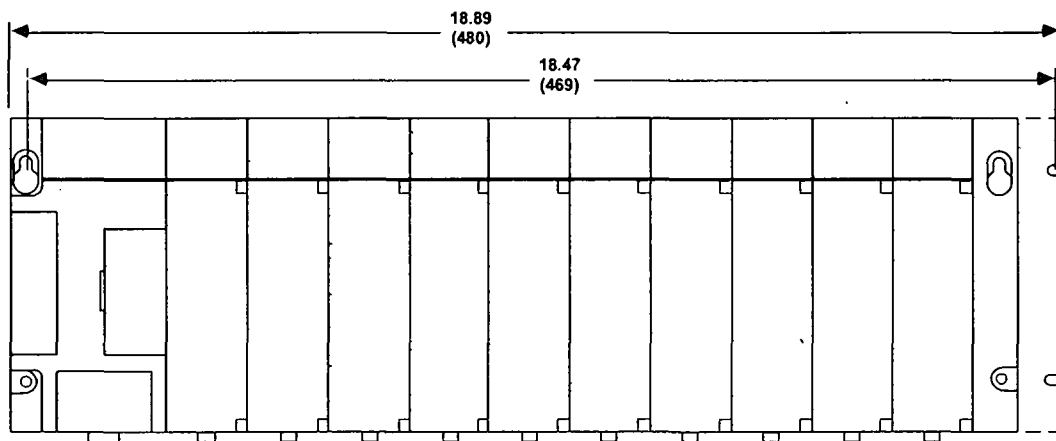
- **IC693ACC313 Recessed Mount Adapter Bracket.** Used to recess mount a baseplate inside a 19" rack. A baseplate mounts on the rear panel of this adapter bracket using four 8-32 (4mm) screws, nuts, lock washers, and flat washers. The Adapter Bracket bolts through its four slotted holes to the face of the 19" rack using applicable hardware (lock washers recommended).



**Note:** Baseplate is shown with cover removed for illustration purposes. It is not necessary to remove the baseplate cover to install the bracket.

**Figure 2-7. IC693ACC308 Front Mount Adapter Bracket Installation**

Dimensions for rack mounting a 10-slot baseplate with the IC693ACC308 Front Mount Adapter Bracket are shown in the following figure.



DIMENSIONS IN INCHES (MILLIMETERS IN PARENTHESES)

**Figure 2-8. Dimensions for 19-inch Rack Mounting Using IC693ACC308 Adapter Bracket**

2

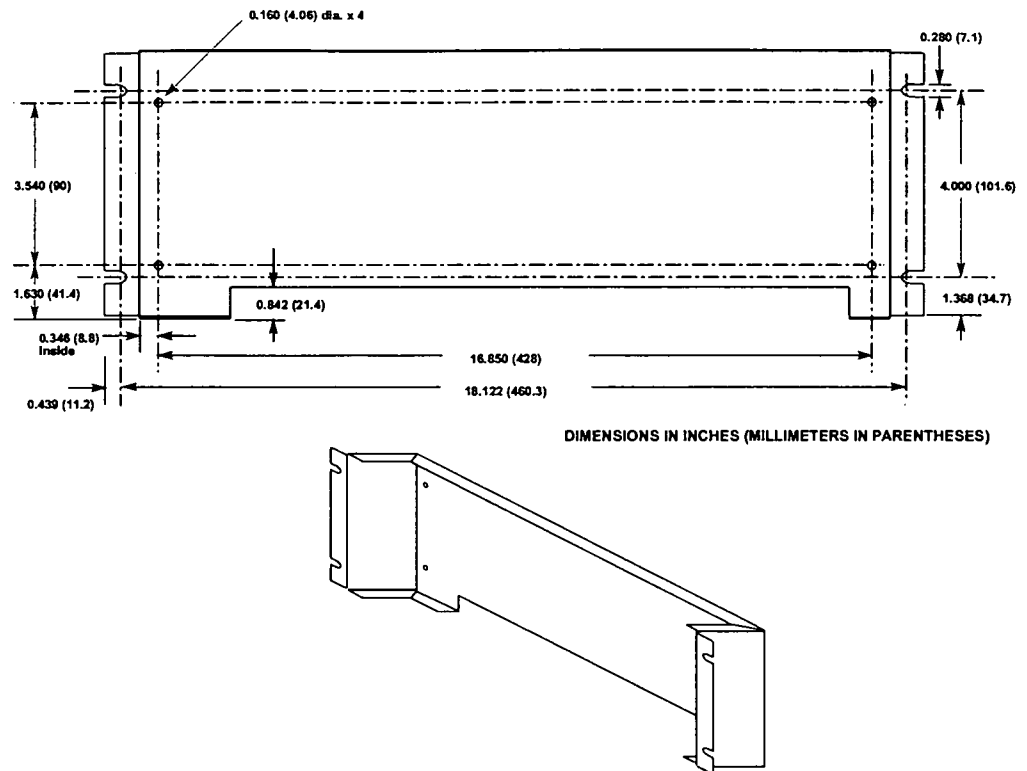


Figure 2-9. IC693ACC313 Recessed Mount Adapter Bracket



## Grounding Procedures

### System Grounding Procedures

#### Warning

In addition to the following grounding information, we strongly urge that you follow all applicable codes that apply to your area. For example, in the United States, most areas have adopted the National Electrical Code standard and specify that all wiring conform to its requirements. In other countries, different codes will apply. For maximum safety to personnel and property you must follow these codes. Failure to do so can mean injury or death to personnel, damage to property, or both.

All components of a programmable logic control system and the devices it is controlling must be properly grounded. This is particularly important for the following reasons.

- A low resistance path from all parts of a system to earth minimizes exposure to shock in the event of short circuits or equipment malfunction.
- The Series 90-30 PLC system requires proper grounding for correct operation.

### Ground Conductors

- Ground conductors should be connected in a tree fashion with branches routed to a central earth ground point, shown in the figure below. This ensures that no ground conductor carries current from any other branch. This method is shown in the following figure.
- Ground conductors should be as short and as large in size as possible. Braided straps or ground cables (typically green insulation with a yellow tracer - AWG #12 (3.3 mm<sup>2</sup>) or larger) can be used to minimize resistance. Conductors must always be large enough to carry the maximum short circuit current of the path being considered.

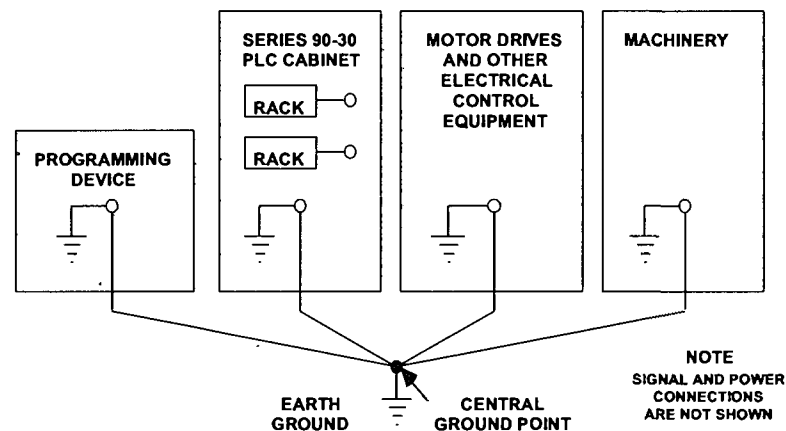


Figure 2-10. Recommended System Grounding

## Series 90-30 PLC Equipment Grounding

Equipment grounding recommendations and procedures are listed below. These grounding procedures must be properly followed for safe, proper operation of your Series 90-30 PLC system.

### Baseplate Safety Grounding

The following recommendations are offered, but applicable safety codes for your area or equipment type should also be consulted. The baseplate's metal back must be grounded using a separate conductor; the baseplate mounting screws are not considered to an acceptable ground connection by themselves. Use a minimum AWG #12 (3.3 mm<sup>2</sup>) wire with a ring terminal and star lock washer under the head of one of the baseplate's two lower mounting holes. These two holes have openings to the side to allow connecting a wire and ring terminal under the head of a mounting screw. Connect the other end of this ground wire to a tapped hole in the panel that the baseplate is mounted to, using a machine screw, star lock washer, and flat washer. Alternately, if your panel has a ground stud, it is recommended you use a nut and star lock washer for each wire on the ground stud to ensure adequate grounding. Where connections are made to a painted panel, the paint should be removed so clean, bare metal is exposed at the connection point. Terminals and hardware used should be rated to work with the aluminum baseplate material.

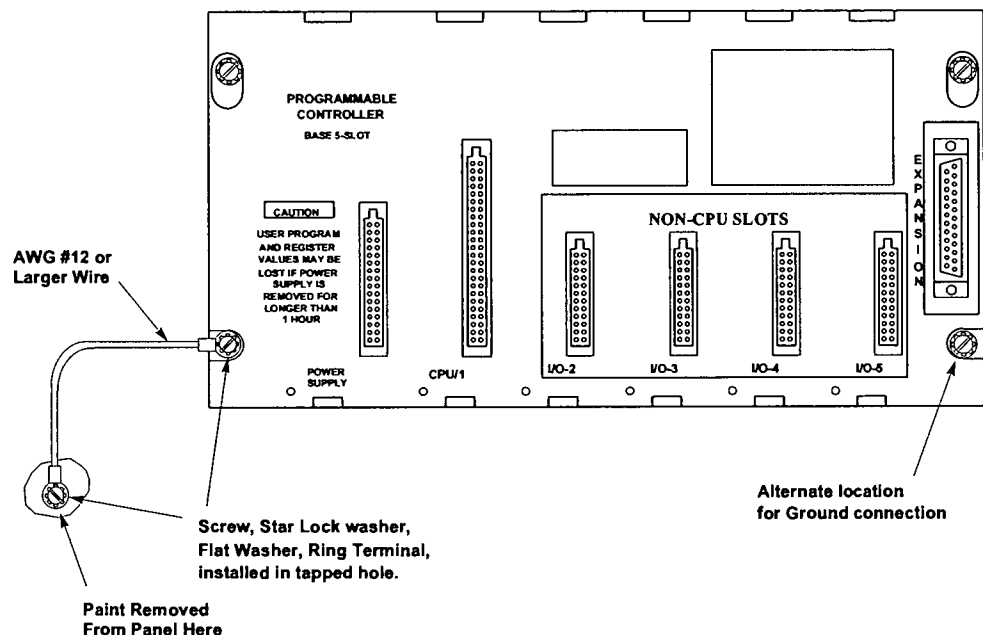


Figure 2-11. Baseplate Grounding

### Warning

All baseplates must be grounded to minimize electrical shock hazard. Failure to do so can result in severe personal injury.

All baseplates grouped together in a Series 90-30 PLC system must have a common ground connection. This is especially important for baseplates that are not mounted in the same control cabinet.

## Grounding 19" Rack-Mounted Baseplates

There are two Adapter Brackets used for mounting a 10-slot Series 90-30 baseplate to a 19" Rack. Regardless of which of the two Adapter Brackets is used, the 19" Rack should be grounded as per the instructions in "System Grounding Procedures," including Figure 2-10. (For details on the Adapter Brackets, see the "Mounting a Baseplate to a 19" Rack" section earlier in this chapter.)

Nineteen-Inch Rack-mounted PLC baseplates should be grounded according to the guidelines in the "Baseplate Safety Grounding" section, using a separate ground wire from the PLC baseplate as shown in the previous figure (Fig. 2-11).

- If using the **Recessed Mount Adapter Bracket (IC693ACC313)**, the ground wire can be installed as shown in Figure 2-11 with the ground attached to the Recessed Mount Adapter Bracket. An additional ground wire connecting the Adapter Bracket to a solid chassis ground on the 19" Rack should be installed. Use the same or equivalent hardware and paint removal scheme as shown in Figure 2-11.
- If using the **Surface Mount Adapter Bracket (IC693ACC308)**, the ground wire should be run from the baseplate as shown in Figure 2-11, to a solid chassis ground on the 19" Rack. Use the same or equivalent hardware and paint removal scheme as shown in Figure 2-11.

## Programmer Grounding

For proper operation, the computer (programmer) running the PLC software must have a ground connection in common with the CPU baseplate. Normally, this common ground connection is provided by ensuring that the programmer's power cord is connected to the same power source (with the same ground reference point) as the baseplate. If it is not possible to ensure this common ground scheme, use a port isolator (IC690ACC903) between the programmer and PLC serial connection. If the programmer ground is at a different potential than the PLC ground, a shock hazard could exist. Also, damage to the ports or converter (if used) could occur when the programmer serial cable is connected between the two.

### Warning

**Failure to follow programmer grounding recommendations could result in personal injury, equipment damage, or both.**

## Module Shield Grounding

In general, the aluminum PLC baseplate is used for module shield grounding. On some Series 90-30 modules, shield connections to the user terminal connector on the module are routed to the baseplate through the module's backplane connector. Other modules, such as CPUs 351, 352, 363, 364, and 374 require a separate shield ground. These are discussed in the next several sections.

### Shield Grounding Information for CPUs with External Port Connections

CPUs with external port connections, the 351, 352, 363, 364, and 374 must have a separate shield ground connection to provide shielding for these ports. Because the design of the ground connection for the CPU351 and 352 is different from that of the CPU363, 364, and 374, each grounding method is discussed in a separate section.

### CPU351 and 352 Shield Grounding

The CPU 351 or 352 module must be connected to frame ground at the slot where it is installed. Two methods are provided for making this ground connection. Each CPU comes with an EMC Grounding Kit (44A737591-G01) that contains a ground wire, grounding bracket, and screws.

1. The connection from the CPU to frame ground can be made using the ground wire (part number 44A735970-001R01) that comes with the module in the EMC Grounding Kit. This wire has a stab-on connector on one end for connection to a mating terminal on the bottom of the CPU, and a ring terminal on the other end for connection to a grounded enclosure. Where the ring terminal contacts a painted enclosure panel, either a star lock washer can be installed between the terminal and the panel to cut through the paint, or the paint can be scraped away down to clean, bare metal to ensure a good contact. **Note: The star lock washer method is suitable for a shield ground, but not suitable for a safety ground.**

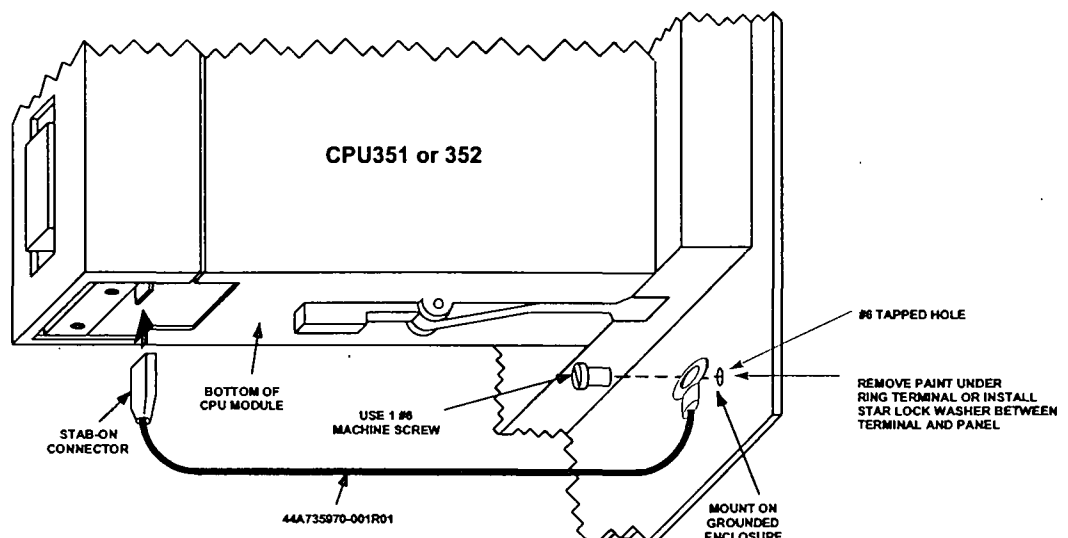
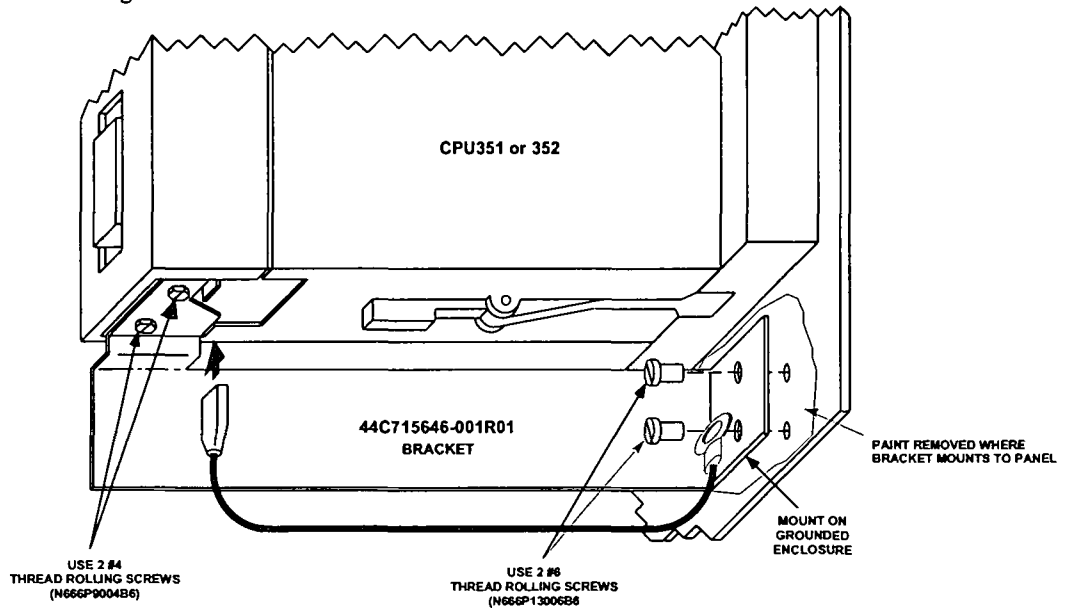


Figure 2-12. CPU 351 or 352 - Attaching Shield Ground Wire

2. The second method, which can be used for systems in noisy environments consists of installing the green ground wire *and* the optional grounding bracket (part number 44C715646-001R01). This bracket attaches to the CPU using two #4 thread-rolling screws (part number N666P9004B6) and to the grounded enclosure using two #6 thread-rolling screws (part number N666P13006B6). Two holes must be drilled in the enclosure for mounting this bracket. Also, if the bracket will be attached to a painted surface, the paint should be removed down to bare metal under the bracket to ensure good contact between the bracket and the surface. See the next figure.



**Figure 2-13. CPU 351 or 352 - Mounting the Shield Grounding Bracket and Wire**

**Note:** When the grounding bracket is used, pin 1 of the cable connector that plugs into the Port 2 connector should not be connected. A metal connector shell must be used on the cable for this port, and the cable shield must be terminated at the metal shell instead of pin 1 of the connector.

## CPU363, CPU364, and CPU374 Shield Grounding

The CPU363, CPU364, and CPU374 modules must be connected to frame ground at the slot where they are installed. Each module comes with a grounding wire for this purpose. These modules do not support or require the use of a grounding bracket. If the ring terminal on the grounding wire is to be mounted to a painted surface, remove the paint under the ring terminal to ensure good contact, or place a star lock washer between the ring terminal and the painted surface. See the next figure.

**Note:** The star lock washer method is suitable for a shield ground, but not suitable for a safety ground.

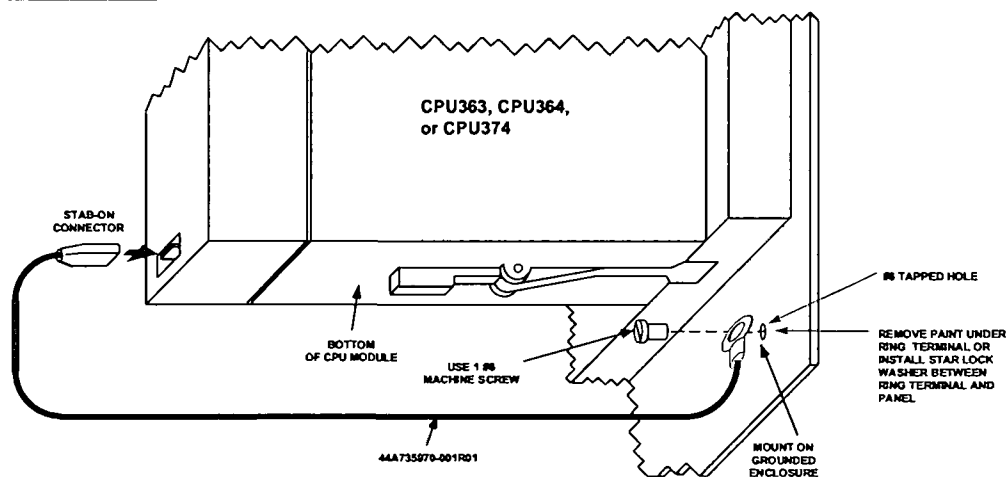


Figure 2-14. CPU 363, CPU364, or CPU374 - Attaching Ground Wire

## Additional Modules with Shield Grounding Requirements

Some of the Series 90-30 Option modules, such as the FIP Remote I/O Scanner (IC693BEM330), and DSM modules (IC693DSM302 and IC693DSM314) also have shield grounding requirements. These modules come equipped with suitable grounding hardware. Please refer to each module's user's manual for grounding instructions. Appendix G contains a product to publication cross-reference to help you identify the correct manual.

## General Wiring Guidelines

### Warning

In addition to the following wiring suggestions, we strongly urge that you follow all wiring and safety codes that apply to your area or your type of equipment. For example, in the United States, most areas have adopted the National Electrical Code standard and specify that all wiring conform to its requirements. In other countries, different codes will apply. For maximum safety to personnel and property you must follow these codes. Failure to do so can lead to personal injury or death, property damage or destruction, or both.

### Color Coding Wires

These color codes are commonly used in industrial equipment manufactured in the United States. They are cited here as a reference. Where they are in conflict with codes that apply to your area or your type of equipment, you should follow your applicable codes instead. Besides satisfying code requirements, wire color coding makes testing and troubleshooting safer, faster, and easier.

- Green or green with stripe- Ground
- Black - Primary AC
- Red - Secondary AC
- Blue - DC
- White - Common or neutral
- Yellow - Secondary power source not controlled by the main disconnect. Alerts maintenance personnel that there may be power present (from an external source) even if the equipment is disconnected from its main power source.

### Wire Routing

To reduce noise coupling among PLC wires, it is recommended you keep electrically noisy wiring, such as AC power wiring and Discrete Output Module wiring, physically separated from low-level signal wiring such as DC and Analog Input module wiring or communications cables. This can be accomplished by grouping separately, where practical, the following categories of wiring:

- **AC power wiring.** This includes the AC input to the PLC power supply, as well as other AC devices in the control cabinet.
- **Analog Input or Output Module wiring.** This should be shielded to further reduce noise coupling. See the *Series 90-30 I/O Module Specifications Manual*, GFK-0898 for details.
- **Discrete Output Module wiring.** These often switch inductive loads that produce noise spikes when switched off.
- **DC Input Module wiring.** Although suppressed internally, these low-level inputs should be further protected against noise coupling by observing these wiring practices.
- **Communications Cables.** Wiring such as Genius Bus or serial cables should be kept away from noise-producing wiring.

Where AC or Output wiring bundles must pass near noise-sensitive signal wiring bundles, avoid running them beside each other. Route them so that, if they have to cross, they do so at a right angle. This will minimize coupling between them.

### Grouping Modules to Keep Wires Segregated

If practical, grouping similar modules together in the PLC racks can help keep wiring segregated. For example, one rack could contain only AC modules, and a different rack only DC modules, with further grouping in each rack by input and output types. For smaller systems, as an example, the left end of a rack could contain Analog modules, the middle could contain DC modules, and the right end could contain AC modules.

## Discrete I/O Module Connection Methods

- For modules with 16 points or less, the standard method is to use the removable terminal board which comes with these modules. The removable terminal board makes it easy to prewire field wiring to the user supplied input and output devices, and to replace modules in the field without disturbing existing field wiring.
- Some discrete 16-point I/O modules can be used with an optional Terminal Block Quick Connect (TBQC) assembly. This assembly contains a module faceplate, with built-in connector, that replaces the removable terminal board. The assembly also contains a DIN-rail mounted terminal block and a cable to connect the module to the terminal block. The advantage of this method is that it saves about two hours of wiring time per module compared with hand wiring from a module's removable terminal board to a user-supplied, panel-mounted terminal block or strip.
- Older 32-point I/O modules have one 50-pin connector on the front of the module that is either connected by a cable with a connector on each end to a Weidmuller panel-mounted terminal block (Weidmuller catalog no. 912263), or is connected by a cable with stripped, tinned leads to a user-supplied terminal block or strip.
- Newer 32-point I/O modules have two 24-pin connectors on the front of the module. These module may be wired in one of three ways. (1) Use a pair of cables (IC693CBL327/328 - see data sheet in "Cables" chapter) to connect the module to a user-supplied, panel-mounted terminal block or strip. These cables have a 24-pin connector on one end, and stripped, tinned leads with wire markers on the other end. (2) Use a pair of dual-connector cables to connect the module to a Terminal Block Quick Connect (TBQC) terminal block (IC693ACC377). See Appendix H for details. (3) Make your own custom cables. Instructions are found in the IC693CBL327/328 data sheet in Chapter 10.

## Connections to I/O Module Terminal Boards

Series 90-30 PLC I/O terminal boards have either 10 or 20 screw terminals that will accept from two AWG #22 (0.36 mm<sup>2</sup>) to two AWG #16 (1.3 mm<sup>2</sup>), or one AWG #14 (2.1 mm<sup>2</sup>) copper 90°C (194°F) wire(s). Each terminal can accept solid or stranded wires, but the wires into any given terminal should be the same type (both solid or both stranded) to ensure a good connection. Wires are routed to and from the terminals out of the bottom of the terminal board cavity. The suggested torque for the I/O terminal board connection screws is from 9.6 in-lbs to 11.5 in-lbs (1.1–1.3 Newton-meters).



For 24 volt DC input modules, an internal 24 volt power connection is provided on the terminal board to supply a limited number of input devices. Also, a 24 volt DC output is available on the power supply module's terminal board to supply a limited number of output devices.

## Terminal Block Quick Connect Installation for 16-Point Discrete Modules

The Terminal Block Quick Connect (TBQC) Assembly is an option for certain Series 90-30 discrete I/O modules. See Appendix H for more information.

- Remove standard terminal board from module.
- Install TBQC faceplate (it has a 24-pin connector).
- Mount the TBQC terminal block. It has a 24-pin connector and a terminal strip, and mounts on a standard 35 mm DIN-rail.
- Connect a TBQC cable between the TBQC faceplate connector on the module and the connector on the TBQC terminal block.
- Wire I/O devices to the terminal block.

## Installation of 32-Point Discrete, 50-Pin Connector Modules

These 50-Pin modules are an older design and are not generally used on new systems, unless to fulfill standardization requirements. They are mainly used as replacements for existing installations. For new installations, we recommend the dual 24-pin connector style because they have additional features not found on the older modules (LED indicators, TBQC), and it is much easier to fabricate custom-length cables for them. Installation information is provided here for the convenience of those still using these modules.

### Using Weidmuller #912263 Terminal Block

**Note:** The TBQC is not available for these modules, but you may purchase a Weidmuller #912263 from your electronics distributor for this application.

- Mount the Weidmuller#912263 terminal block. It has a 50-pin connector and a terminal strip, and mounts on a standard 35 mm DIN-rail.
- Connect an IC693CBL306/307 cable between the module's faceplate connector and the connector on the Weidmuller terminal block. See Chapter 10 for cable data.
- Wire I/O devices to the terminal block. See the *Series 90-30 PLC I/O Module Specifications Manual*, GFK-0898, for pin-out information.

## Using a Generic Terminal Block or Strip

- Mount terminal block/strip to the enclosure panel.
- Connect an IC693CBL308 or 309 cable, or a custom made cable, to the module's faceplate connector and wire the stripped ends of the cable to the terminal block/strip. See Chapter 10 for cable data.
- Wire I/O devices to the terminal block/strip.

## Direct Method

- Connect an IC693CBL308 or 309 cable, or a custom made cable, to the module's faceplate connector and wire the stripped ends of the cable directly to the field devices. See Chapter 10 for cable data. See the Series 90-30 PLC I/O Module Specifications Manual, GFK-0898, for pin-out information.

## Installation of Discrete 32-Point, Dual 24-Pin Connector Modules

### Using a TBQC

- Mount two TBQC terminal blocks. Each has a 24-pin connector and a terminal strip, and mounts on a standard 35 mm DIN-rail.
- Connect a pair of TBQC cables (IC693CBL329 - 334) between the module's faceplate connector and the connectors on the two TBQC terminal blocks. Note that both a right side and left side cable is required. See Appendix H for a list of cables.
- Wire I/O devices to the terminal blocks. See the Series 90-30 PLC I/O Module Specifications Manual, GFK-0898, for pin-out information.

The Terminal Block Quick Connect (TBQC) Assembly is an option for certain Series 90-30 discrete I/O modules. See Appendix H for more information.

### With a Generic Terminal Block/Strip

- Mount terminal block/strip to the enclosure panel.
- Connect an IC693CBL327/328 cables, or a custom made cables, to the module's faceplate connectors, and wire the stripped ends of the cables to the terminal block/strip. Note that both a right side and left side cable is required. See Appendix H for a list of cables. See Chapter 10 for cable data sheets.
- Wire I/O devices to the terminal block/strip. See the Series 90-30 PLC I/O Module Specifications Manual, GFK-0898, for pin-out information.

## Direct Method

- Connect an IC693CBL327/328 cable, or a custom made cable, to the module's faceplate connectors, and wire the stripped ends of the cable directly to the field devices. See Chapter 10 for cable data. See the *Series 90-30 PLC I/O Module Specifications Manual*, GFK-0898, for pin-out information.

## General Wiring Methods for Analog Modules

Twisted, shielded instrumentation cable is strongly recommended for analog module input or output signal connections. Proper grounding of the shield is also important. For maximum electrical noise suppression, the cable shield should only be grounded at one end of the cable. For Input modules, ground the end that is in the noisiest environment (which often is at the field device end). For Output modules, ground at the module end. See GFK-0898, *Series 90-30 PLC I/O Module Specifications*, for more shield grounding information.

## Analog Input Module Wiring Methods

Correcting electrical noise problems can sometimes be a trial-and-error routine. However, in general, it is generally best to ground the cable shield as close to the source of the noise as possible, which is usually at the device end. In troubleshooting noise problems, sometimes it is beneficial to experiment with the shield grounding point location. Remember, the cable shield should be grounded at one end only. Also, it is best to keep the length of stripped cable leads as short as possible to minimize the length of unshielded conductors that will be exposed to the noisy environment. See the *Series 90-30 PLC I/O Module Specifications Manual*, GFK-0898 for additional details.

## Using a Generic Terminal Block or Strip

- Mount a terminal strip inside the control enclosure and run a shielded cable from the terminal strip to each input circuit on the module's terminal board terminals.
- Connect each cable's shield to the metal panel next to the terminal strip. Do not connect the shields at the module end (cut shield off at module end of cable and insulate with shrink tubing).
- Wire the field device to the terminal strip with a shielded cable, grounding the shield at the device end only (cut shield off at terminal strip end of cable and insulate with shrink tubing). Also, keep the length of exposed (outside of shield) leads at the terminal strip and device ends as short as possible.

## Direct Method

- Run a shielded cable from the field device (transducer, potentiometer, etc.) directly to the module.
- Connect the conductors to the applicable screws on the module's terminal board.

- Ground the shield at the field device end, exposing a minimum amount of conductor to the noisy environment. Do not connect the shield at the module end (cut shield off at module end of cable and insulate with shrink tubing).

## TBQC not Recommended for Analog Modules

The Terminal Block Quick Connect (TBQC) Assembly is not recommended for use with analog modules due to cable shielding requirements.

## Analog Output Module Wiring

### General

Each output should be connected using a good quality shielded wire with the cable shield grounded at the module end. See GFK-0898, *Series 90-30 PLC I/O Module Specifications*, for more information.

### Using a Generic Terminal Block or Strip

- Mount a terminal strip inside the control enclosure and run a shielded cable from the terminal strip to each output circuit on the module's terminal board terminals.
- Ground each cable's shield at the module end only. Do not connect the shields at the terminal strip end (cut shields off at terminal strip end of cables and insulate with shrink tubing).
- Wire the field device to the terminal strip with shielded cables, grounding the shields at the terminal strip end only (cut shields off at field device end of cables and insulate with shrink tubing). Also, keep the length of exposed (outside of shield) leads at the terminal strip and device ends as short as possible.

### Direct Method

- Run a shielded cable from each field device (transducer, potentiometer, etc.) directly to the module.
- Connect the conductors to the applicable screws on the module's terminal board.
- Ground the shield at the module end only, exposing a minimum amount of conductor to the noisy environment. Do not connect the shield at the device end (cut shield off at device end of cable and insulate with shrink tubing).

## TBQC not Recommended for Analog Modules

The Terminal Block Quick Connect (TBQC) Assembly is not recommended for use with analog modules due to cable shielding requirements.

## AC Power Source Connections

### AC Input Wiring to AC/DC Power Supplies

#### Warning

If the same AC power source is used to provide AC power to other baseplates in a Series 90-30 PLC System, ensure that all AC input connections are identical at each rack. Do not cross Line 1 (L1) and Line 2 (L2). A resulting difference in potential can injure personnel or cause damage to equipment. Each baseplate must be connected to a common ground.

Ensure that the protective cover is installed over all terminal boards. During normal operation with an AC power source either 120 VAC or 240 VAC is present on the AC Power Supply. The cover protects against accidental shock hazard which could cause severe or fatal injury to the operator or maintenance personnel.

Both the Standard (IC693PWR321) and High Capacity (IC693PWR330) AC/DC power supplies currently have six terminals for user connections. Early versions of some Series 90-30 power supplies had five terminals (see next figure). The wiring methods for both five-terminal and six-terminal types is similar, except that step 3 below does not apply to the five-terminal type.

The power supply terminal boards will accept one AWG #14 (2.1 mm<sup>2</sup>) or two AWG #16 (1.3 mm<sup>2</sup>) copper 75°C (167°F) wires. Each terminal can accept solid or stranded wires, but the wires in any given terminal should be the same type. The suggested torque for the power supply terminal board is 12 in-lbs (1.36 Newton-meters). Open the door protecting the terminal board and make the following connections from the AC power source, and ground connections (system grounding requirements are described in detail later in this chapter).

1. These are wide range supplies that can operate from an AC power source within the nominal range of 100 VAC to 240 VAC at 50/60 Hz. This may vary -15% to +10% for a total maximum range of 85 VAC to 264 VAC. These are auto-ranging supplies that do not require jumper or switch settings for selection of power source voltage.
2. Connect the hot and neutral wires or lines L1 and L2 to the upper two terminals on the terminal board. Connect the safety ground wire to the ground terminal, which is the third terminal from the top, and is marked with a ground symbol.
3. For power supplies with six terminals, the factory jumper between the 3rd and 4th terminals (see figure below), should be left in place for normal installations. However, this jumper must be removed and external surge suppressors installed in installations with a "Floating Neutral" input. Please see the section "Special Instructions for Floating Neutral (IT) Systems" later in this chapter for details.
4. After all connections to Power Supply terminal board have been completed, the protective cover plate should be carefully reinstalled.

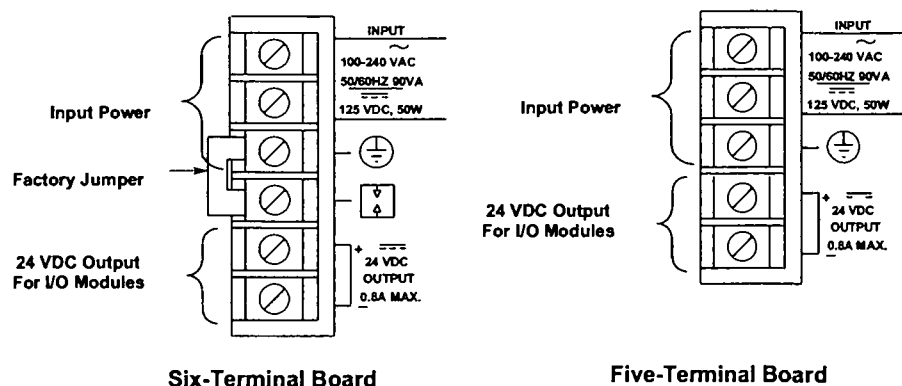


Figure 2-15. Power Supply Terminal Boards

## Power Supply Overvoltage Protection Devices

The overvoltage protection devices for this power supply are connected internally to pin 4 on the user terminal board. This pin is normally connected to frame ground (pin 3) with the supplied jumper strap which is installed at the factory. If overvoltage protection is not required *or* is supplied upstream, this feature can be disabled by leaving pin 4 unconnected by removing the jumper strap. Also, this jumper must be removed and external surge suppressors installed in installations with a "Floating Neutral" input, please see the following section "Special Instructions for Floating Neutral (IT) Systems" later in this chapter.

If you want to Hi-pot test this supply, overvoltage protection *must be disabled* during the test by removing the terminal board strap. Re-enable overvoltage protection after testing by reinstalling the strap.

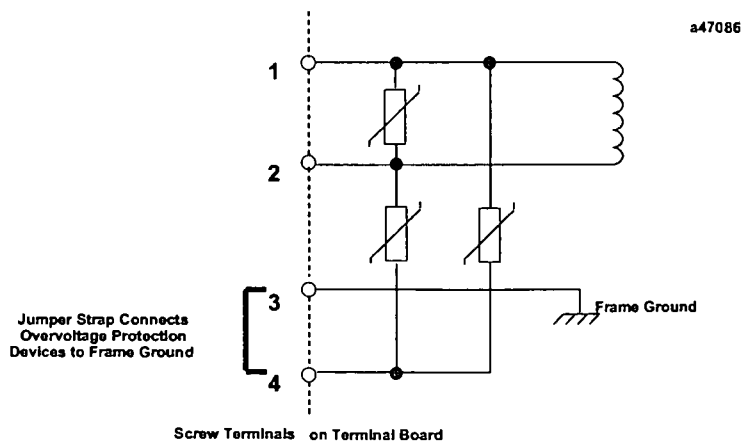


Figure 2-16. Overvoltage Protection Devices and Jumper Strap

## Special Installation Instructions for Floating Neutral (IT) Systems

When the AC input power supplies listed below are installed in a system where the Neutral line is **not** referenced to Protective Earth Ground, these special installation instructions must be followed to prevent damage to the power supply.

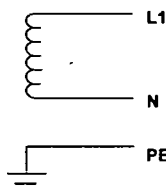
IC693PWR321S (or later version)

IC693PWR330A (or later version)

### Definition of Floating Neutral Systems

A *Floating Neutral System* is a system of power distribution wiring where Neutral and Protective Earth Ground are **not** tied together by a negligible impedance. In Europe this is referred to as an **IT** system (see IEC950). In a *Floating Neutral System*, voltages measured from input terminals to protective earth ground may exceed the 264 Volts AC maximum input voltage specified in the power supply specifications in Chapter 24 in this manual.

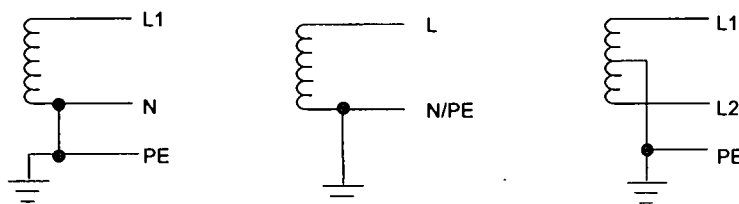
### Example of Floating Neutral System



This system **must** be installed using the special installation instructions on the following page.

Systems in which one leg of the power distribution wiring is tied to Protective Earth or a tap between two legs of the power distribution wiring is tied to Protective Earth are **not** *Floating Neutral Systems*.

### Examples of Non-Floating Neutral System



These non-floating neutral systems **do not** require these special installation instructions.

## Use These Special Installation Instructions for Floating Neutral Systems

1. The input power terminals should be wired according to the instructions in the “AC Power Source Connections” section of this chapter.
2. The factory installed jumper between terminals 3 and 4 of the Power Supply module **must** be removed if using one of the Power Supplies that have this feature. See the “Overvoltage Protection Devices” section of the “Power Supplies” chapter for details.
3. Voltage surge protection devices, such as MOVs, **MUST** be installed between the following terminals:
  - From L1 to earth ground
  - From L2 (Neutral) to earth ground

The voltage surge devices must be rated such that the system is protected from power line transients that exceed  $Line\ voltage + 100V + (N-PE)_{MAX}$ .

The expression  $N-PE$  refers to the voltage potential between neutral and Protective Earth (PE) ground.

For example, in a 240 Volt AC system with neutral floating 50V above earth ground, the transient protection should be rated at:

$$240V + 100V + 50V = 390V$$



## DC Power Source Connections

### DC Input Wiring to AC/DC and DC-Only Power Supplies

DC Input power can range from 12 to 30 VDC for the 24 VDC supply, 18 to 56 VDC for the 24/48 VDC supply or 100 to 150 VDC for the 125 VDC supply. All Series 90-30 power supplies have DC input capabilities. The following connection information applies to all of them:

Connect the + and - wires from the power source to the top terminals on the terminal board (+ to the top terminal, - to the second terminal). Connect the third terminal from the top to system ground.

### +24 VDC Output (All Supplies)

The bottom two terminals are connected to the isolated 24 volt DC output that can be used to supply power to input circuits (within power limitations of the supply).

#### Warning

If the same DC input power source is used to provide power to two or more power supplies in a Series 90-30 PLC System, ensure that connection polarity is identical at each rack (top terminal + and second terminal -). Do not cross the Positive (+) and Negative (-) lines. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each baseplate must be connected to a common system ground, described earlier in this chapter.

## Basic Installation Procedure

**Note:** Series 90-30 PLCs must be mounted in a protective enclosure. The enclosure should be capable of properly dissipating the heat produced by all of the devices mounted inside it. For details on calculating heat dissipation, refer to Appendix F.

The system design, which includes producing the layout and wiring drawings, should be completed before beginning the installation procedure. This section offers a basic step-by-step approach to installing a Series 90-30 PLC system. Some steps refer to earlier sections of this chapter for additional details. An attempt was made to place the steps in an order that will make the process as efficient as possible. However, due to the wide variance in system designs, this order may not be the most efficient for your system, so you may wish modify this procedure to fit your needs.

1. Gather the schematics, layouts, prints, and other information for the job.

### Warning

**To avoid the possibility of electrical shock to personnel or damage to your PLC, we recommend that you shut off all power to the system before mounting and wiring the PLC. Also, keep all electronic components away from the area while drilling and tapping to keep metal chips and filings out of these sensitive components.**

2. From the layout drawing, determine where the baseplate(s) will be mounted. Lay out the hole locations, either using the dimensions given on your layout drawing or from the "Baseplates" chapter of this manual.
3. Mark the hole locations for the baseplate safety ground wire (see "Baseplate Safety Ground" in this chapter).
4. Mark the hole locations for module shield ground connections (if any). See "Module Shield Ground" (and accompanying sections) in this chapter for instructions.
5. Finish laying (marking hole locations) out the rest of the system. This includes any terminal blocks you will be using. DIN-rail mounted terminal blocks for some of the 32-point I/O modules are manufactured by Weidmuller. DIN-rail mounted GE Fanuc Terminal Block Quick Connect (TBQC) assemblies are optional for some of the 16-point and 32-point discrete I/O modules. If using these TBQCs, refer to Appendix H for data. Also, APM and DSM modules use DIN-rail mounted terminal blocks.

### Note

We recommend drilling and tapping all holes before mounting any components. This will avoid getting chips and filings in the components.

6. Drill and tap the marked holes. For baseplate mounting, use 8-32 or 4mm size.
7. Mount the baseplates. Use good quality 8-32 x 1/2 inch or 4 x 12mm size screws. We recommend using star lock washers and flat washers under the screw heads (star lock washer should be located between screw head and flat washer) to ensure a tight baseplate ground connection, and to keep the screws from loosening. Connect each baseplate ground wire as shown in the "Baseplate Safety Ground" section of this chapter.
8. If you have Expansion or Remote racks, determine the correct rack number for each one, then set the rack numbers using the Rack Number Selection dual in-line package (DIP) switch on

the baseplate. Please refer to the “Baseplates” chapter for details on setting these DIP switches. Rack numbers should be assigned by the system programmer because they correspond to system configuration settings and program memory addressing.

9. If you have more than one baseplate (rack), connect the I/O Bus Expansion Cables between the I/O Bus Expansion Connectors, which are located on the right end of the baseplates. The cables are connected in a “daisy-chain” arrangement from one baseplate to the other. This is made possible by the fact that the cables have a dual connector on one end. Therefore, when the cable is plugged into a baseplate connector, the second connector on that end of the cable provides a socket for connecting to the next cable. The data sheet for the I/O Bus Expansion cables (IC693CBL300 etc.) in the “Cables” chapter has sample wiring figures.
10. On the last I/O Bus Expansion Connector, plug in an I/O Bus Expansion Terminator, Catalog Number IC693ACC307 (unless using a cable with built-in terminator resistors, which would either be GE Fanuc cable IC693CBL302, or your own custom-built cable).
11. Install the modules in their correct slots using your system layout drawings. (The label on the side of each module identifies the module type and catalog number.) Refer to the section “Installing Modules” if you are not familiar with how to do this.
12. Connect cables to Option modules. Route cables away from noise-producing wires. See the “Wire Routing” section of this chapter.
13. Be sure to follow the information in the “Wiring Guidelines” section of this chapter to protect the system from electrical noise. Install the power wires to the Power Supply and I/O modules:
  - **I/O modules with removable terminal boards.** You can wire the terminal boards in-place on the modules or remove them from the modules before wiring. Although removing them may help make wiring easier (a previous section “Working with Removable Terminal Boards” shows how to remove a terminal board), care should be taken to avoid mixing them (each terminal board has the catalog number of the module printed on it, and the hinged cover has a wiring diagram for that module type). If you are using wire duct, routing each module’s wires through the opening in the duct directly under the module will help to keep each terminal board in its correct position.
  - **I/O Modules with terminal blocks.** Some modules use terminal blocks that mount to the enclosure panel. This includes all 32-point modules and, can include other I/O modules if they are fitted with the optional Terminal Block Quick Connect Assembly. Connect the terminal blocks to the connectors on the modules with the provided cables.
14. Connect the signal (switches, sensors, solenoids, etc.) wires to the terminal boards, or terminal blocks/strips. If wiring to terminal boards, these can be removed for ease of wiring, if desired. See the section “Removing a Module’s Terminal Board.”
15. When finished wiring the I/O terminal boards (if used and if you removed them for ease of wiring), re-install them on the modules, being careful to match each one with the correct module.



## ***GE Fanuc Automation***

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***Programmable Control Products***



## ***GE Fanuc Automation***

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***P.O. Box 8106  
Charlottesville, VA 22906***

**GFZ-0085**

***Series 90<sup>TM</sup>-30  
Programmable Controller  
Troubleshooting Guide***



## ***GE Fanuc Automation***

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***Programmable Control Products***

### ***Series 90<sup>TM</sup>-30 Programmable Controller Troubleshooting Guide***

***GFZ-0085***

***August 1993***

## Notice

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained in this document does not purport to cover all details or variations in hardware and software, nor to provide for every contingency in connection with installation, operation and maintenance. This document may describe features not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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|              |                      |             |
|--------------|----------------------|-------------|
| Alarm Master | CIMSTAR              | Helpmate    |
| PROMACRO     | Series Six           | CIMPLICITY  |
| GENet        | Logicmaster          | Series One  |
| Series 90    | CIMPLICITY 90-ADS    | Genius      |
| Modelmaster  | Series Three         | VuMaster    |
| ProLoop      | CIMPLICITY PowerTRAC | Series Five |
| Workmaster   | Genius Power TRAC    |             |

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## Safety Considerations

### General Warnings When Troubleshooting

Stand clear of controlled equipment when power is applied. If the problem is intermittent, sudden unexpected machine motion could occur, causing injury. Also reference NFPA 70E Part II for additional guidelines for safety practices.

Never reach into a machine to operate a switch since unexpected motion could occur, causing injury.

Remove all electrical power at the Main Power Disconnect to ensure total power removal.

Always remove power before inserting or removing modules, or before connecting I/O cabling.

## Preface

This guide describes a logical sequence for troubleshooting your Series 90–30 programmable controller. It includes the procedure for changing or adding a EPROM or EEPROM to your CPU. The Series 90–30 PLC is a member of the Series 90™ family of programmable logic controllers from GE Fanuc Automation.

### Revisions to this Troubleshooting Guide

This is the first release of this Troubleshooting Guide. Included are models CPU 311, 313, 321, 323, 331 and 341.

### Related Publications

*Series 90™–30 Programmable Controller Installation Manual* (GFK–0356).

*Series 90™–30 and 90–20 PLC Hand–Held Programmer User's Manual* (GFK–0402)

*Logicmaster™ 90 Series 90–30 and 90–20 Programming Software User's Manual* (GFK–0466)

*Series 90™–30/90–20 Programmable Controllers Reference Manual* (GFK–0467)

## We Welcome Your Comments and Suggestions

At GE Fanuc Automation, we strive to produce quality technical documentation. After you have used this troubleshooting guide, please take a few moments to write us with your comments and suggestions. Our address is: Manager Technical Publications, GE Fanuc Automation, PO Box 8106, Charlottesville, VA 22906

*Drake C. Fink*

Sr. Staff Systems Engineer

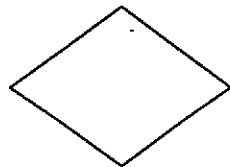


BEGIN AT THIS SYMBOL  
ON THE FIRST CHART.



FOLLOW THE PATH WITH  
THE CORRECT ANSWER IN  
THE DIRECTION OF THE  
ARROW

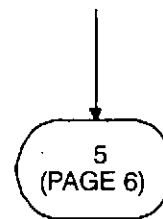
SYMBOLS USED THROUGHOUT THE GUIDE  
ARE GEOMETRICALLY CODED



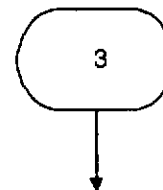
A DIAMOND ASKS A  
QUESTION



A RECTANGLE TELLS  
YOU TO DO SOMETHING



A NUMBERED BUBBLE WITH  
AN ARROW INTO THE BUBBLE  
INDICATES THAT THE  
PROCEDURE IS CONTINUED  
AT A CORRESPONDINGLY  
NUMBERED BUBBLE ON THE  
INDICATED PAGE NUMBER.



A NUMBERED BUBBLE WITH  
AN ARROW OUT OF THE  
BUBBLE INDICATES THE  
START OF A PROCEDURE ON  
THAT PAGE.



## Adding or Changing the EEPROM in the 90™—30

Application programs are normally developed in the CPU's RAM memory and executed from RAM memory. If additional program integrity is desired, or operation of the PLC without a battery is desired, an optional EEPROM or EPROM can be installed in a spare socket (labeled PROGRAM PROM) on the Model 311/313 backplane or in a socket on the model 331/341 CPU module. EEPROMs can be written to and read from. EPROMs can be read when installed in the PLC; however, they must be written to using an external PROM programming device.

Following is the procedure for adding or changing the EEPROM or EPROM. For clarity, the term PROM is used to refer to either an EEPROM or an EPROM.

1. Remove power from the system.
2. If 311/313
  - Remove all modules, including the power supply.
  - Remove the plastic cover.
3. If 331/341:
  - Remove CPU from backplane.
  - Remove front plate and bezel. Unsnap circuit board and remove from case.
4. If the socket is the type which has a screw near the top edge (some versions of 311/331), loosen screw at top of PROM socket (CCW twist;).
5. If present, remove old PROM from socket. Replace with or install new PROM. Orient the PROM so the end with a notch (the top of the prom) is toward the top edge of the backplane. Pin 1 of the prom is the first pin on the left as you move counter-clockwise from the notch. On the 311/331, correct installation orients the notch toward the screw.
6. When present, tighten screw at top of PROM socket (CW twist).
7. If 311/313:
  - Replace the plastic cover.
  - Replace all modules, including the power supply.

### 8. If 331 CPU:

- Assure jumper JP1, located at the bottom of the PROM socket, is in the 1–2 position for EPROM and the 3–2 position for EEPROM. This informs the CPU firmware which type of device is present.

### 9. If 331/341 CPU:

- Replace circuit board in case.
- Reinstall front plate and bezel.
- Replace CPU in backplane.

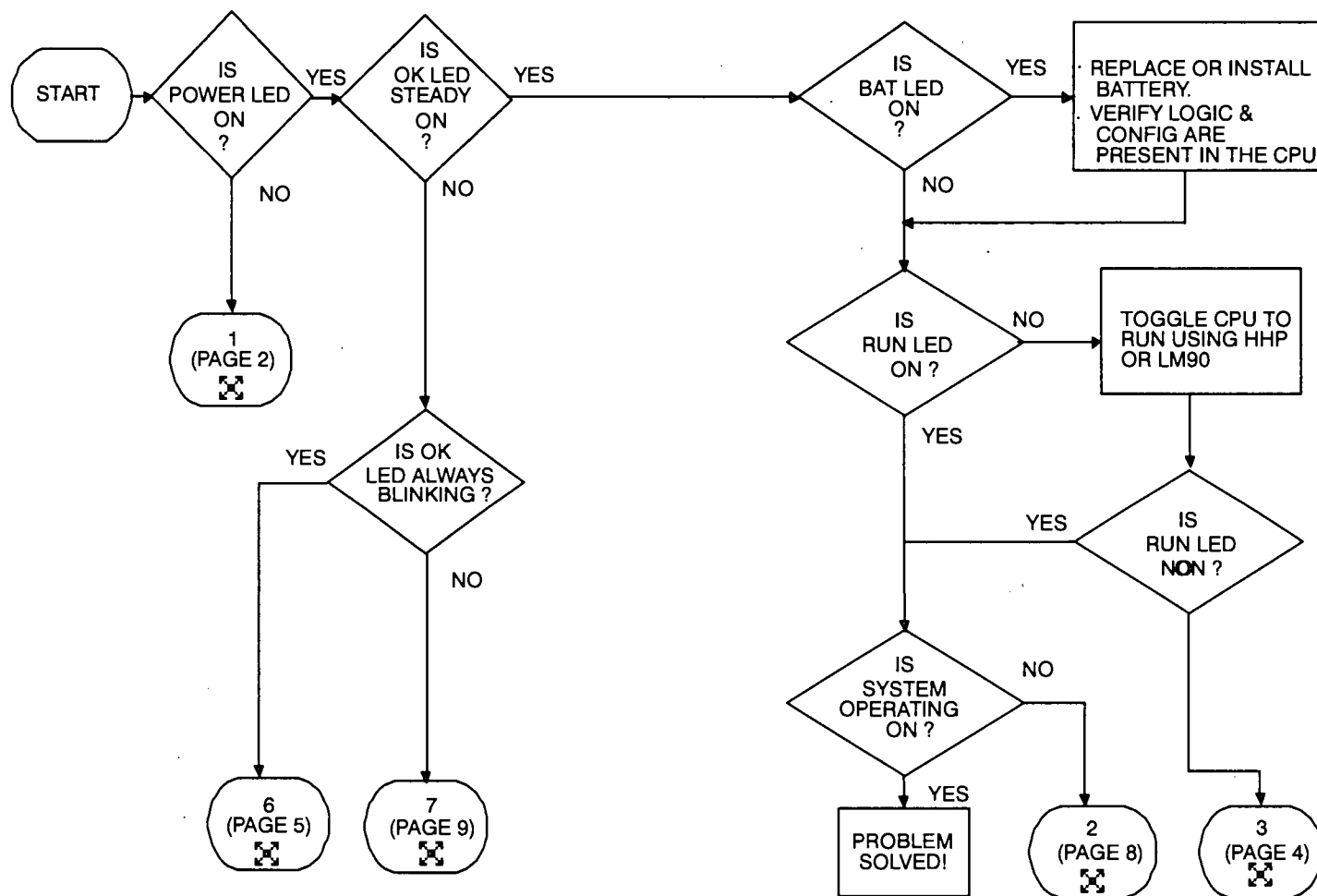
## Changing the EEPROM (continued)

10. Apply power. The PLC follows the flowchart found in the "Power-Up Sequence" figure in the Power-Up and Power-Down Section of the *Series 90-30/90-20 Programmable Controllers Reference Manual* (GFK-0467) to determine if a program will be loaded from PROM to RAM.
11. For the EEPROM to be used by the CPU, the CPU configuration must be set to use EEPROM as the "Program Source". You may use the LM90 Configuration software or the HHP to accomplish this.
12. To store the program in RAM, you may use either the Hand-Held Programmer or Logicmaster 90-30, Rev 3.5 or higher. Refer to the instructions in the *HHP User's Manual* (GFK-0402) for HHP. To use Logicmaster 90-30, follow these instructions:
  - Start the LM90-30 Programmer Package
  - Activate the Utilities Menu (F9)
  - Select the EEPROM function (F10)
  - Select the WRITE operation
  - Verify the items you want to write to EEPROM are selected.
  - Press ENTER to start the operation. Refer to the *Logicmaster 90 Series 90-30 and 90-20 Programming Software User's Manual* (GFK-0466) for more information.

## Notes and Precautions

1. **WARNING:** Do not discard the lithium–manganese dioxide battery in fire. Do not attempt to discharge the battery. The battery may burst or burn or release hazardous materials. Dispose of the battery as you would any hazardous material.
2. **CAUTION:** After a power fault, the system will come back on in the mode (*STOP, RUN/ENABLED, RUN/DISABLED*) in which it was operating before power loss, unless the power up configuration specifies a particular mode.
3. Not having a battery installed will not prevent the PLC from running. It will generate a PLC fault on power cycle that prevents the PLC from entering *RUN* mode automatically. Clearing this fault will enable the PLC to be placed in *RUN* mode.
4. To short the 'super cap' on a 311/321 PLC:
  - Remove power from the system.
  - Remove all modules, including the power supply.
  - Remove the plastic face plate.
  - Find component C20 along the left edge of the module. This is the 'super cap'. Short the positive (+) and negative (–) leads of this device.
  - Replace the plastic face plate.
  - Replace all modules.
  - Restore power to the system.
5. Supply (input) voltage tolerances for Series 90–30 power supplies:
 

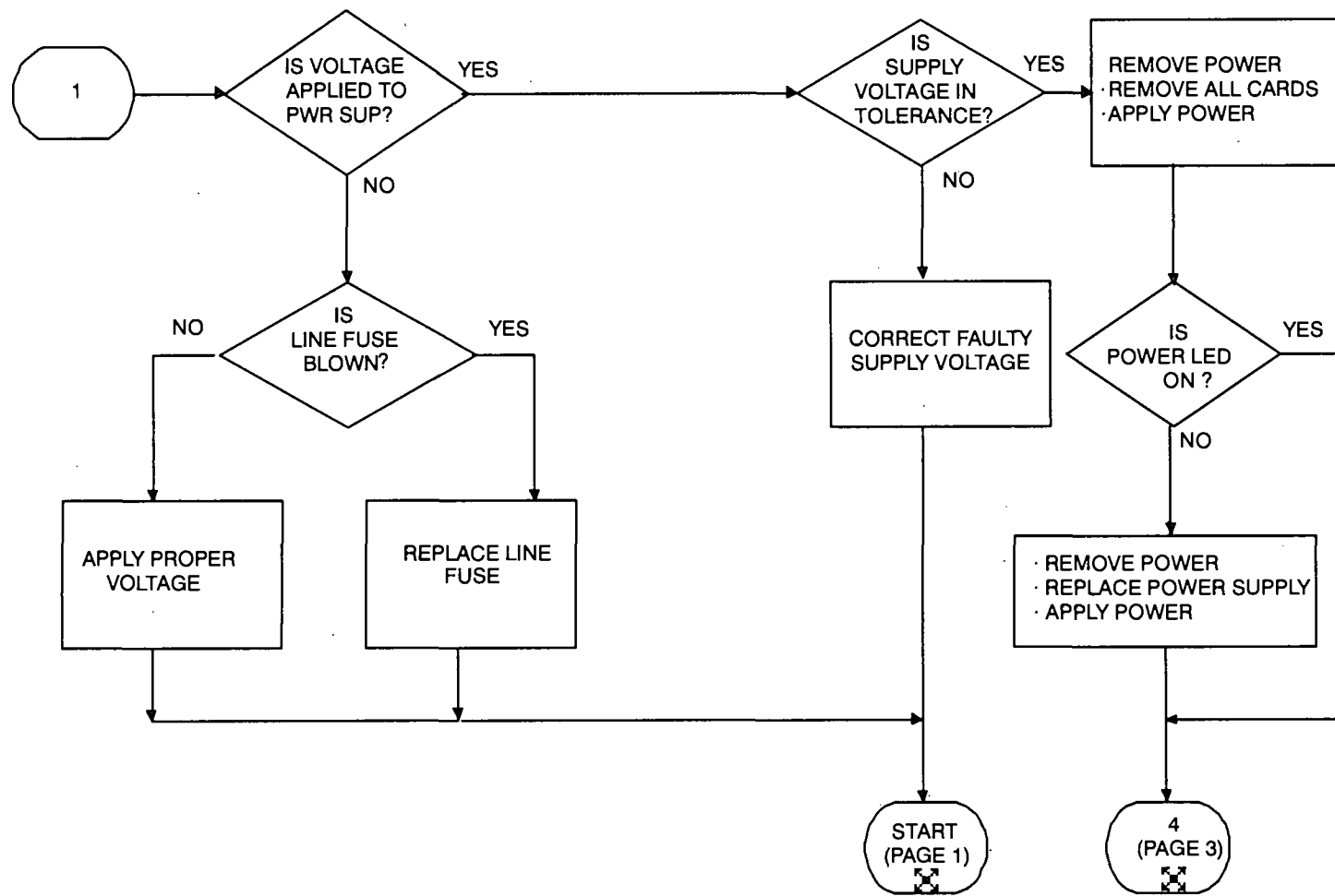
|              |  |
|--------------|--|
| IC693PWR321: | 100 to 240 VAC<br>100 to 250 VDC (125 VDC nominal)                   |
| IC693PWR322: | 18 to 56 VDC, 21 VDC<br>minimum to start<br>24 VDC OR 48 VDC nominal |
6. Total cable length must not exceed 50 feet between a CPU rack and an expansion rack. Length must not exceed 700 feet between a CPU rack and a remote rack. No termination plug is needed on a one–rack system.



PAGE 1

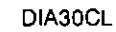
(Refer to the Preface for information on safety considerations, related publications and the symbols used in this guide.)

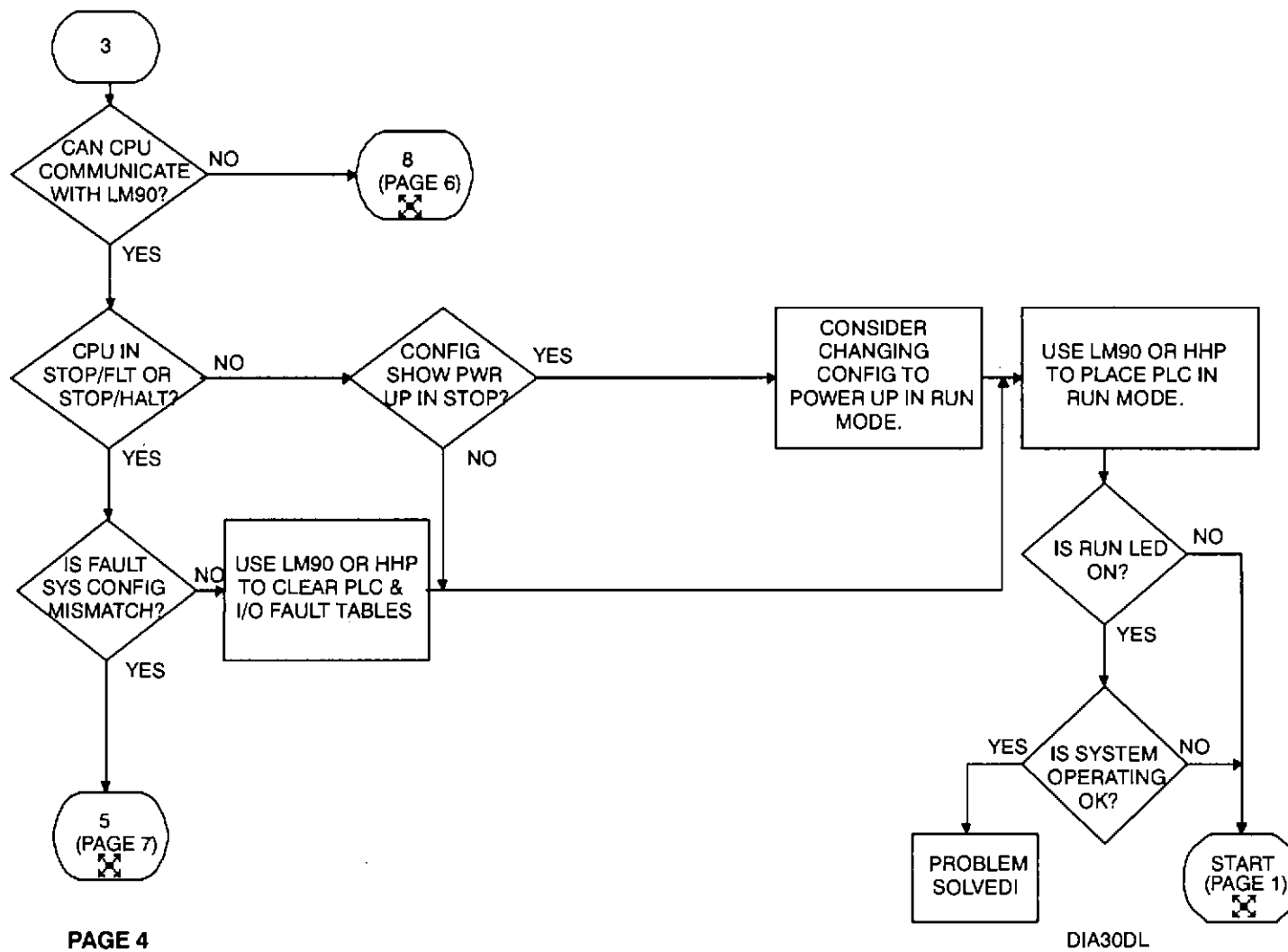
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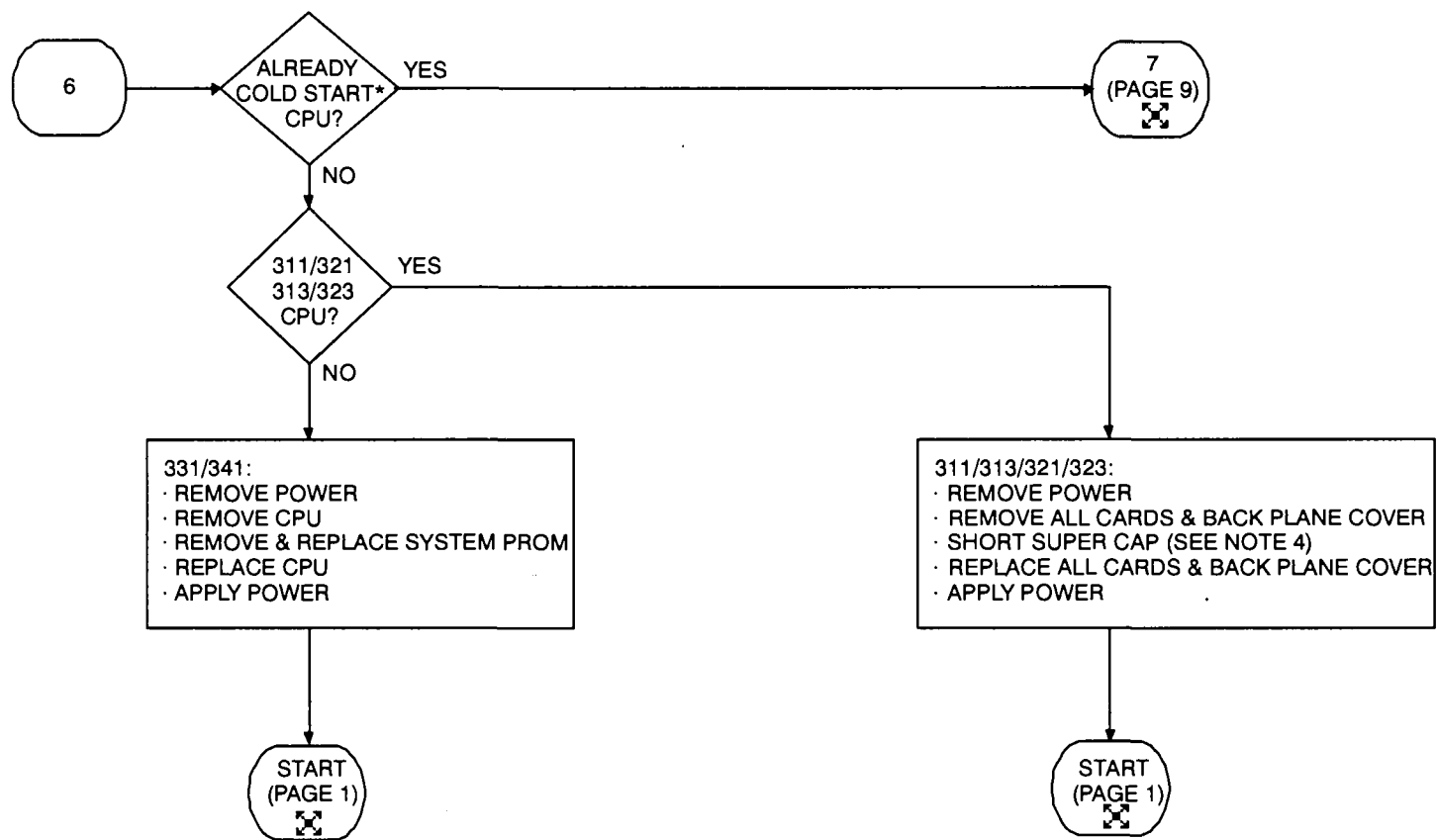


PAGE 2

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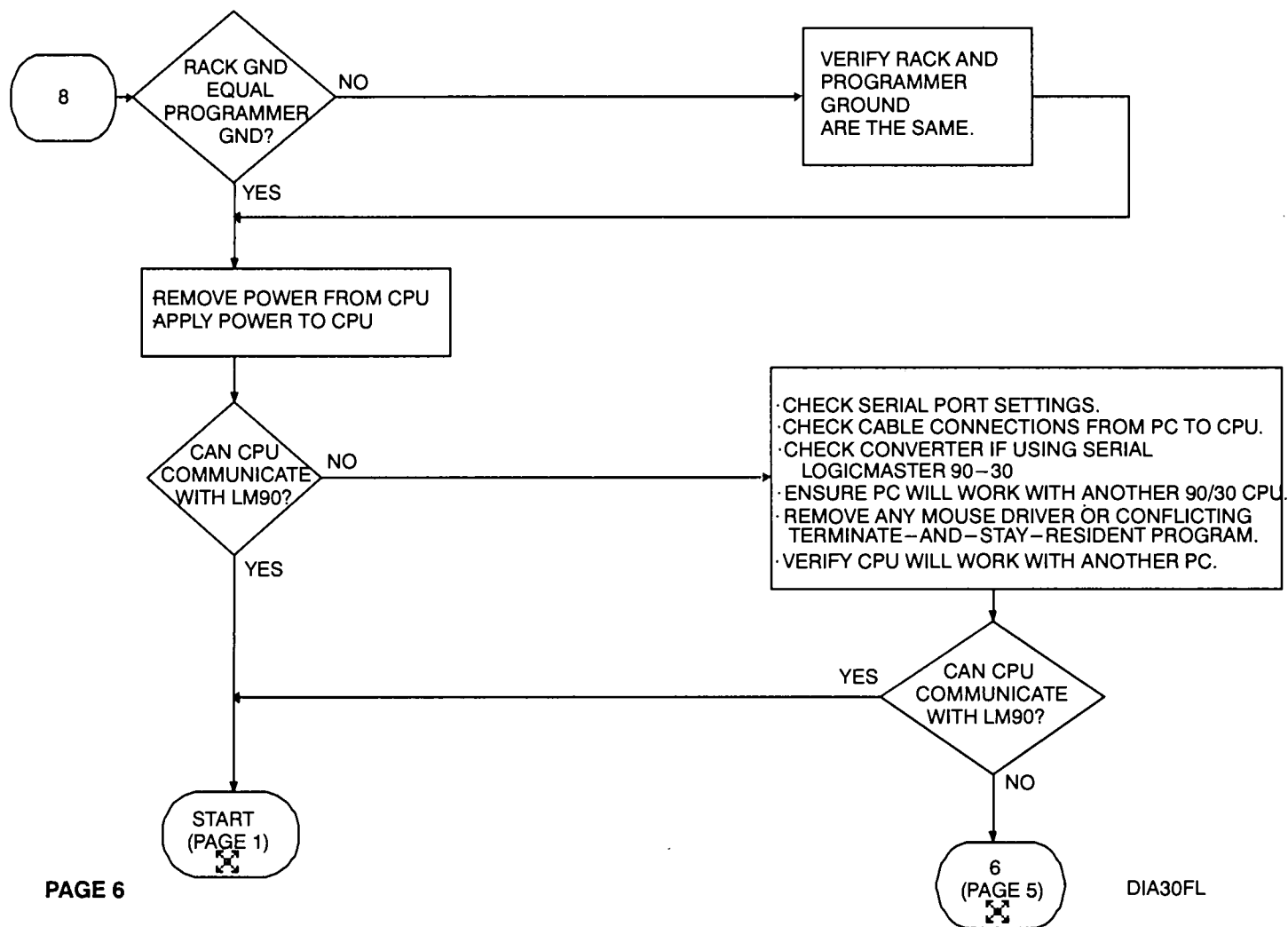


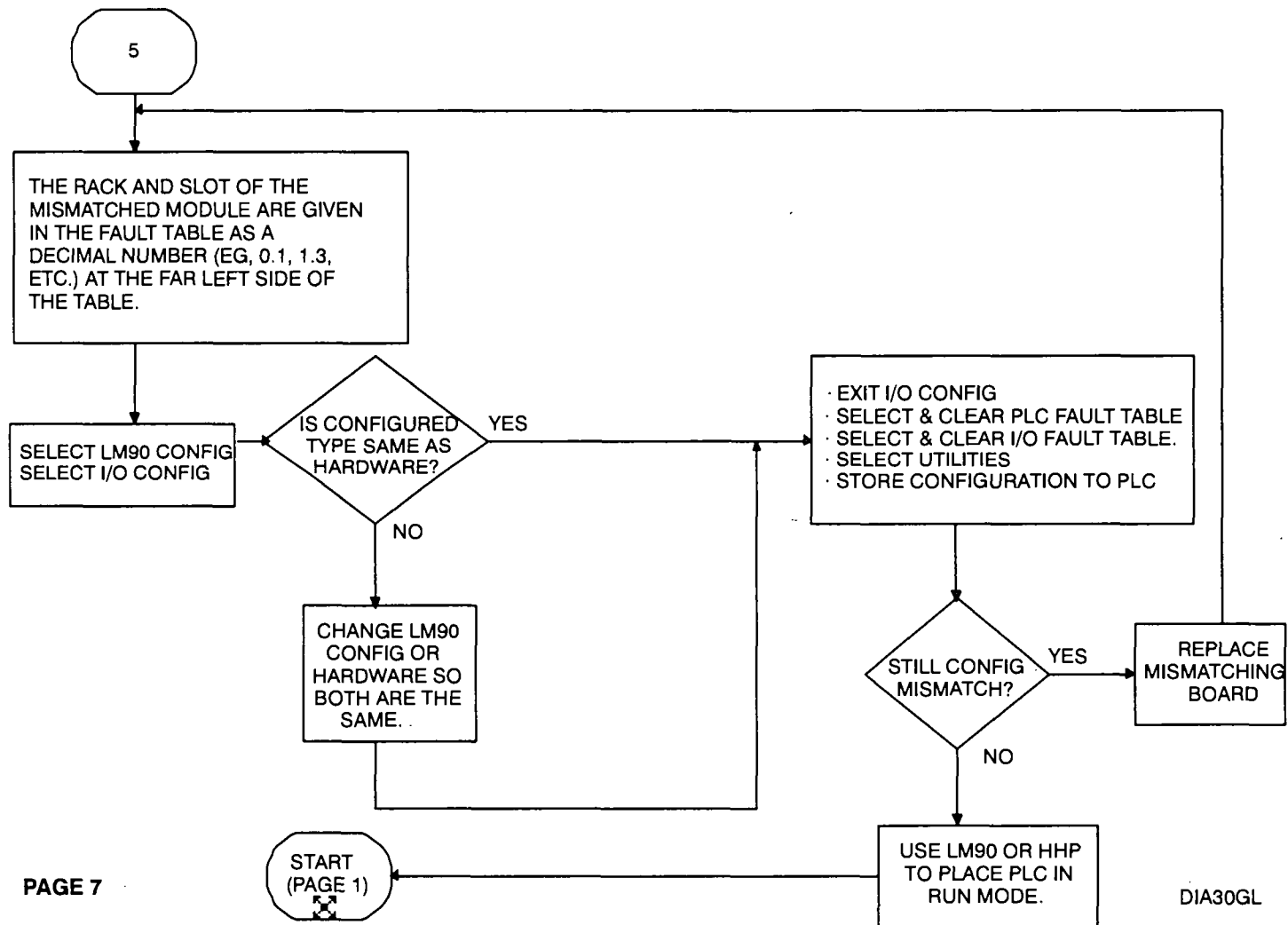
\*COLD START DELETES THE CONTENTS OF THE CPU'S MEMORY AND RESTORES COMMUNICATION PARAMETERS (BAUD RATE, PARITY, ETC.) TO THEIR DEFAULT VALUES.

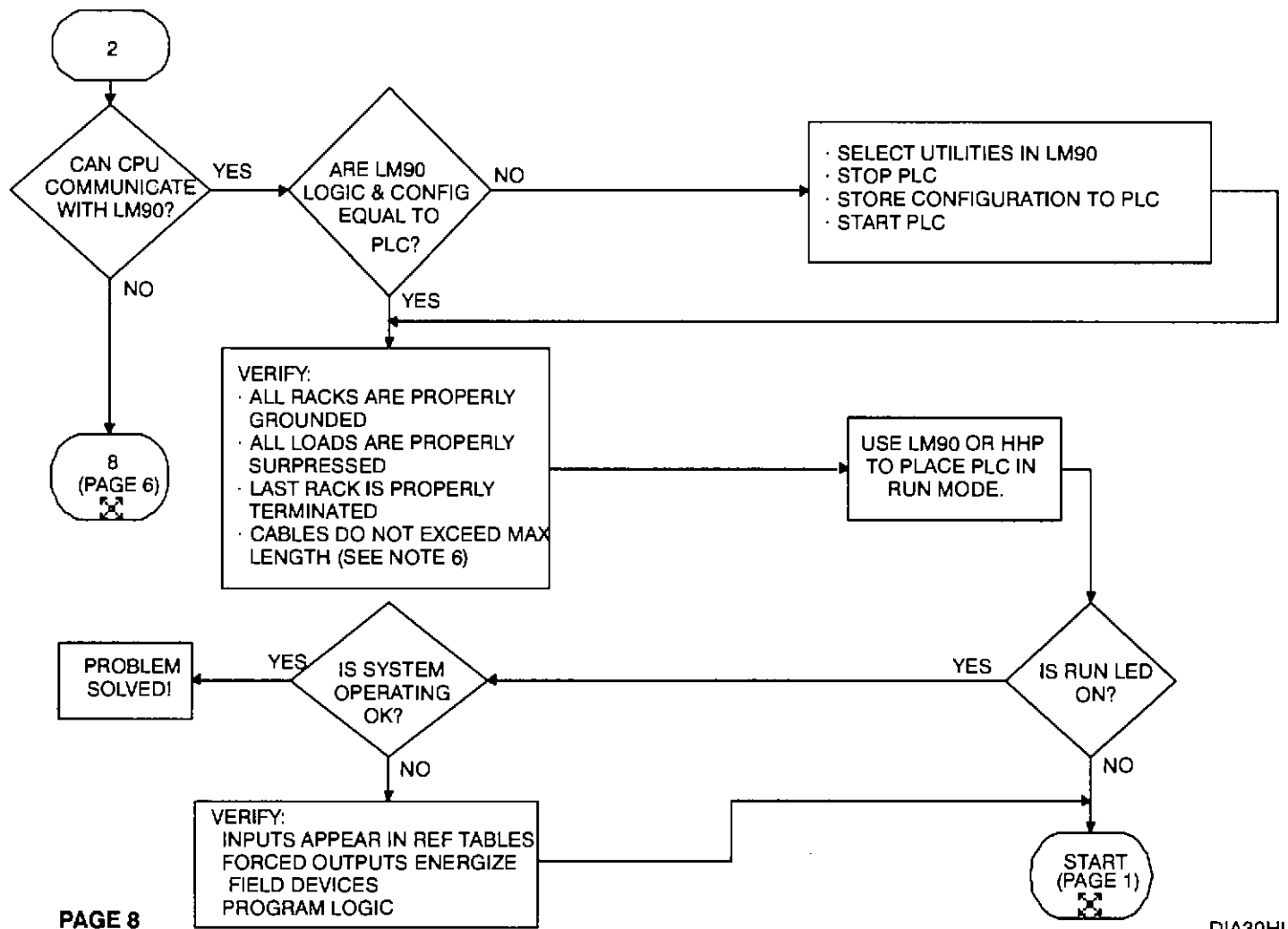
PAGE 5

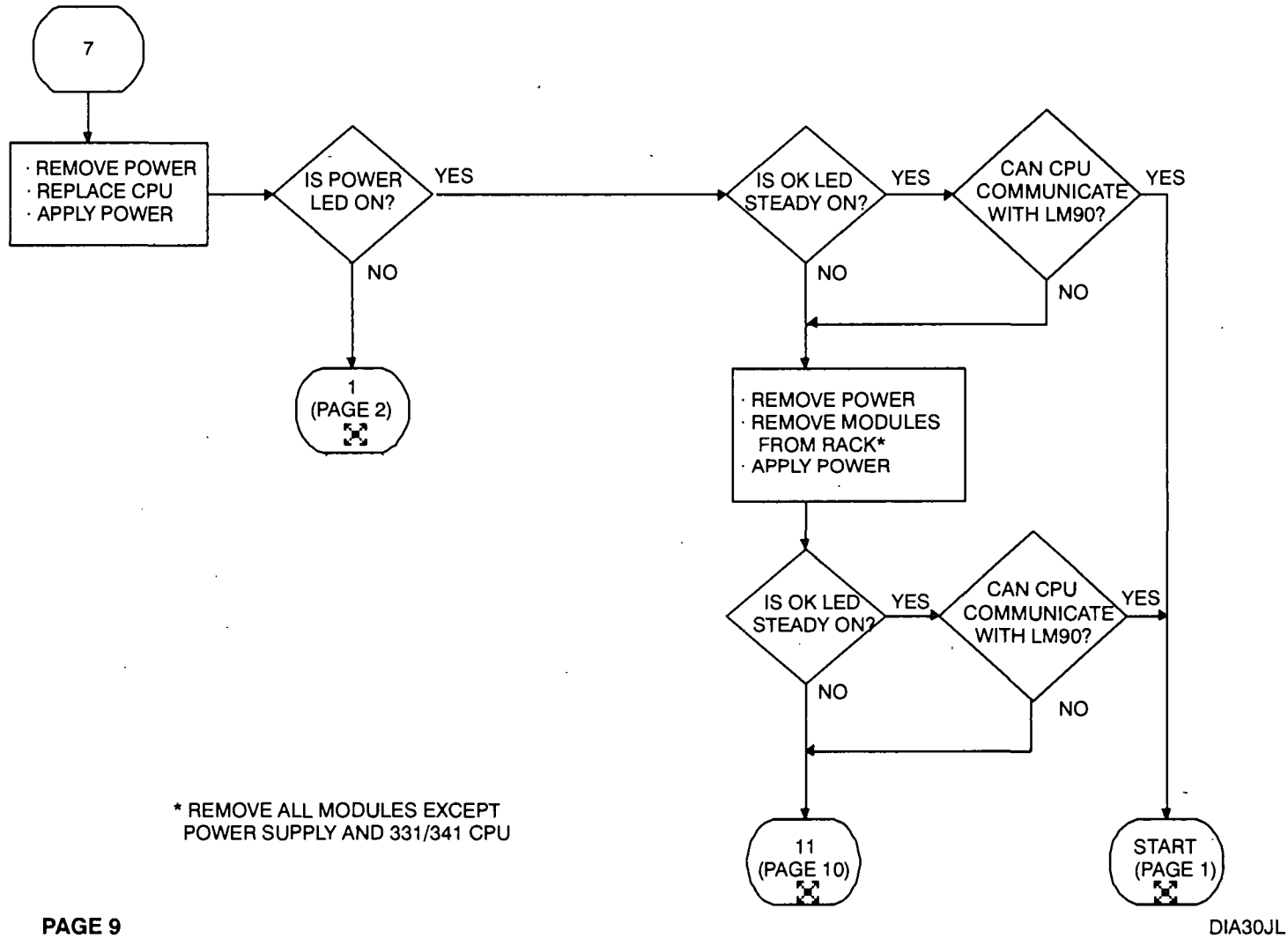
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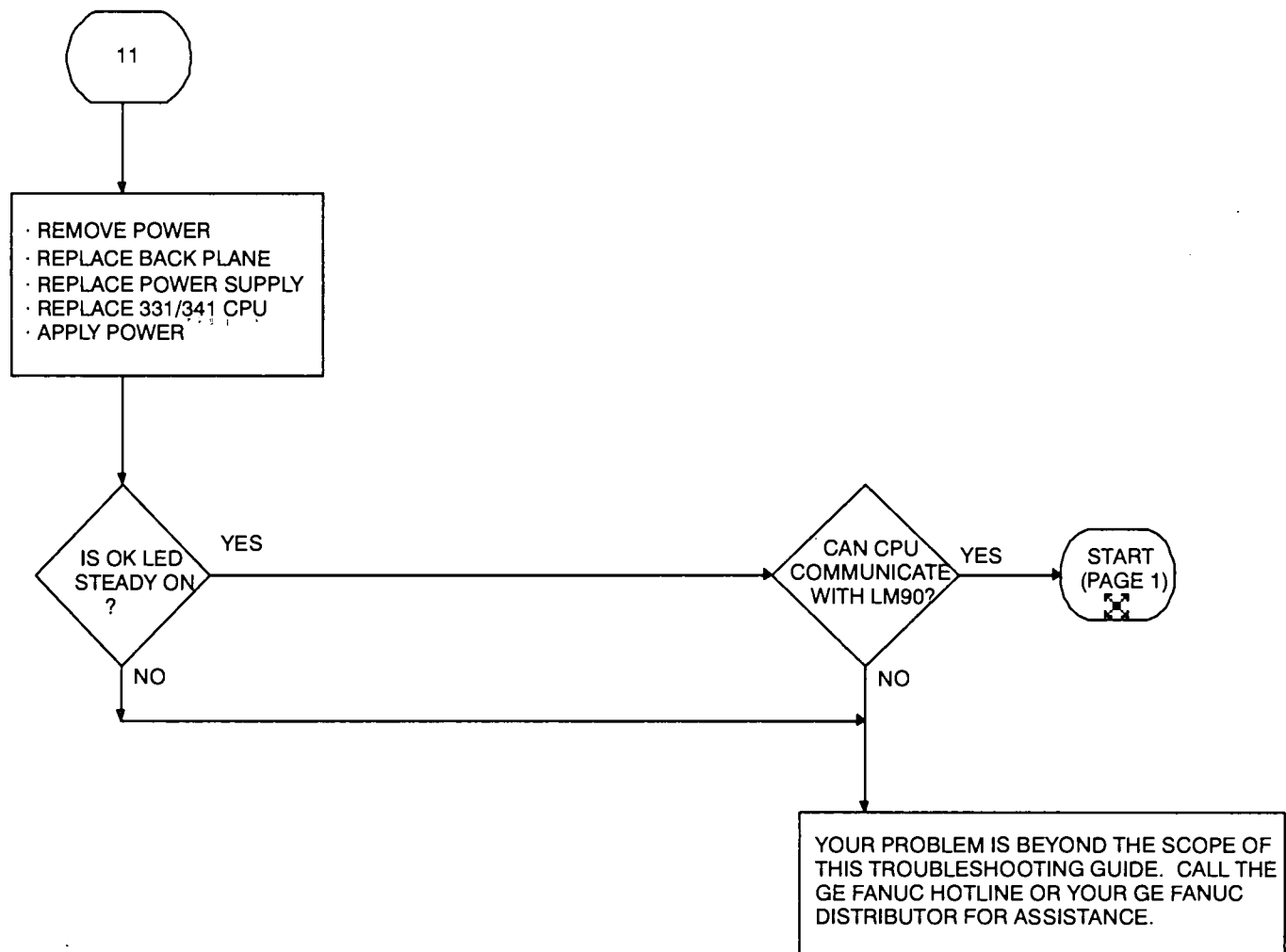












PAGE 10

DIA30KL



**DIESEL STANDBY GENERATOR**

**LOCAL CONTROL PANEL**

**FUNCTIONAL DESCRIPTION**

**FOR**

**Brisbane City Council**

19th May 2003

## ABBREVIATIONS

G1     Generator 1 Diesel

## 1. GENERAL

- 1.1. The PLC for the above operation is a GE Fanuc IC693CPU350. This program has been designed for the use on G1. The operation below controls G1.
- 1.2. A mode selector switch selects how G1 shall operate :
  - 1.2.1. Off
  - 1.2.2. Manual Mode
  - 1.2.3. Test Mode.
  - 1.2.4. Automatic Mode.

## 2. MANUAL MODE

- 2.1. To operate G1 in MANUAL Mode.
- 2.2. Select this operation by turning the AUTO – TEST – MAN- OFF selector switch to the MANUAL position.
- 2.3. Press the MANUAL START push button to start the generator.
- 2.4. The generator will begin to crank.
  - 2.4.1. If it fails to start within the 10 seconds, the starter motor is stopped and a delay of 10 seconds before it will attempt to restart.
  - 2.4.2. The generator set is allowed 3 attempts to start.
  - 2.4.3. If it fails to start on the third attempt, the generator is locked out on FAIL TO START Alarm.
  - 2.4.4. When the generator starts, the starter motor is stopped by a stop cranking input which measures the speed of the generator.
  - 2.4.5. Once the generator has started, there is a 10 second time delay for the oil pressure to stabilise.
  - 2.4.6. If the oil pressure is not up to pressure after the 10 second time delay, the generator shall shut down on LOW OIL PRESS Alarm.
  - 2.4.7. Once the generator is running there is a 5 second warm up time before it is ready to accept load.



- 2.5. To Manual Transfer to Generator in the MANUAL Mode.
  - 2.5.1. Start the generator and wait for the generator to run up to speed and voltage and ready to accept load.
  - 2.5.2. Press the MANUAL TRANSFER TO GEN push button.
  - 2.5.3. The MAINS ATS shall Open.
  - 2.5.4. After a 30 second delay the GEN ATS shall Close.
  - 2.5.5. If the MAINS ATS fails to Open.
    - 2.5.5.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.
    - 2.5.5.2. The system shall return back to MAINS ATS operation.
  - 2.5.6. If the GEN ATS fails to Close.
    - 2.5.6.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
    - 2.5.6.2. The system shall return back to MAINS ATS operation.
- 2.6. To Manual Transfer to Mains in the MANUAL Mode.
  - 2.6.1. The GENERATOR ATS is Closed.
  - 2.6.2. Press the MAN TRANSFER TO MAINS push button.
  - 2.6.3. The GEN ATS shall Open.
  - 2.6.4. After a 30 second delay the MAINS ATS shall Close.
  - 2.6.5. If the GEN ATS fails to Open.
    - 2.6.5.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
    - 2.6.5.2. The system shall return back to GEN ATS operation.
  - 2.6.6. If the MAINS ATS fails to Close.

2.6.6.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.

2.6.6.2. The system shall return back to GEN ATS operation.

2.7. To stop the generator in the MANUAL Mode.

2.7.1. When the generator is running, it may be stopped by pressing the MANUAL STOP push button.

2.7.2. If the generator is still GEN ATS operation. The MANUAL TRANSFER TO MAINS is initiated.

2.7.3. When the GEN ATS is Open, the generator will enter the cool down time of 1 second.

2.7.4. After the cool down time, the generator will shut down.

2.7.5. Once the generator has shut down there is a 15 second delay before it may be restarted. This is to ensure the engine has mechanically stopped.

### 3. **NON-PERMANENT SITE, MANUAL MODE**

- 3.1. To operate G1 in a Non-Permanent Site Location in MANUAL Mode.
- 3.2. Connect the generator cables to the site generator CB ensuring the site generator CB is OFF. See BCC procedures.
- 3.3. A plug with shorting links is required to be installed. It is required to be plugged into the 27 Pin Station Plug.
  - 3.3.1. Pins 11 and 12 are required to be connected. This is to indicate that the Mains ATS is Closed. If they are not connected a MAINS ATS Alarm shall be indicated.
- 3.4. Select from the AUTO – TEST – MAN- OFF selector switch to the MANUAL position.
- 3.5. Press the MANUAL START push button to start the generator.
- 3.6. The generator will begin to crank.
  - 3.6.1. If it fails to start within the 10 seconds, the starter motor is stopped and a delay of 10 seconds before it will attempt to restart.
  - 3.6.2. The generator set is allowed 3 attempts to start.
  - 3.6.3. If it fails to start on the third attempt, the generator is locked out on FAIL TO START Alarm.
  - 3.6.4. When the generator starts, the starter motor is stopped by a stop cranking input which measures the speed of the generator.
  - 3.6.5. Once the generator has started, there is a 10 second time delay for the oil pressure to stabilise.
  - 3.6.6. If the oil pressure is not up to pressure after the 10 second time delay, the generator shall shut down on LOW OIL PRESS Alarm.
  - 3.6.7. Once the generator is running there is a 5 second warm up time before it is ready to accept load.
- 3.7. To connect the generator to the site load.
  - 3.7.1. Manually switch over to the generator supply via the site CB's. See BCC procedures.
  - 3.7.2. Do not use the MANUAL TRANSFER TO GEN or the MAN TRANSFER TO MAINS push buttons.

- 3.8. To disconnect the generator from the site load.
  - 3.8.1. Manually switch over to the mains supply via the site CB's. See BCC procedures.
  - 3.8.2. Do not use the MANUAL TRANSFER TO GEN or the MAN TRANSFER TO MAINS push buttons.
- 3.9. To stop the generator in the MANUAL Mode.
  - 3.9.1. When the generator is running, it may be stopped by pressing the MANUAL STOP push button.
  - 3.9.2. The generator will enter the cool down time of 1 second.
  - 3.9.3. After the cool down time, the generator will shut down.
  - 3.9.4. Once the generator has shut down there is a 15 second delay before it may be restarted. This is to ensure the engine has mechanically stopped.

## 4. TEST OPERATION

- 4.1. To operate the generator in the TEST Mode.
- 4.2. Select this operation by turning the AUTO – TEST – MAN- OFF selector switch to the TEST position.
- 4.3. If the selector is changed to MAN while the generator is operating on TEST, the system shall change to MANUAL TRANSFER TO GEN.
- 4.4. The generator shall begin to crank.
  - 4.4.1. If it fails to start within the 10 seconds, the starter motor is stopped and a delay of 10 seconds before it will attempt to restart.
  - 4.4.2. The generator is allowed 3 attempts to start.
  - 4.4.3. If it fails to start on the third attempt, the generator is faulted on FAIL TO START Alarm.
- 4.5. When the generator starts, the starter motor is stopped by a stop cranking input which measures the speed of the generator.
- 4.6. The MAINS ATS shall Open.
- 4.7. Once the generator has started, there is a 10 second time delay for the oil pressure to stabilise.
- 4.8. If the oil pressure is not up to pressure after the 10 second time delay, the generator shall shut down on LOW OIL PRESS Alarm.
- 4.9. Once the generator is running there is a 5 second warm up time before it is ready to accept load.
- 4.10. After the warm up time has expired and the MAINS ATS has been open for 30 seconds the GEN ATS shall Close.
- 4.11. If the MAINS ATS fails to Open.
  - 4.11.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.
  - 4.11.2. The system shall shut down and return back to MAINS ATS operation.
- 4.12. If the GEN ATS fails to Close.

- 4.12.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
- 4.12.2. The system shall shut down and return back to MAINS ATS operation.
- 4.13. To stop the generator in the TEST Mode.
  - 4.13.1. Select this operation by turning the AUTO – TEST – MAN- OFF selector switch to the AUTO or OFF position.
  - 4.13.2. The GEN ATS shall Open.
  - 4.13.3. After a 30 second delay the MAINS ATS shall Close.
  - 4.13.4. If the GEN ATS fails to Open.
    - 4.13.4.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
    - 4.13.4.2. The system shall return back to GEN ATS operation.
  - 4.13.5. If the MAINS ATS fails to Close.
    - 4.13.5.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.
    - 4.13.5.2. The system shall return back to GEN ATS operation.
  - 4.13.6. When the GEN ATS is Open, the generator will enter the cool down time of 5 minutes.
  - 4.13.7. After the cool down time, the generator will shut down.
  - 4.13.8. If a Mains Failure occurs during the cool down period the generator shall transfer back to the GENERATOR ATS without shutting down.
  - 4.13.9. Once the generator has shut down there is a 15 second delay before it may be restarted. This is to ensure the engine has mechanically stopped.

## 5. **AUTOMATIC OPERATION**

- 5.1. To operate the generator in the AUTO Mode.
- 5.2. Select this operation by turning the AUTO – TEST – MAN- OFF selector switch to the AUTO position.
- 5.3. The Phase Failure Relay from the clients switch board shall give a Start Signal for the generators to run.
- 5.4. The Remote Start Command.
  - 5.4.1. The generator shall begin to crank.
    - 5.4.1.1. If it fails to start within the 10 seconds, the starter motor is stopped and a delay of 10 seconds before it will attempt to restart.
    - 5.4.1.2. The generator is allowed 3 attempts to start.
    - 5.4.1.3. If it fails to start on the third attempt, the generator is faulted on FAIL TO START Alarm.
  - 5.4.2. When the generator starts, the starter motor is stopped by a stop cranking input which measures the speed of the generator.
  - 5.4.3. The MAINS ATS shall Open.
  - 5.4.4. Once the generator has started, there is a 10 second time delay for the oil pressure to stabilise.
  - 5.4.5. If the oil pressure is not up to pressure after the 10 second time delay, the generator shall shut down on LOW OIL PRESS Alarm.
  - 5.4.6. Once the generator is running there is a 5 second warm up time before it is ready to accept load.
  - 5.4.7. After the warm up time has expired and the MAINS ATS has been open for 30 seconds the GEN ATS shall Close.
  - 5.4.8. If the MAINS ATS fails to Open.
    - 5.4.8.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.

- 5.4.8.2. The system shall shut down and return back to MAINS ATS operation.
- 5.4.9. If the GEN ATS fails to Close.
  - 5.4.9.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
  - 5.4.9.2. The system shall shut down and return back to MAINS ATS operation.
- 5.5. To stop the generator in the AUTO Mode.
  - 5.5.1. The Phase Failure Relay from the clients switch board shall give a Stop Signal for the generators to run.
  - 5.5.2. The Remote Stop Command.
  - 5.5.3. There is a 2 minute proving time for the Phase Failure Relay.
  - 5.5.4. After the 2 minute proving time the GEN ATS shall Open.
  - 5.5.5. After a 30 second delay the MAINS ATS shall Close.
  - 5.5.6. If the GEN ATS fails to Open.
    - 5.5.6.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
    - 5.5.6.2. The system shall return back to GEN ATS operation.
  - 5.5.7. If the MAINS ATS fails to Close.
    - 5.5.7.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.
    - 5.5.7.2. The system shall return back to GEN ATS operation.
  - 5.5.8. When the GEN ATS is Open, the generator will enter the cool down time of 5 minutes.
  - 5.5.9. After the cool down time, the generator will shut down.
  - 5.5.10. If a Mains Failure occurs during the cool down period the generator shall transfer back to the GENERATOR ATS without shutting down.



5.5.11. Once the generator has shut down there is a 15 second delay before it may be restarted. This is to ensure the engine has mechanically stopped.

## 6. FAULT OPERATION

### 6.1. Emergency Stop Operation.

6.1.1. Operation of the Emergency Stop push button immediately shuts down the generator and Opens the Generator CB. The Emergency Stop is latched, and requires manual resetting to release the Emergency Stop push button.

6.1.2. After the Emergency Stop push button is released, a fault reset will need to be initiated to reset the PLC.

### 6.2. HIGH HIGH Alarm Operation.

6.2.1. The Generator CB is Opened immediately.

6.2.2. The generator is shut down immediately.

6.2.3. The following alarms will initiate a HIGH HIGH Alarm condition :-

6.2.3.1. Emergency Stop Fault

6.2.3.2. MEN Fault

6.2.3.3. Low Oil Pressure Shutdown Fault, 10 Seconds Startup Delay

6.2.3.4. High Engine Temperature Shutdown Fault, 30 Second Startup Delay

6.2.3.5. Low Radiator Level Fault, 5 Second Delay

6.2.3.6. Over Speed Fault

### 6.3. HIGH Alarm Operation

6.3.1. The Generator CB is Opened immediately.

6.3.2. Once the generator circuit breaker is opened, the generator will run through its normal cool down time and shut down.

6.3.3. The following alarms will initiate a HIGH Alarm condition:-

6.3.3.1. Generator Under Speed Fault, 5 Second Delay

6.3.3.2. Alternator Under Voltage Fault, 5 Second Delay

6.3.3.3. Alternator Over Voltage Fault, 5 Second Delay

#### 6.3.3.4. Generator CB Tripped Fault

#### 6.3.3.5. Alternator High Temperature Fault, 30 Second Startup Delay

### 6.4. MEDIUM Alarm Operation.

6.4.1. A Normal Shutdown shall be Initiated.

6.4.2. If the GEN ATS does not Open then the Generator CB is Opened.

6.4.3. The following alarms will initiate a MEDIUM Alarm condition :-

6.4.3.1. Fuel Empty Level Fault, 5 Second Delay

6.4.3.2. Fail To Start Fault, 3 Attempts

### 6.5. LOW Alarm Operation.

6.5.1. A Warning has occurred on the generator. The generator will not shut down.

6.5.2. The following alarms will initiate a LOW Alarm condition :-

6.5.2.1. Low Oil Pressure Warning Alarm, 10 Seconds Startup Delay

6.5.2.2. High Engine Temperature Warning Alarm, 30 Second Startup Delay

6.5.2.3. Fuel Low Level Alarm, 5 Second Delay

6.5.2.4. Battery Charger AC Supply Failed Alarm, 60 Second Delay

6.5.2.5. Control Battery Low Volts Alarm, 30 Second Delay

6.5.2.6. Start Battery Low Volts Alarm, 60 Second Delay

11/06/04 3:02BCC 4000 4Page: ATable of Contents

|   |   |
|---|---|
| Overview  | 1 |
| Main Rack: Base 10 Slot (IC693CHS391)                         | 1 |
| Detailed View   | 2 |
| IC693PWR331 Power Supply 24 VDC 30W                           | 2 |
| Power Consumption   | 2 |
| Settings  | 2 |
| IC693CPU350 Series 90-30 CPU Model 350                        | 2 |
| Settings  | 2 |
| Scan  | 2 |
| Memory  | 2 |
| Power Consumption   | 3 |
| IC693CMM311 Communications Coprocessor                        | 3 |
| Settings  | 3 |
| Port 1  | 3 |
| Port 2  | 3 |
| Power Consumption   | 3 |
| IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic | 3 |
| Settings  | 3 |
| Wiring  | 3 |
| Power Consumption   | 3 |
| IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic | 4 |
| Settings  | 4 |
| Wiring  | 4 |
| Power Consumption   | 4 |
| IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic | 4 |
| Settings  | 4 |
| Wiring  | 4 |
| Power Consumption   | 4 |
| IC693MDL940 16 Circuit Output Relay 2A                        | 4 |
| Settings  | 4 |
| Wiring  | 4 |
| Power Consumption   | 4 |
| IC693MDL940 16 Circuit Output Relay 2A                        | 5 |
| Settings  | 5 |
| Wiring  | 5 |
| Power Consumption   | 5 |
| IC693MDL940 16 Circuit Output Relay 2A                        | 5 |
| Settings  | 5 |
| Wiring  | 5 |
| Power Consumption   | 5 |
| Reference Details   | 6 |
| %I References   | 6 |
| %Q References   | 6 |

Table of ContentsGE Fanuc Hardware ConfigurationSeries 90-30

11/06/04 3:02

BCC 4000 4

Page: 1

**Main Rack: Base 10 Slot (IC693CHS391)**

**Overview**

**GE Fanuc Hardware Configuration**

**Series 90-30**

11/06/04 3:02BCC 4000 4Page: 2**Main Rack: Slot 0****IC693PWR331 Power Supply 24 VDC 30W****Power Consumption****Voltages / Supplied**

+5VDC (Watts) 30  
 +24VDC Relay Power (Watts) 15  
 +24VDC Isolated (Watts) 20  
 Total System: 30

**Settings****Parameters / Values**

Hand Held Programmer: No  
 Converter: 0

**Main Rack: Slot 1****IC693CPU350 Series 90-30 CPU Model 350****Settings****Parameters / Values**

I/O Scan-Stop: No  
 Power Up Mode: Run  
 Logic / Configuration From: RAM  
 Registers: RAM  
 Passwords: Disabled  
 Checksum Words: 8  
 Data Rate (bps): 19200  
 Parity: Odd  
 Stop Bits: 1  
 Modem Turnaround Time (.01 Sec / Count): 0  
 Idle Time (Sec): 10  
 Timer Faults: Disabled  
 SNP ID:  
 Key Switch Run/Stop: Enabled  
 Memory Protect: Disabled  
 Ignore Fatal Faults: Disabled

**Scan****Parameters / Values**

Sweep Mode: Normal  
 Sweep Timer (mSec): N/A

**Memory****Parameters / Values**

%I Discrete Input: 2048  
 %Q Discrete Output: 2048  
 %S System Use: 128  
 %M Internal Discrete: 4096  
 %T Temporary Status: 256  
 %G Genius® Global: 1280  
 %AI Analog Input: 2048  
 %AQ Analog Output: 512  
 %R Register Memory: 9999

Detailed ViewGE Fanuc Hardware ConfigurationSeries 90-30

11/06/04 3:02BCC 4000 4Page: 3**Power Consumption****Parameters / Values**

+5VDC (Watts) 3.35  
+24VDC Relay Power (Watts) 0  
+24VDC Isolated (Watts) 0

**Main Rack: Slot 2****IC693CMM311 Communications Coprocessor****Settings****Parameters / Values**

Configuration Mode: RTU Only

**Port 1****Parameters / Values**

RTU Enable: Yes  
Data Rate (bps): 9600  
Flow Control: None  
Parity: None  
Station Address: 1

**Port 2****Parameters / Values**

RTU Enable: Yes  
Interface: RS485  
Data Rate (bps): 9600  
Flow Control: None  
Parity: None  
Station Address: 1

**Power Consumption****Parameters / Values**

+5VDC (Watts) 2.00  
+24VDC Relay Power (Watts) 0  
+24VDC Isolated (Watts) 0

**Main Rack: Slot 3****IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic****Settings****Parameters / Values**

Reference Address: %I00001  
Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.40  
+24VDC Relay Power (Watts) 0

Detailed ViewGE Fanuc Hardware ConfigurationSeries 90-30

11/06/04 3:02BCC 4000 4Page: 4

+24VDC Isolated (Watts) 0.6

**Main Rack: Slot 4****IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic Settings****Parameters / Values**

Reference Address: %I00017

Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.40

+24VDC Relay Power (Watts) 0

+24VDC Isolated (Watts) 0.6

**Main Rack: Slot 5****IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic Settings****Parameters / Values**

Reference Address: %I00033

Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.40

+24VDC Relay Power (Watts) 0

+24VDC Isolated (Watts) 0.6

**Main Rack: Slot 7****IC693MDL940 16 Circuit Output Relay 2A Settings****Parameters / Values**

Reference Address: %Q00001

Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption**Detailed ViewGE Fanuc Hardware ConfigurationSeries 90-30



11/06/04 3:02BCC 4000 4Page: 5**Parameters / Values**

+5VDC (Watts) 0.04

+24VDC Relay Power (Watts) 3.24

+24VDC Isolated (Watts) 0

**Main Rack: Slot 8****IC693MDL940 16 Circuit Output Relay 2A****Settings****Parameters / Values**

Reference Address: %Q00017

Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.04

+24VDC Relay Power (Watts) 3.24

+24VDC Isolated (Watts) 0

**Main Rack: Slot 9****IC693MDL940 16 Circuit Output Relay 2A****Settings****Parameters / Values**

Reference Address: %Q00033

Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.04

+24VDC Relay Power (Watts) 3.24

+24VDC Isolated (Watts) 0

Detailed ViewGE Fanuc Hardware ConfigurationSeries 90

11/06/04 3:02BCC 4000 4Page: 6**%I References**

| <b>Overlap</b> | <b>Start</b> | <b>End</b> | <b>Addr</b> | <b>Mem Type</b> | <b>Cat Num</b> |
|----------------|--------------|------------|-------------|-----------------|----------------|
|                | 1            | 16         | (0.3)       | Consumed        | IC693MDL645    |
|                | 17           | 32         | (0.4)       | Consumed        | IC693MDL645    |
|                | 33           | 48         | (0.5)       | Consumed        | IC693MDL645    |

Total %I: 48                      Highest Reference: 48

**%Q References**

| <b>Overlap</b> | <b>Start</b> | <b>End</b> | <b>Addr</b> | <b>Mem Type</b> | <b>Cat Num</b> |
|----------------|--------------|------------|-------------|-----------------|----------------|
|                | 1            | 16         | (0.7)       | Produced        | IC693MDL940    |
|                | 17           | 32         | (0.8)       | Produced        | IC693MDL940    |
|                | 33           | 48         | (0.9)       | Produced        | IC693MDL940    |

Total %Q: 48                      Highest Reference: 48

Reference DetailsGE Fanuc Hardware ConfigurationSeries 90-30

| Name             | Type | Len | Address | Description                         | Stored Val | Scope  | Ret | Ovr | E |
|------------------|------|-----|---------|-------------------------------------|------------|--------|-----|-----|---|
| SEL_AUTO         | BIT  | 1   | %I00001 | Selector Switch Auto                |            | Global | R   |     |   |
| SEL_TEST         | BIT  | 1   | %I00002 | Selector Switch Test                |            | Global | R   |     |   |
| SEL_MAN          | BIT  | 1   | %I00003 | Selector Switch Manual              |            | Global | R   |     |   |
| EM_STOP_PB       | BIT  | 1   | %I00004 | Emergency Stop PB                   |            | Global | R   |     |   |
| LAMP_TEST_PB     | BIT  | 1   | %I00005 | Lamp Test PB                        |            | Global | R   |     |   |
| ALM_RESET_PB     | BIT  | 1   | %I00006 | Alarm Reset PB                      |            | Global | R   |     |   |
| ALM_MUTE_PB      | BIT  | 1   | %I00007 | Alarm Mute PB                       |            | Global | R   |     |   |
| MAN_STR_PB       | BIT  | 1   | %I00008 | Manual Start PB                     |            | Global | R   |     |   |
| MAN_STP_PB       | BIT  | 1   | %I00009 | Manual Stop PB                      |            | Global | R   |     |   |
| MAN_TRF_MAINS_PB | BIT  | 1   | %I00010 | Manual Transfer to Mains PB         |            | Global | R   |     |   |
| MAN_TRF_GEN_PB   | BIT  | 1   | %I00011 | Manual Transfer to Generator PB     |            | Global | R   |     |   |
| SPD_STP_CRK      | BIT  | 1   | %I00017 | Crank Cutout Relay                  |            | Global | R   |     |   |
| SPD_UNDER        | BIT  | 1   | %I00018 | Under Speed Relay                   |            | Global | R   |     |   |
| SPD_OVER         | BIT  | 1   | %I00019 | Over Speed Relay                    |            | Global | R   |     |   |
| VOLTS_UNDER      | BIT  | 1   | %I00020 | Under Voltage Relay                 |            | Global | R   |     |   |
| VOLTS_OVER       | BIT  | 1   | %I00021 | Over Voltage Relay                  |            | Global | R   |     |   |
| ALT_TEMP         | BIT  | 1   | %I00022 | Alternator High Temperature Relay   |            | Global | R   |     |   |
| GEN_CB_TRIP      | BIT  | 1   | %I00023 | Generator CB Tripped                |            | Global | R   |     |   |
| MEN_FLT          | BIT  | 1   | %I00024 | MEN Fault Relay                     |            | Global | R   |     |   |
| BAT_CHG_AC       | BIT  | 1   | %I00025 | Battery Charger AC Relay            |            | Global | R   |     |   |
| BAT_CONT_LOW_V   | BIT  | 1   | %I00026 | Control Battery Charger Low Voltage |            | Global | R   |     |   |
| BAT_STR_LOW_V    | BIT  | 1   | %I00027 | Start Battery Charger Low Voltage   |            | Global | R   |     |   |
| MAINS_FAILED     | BIT  | 1   | %I00033 | BCC Mains Failed                    |            | Global | R   |     |   |
| MAINS_ATS_CLS    | BIT  | 1   | %I00034 | BCC Mains ATS Closed                |            | Global | R   |     |   |
| GEN_ATS_CLS      | BIT  | 1   | %I00035 | BCC Generator ATS Closed            |            | Global | R   |     |   |
| REM_STR          | BIT  | 1   | %I00036 | BCC Remote Start                    |            | Global | R   |     |   |
| REM_STP          | BIT  | 1   | %I00037 | BCC Remote Stop                     |            | Global | R   |     |   |
| OIL_P_LOW_SD     | BIT  | 1   | %I00041 | Low Oil Pressure Shutdown           |            | Global | R   |     |   |
| OIL_P_LOW_W      | BIT  | 1   | %I00042 | Low Oil Pressure Warning            |            | Global | R   |     |   |
| ENG_T_HI_SD      | BIT  | 1   | %I00043 | High Engine Temperature Shutdown    |            | Global | R   |     |   |
| ENG_T_HI_W       | BIT  | 1   | %I00044 | High Engine Temperature Warning     |            | Global | R   |     |   |
| RAD_WATER_LOW    | BIT  | 1   | %I00045 | Low Radiator Water Level            |            | Global | R   |     |   |
| FUEL_LEV_LOW     | BIT  | 1   | %I00046 | Low Fuel Level                      |            | Global | R   |     |   |
| FUEL_LEV_EMPTY   | BIT  | 1   | %I00047 | Fuel Empty                          |            | Global | R   |     |   |
| CAN_DOORS_OPEN   | BIT  | 1   | %I00048 | Canopy Doors Open                   |            | Global | R   |     |   |
| STEP_1           | BIT  | 1   | %M00001 | Step Sequence No.1                  |            | Global |     |     |   |
| STEP_2_E         | BIT  | 1   | %M00002 | Step Sequence No.2                  |            | Global |     |     |   |
| STEP_3           | BIT  | 1   | %M00003 | Step Sequence No.3                  |            | Global |     |     |   |
| STEP_4           | BIT  | 1   | %M00004 | Step Sequence No.4                  |            | Global |     |     |   |
| STEP_5           | BIT  | 1   | %M00005 | Step Sequence No.5                  |            | Global |     |     |   |
| STEP_6           | BIT  | 1   | %M00006 | Step Sequence No.6                  |            | Global |     |     |   |
| STEP_7           | BIT  | 1   | %M00007 | Step Sequence No.7                  |            | Global |     |     |   |
| STEP_8           | BIT  | 1   | %M00008 | Step Sequence No.8                  |            | Global |     |     |   |
| STEP_9           | BIT  | 1   | %M00009 | Step Sequence No.9                  |            | Global |     |     |   |
| STEP_2_GE        | BIT  | 1   | %M00022 | Step Sequence No.2 GE               |            | Global |     |     |   |
| GEN_OFF          | BIT  | 1   | %M00101 | Generator OFF                       |            | Global |     |     |   |
| AUTO_TEST_STR    | BIT  | 1   | %M00102 | Auto Test Start / Stop              |            | Global |     |     |   |
| REMOTE_STR       | BIT  | 1   | %M00103 | Remote Start                        |            | Global |     |     |   |
| MAINS_FAIL_STP   | BIT  | 1   | %M00104 | Mains Failed Stop                   |            | Global |     |     |   |
| REMOTE_STP       | BIT  | 1   | %M00105 | Remote Stop                         |            | Global |     |     |   |
| TEST_STR         | BIT  | 1   | %M00106 | Test Start                          |            | Global |     |     |   |
| TEST_STP         | BIT  | 1   | %M00107 | Test Stop                           |            | Global |     |     |   |
| GEN_RUN_OFF      | BIT  | 1   | %M00108 | Generator Run Off                   |            | Global |     |     |   |
| ENABLE_OFFLINE   | BIT  | 1   | %M00109 | Enable Generator to go Offline      |            | Global |     |     |   |
| HH_ALM_OS1       | BIT  | 1   | %M00110 | High High Alarm One Shot            |            | Global |     |     |   |
| H_ALM_OS1        | BIT  | 1   | %M00111 | High Alarm One Shot                 |            | Global |     |     |   |
| H_ALM_OS2        | BIT  | 1   | %M00112 | High Alarm One Shot                 |            | Global |     |     |   |
| M_ALM_OS1        | BIT  | 1   | %M00113 | Medium Alarm One Shot               |            | Global |     |     |   |
| M_ALM_OS2        | BIT  | 1   | %M00114 | Medium Alarm One Shot               |            | Global |     |     |   |
| M_ATS_ALM_OS1    | BIT  | 1   | %M00115 | Mains ATS Alarm One Shot            |            | Global |     |     |   |
| M_ATS_ALM_OS2    | BIT  | 1   | %M00116 | Mains ATS Alarm One Shot            |            | Global |     |     |   |
| MAINS_FAIL_STR   | BIT  | 1   | %M00117 | Mains Fail Start                    |            | Global |     |     |   |
| GEN_RUNNING      | BIT  | 1   | %M00201 | Generator Running                   |            | Global |     |     |   |
| FAIL_STR_TM      | BIT  | 1   | %M00202 | Failed to Start Time                |            | Global |     |     |   |
| FAIL_STR_DLY     | BIT  | 1   | %M00203 | Failed to Start Pulse Delay         |            | Global |     |     |   |

Program: BCC\_4000\_4

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| Name               | Type | Len | Address | Description                               | Stored Val | Scope  | Ret | Ovr | En |
|--------------------|------|-----|---------|---|------------|--------|-----|-----|----|
| FAIL_STR_CNT       | BIT  | 1   | %M00204 | Failed to Start Counter                   |            | Global |     |     |    |
| CRK_CUTOOUT        | BIT  | 1   | %M00205 | Generator Crank Cutout                    |            | Global |     |     |    |
| ENB_STR_DLY        | BIT  | 1   | %M00206 | Enable Start Delay for Alarms             |            | Global |     |     |    |
| OIL_P_DLY          | BIT  | 1   | %M00207 | Oil Pressure Alarm Delay                  |            | Global |     |     |    |
| UP_DLY             | BIT  | 1   | %M00208 | Startup Alarm Delay                       |            | Global |     |     |    |
| ATS_OPN_1          | BIT  | 1   | %M00209 | Mains ATS Open Command                    |            | Global |     |     |    |
| G_ATS_CLS_1        | BIT  | 1   | %M00210 | Generator ATS Close Command               |            | Global |     |     |    |
| G_ATS_OPN_1        | BIT  | 1   | %M00211 | Generator ATS Open Command                |            | Global |     |     |    |
| M_ATS_CLS_1        | BIT  | 1   | %M00212 | Mains ATS Close Command                   |            | Global |     |     |    |
| M_ATS_CLS_ENB      | BIT  | 1   | %M00213 | Mains ATS Close Enable                    |            | Global |     |     |    |
| G_ATS_CLS_ENB      | BIT  | 1   | %M00214 | Generator ATS Close Enable                |            | Global |     |     |    |
| HIGH_HIGH_ALM      | BIT  | 1   | %M00300 | High High Alarm                           |            | Global |     |     |    |
| EM_STP_ALM         | BIT  | 1   | %M00301 | Emergency Stop Alarm                      |            | Global |     |     |    |
| MEN_ALM            | BIT  | 1   | %M00302 | MEN Alarm                                 |            | Global |     |     |    |
| OIL_P_SD_ALM       | BIT  | 1   | %M00303 | Low Oil Pressure Shutdown Alarm           |            | Global |     |     |    |
| ENG_T_SD_ALM       | BIT  | 1   | %M00304 | High Engine Temperature Shutdown Alarm    |            | Global |     |     |    |
| RAD_WATER_LOW_ALM  | BIT  | 1   | %M00305 | Low Radiator Water Level Alarm            |            | Global |     |     |    |
| SPD_OVER_ALM       | BIT  | 1   | %M00306 | Over Speed Alarm                          |            | Global |     |     |    |
| RAD_WATER_LOW_DLY  | BIT  | 1   | %M00315 | Radiator Water Level Low Delay            |            | Global |     |     |    |
| SPD_OVER_DLY       | BIT  | 1   | %M00316 | Over Speed Delay Timer                    |            | Global |     | R   |    |
| HIGH_ALM           | BIT  | 1   | %M00320 | High Alarm                                |            | Global |     |     |    |
| UNDER_ALM          | BIT  | 1   | %M00321 | Under Speed Alarm                         |            | Global |     |     |    |
| VOLTS_UNDER_ALM    | BIT  | 1   | %M00322 | Alternator Voltage Under Alarm            |            | Global |     |     |    |
| VOLTS_OVER_ALM     | BIT  | 1   | %M00323 | Alternator Voltage Over Alarm             |            | Global |     |     |    |
| GEN_CB_TRIP_ALM    | BIT  | 1   | %M00324 | Generator CB Tripped Alarm                |            | Global |     |     |    |
| ALT_TEMP_ALM       | BIT  | 1   | %M00325 | Alternator High Temperature Alarm         |            | Global |     |     |    |
| SPD_UNDER_DLY      | BIT  | 1   | %M00331 | Under Speed Alarm Delay                   |            | Global |     |     |    |
| VOLTS_UNDER_DLY    | BIT  | 1   | %M00332 | Under Voltage Alarm Delay                 |            | Global |     |     |    |
| VOLTS_OVER_DLY     | BIT  | 1   | %M00333 | Over Voltage Alarm Delay                  |            | Global |     |     |    |
| MEDIUM_ALM         | BIT  | 1   | %M00340 | Medium Alarm                              |            | Global |     |     |    |
| FUEL_LEV_EMPTY_ALM | BIT  | 1   | %M00341 | Fuel Empty Alarm                          |            | Global |     |     |    |
| FAIL_TO_STR_ALM    | BIT  | 1   | %M00342 | Fail to Start Alarm                       |            | Global |     |     |    |
| FUEL_LEV_EMPTY_DLY | BIT  | 1   | %M00351 | Fuel Level Empty Alarm Delay              |            | Global |     |     |    |
| LOW_ALM            | BIT  | 1   | %M00360 | Low Alarm                                 |            | Global |     |     |    |
| OIL_P_W_ALM        | BIT  | 1   | %M00361 | Low Oil Pressure Warning Alarm            |            | Global |     |     |    |
| ENG_T_W_ALM        | BIT  | 1   | %M00362 | High Engine Temperature Warning Alarm     |            | Global |     |     |    |
| FUEL_LEV_LOW_ALM   | BIT  | 1   | %M00363 | Low Fuel Level Alarm                      |            | Global |     |     |    |
| BAT_CHG_AC_ALM     | BIT  | 1   | %M00364 | Battery Charger AC Alarm                  |            | Global |     |     |    |
| BAT_CONT_LOW_V_ALM | BIT  | 1   | %M00365 | Control Battery Charger Low Voltage Alarm |            | Global |     |     |    |
| BAT_STR_LOW_V_ALM  | BIT  | 1   | %M00366 | Start Battery Charger Low Voltage Alarm   |            | Global |     |     |    |
| FUEL_LEV_LOW_DLY   | BIT  | 1   | %M00373 | Fuel Level Low Alarm Delay                |            | Global |     | R   |    |
| BAT_CHG_AC_DLY     | BIT  | 1   | %M00374 | Battery Charger AC Failure Delay          |            | Global |     | R   |    |
| BAT_CONT_LOW_V_DLY | BIT  | 1   | %M00375 | Control Battery Low Voltage Delay         |            | Global |     | R   |    |
| BAT_STR_LOW_V_DLY  | BIT  | 1   | %M00376 | Start Battery Low Voltage Delay           |            | Global |     | R   |    |
| MAINS_ATS_OPN_ALM  | BIT  | 1   | %M00381 | Mains ATS Failed to Open Alarm            |            | Global |     |     |    |
| MAINS_ATS_CLS_ALM  | BIT  | 1   | %M00382 | Mains ATS Failed to Close Alarm           |            | Global |     |     |    |
| GEN_ATS_OPN_ALM    | BIT  | 1   | %M00383 | Generator ATS Failed to Open Alarm        |            | Global |     |     |    |
| GEN_ATS_CLS_ALM    | BIT  | 1   | %M00384 | Generator ATS Failed to Close Alarm       |            | Global |     |     |    |
| NEW_ALM            | BIT  | 1   | %M00400 | New Alarm                                 |            | Global |     | R   |    |
| %M00401            | BIT  | 1   | %M00401 | **No Description**                        |            | Global |     | R   |    |

Program: BCC\_4000\_4

A:

GLOBAL VARIABLE

| Name               | Type | Len | Address | Description                                      | Stored Val | Scope  | Ret | Ovr | E |
|--------------------|------|-----|---------|--|------------|--------|-----|-----|---|
| %M00402            | BIT  | 1   | %M00402 | **No Description**                               |            | Global | R   |     |   |
| %M00403            | BIT  | 1   | %M00403 | **No Description**                               |            | Global | R   |     |   |
| %M00404            | BIT  | 1   | %M00404 | **No Description**                               |            | Global | R   |     |   |
| %M00405            | BIT  | 1   | %M00405 | **No Description**                               |            | Global | R   |     |   |
| %M00406            | BIT  | 1   | %M00406 | **No Description**                               |            | Global | R   |     |   |
| %M00421            | BIT  | 1   | %M00421 | **No Description**                               |            | Global | R   |     |   |
| %M00422            | BIT  | 1   | %M00422 | **No Description**                               |            | Global | R   |     |   |
| %M00423            | BIT  | 1   | %M00423 | **No Description**                               |            | Global | R   |     |   |
| %M00424            | BIT  | 1   | %M00424 | **No Description**                               |            | Global | R   |     |   |
| %M00425            | BIT  | 1   | %M00425 | **No Description**                               |            | Global | R   |     |   |
| %M00441            | BIT  | 1   | %M00441 | **No Description**                               |            | Global | R   |     |   |
| %M00442            | BIT  | 1   | %M00442 | **No Description**                               |            | Global | R   |     |   |
| %M00461            | BIT  | 1   | %M00461 | **No Description**                               |            | Global | R   |     |   |
| %M00462            | BIT  | 1   | %M00462 | **No Description**                               |            | Global | R   |     |   |
| %M00463            | BIT  | 1   | %M00463 | **No Description**                               |            | Global | R   |     |   |
| %M00464            | BIT  | 1   | %M00464 | **No Description**                               |            | Global | R   |     |   |
| %M00465            | BIT  | 1   | %M00465 | **No Description**                               |            | Global | R   |     |   |
| %M00466            | BIT  | 1   | %M00466 | **No Description**                               |            | Global | R   |     |   |
| %M00481            | BIT  | 1   | %M00481 | **No Description**                               |            | Global | R   |     |   |
| %M00482            | BIT  | 1   | %M00482 | **No Description**                               |            | Global | R   |     |   |
| %M00483            | BIT  | 1   | %M00483 | **No Description**                               |            | Global | R   |     |   |
| %M00484            | BIT  | 1   | %M00484 | **No Description**                               |            | Global | R   |     |   |
| AUTO_IND           | BIT  | 1   | %Q00001 | Controls in Auto Indicator                       |            | Global |     |     |   |
| TEST_IND           | BIT  | 1   | %Q00002 | Controls in Test Indicator                       |            | Global |     |     |   |
| MAN_IND            | BIT  | 1   | %Q00003 | Controls in Manual Indicator                     |            | Global |     |     |   |
| REM_STR_IND        | BIT  | 1   | %Q00004 | Remote Start Indicator                           |            | Global |     |     |   |
| MAINS_AVAIL_IND    | BIT  | 1   | %Q00005 | Mains Available Indicator                        |            | Global |     |     |   |
| MAINS_CON_IND      | BIT  | 1   | %Q00006 | Mains Connected Indicator                        |            | Global |     |     |   |
| GEN_RUN_IND        | BIT  | 1   | %Q00007 | Generator Running Indicator                      |            | Global |     |     |   |
| GEN_CON_IND        | BIT  | 1   | %Q00008 | Generator Connected<br>Indicated                 |            | Global |     |     |   |
| MAINS_FAILED_IND   | BIT  | 1   | %Q00009 | Mains Failed Indicator                           |            | Global |     |     |   |
| EM_STOP_IND        | BIT  | 1   | %Q00010 | Emergency Stop Indicator                         |            | Global |     |     |   |
| MEN_FLT_IND        | BIT  | 1   | %Q00011 | MEN Fault Indicator                              |            | Global |     |     |   |
| OIL_P_LOW_SD_IND   | BIT  | 1   | %Q00012 | Low Oil Pressure Shutdown<br>Indicator           |            | Global |     |     |   |
| OIL_P_LOW_W_IND    | BIT  | 1   | %Q00013 | Low Oil Pressure Warning<br>Indicator            |            | Global |     |     |   |
| ENG_T_HI_SD_IND    | BIT  | 1   | %Q00014 | High Engine Temperature<br>Shutdown Indicator    |            | Global |     |     |   |
| ENG_T_HI_W_IND     | BIT  | 1   | %Q00015 | High Engine Temperature<br>Warning Indicator     |            | Global |     |     |   |
| RAD_WATER_LOW_IND  | BIT  | 1   | %Q00016 | Low Radiator Water Level<br>Indicator            |            | Global |     |     |   |
| FUEL_LEV_EMPTY_IND | BIT  | 1   | %Q00017 | Fuel Empty Indicator                             |            | Global |     |     |   |
| FUEL_LEV_LOW_IND   | BIT  | 1   | %Q00018 | Low Fuel Level Indicator                         |            | Global |     |     |   |
| SPD_OVER_IND       | BIT  | 1   | %Q00019 | Over Speed Indicator                             |            | Global |     |     |   |
| SPD_UNDER_IND      | BIT  | 1   | %Q00020 | Under Speed Indicator                            |            | Global |     |     |   |
| FAIL_TO_STR_IND    | BIT  | 1   | %Q00021 | Fail to Start Indicator                          |            | Global |     |     |   |
| VOLTS_UNDER_IND    | BIT  | 1   | %Q00022 | Alternator Voltage Under<br>Indicator            |            | Global |     |     |   |
| VOLTS_OVER_IND     | BIT  | 1   | %Q00023 | Alternator Voltage Over<br>Indicator             |            | Global |     |     |   |
| ALT_TEMP_IND       | BIT  | 1   | %Q00024 | Alternator High Temperature<br>Indicator         |            | Global |     |     |   |
| GEN_CB_TRIP_IND    | BIT  | 1   | %Q00025 | Generator CB Tripped<br>Indicator                |            | Global |     |     |   |
| BAT_CHG_AC_IND     | BIT  | 1   | %Q00026 | Battery Charger AC Indicator                     |            | Global |     |     |   |
| BAT_CONT_LOW_V_IND | BIT  | 1   | %Q00027 | Control Battery Charger Low<br>Voltage Indicator |            | Global |     |     |   |
| BAT_STR_LOW_V_IND  | BIT  | 1   | %Q00028 | Start Battery Charger Low<br>Voltage Indicator   |            | Global |     |     |   |
| CAN_DOORS_OPEN_IND | BIT  | 1   | %Q00029 | Canopy Doors Open<br>Indicator                   |            | Global |     |     |   |
| MAINS_ATS_OPN_CMD  | BIT  | 1   | %Q00033 | BCC Mains ATS Open<br>Command                    |            | Global |     |     |   |
| GEN_ATS_CLS_CMD    | BIT  | 1   | %Q00034 | BCC Generator ATS Close<br>Command               |            | Global |     |     |   |
| GEN_SD_ALM         | BIT  | 1   | %Q00035 | BCC Generator Shutdown<br>Alarm                  |            | Global |     |     |   |
| GEN_W_ALM          | BIT  | 1   | %Q00036 | BCC Generator Warning<br>Alarm                   |            | Global |     |     |   |

Program: BCC\_4000\_4

A:

GLOBAL VA

31

| Name            | Type | Len | Address | Description  | Stored Val | Scope  | Ret | Ovr | E |
|-----------------|------|-----|---------|--|------------|--------|-----|-----|---|
| FUEL_LOW        | BIT  | 1   | %Q00037 | BCC Low Fuel   |            | Global |     |     |   |
| GEN_RUN         | BIT  | 1   | %Q00038 | BCC Generator Running                                      |            | Global |     |     |   |
| GEN_CON         | BIT  | 1   | %Q00039 | BCC Generator Connected                                    |            | Global |     |     |   |
| SMR             | BIT  | 1   | %Q00040 | Starter Motor Relay  |            | Global |     |     |   |
| GCR             | BIT  | 1   | %Q00041 | Governor Control Relay                                     |            | Global |     |     |   |
| IR              | BIT  | 1   | %Q00042 | Audible Alarm Relay  |            | Global |     |     |   |
| IAR             | BIT  | 1   | %Q00043 | Generator Shunt Trip Relay                                 |            | Global |     |     |   |
| DOORS_OPEN      | BIT  | 1   | %Q00044 | BCC Doors Open Alarm                                       |            | Global |     |     |   |
| GEN_AUTO        | BIT  | 1   | %Q00045 | Generator Auto Mode  |            | Global |     |     |   |
| SEQ_CNT         | WORD | 1   | %R00001 | Sequence Counter   |            | Global |     | R   |   |
| MODBUS_INPUTS   | WORD | 1   | %R00002 | Modbus Digital Inputs                                      |            | Global |     | R   |   |
| MODBUS_OUTPUTS  | WORD | 1   | %R00005 | Modbus Digital Outputs                                     |            | Global |     | R   |   |
| MODBUS_STATUS_1 | WORD | 1   | %R00008 | Modbus Status 1  |            | Global |     | R   |   |
| MODBUS_STATUS_2 | WORD | 1   | %R00009 | Modbus Status 2  |            | Global |     | R   |   |
| MODBUS_ALARMS   | WORD | 1   | %R00010 | Modbus Alarms  |            | Global |     | R   |   |
| %R00100         | WORD | 3   | %R00100 | **No Description**   |            | Global |     | R   |   |
| %R00103         | WORD | 3   | %R00103 | **No Description**   |            | Global |     | R   |   |
| %R00106         | WORD | 3   | %R00106 | **No Description**   |            | Global |     | R   |   |
| %R00109         | WORD | 3   | %R00109 | **No Description**   |            | Global |     | R   |   |
| %R00112         | WORD | 3   | %R00112 | **No Description**   |            | Global |     | R   |   |
| %R00115         | WORD | 3   | %R00115 | **No Description**   |            | Global |     | R   |   |
| %R00118         | WORD | 3   | %R00118 | **No Description**   |            | Global |     | R   |   |
| %R00121         | WORD | 3   | %R00121 | **No Description**   |            | Global |     | R   |   |
| %R00124         | WORD | 3   | %R00124 | **No Description**   |            | Global |     | R   |   |
| %R00127         | WORD | 3   | %R00127 | **No Description**   |            | Global |     | R   |   |
| %R00130         | WORD | 3   | %R00130 | **No Description**   |            | Global |     | R   |   |
| %R00133         | WORD | 3   | %R00133 | **No Description**   |            | Global |     | R   |   |
| %R00136         | WORD | 3   | %R00136 | **No Description**   |            | Global |     | R   |   |
| %R00139         | WORD | 3   | %R00139 | **No Description**   |            | Global |     | R   |   |
| %R00200         | WORD | 3   | %R00200 | **No Description**   |            | Global |     | R   |   |
| %R00203         | WORD | 3   | %R00203 | **No Description**   |            | Global |     | R   |   |
| %R00206         | WORD | 3   | %R00206 | **No Description**   |            | Global |     | R   |   |
| %R00209         | WORD | 3   | %R00209 | **No Description**   |            | Global |     | R   |   |
| %R00212         | WORD | 3   | %R00212 | **No Description**   |            | Global |     | R   |   |
| %R00215         | WORD | 3   | %R00215 | **No Description**   |            | Global |     | R   |   |
| %R00218         | WORD | 3   | %R00218 | **No Description**   |            | Global |     | R   |   |
| %R00221         | WORD | 3   | %R00221 | **No Description**   |            | Global |     | R   |   |
| %R00224         | WORD | 3   | %R00224 | **No Description**   |            | Global |     | R   |   |
| %R00227         | WORD | 3   | %R00227 | **No Description**   |            | Global |     | R   |   |
| %R00230         | WORD | 3   | %R00230 | **No Description**   |            | Global |     | R   |   |
| %R00300         | WORD | 3   | %R00300 | **No Description**   |            | Global |     | R   |   |
| %R00303         | WORD | 3   | %R00303 | **No Description**   |            | Global |     | R   |   |
| %R00306         | WORD | 3   | %R00306 | **No Description**   |            | Global |     | R   |   |
| %R00309         | WORD | 3   | %R00309 | **No Description**   |            | Global |     | R   |   |
| %R00312         | WORD | 3   | %R00312 | **No Description**   |            | Global |     | R   |   |
| %R00315         | WORD | 3   | %R00315 | **No Description**   |            | Global |     | R   |   |
| %R00318         | WORD | 3   | %R00318 | **No Description**   |            | Global |     | R   |   |
| %R00321         | WORD | 3   | %R00321 | **No Description**   |            | Global |     | R   |   |
| %R00324         | WORD | 3   | %R00324 | **No Description**   |            | Global |     | R   |   |
| %R00327         | WORD | 3   | %R00327 | **No Description**   |            | Global |     | R   |   |
| %R00330         | WORD | 3   | %R00330 | **No Description**   |            | Global |     | R   |   |
| %R00333         | WORD | 3   | %R00333 | **No Description**   |            | Global |     | R   |   |
| %R00336         | WORD | 3   | %R00336 | **No Description**   |            | Global |     | R   |   |
| %R00339         | WORD | 3   | %R00339 | **No Description**   |            | Global |     | R   |   |
| FST_SCN         | BIT  | 1   | %S00001 | Set to 1 when the current sweep is the first sweep         |            | Global |     | R   |   |
| LST_SCAN        | BIT  | 1   | %S00002 | Reset from 1 to 0 when the current sweep is the last sweep |            | Global |     | R   |   |
| T_10MS          | BIT  | 1   | %S00003 | 0.01 Second Timer Contact                                  |            | Global |     | R   |   |
| T_100MS         | BIT  | 1   | %S00004 | 0.1 Second Timer Contact                                   |            | Global |     | R   |   |
| T_1S            | BIT  | 1   | %S00005 | 1 Second Timer Contact                                     |            | Global |     | R   |   |
| T_1M            | BIT  | 1   | %S00006 | 1 Minute Timer Contact                                     |            | Global |     | R   |   |
| ALW_ON          | BIT  | 1   | %S00007 | Always ON  |            | Global |     | R   |   |
| ALW_OFF         | BIT  | 1   | %S00008 | Always OFF   |            | Global |     | R   |   |
| PLC_BAT         | BIT  | 1   | %S00014 | Set to indicate a bad battery in the CPU                   |            | Global |     | R   |   |
| %R00400         | WORD | 1   | %R00400 | **No Description**   |            | Global |     | R   |   |

Program: BCC\_4000\_4

A:

GLOBAL VARIABLE

| Name    | Type | Len | Address | Description  | Stored Val | Scope  | Ret | Ovr | E |
|---------|------|-----|---------|--|------------|--------|-----|-----|---|
| FST_SCN | BIT  | 1   | %S00001 | Set to 1 when the current sweep is the first sweep               |            | System | R   |     |   |
| LST_SCN | BIT  | 1   | %S00002 | Reset from 1 to 0 when the current sweep is the last sweep       |            | System | R   |     |   |
| T_10MS  | BIT  | 1   | %S00003 | 0.01 second timer contact  |            | System | R   |     |   |
| T_100MS | BIT  | 1   | %S00004 | 0.1 second timer contact   |            | System | R   |     |   |
| T_SEC   | BIT  | 1   | %S00005 | 1.0 second timer contact   |            | System | R   |     |   |
| T_MIN   | BIT  | 1   | %S00006 | 1.0 minute timer contact   |            | System | R   |     |   |
| ALW_ON  | BIT  | 1   | %S00007 | Always ON  |            | System | R   |     |   |
| ALW_OFF | BIT  | 1   | %S00008 | Always OFF   |            | System | R   |     |   |
| SY_FULL | BIT  | 1   | %S00009 | Set when the PLC fault table fills up                            |            | System | R   |     |   |
| IO_FULL | BIT  | 1   | %S00010 | Set when the I/O fault table fills up                            |            | System | R   |     |   |
| OVR_PRE | BIT  | 1   | %S00011 | Set when an override exists in %I, %Q, %M or %G memory           |            | System | R   |     |   |
| PRG_CHK | BIT  | 1   | %S00013 | Set when background program check is active                      |            | System | R   |     |   |
| PLC_BAT | BIT  | 1   | %S00014 | Set to indicate a bad battery in a Release 4 or later CPU        |            | System | R   |     |   |
| SNPXACT | BIT  | 1   | %S00017 | SNP-X host is actively attached to the CPU                       |            | System | R   |     |   |
| SNPX_RD | BIT  | 1   | %S00018 | SNP-X host has read data from the CPU                            |            | System | R   |     |   |
| SNPX_WT | BIT  | 1   | %S00019 | SNP-X host has written data to the CPU                           |            | System | R   |     |   |
| RLTN_OK | BIT  | 1   | %S00020 | Set ON when a relational function using REAL data is success     |            | System | R   |     |   |
| CONTCON | BIT  | 1   | %S00032 | Reserved for use by the programming software for cont contact    |            | System | R   |     |   |
| PB_SUM  | BIT  | 1   | %SA0001 | Set when PLC checksum does not match app checksum                |            | System | R   |     |   |
| OV_SWP  | BIT  | 1   | %SA0002 | Set when PLC sweep time is longer than user specified sweep time |            | System | R   |     |   |
| APL_FLT | BIT  | 1   | %SA0003 | Set when an application fault occurs                             |            | System | R   |     |   |
| CFG_MM  | BIT  | 1   | %SA0009 | Set when a config mismatch is detected during system powerup     |            | System | R   |     |   |
| HRD_CPU | BIT  | 1   | %SA0010 | Set when the diagnostics detects a problem with the CPU hardware |            | System | R   |     |   |
| LOW_BAT | BIT  | 1   | %SA0011 | Set when a low battery fault occurs                              |            | System | R   |     |   |
| LOS_RCK | BIT  | 1   | %SA0012 | Set when an expansion rack stops communicating with the CPU      |            | System | R   |     |   |
| LOS_IOM | BIT  | 1   | %SA0014 | Set when an I/O module stops communicating with the PLC CPU      |            | System | R   |     |   |
| LOS_SIO | BIT  | 1   | %SA0015 | Set when an option module stops communicating with the PLC CPU   |            | System | R   |     |   |
| ADD_RCK | BIT  | 1   | %SA0017 | Set when an expansion rack is added to the system                |            | System | R   |     |   |
| ADD_IOM | BIT  | 1   | %SA0019 | Set when an I/O module is added to a rack                        |            | System | R   |     |   |
| ADD_SIO | BIT  | 1   | %SA0020 | Set when an option module is added to a rack                     |            | System | R   |     |   |
| HRD_SIO | BIT  | 1   | %SA0027 | Set when a hardware failure is detected in an option module      |            | System | R   |     |   |
| SFT_SIO | BIT  | 1   | %SA0031 | Set when an unrecoverable fault is detected in an option module  |            | System | R   |     |   |
| BAD_RAM | BIT  | 1   | %SB0010 | Set when the CPU detects   |            | System | R   |     |   |

Program: BCC\_4000\_4

A:

SYSTEM V. BI

| Name    | Type | Len | Address | Description   | Stored Val | Scope  | Ret | Ovr | Ex |
|---------|------|-----|---------|---|------------|--------|-----|-----|----|
| BAD_PWD | BIT  | 1   | %SB0011 | corrupted RAM memory at powerup<br>Set when a password violation occurs |            | System | R   |     |    |
| SFT_CPU | BIT  | 1   | %SB0013 | Set when the CPU detects an unrecoverable error in the software         |            | System | R   |     |    |
| STOR_ER | BIT  | 1   | %SB0014 | Set when an error occurs during a programmer store operation            |            | System | R   |     |    |
| ANY_FLT | BIT  | 1   | %SC0009 | Set when any fault occurs   |            | System | R   |     |    |
| SY_FLT  | BIT  | 1   | %SC0010 | Set when fault occurs where an entry is put in the PLC fault tbl        |            | System | R   |     |    |
| IO_FLT  | BIT  | 1   | %SC0011 | Set when fault occurs where an entry is put in the I/O fault tbl        |            | System | R   |     |    |
| SY_PRES | BIT  | 1   | %SC0012 | Set as long as there is at least one entry in the PLC fault tbl         |            | System | R   |     |    |
| IO_PRES | BIT  | 1   | %SC0013 | Set as long as there is at least one entry in the I/O fault tbl         |            | System | R   |     |    |
| HRD_FLT | BIT  | 1   | %SC0014 | Set when a hardware fault occurs  |            | System | R   |     |    |
| SFT_FLT | BIT  | 1   | %SC0015 | Set when a software fault occurs  |            | System | R   |     |    |

Program: BCC\_4000\_4

A:

SYSTEM VARIABLE



Written for EPAC.

Project: Brisbane City Council, Standby Generator Program.

FST\_SCN PRESETS

CALL

%S00001

Set to 1 when the  
current sweep is  
the first sweep

SEQ

CALL

MAIN

CALL

ALARM

CALL

AUD\_ALM

CALL

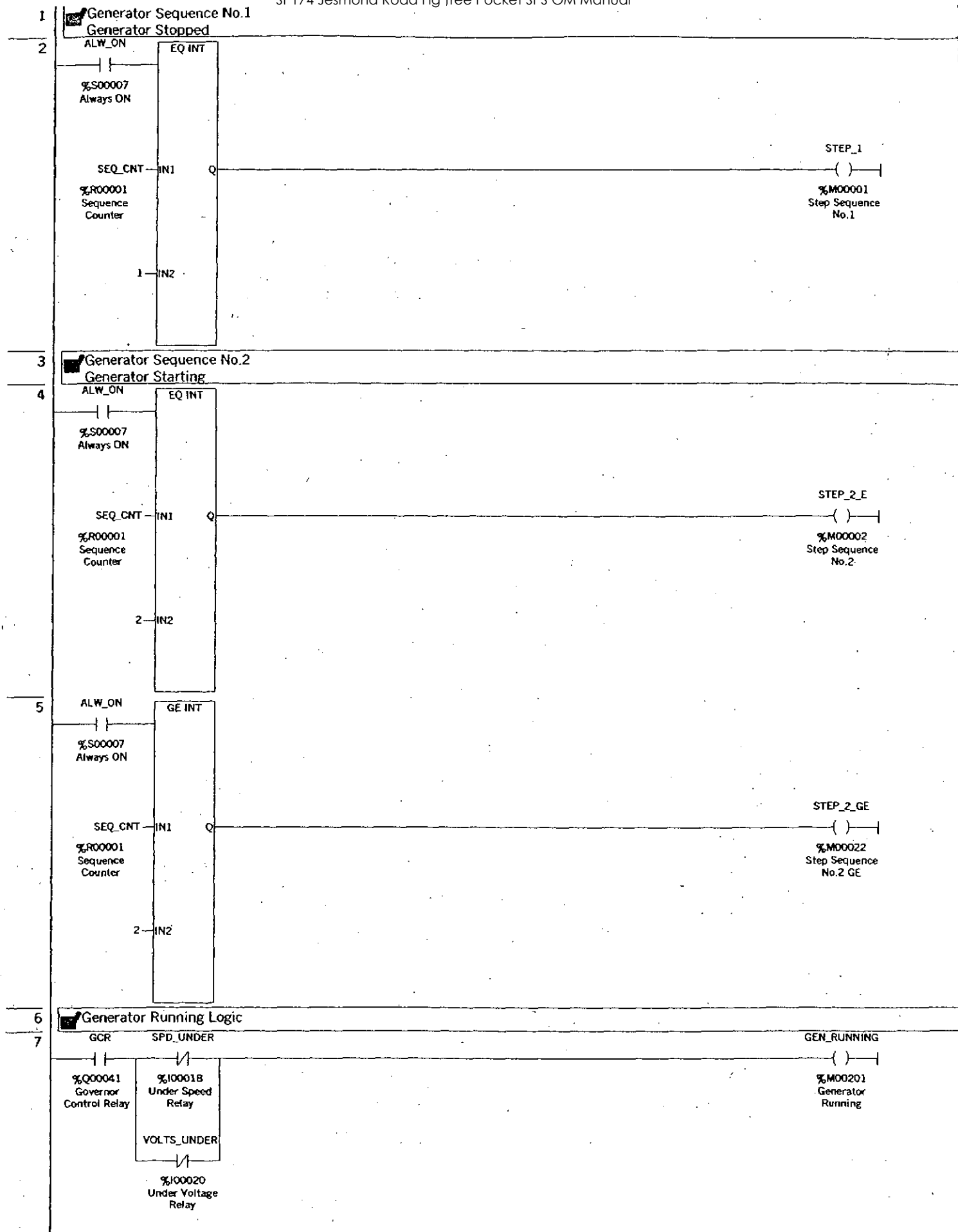
MODBUS

CALL

Program: BCC\_4000\_4

A:

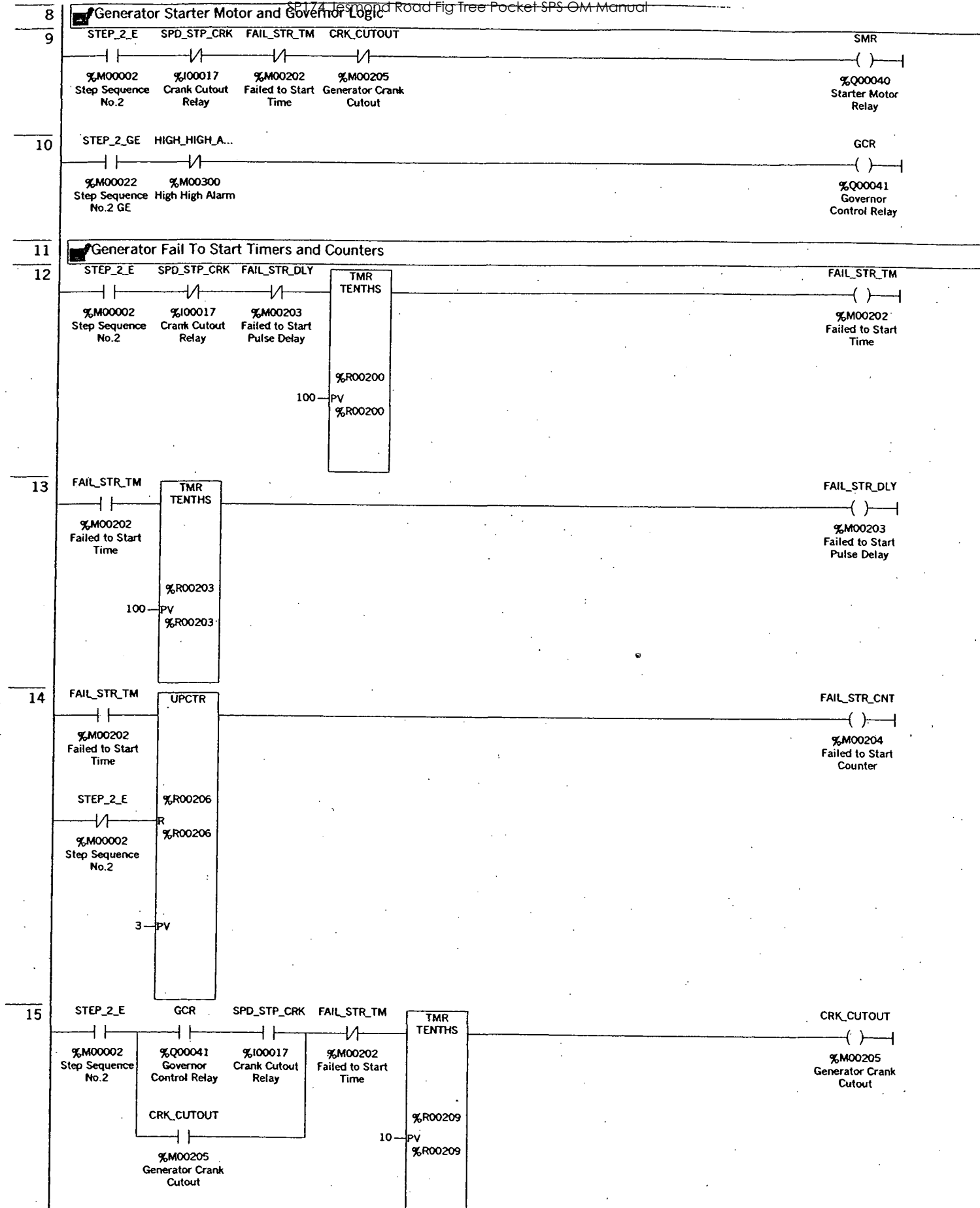
M



Program: BCC\_4000\_4

A:

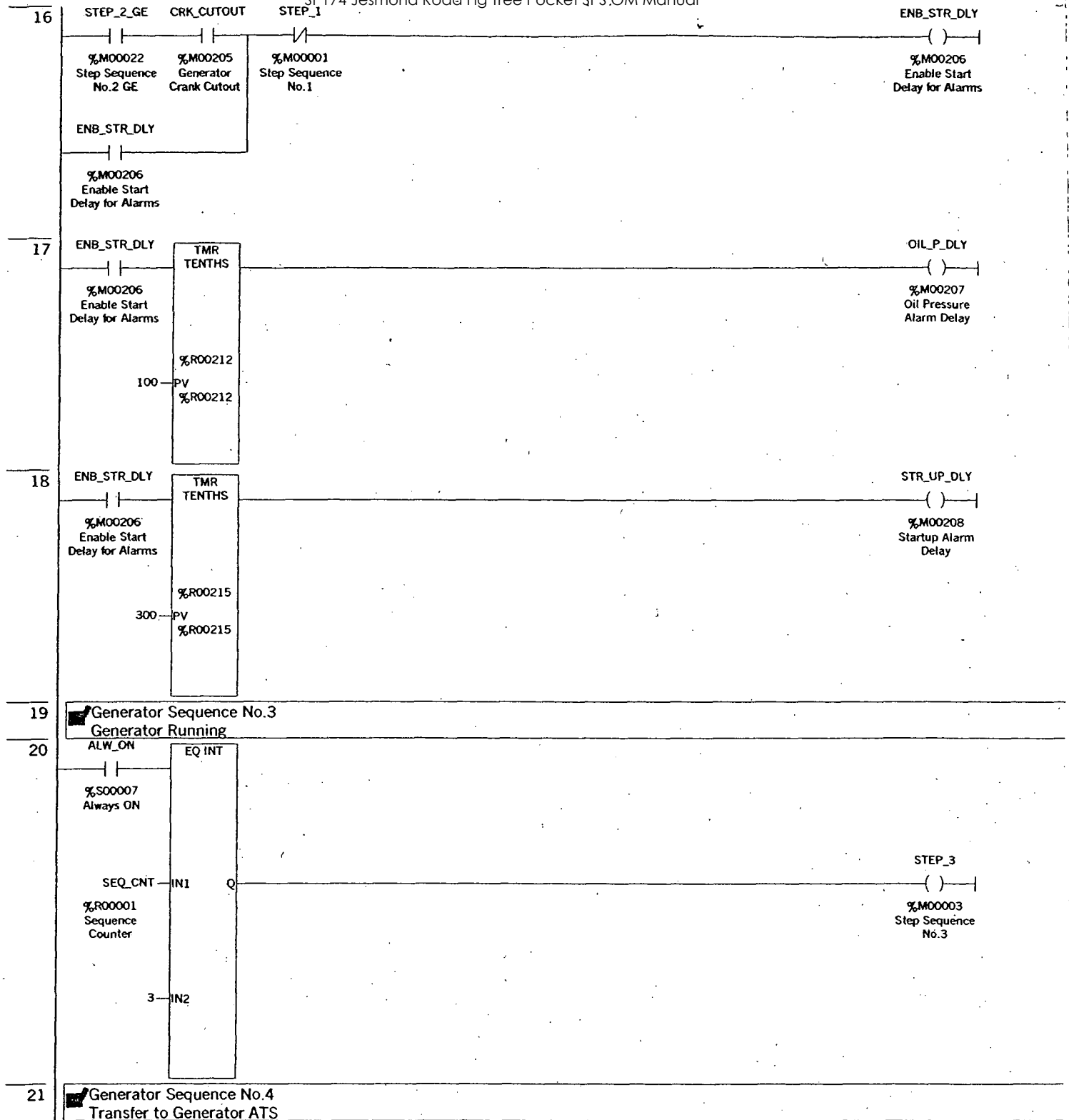
M:

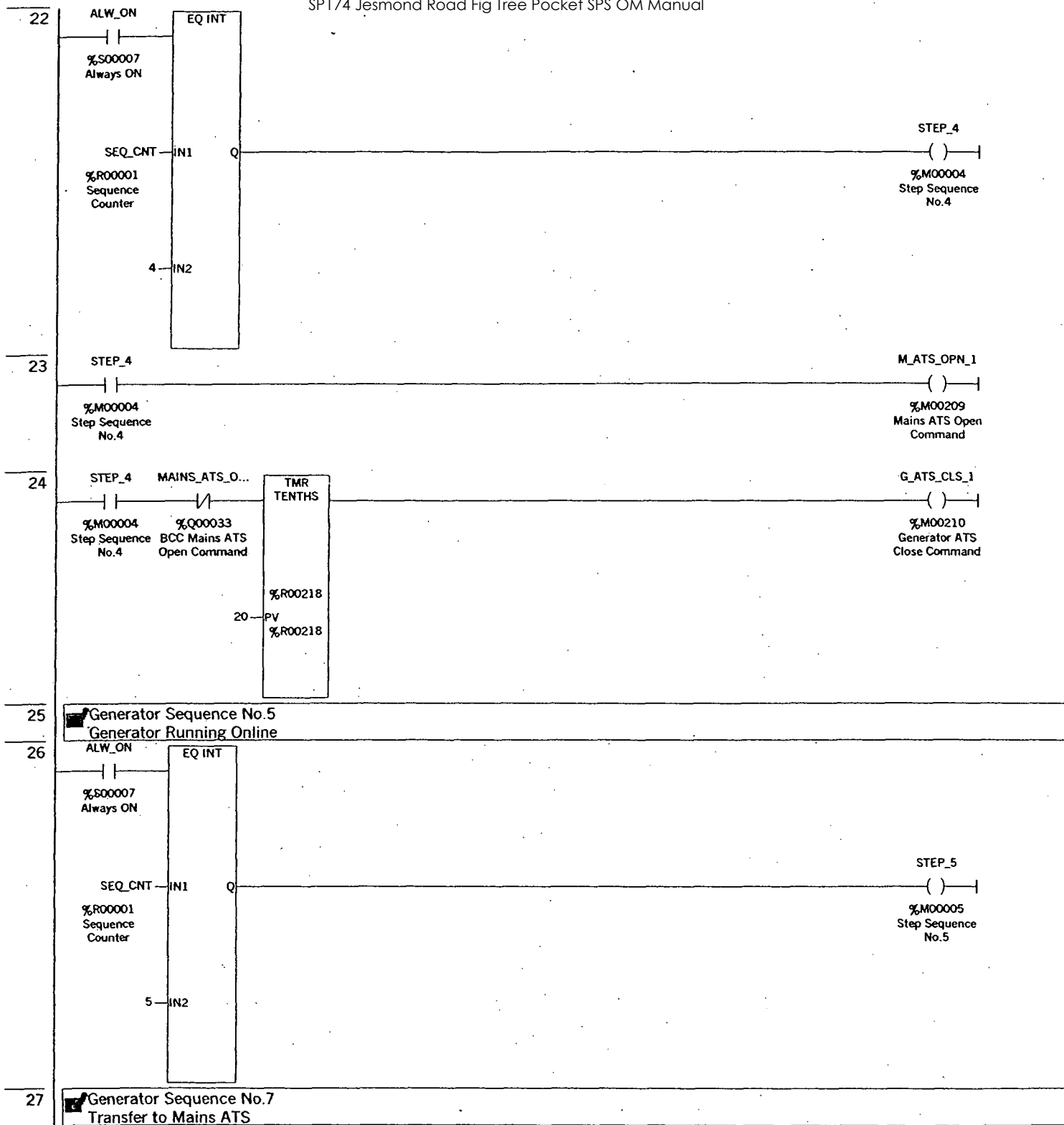


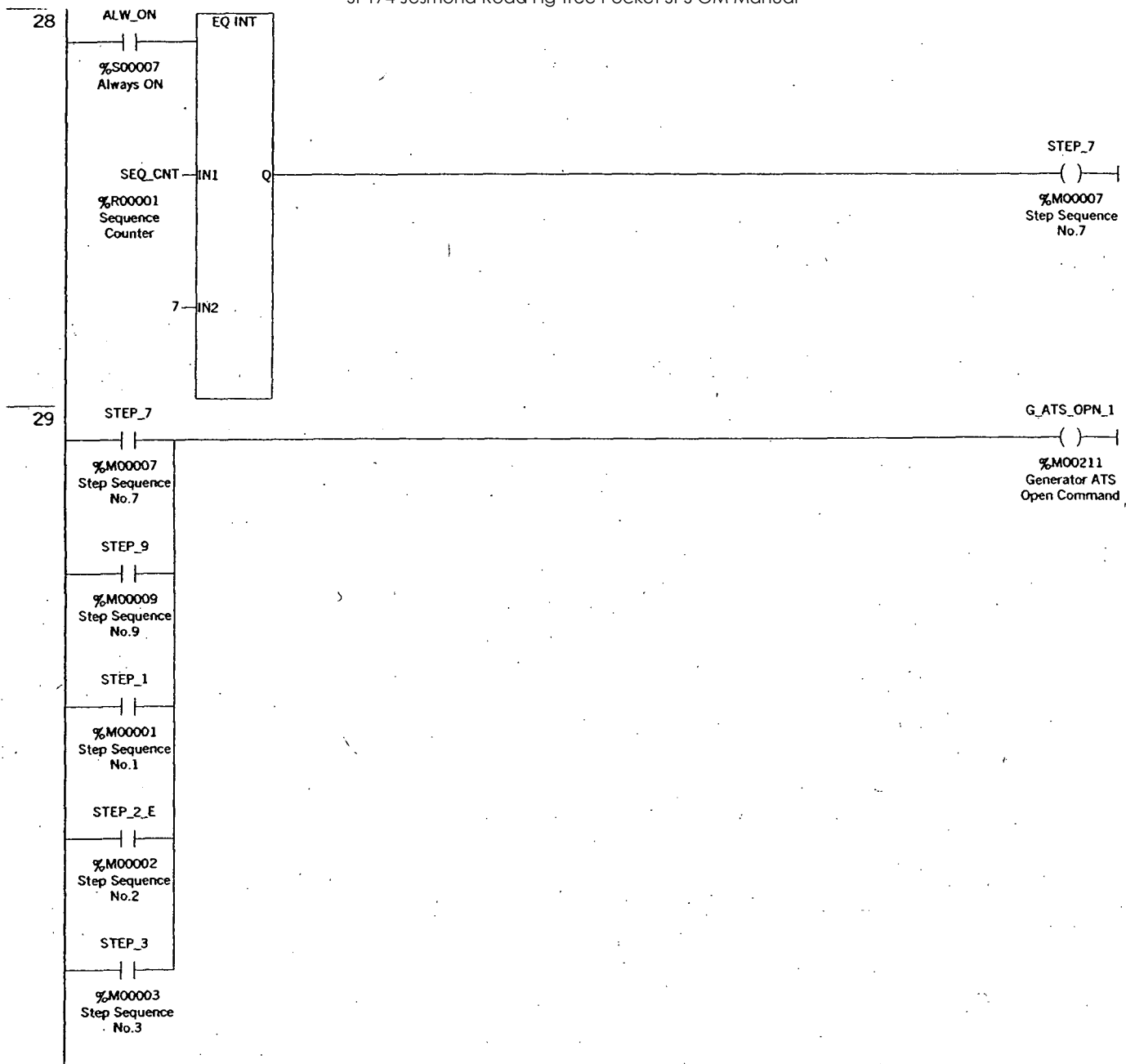
Program: BCC\_4000\_4

A:

M/



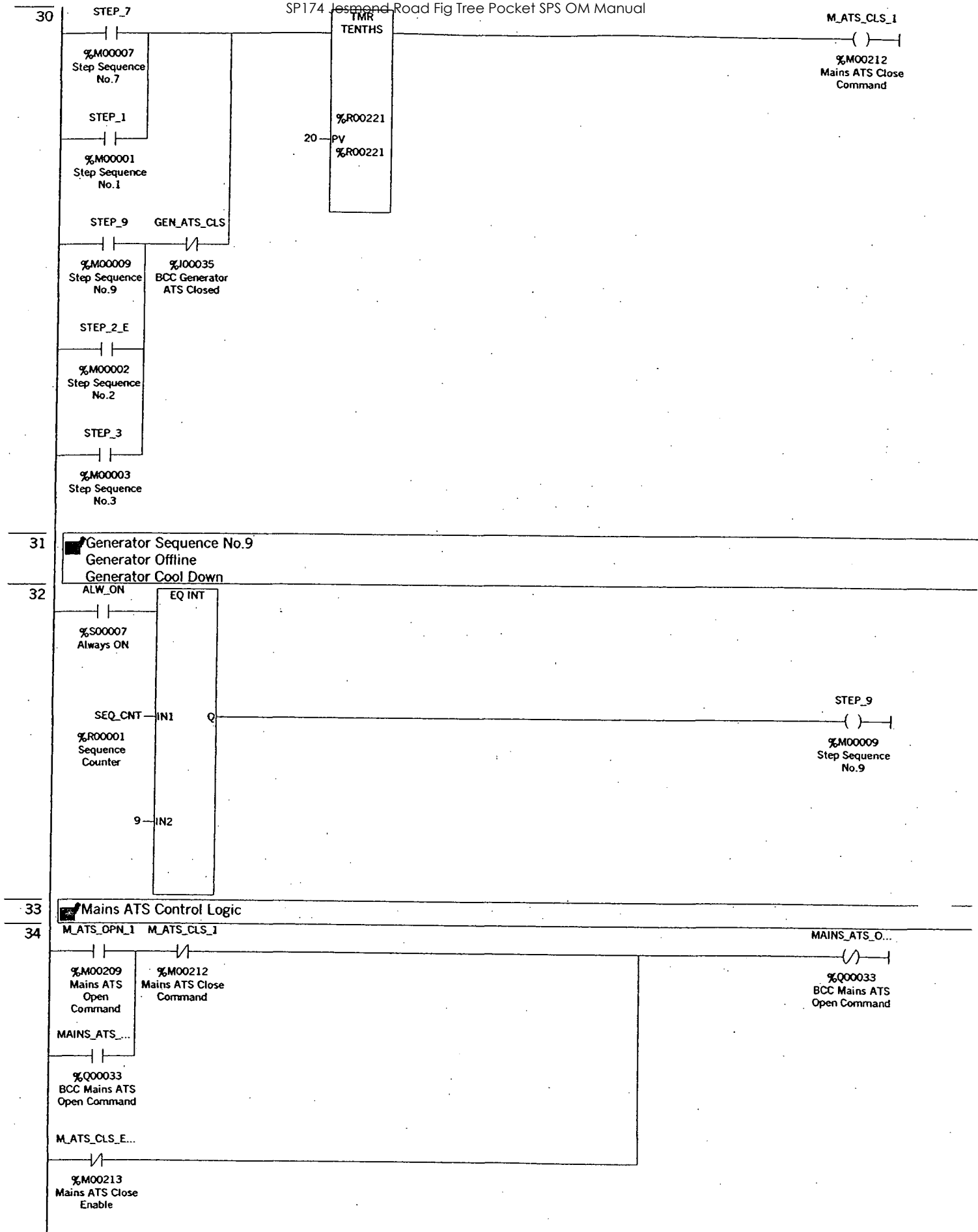




P-----m: BCC\_4000\_4

A:

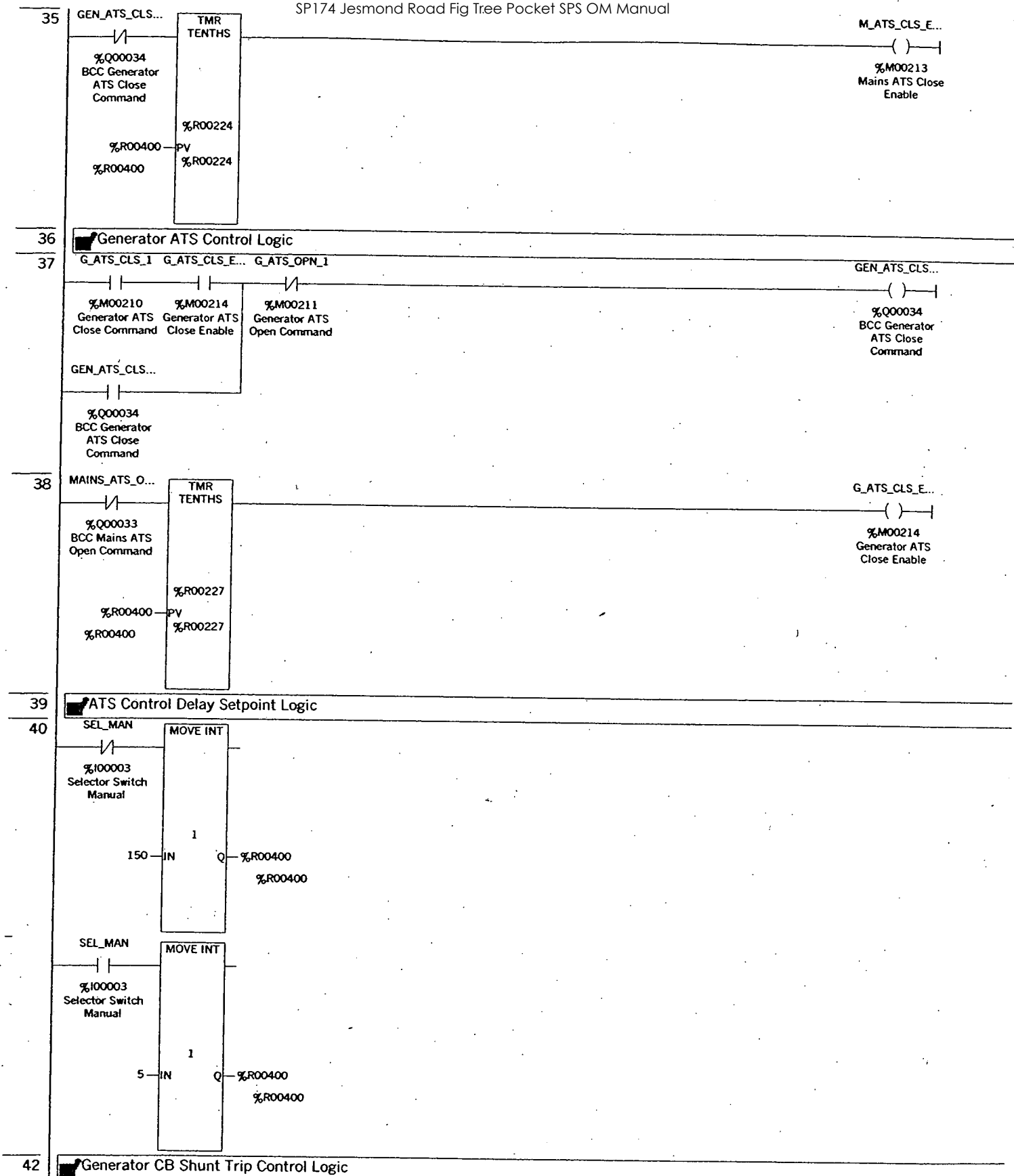
M:



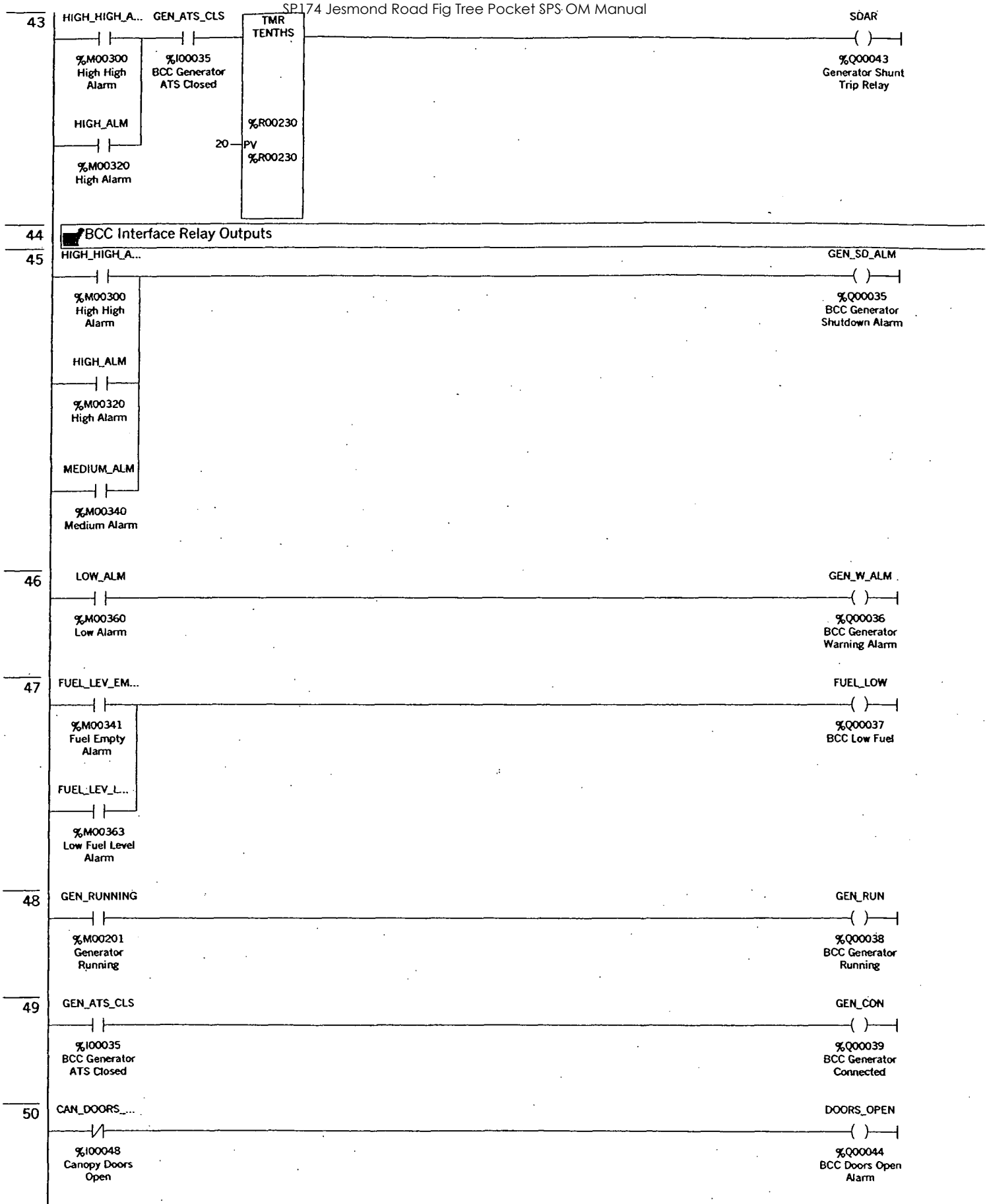
Program: BCC\_4000\_4

A:

M:



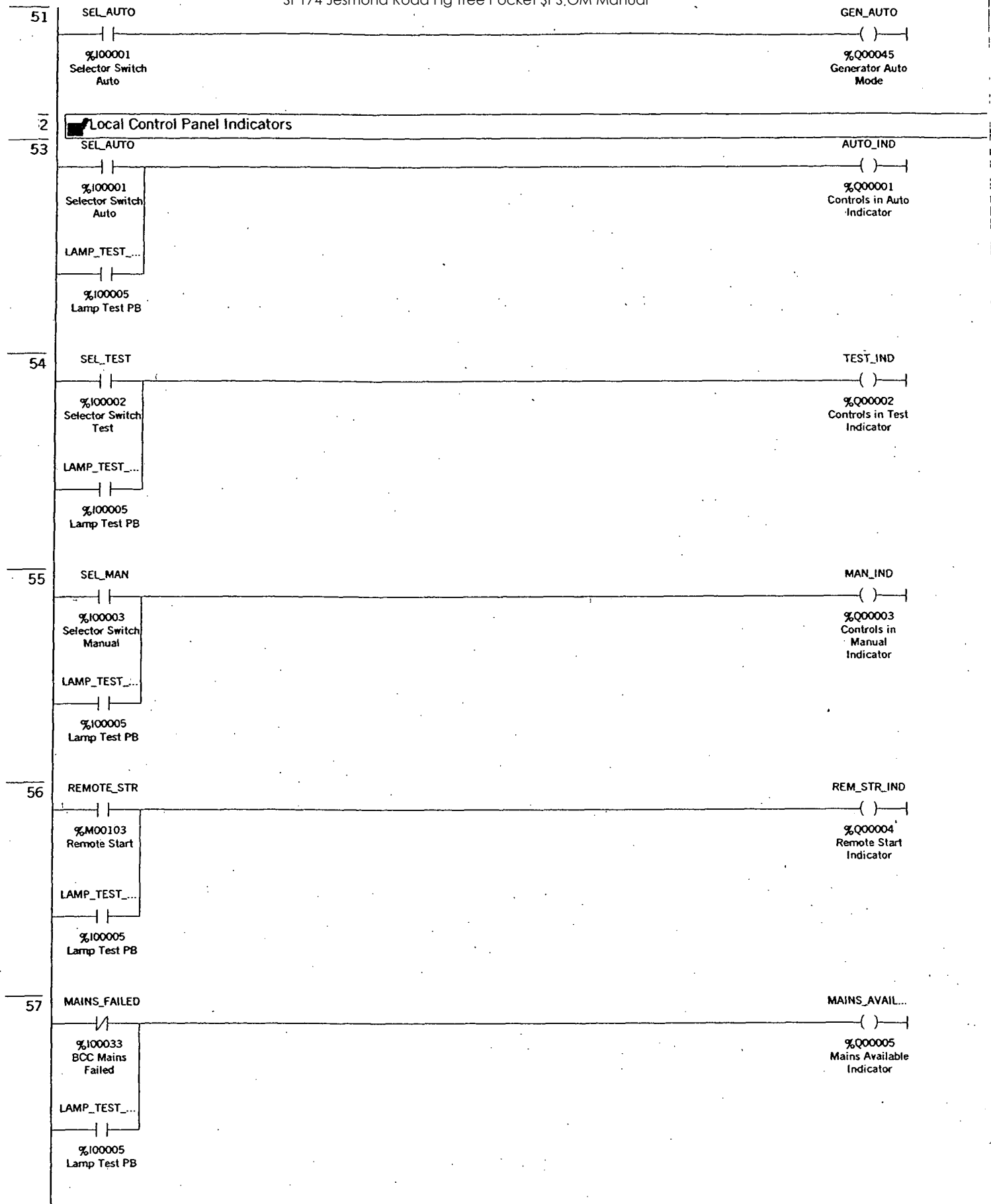




Program: BCC\_4000\_4

A:

M/



P m: BCC\_4000\_4

A:

M

62

CAN\_DOORS...

%I00048  
Canopy Doors  
Open

LAMP\_TEST...

%I00005  
Lamp Test PB

CAN\_DOORS...

%Q00029  
Canopy Doors  
Open Indicator

Program: BCC\_4000\_4

A:

M

Presets Routine  
Move 1 to the Sequence Counter

ALW\_ON

MOVE INT

%S00007  
Always ON

1—IN

1

Q—SEQ\_CNT

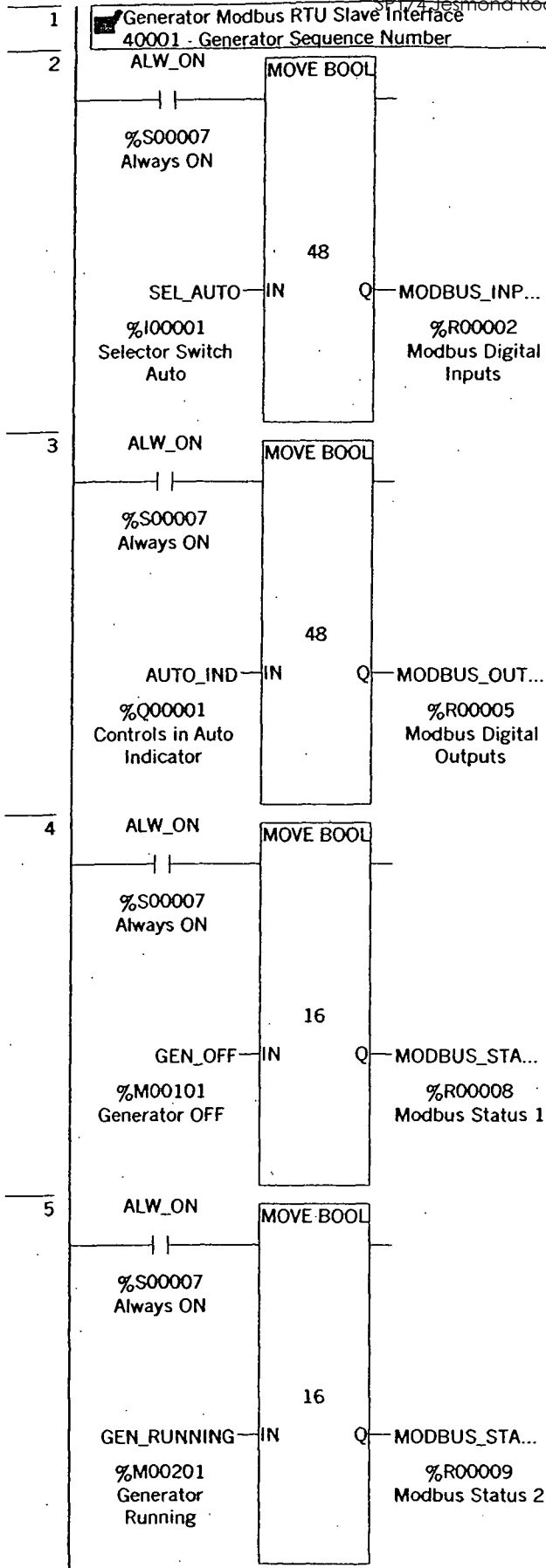
%R00001  
Sequence  
Counter

P1 n: BCC\_4000\_4

A:

PRESI

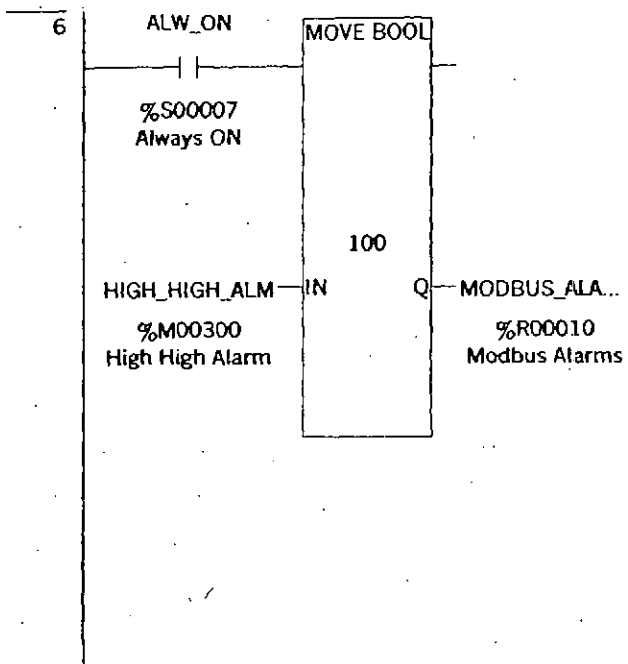
Generator Modbus RTU Slave Interface  
40001 - Generator Sequence Number



Program: BCC\_4000\_4

A:

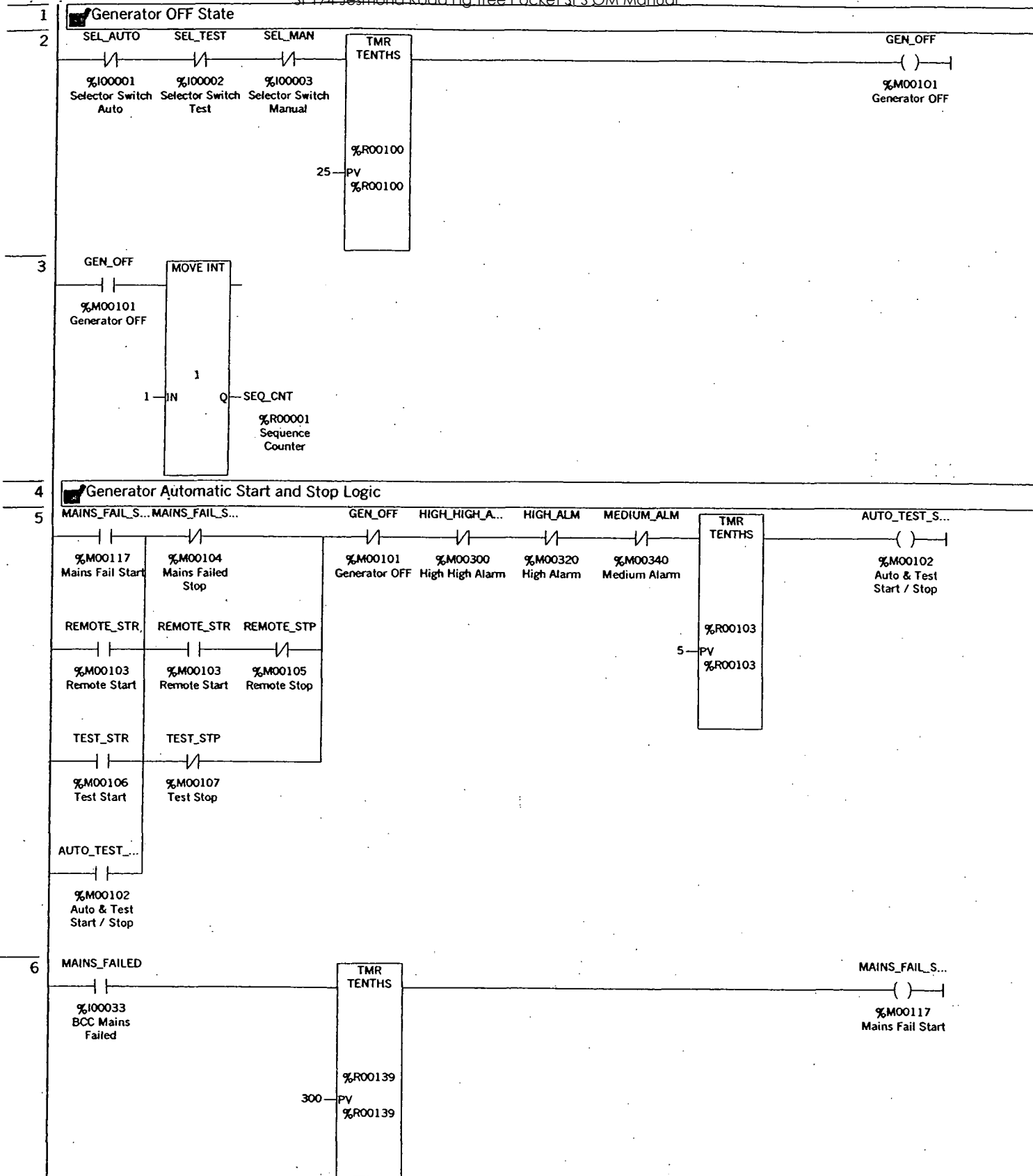
D)



P m: BCC\_4000\_4

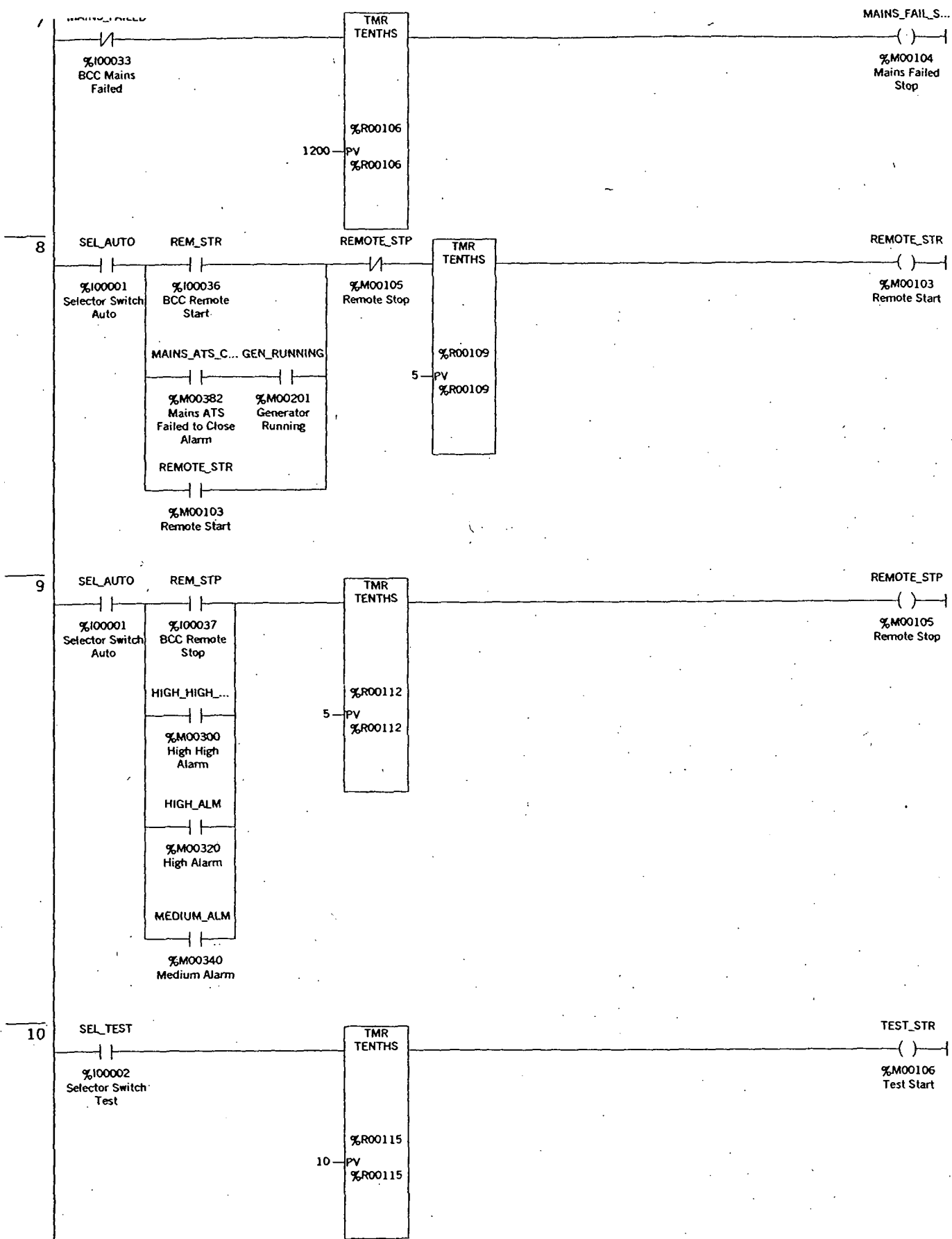
A:

MODI



Program: BCC\_4000\_4

A:

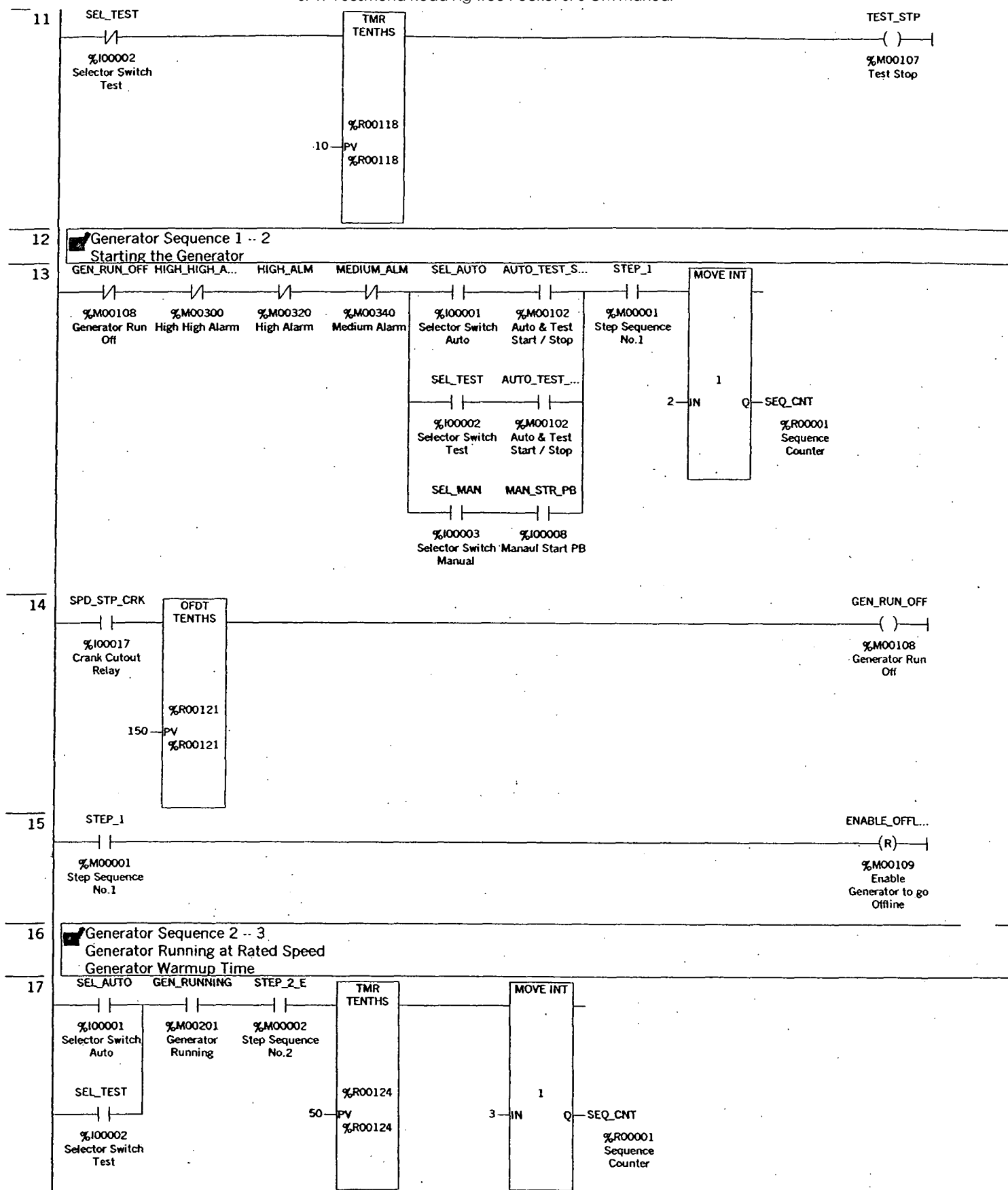


Pr a: BCC\_4000\_4

A:

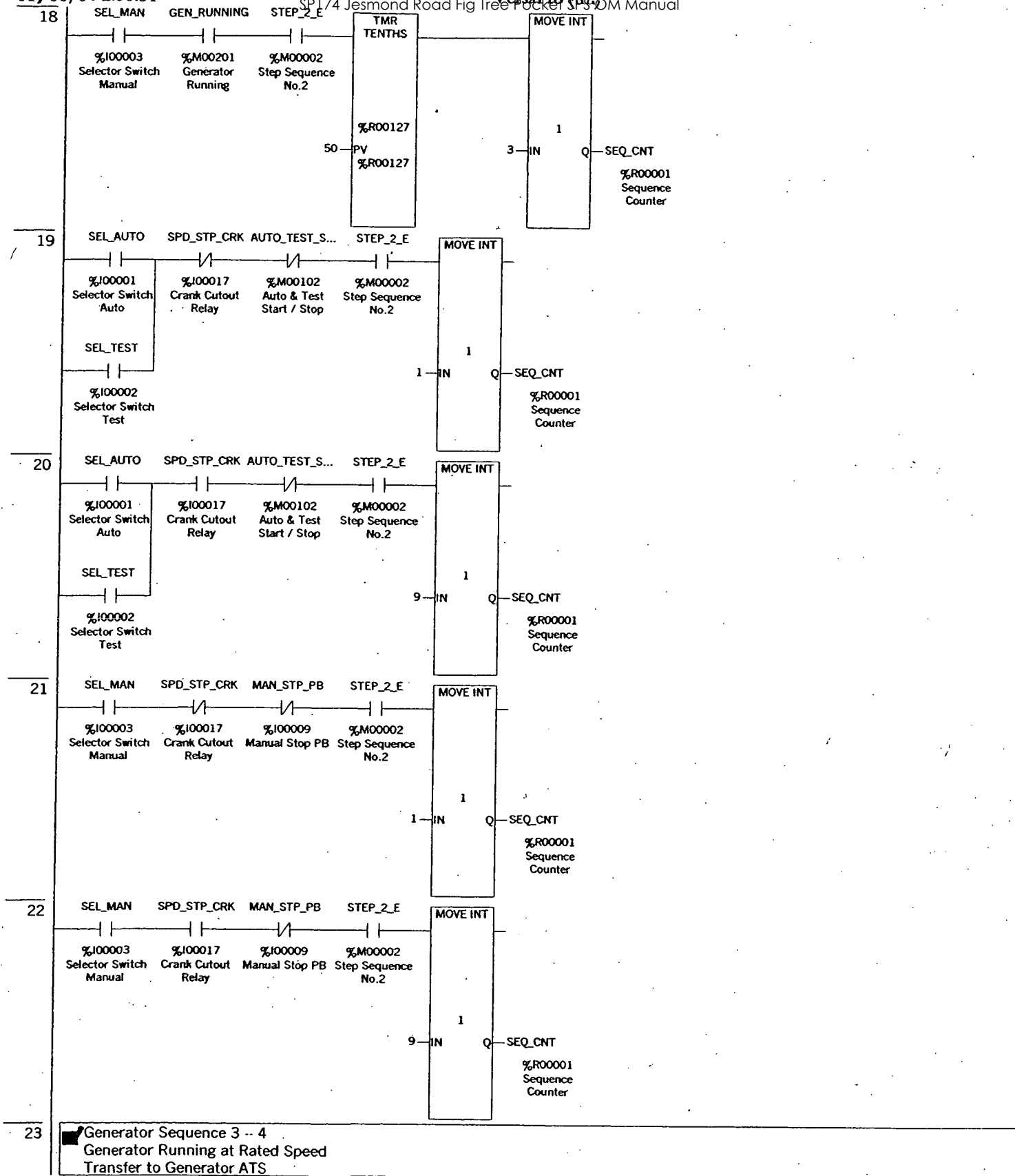
SI

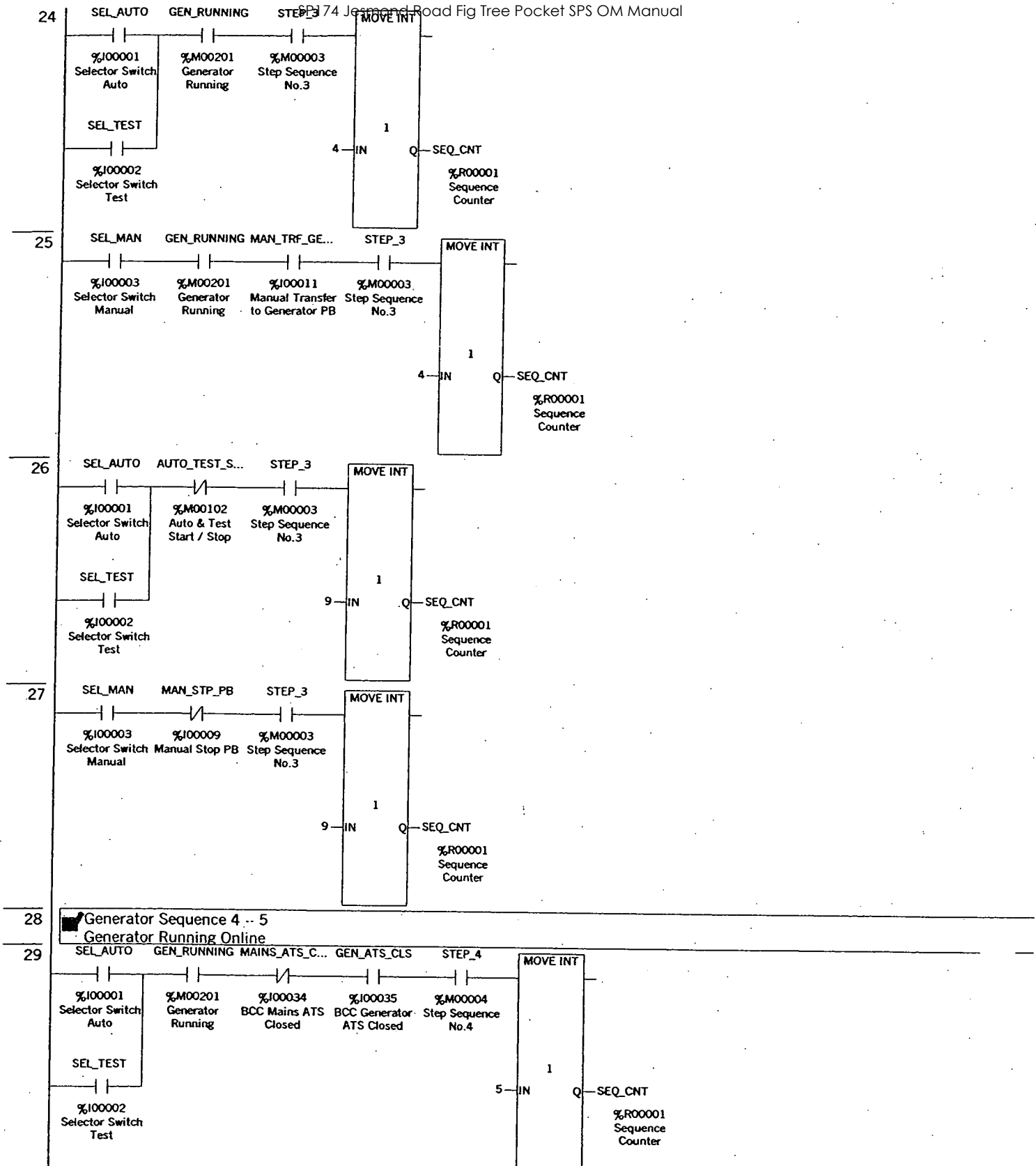




Program: BCC\_4000\_4

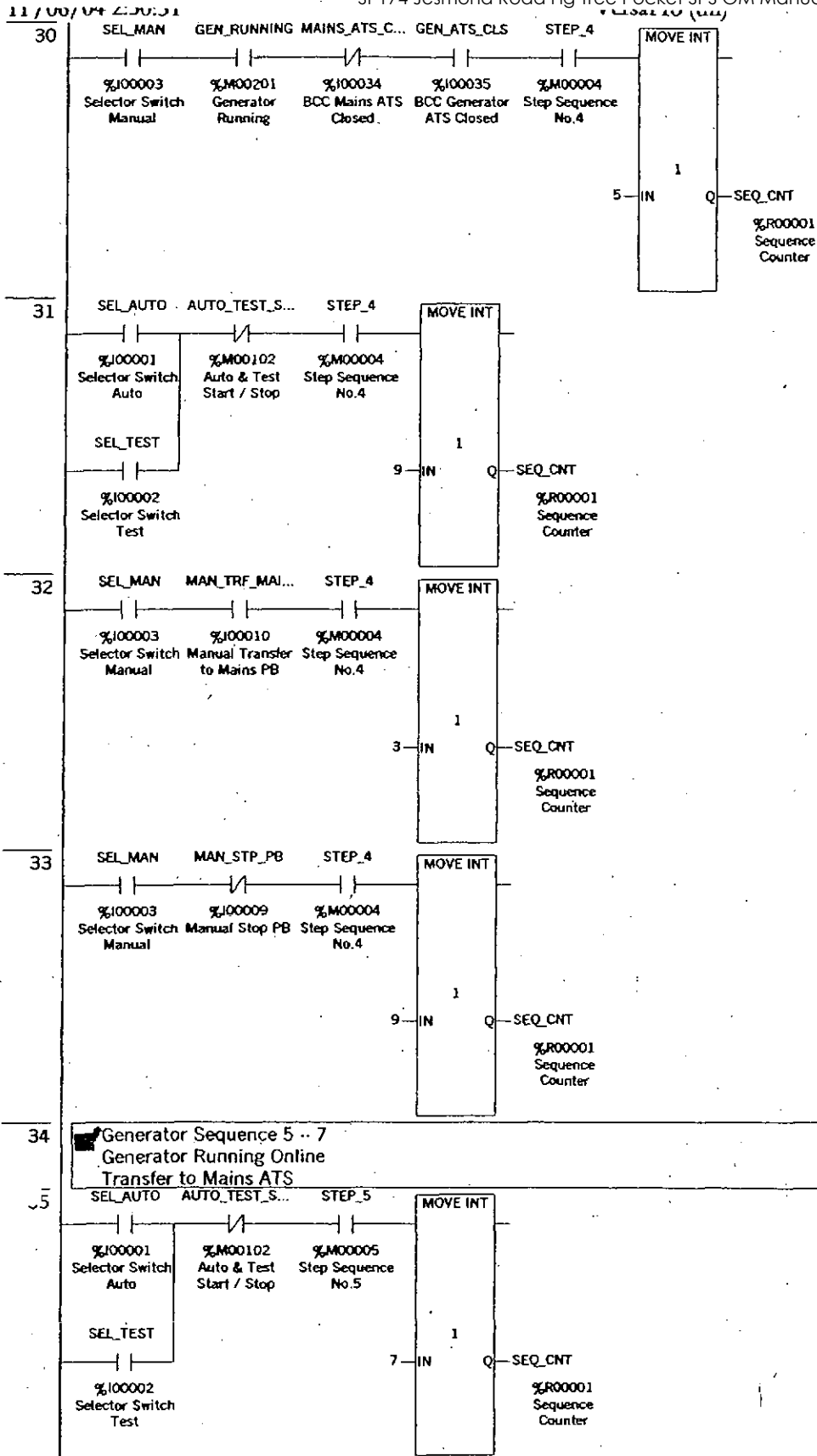
A:





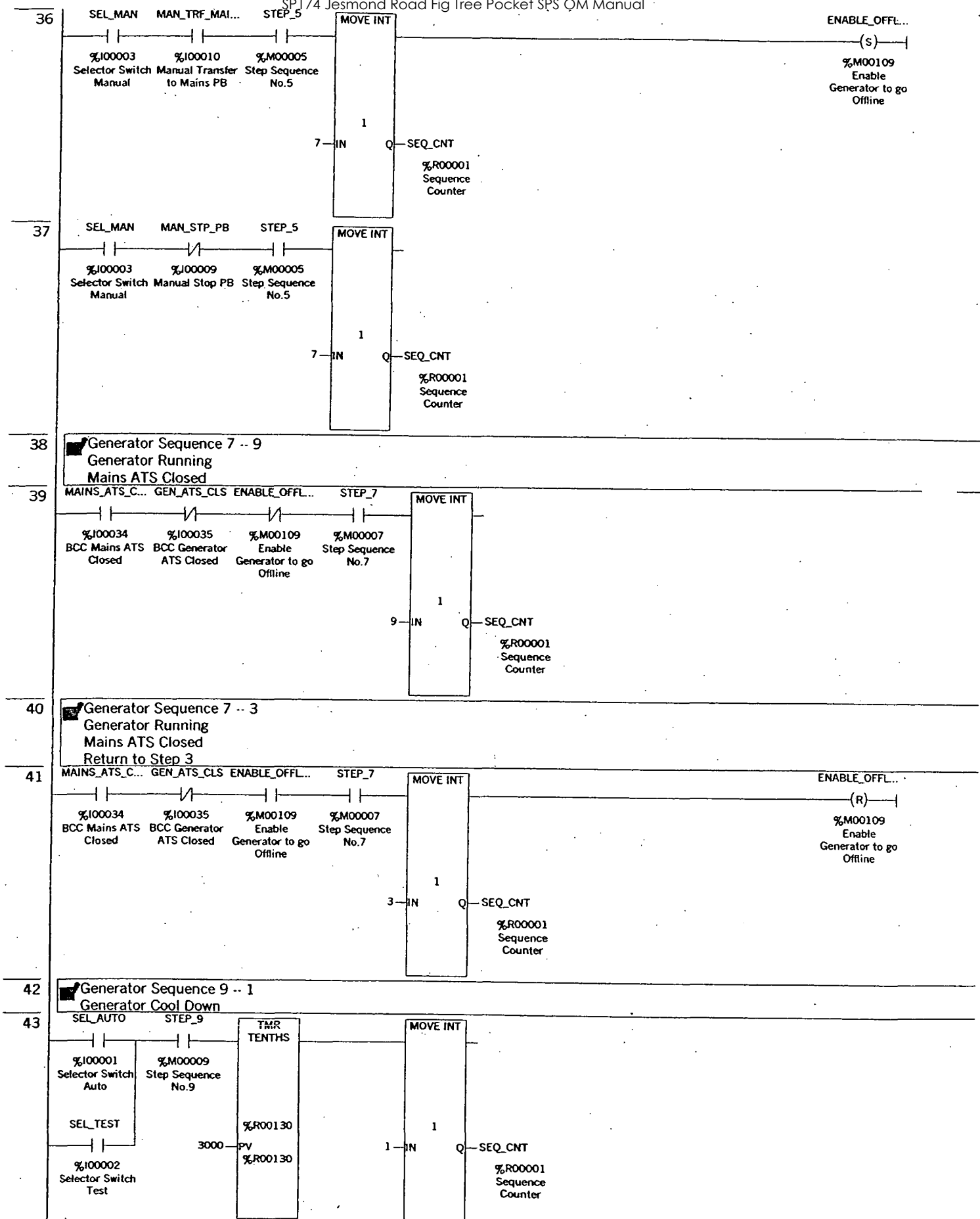
Program: BCC\_4000\_4

A:



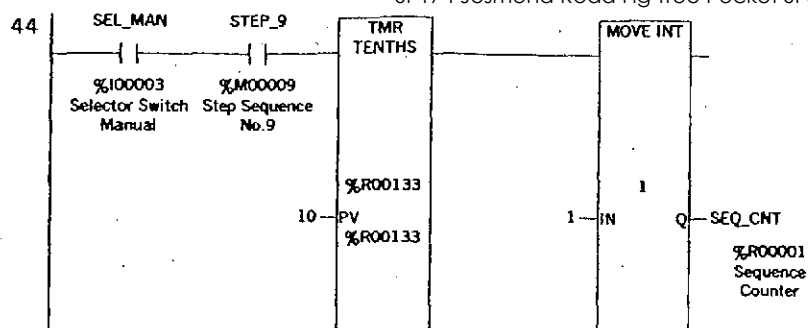
ram: BCC\_4000\_4

A:



Program: BCC\_4000\_4

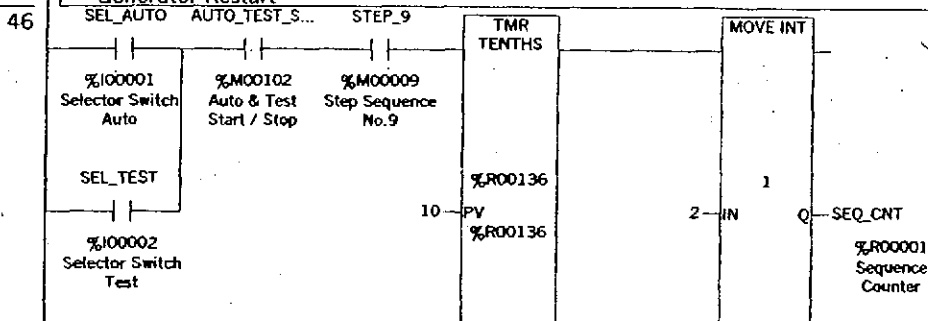
A:



45

Generator Sequence 9 -- 2

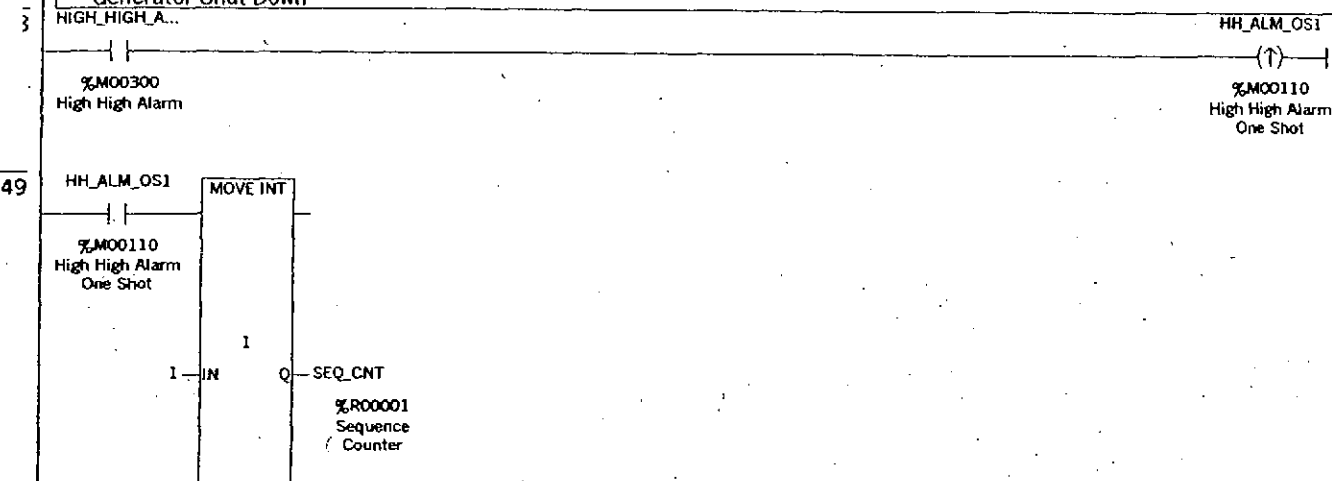
Generator Restart



47

Generator High High Alarm

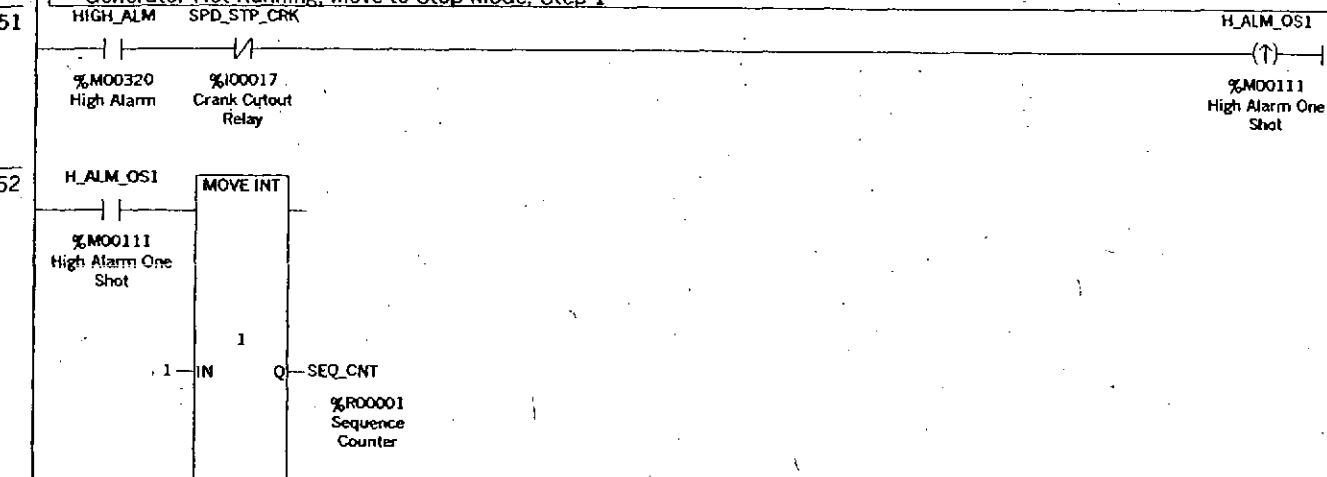
Generator Shut Down



50

Generator High Alarm

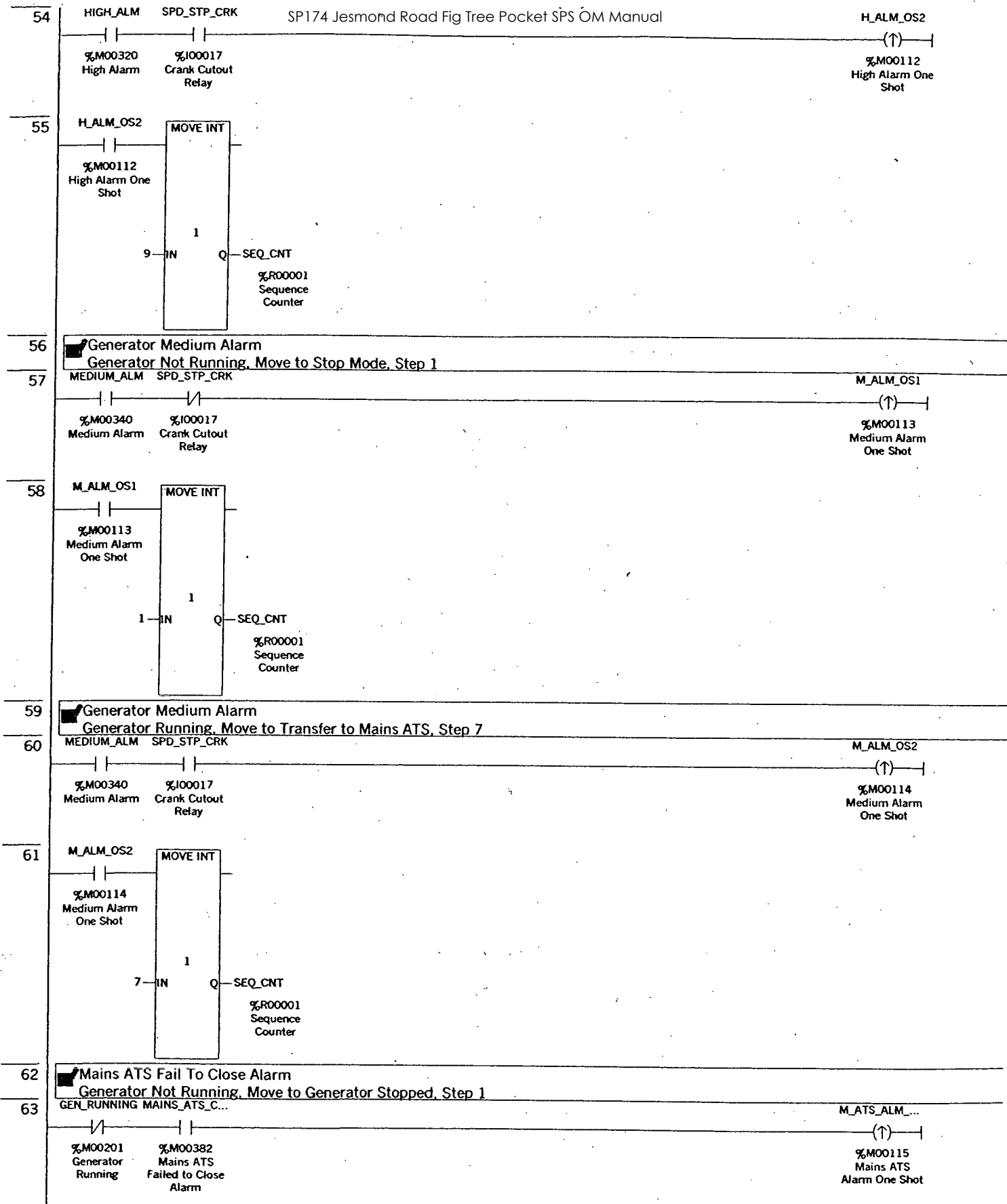
Generator Not Running, Move to Stop Mode, Step 1



53

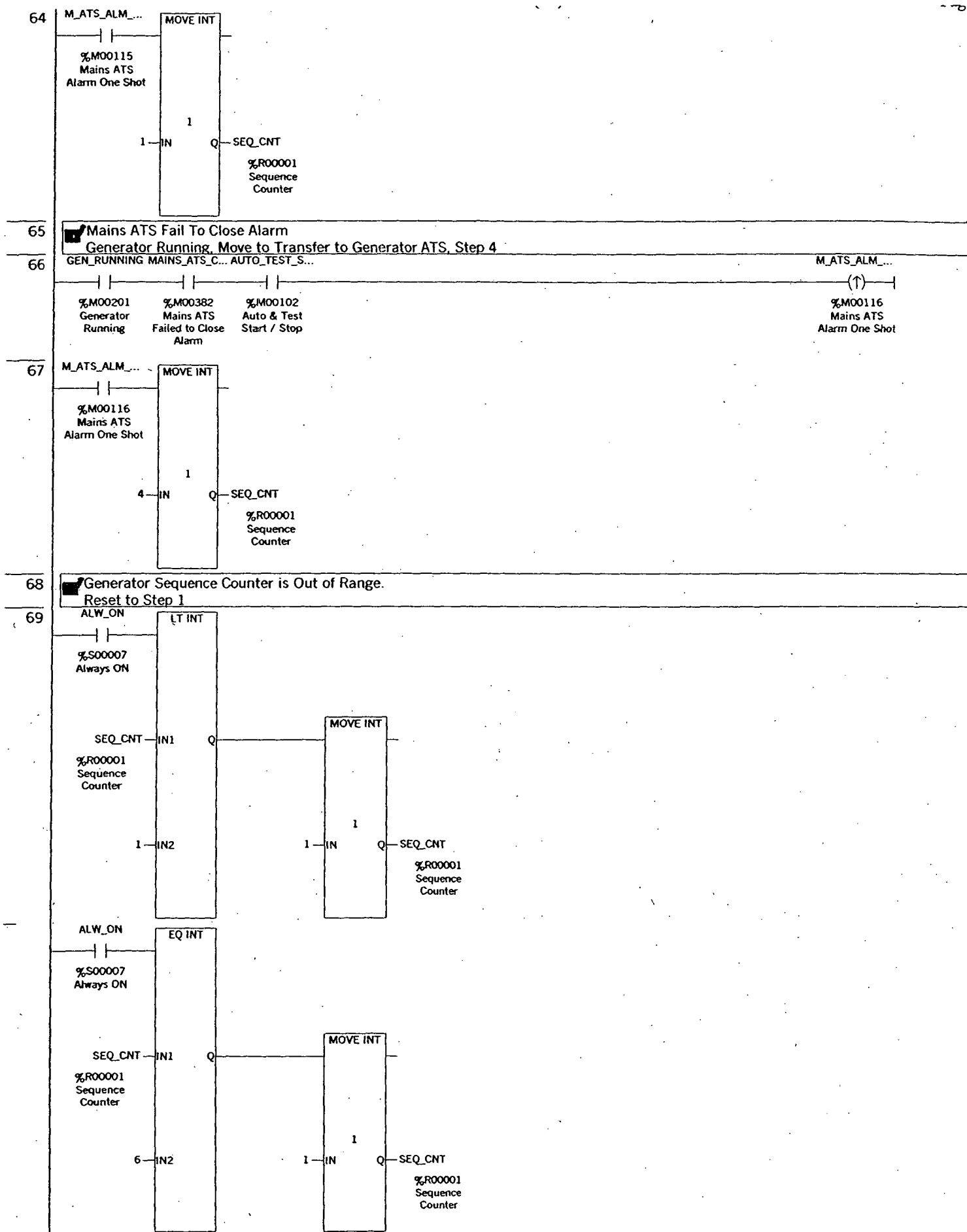
Generator High Alarm

Generator Running, Move to Cool Down Mode, Step 9



Program: BCC\_4000\_4

A:

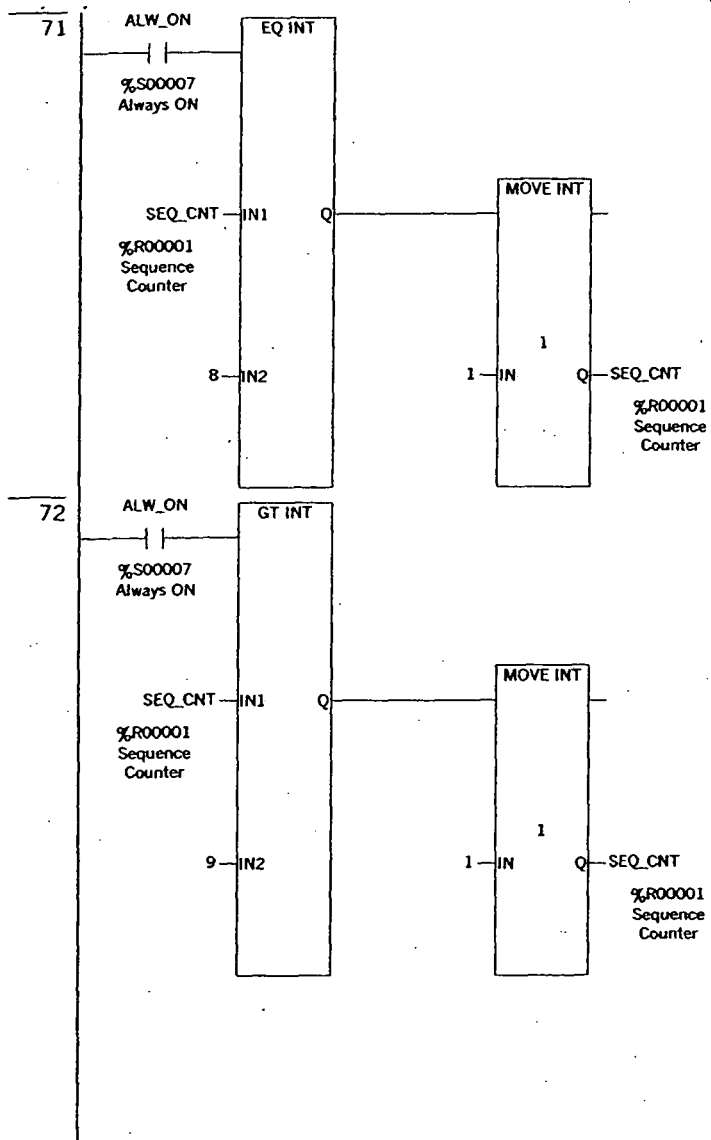


Program: BCC\_4000\_4

A:

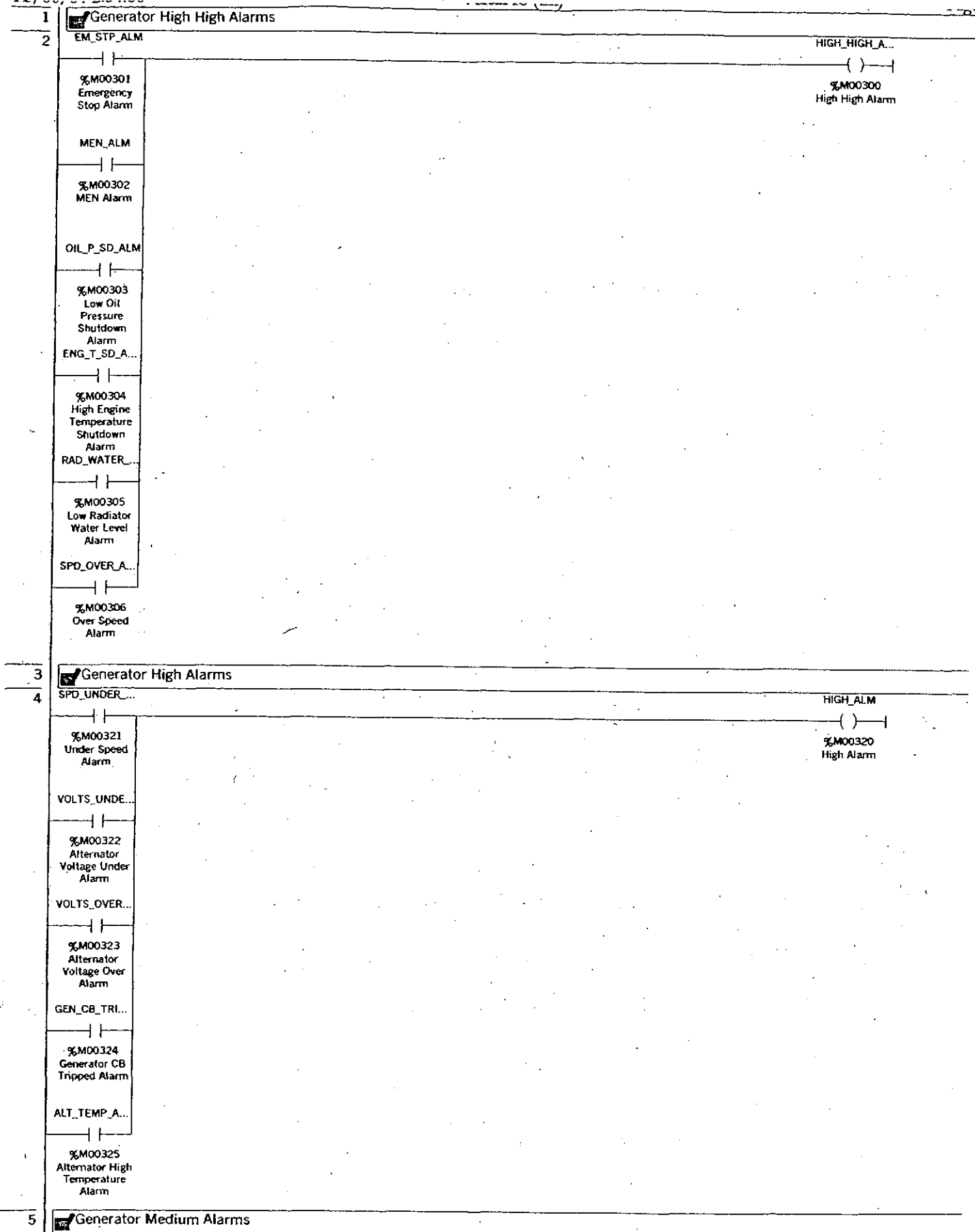
SI





Program: BCC\_4000\_4

A:



6

FUEL\_LEV\_EM...

%M00341  
Fuel Empty  
Alarm

FAIL\_TO\_STR...

%M00342  
Fail to Start  
Alarm

MAINS\_ATS...

%M00381  
Mains ATS  
Failed to Open  
Alarm

GEN\_ATS\_CL...

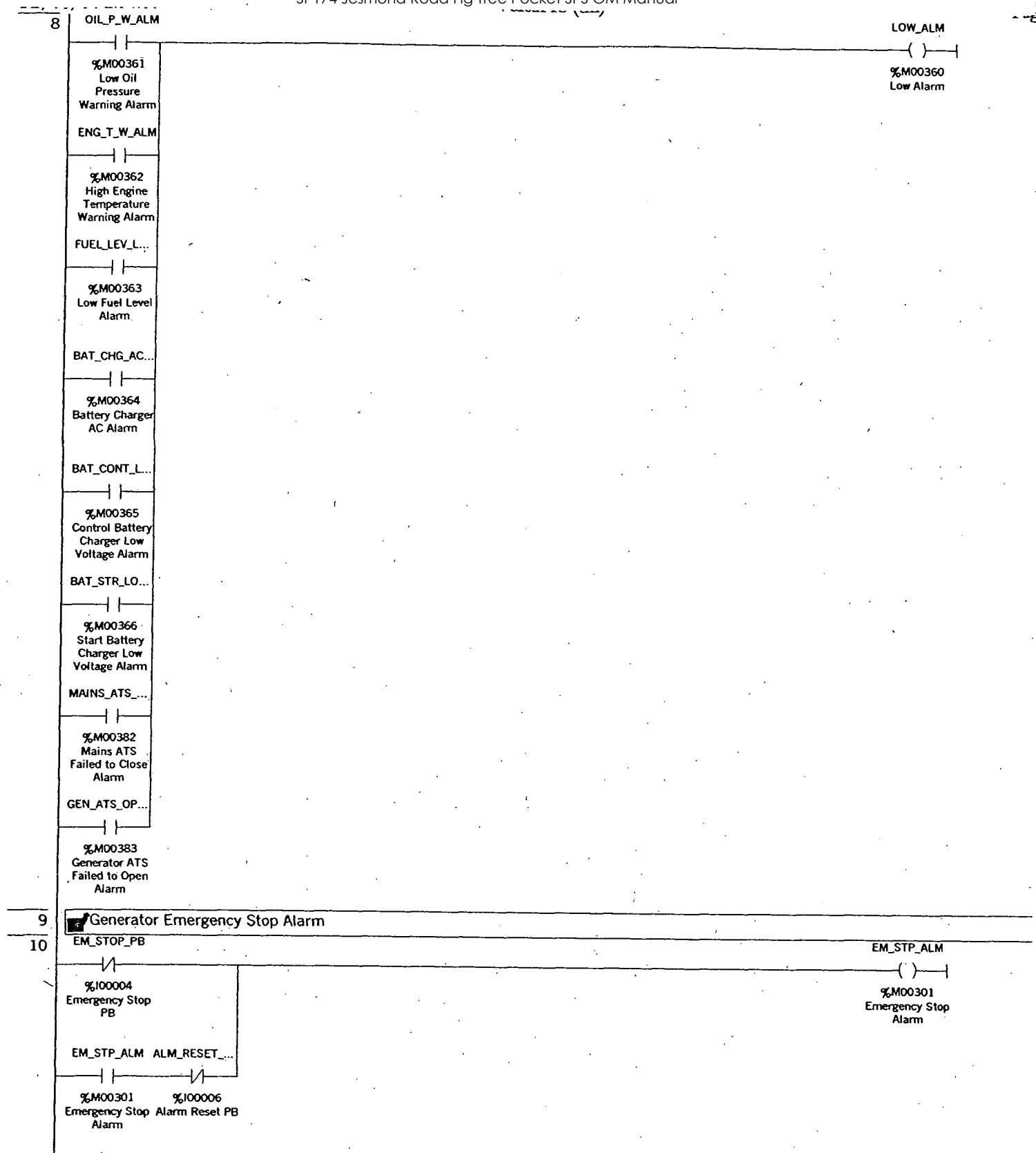
%M00384  
Generator ATS  
Failed to Close  
Alarm

MEDIUM\_ALM

( )  
%M00340  
Medium Alarm

7

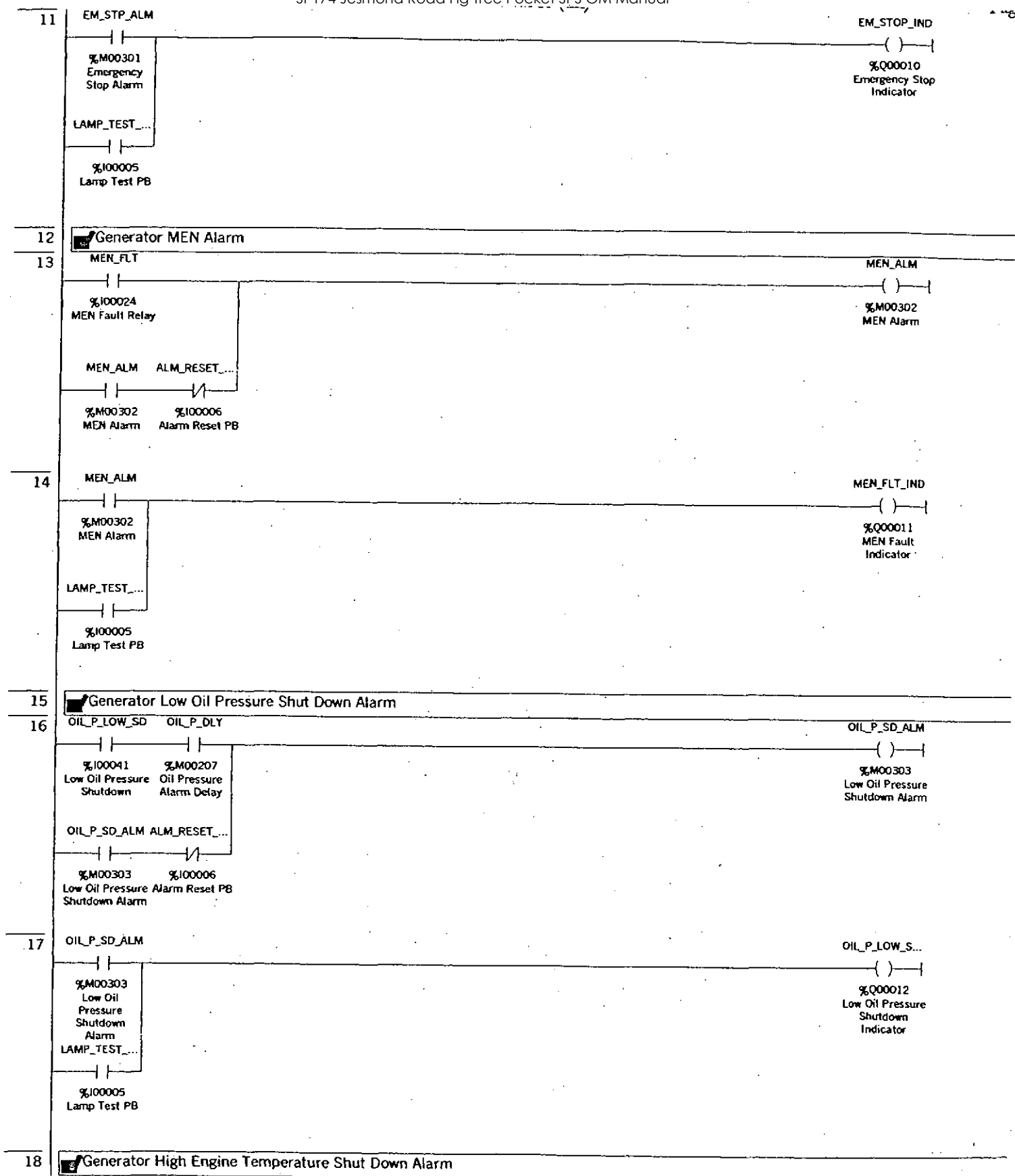
Generator Low Alarms



P-----m: BCC\_4000\_4

A:

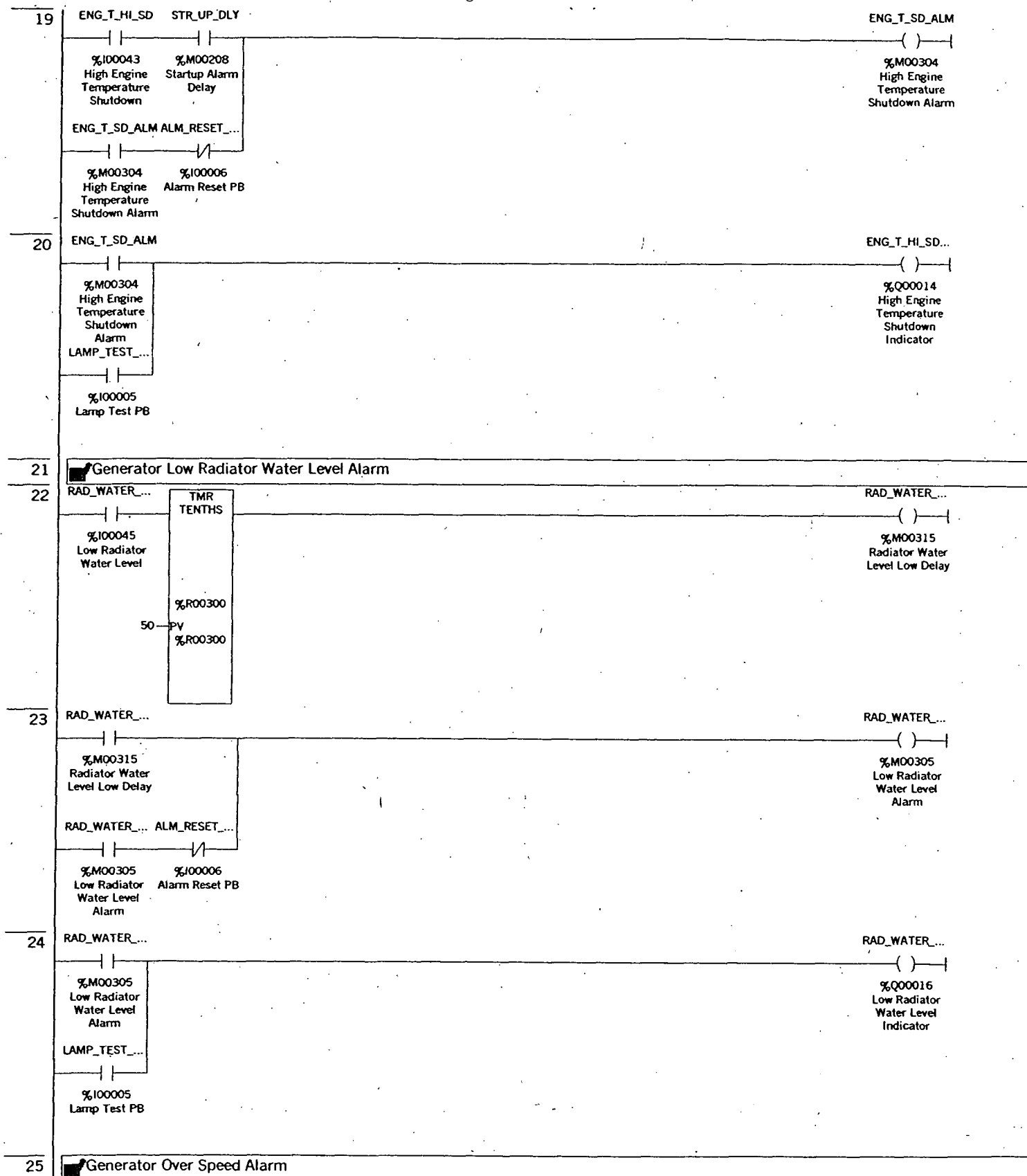
ALA

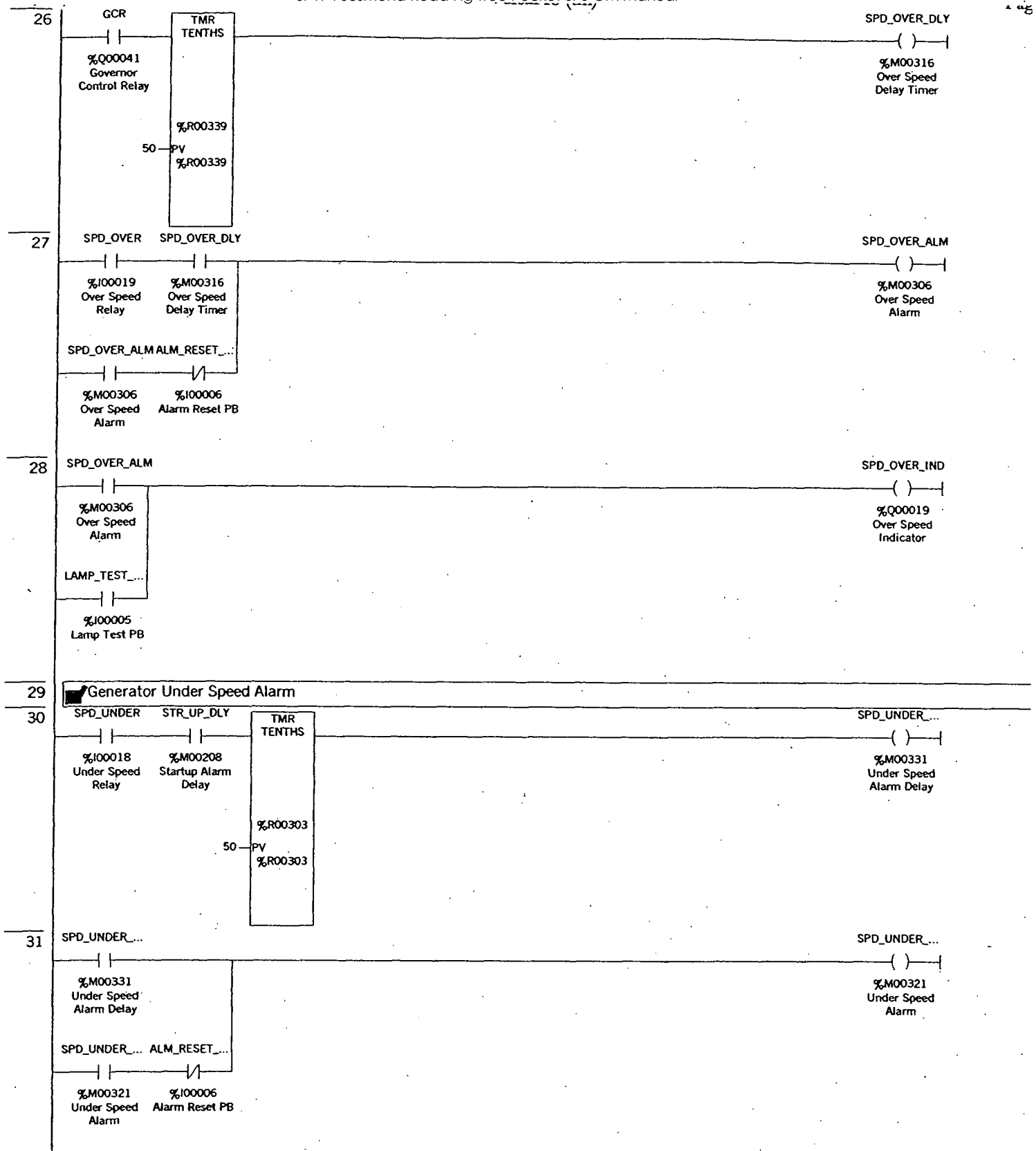


Program: BCC\_4000\_4

A:

A'

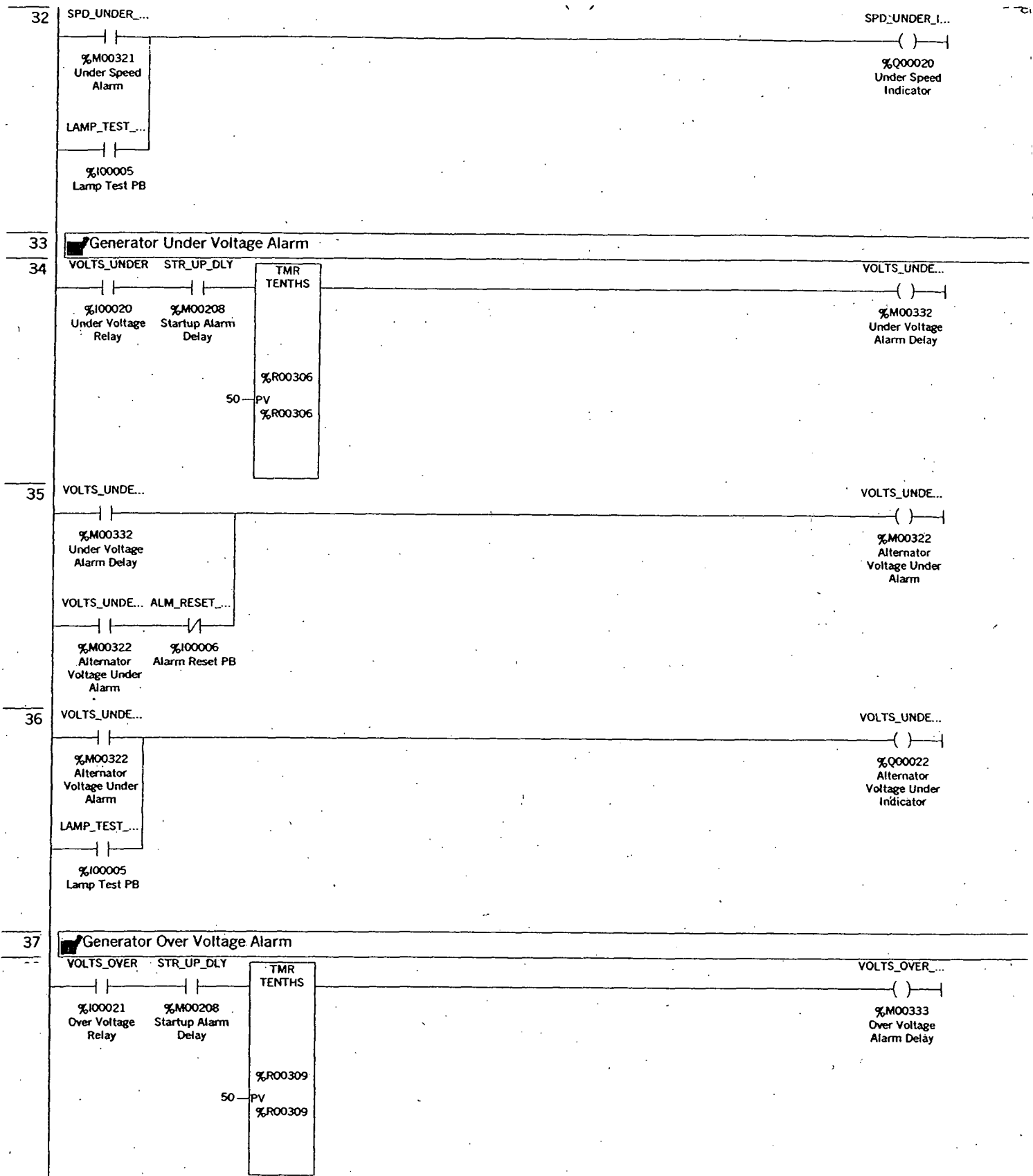




Program: BCC\_4000\_4

A:

A

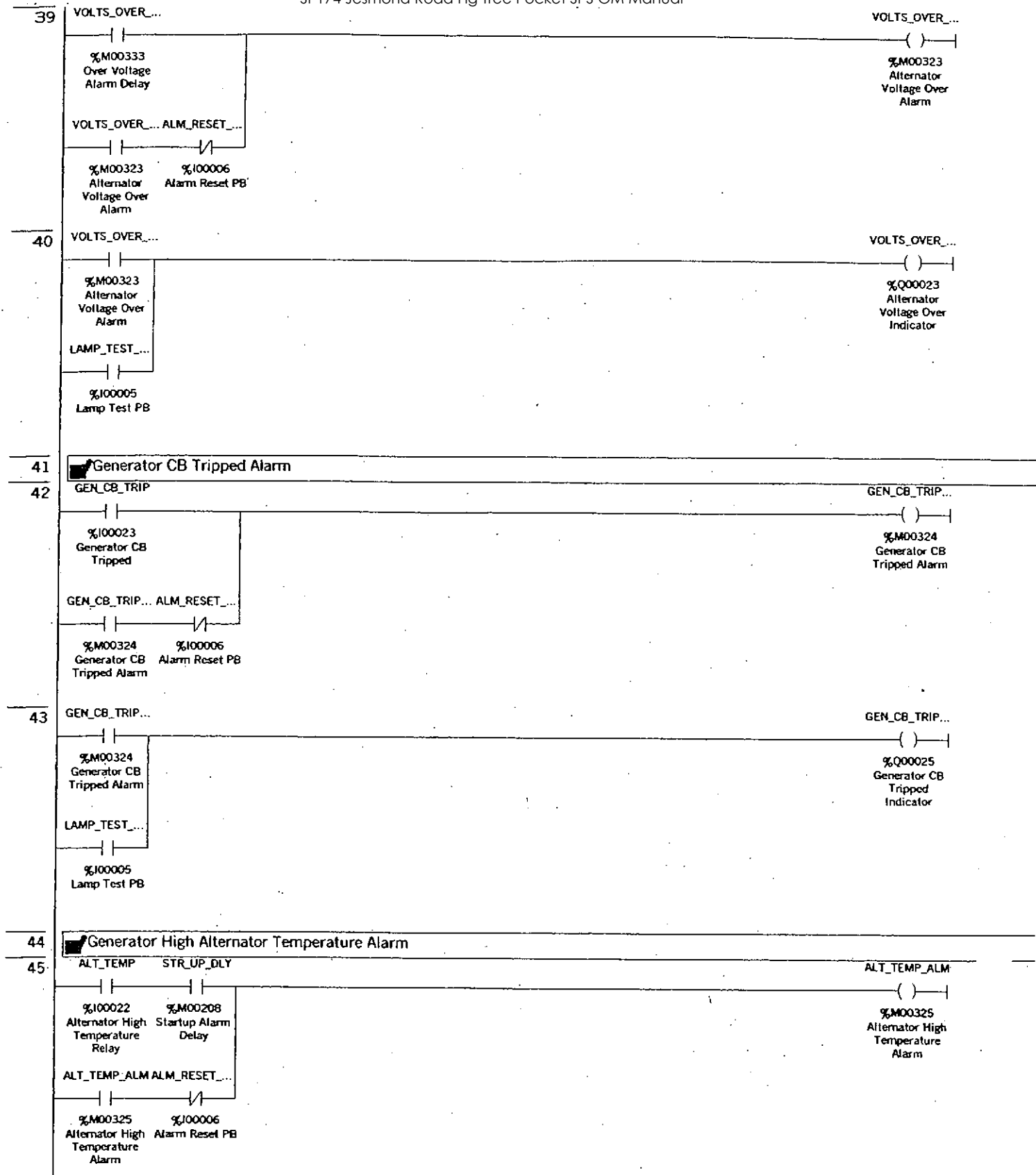


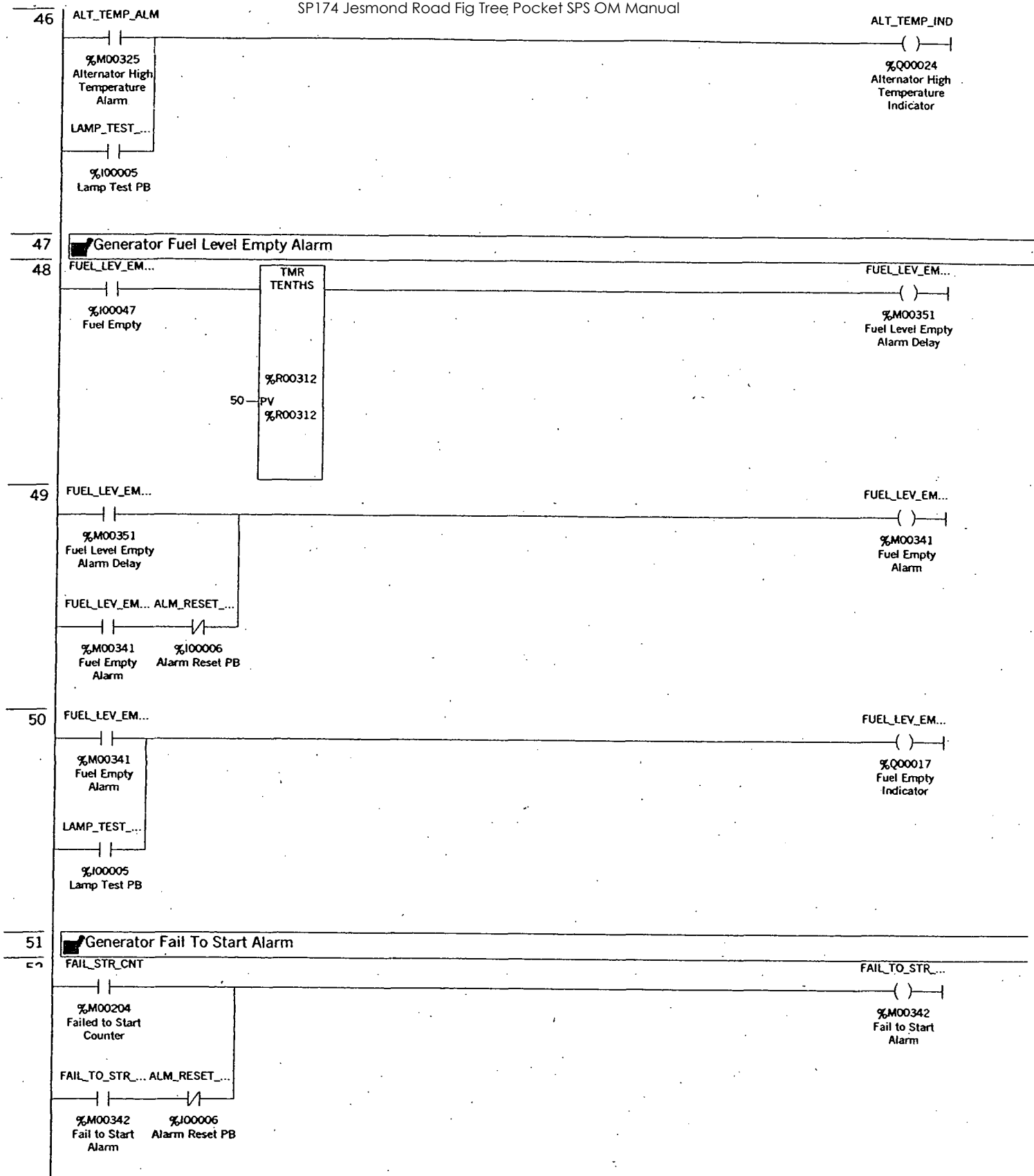
Program: BCC\_4000\_4

A:

ALA



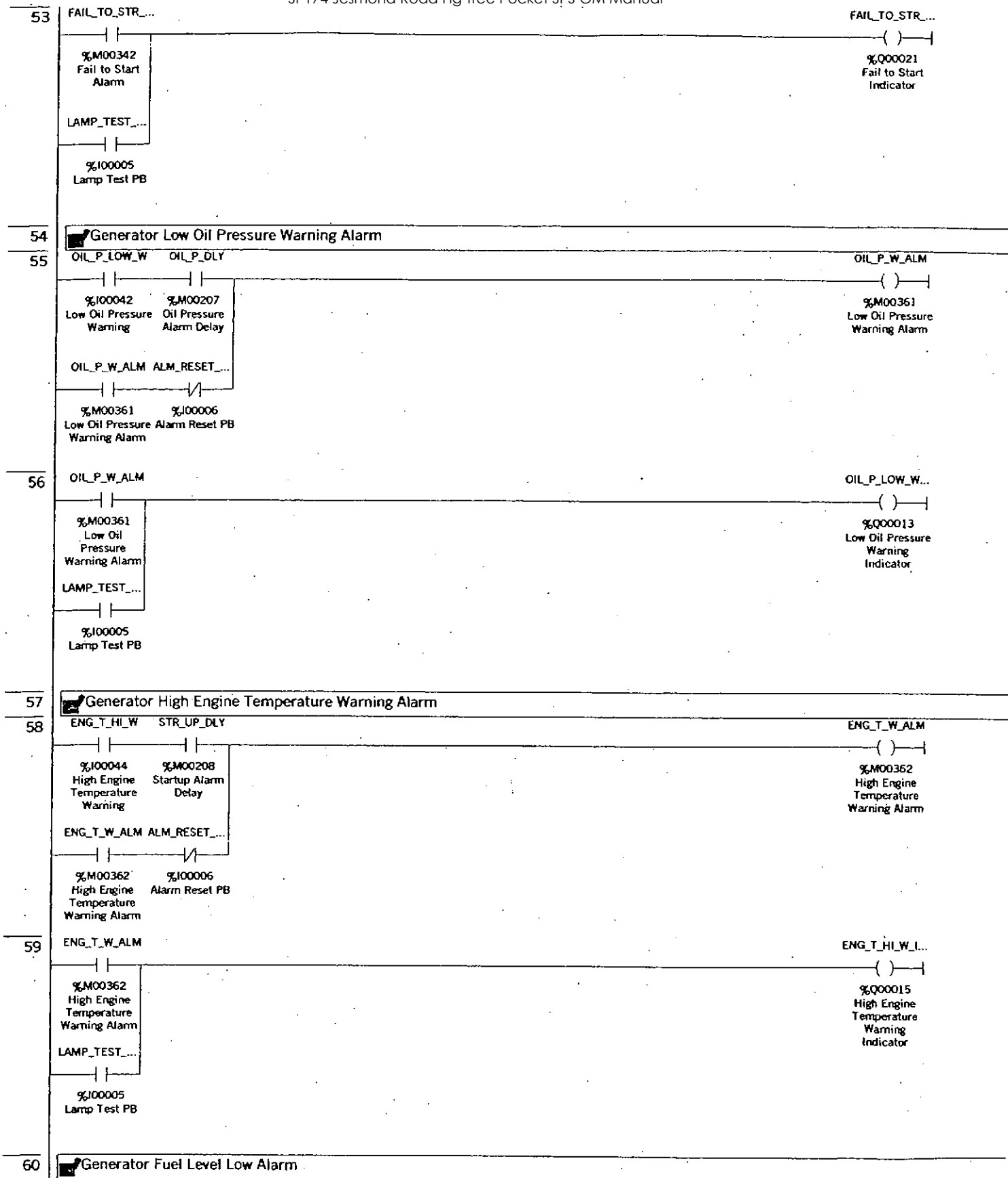


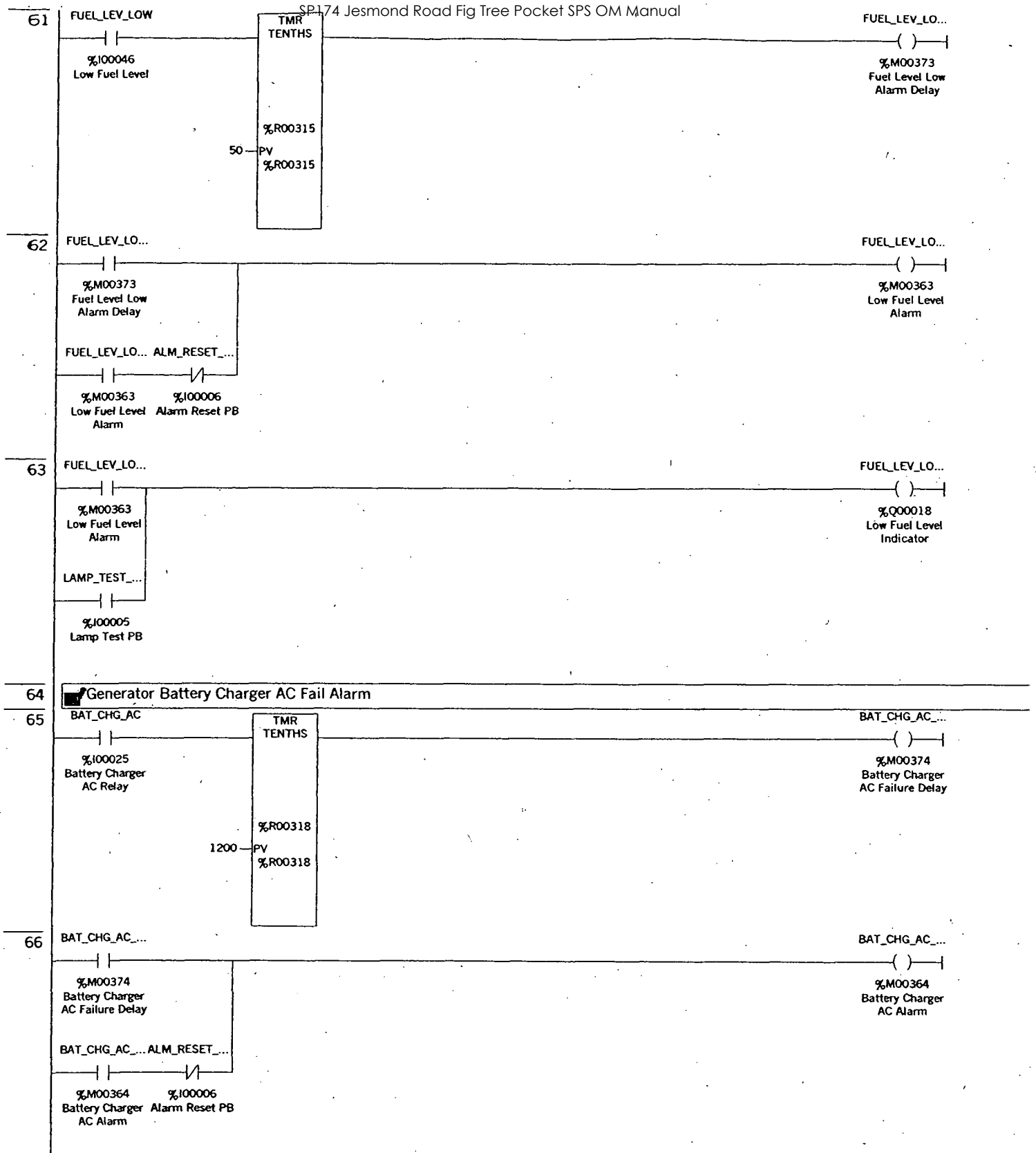


Program: BCC\_4000\_4

A:

ALA

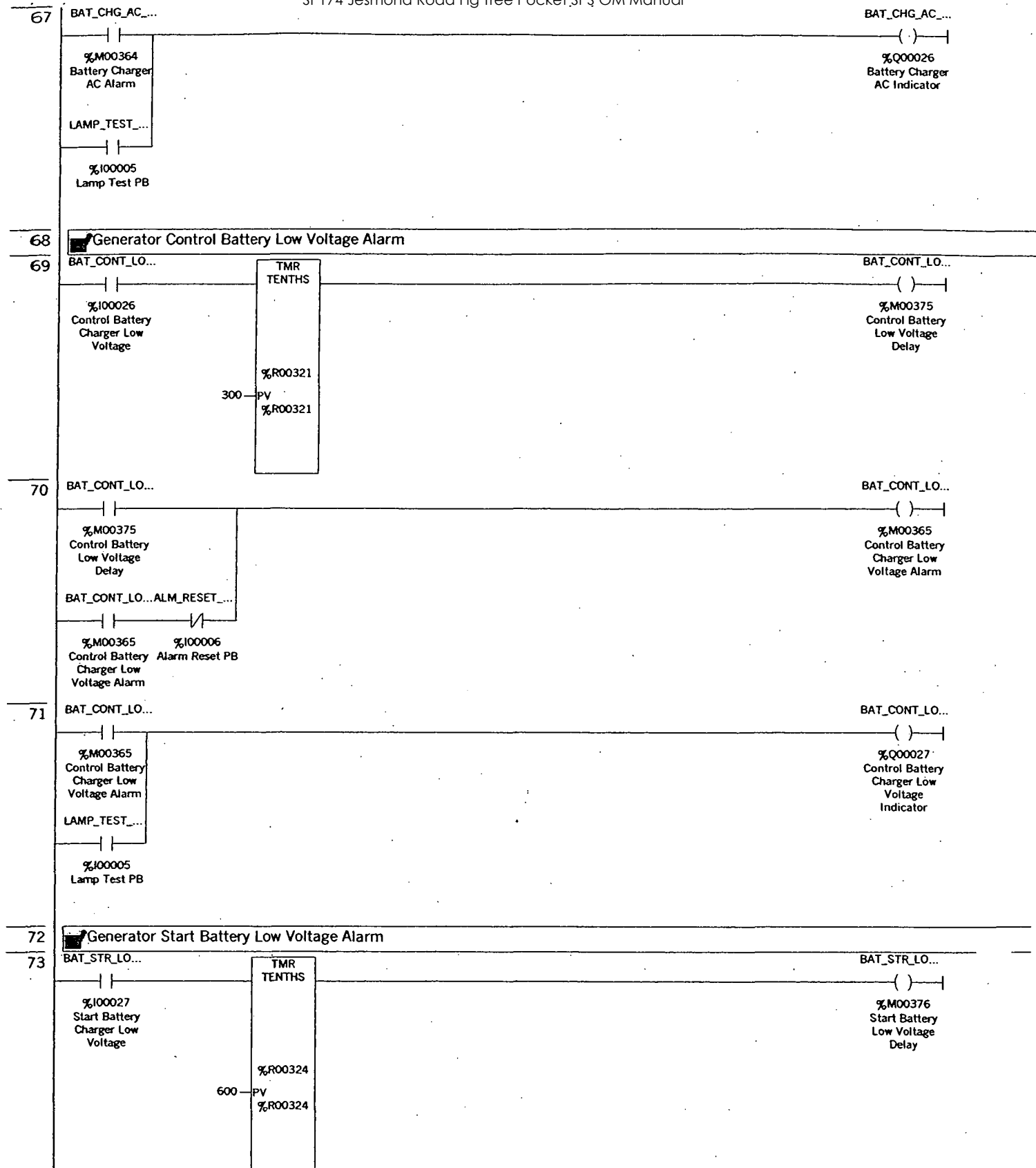




Program: BCC\_4000\_4

A:

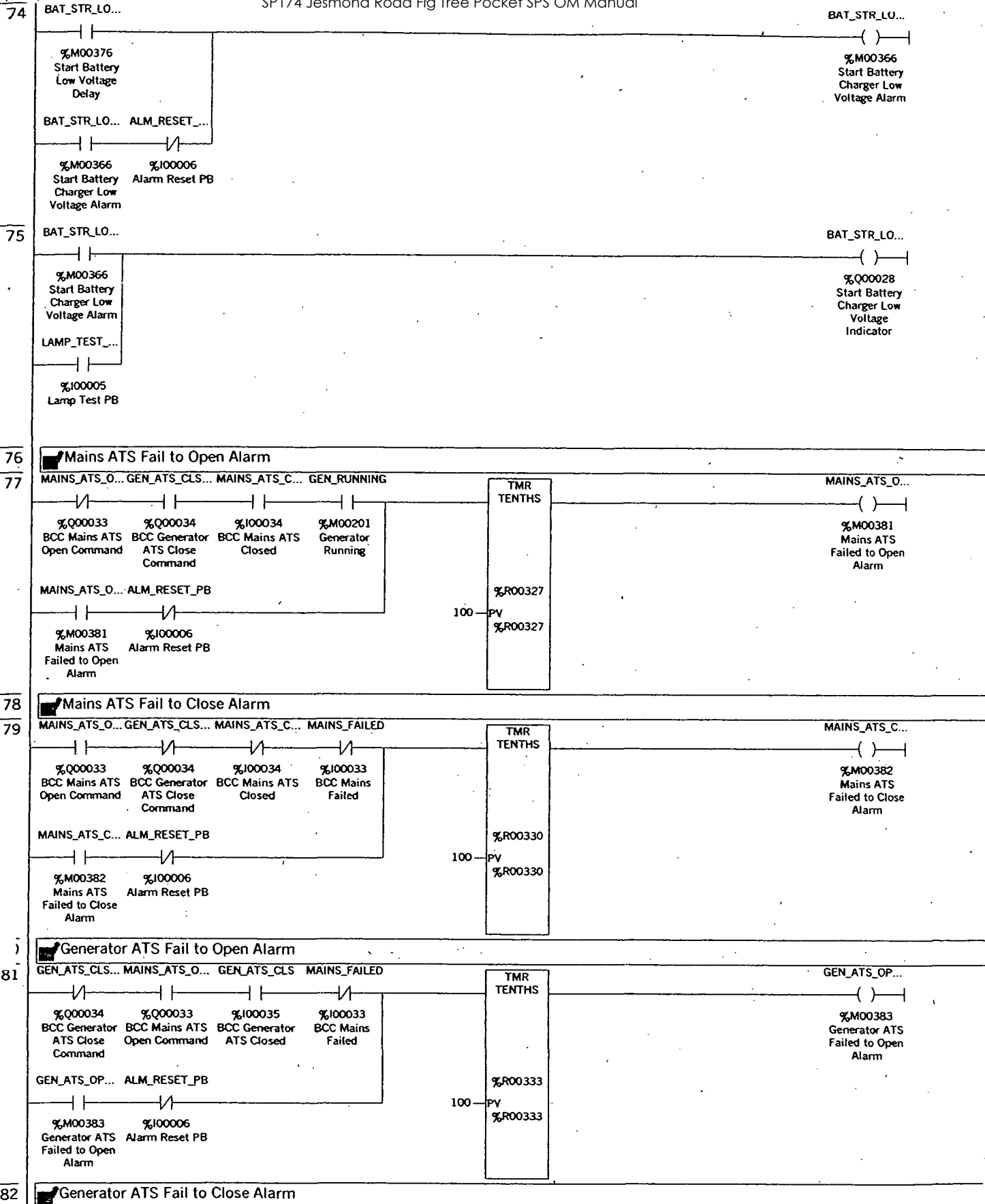
ALA



Program: BCC\_4000\_4

A:

A



am: BCC\_4000\_4

A:

AL

83

GEN\_ATS\_CLS... MAINS\_ATS\_O... GEN\_ATS\_CLS GEN\_RUNNING

%Q00034 BCC Generator  
ATS Close  
Command

%Q00033 BCC Mains ATS  
Open Command

%I00035 BCC Generator  
ATS Closed

%M00201 Generator  
Running

GEN\_ATS\_CLS... ALM\_RESET\_PB

%M00384 Generator ATS  
Failed to Close  
Alarm

%I00006 Alarm Reset PB

TMR  
TENTHS

GEN\_ATS\_CLS...

%M00384  
Generator ATS  
Failed to Close  
Alarm

100--PV  
%R00336

## 1 Audible Alarm Control Logic

2 NEW\_ALM

%M00400  
New Alarm

AAR

( )  
%Q00042  
Audible Alarm  
Relay

## 3 Mutes the New Audible Alarm

4 ALM\_MUTE\_PB

%I00007  
Alarm Mute PB

NEW\_ALM

(R)  
%M00400  
New Alarm

## 5 Sets the New Alarm Bit

6 EM\_STP\_ALM

%M00301  
Emergency Stop  
Alarm

%M00401

(↑)  
%M00401

7 %M00401

%M00401

NEW\_ALM

(S)  
%M00400  
New Alarm

MEN\_ALM

%M00302  
MEN Alarm

%M00402

(↑)  
%M00402

9 %M00402

%M00402

NEW\_ALM

(S)  
%M00400  
New Alarm

10 OIL\_P\_SD\_ALM

%M00303  
Low Oil Pressure  
Shutdown Alarm

%M00403

(↑)  
%M00403

11 %M00403

%M00403

NEW\_ALM

(S)  
%M00400  
New Alarm

12 ENG\_T\_SD\_ALM

%M00304  
High Engine  
Temperature  
Shutdown Alarm

%M00404

(↑)  
%M00404

13 %M00404

%M00404

NEW\_ALM

(S)  
%M00400  
New Alarm

14 RAD\_WATER...

%M00305  
Low Radiator  
Water Level  
Alarm

%M00405

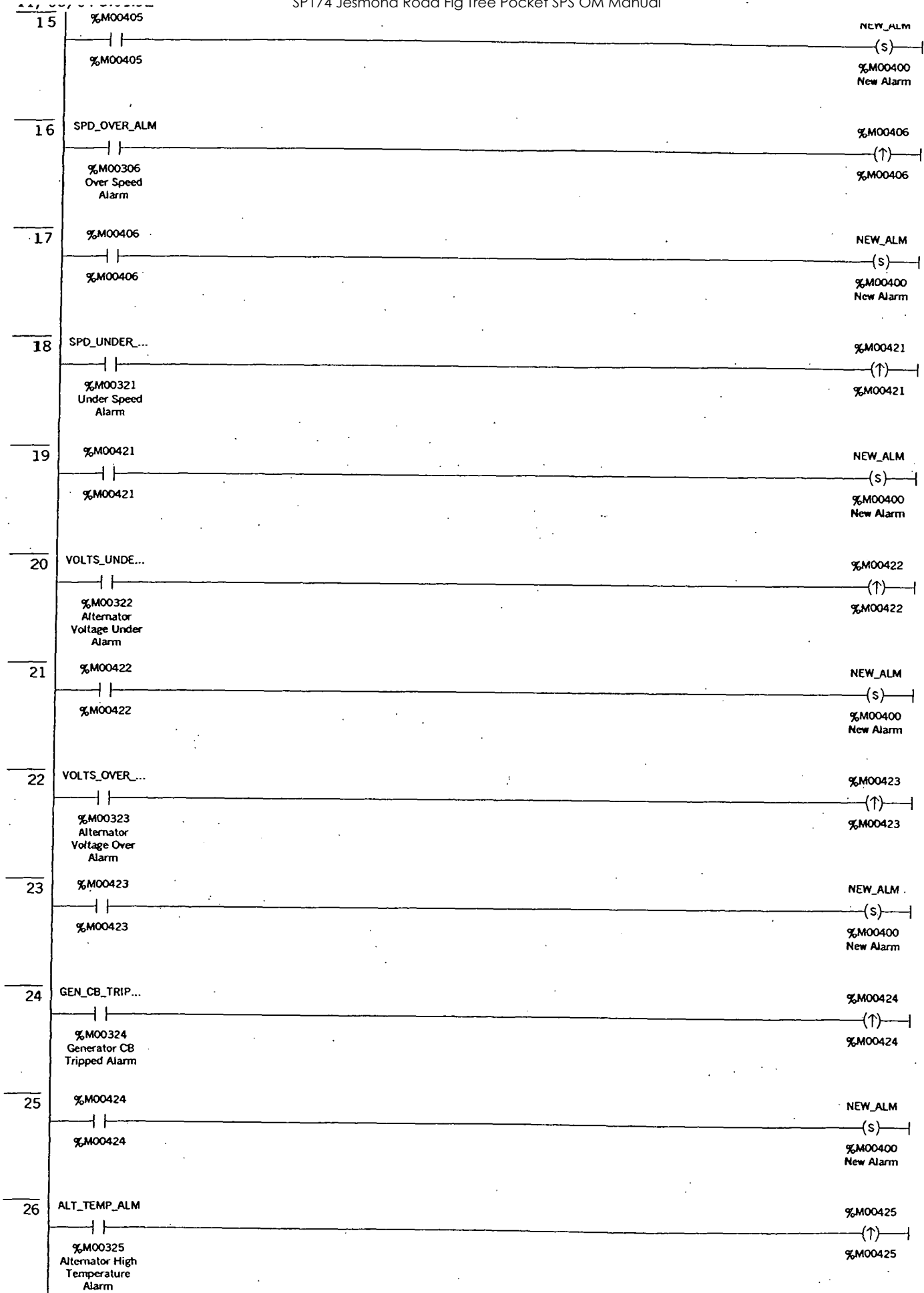
(↑)  
%M00405

I um: BCC\_4000\_4

A:

AUD\_

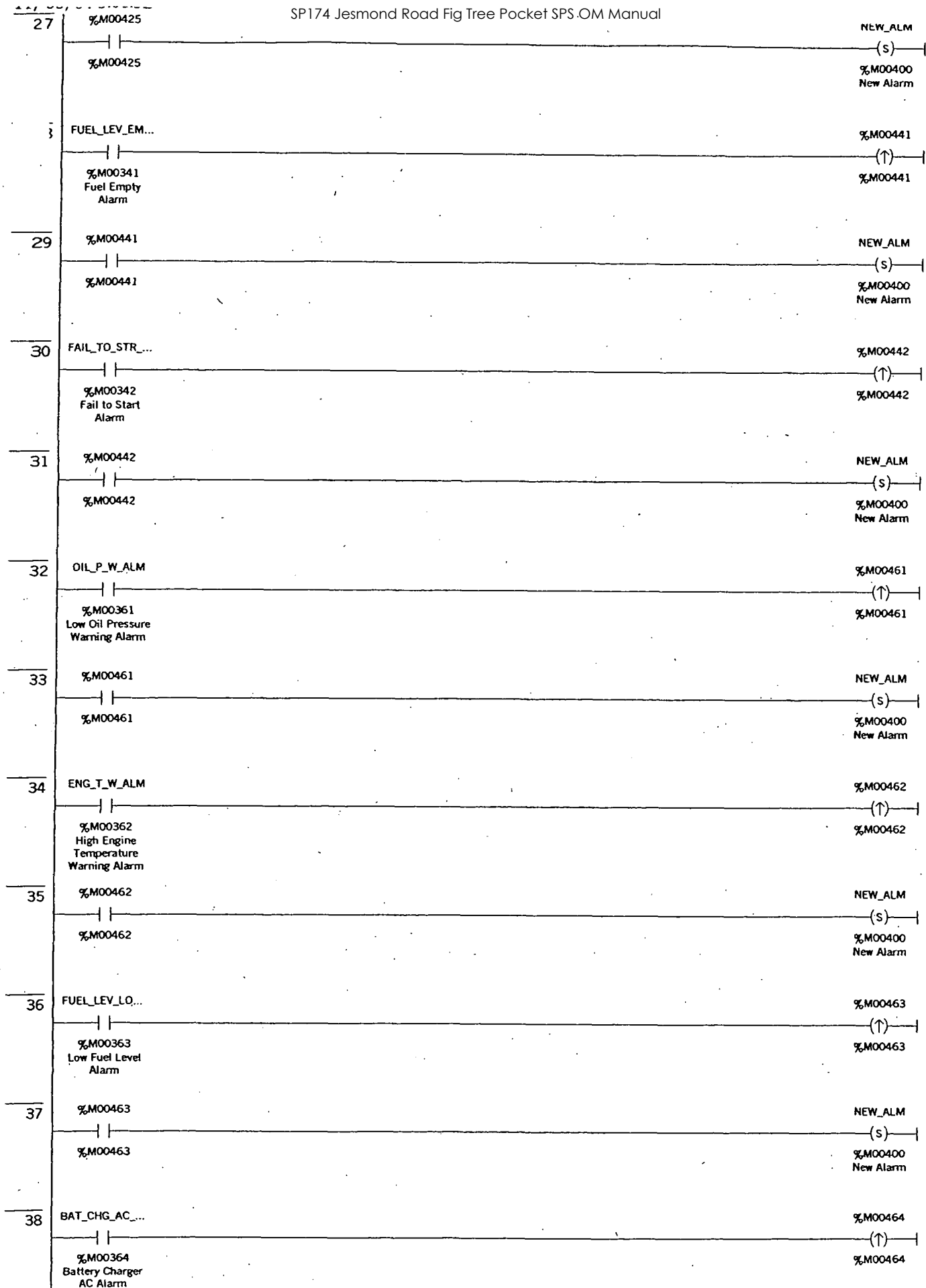




Program: BCC\_4000\_4

A:

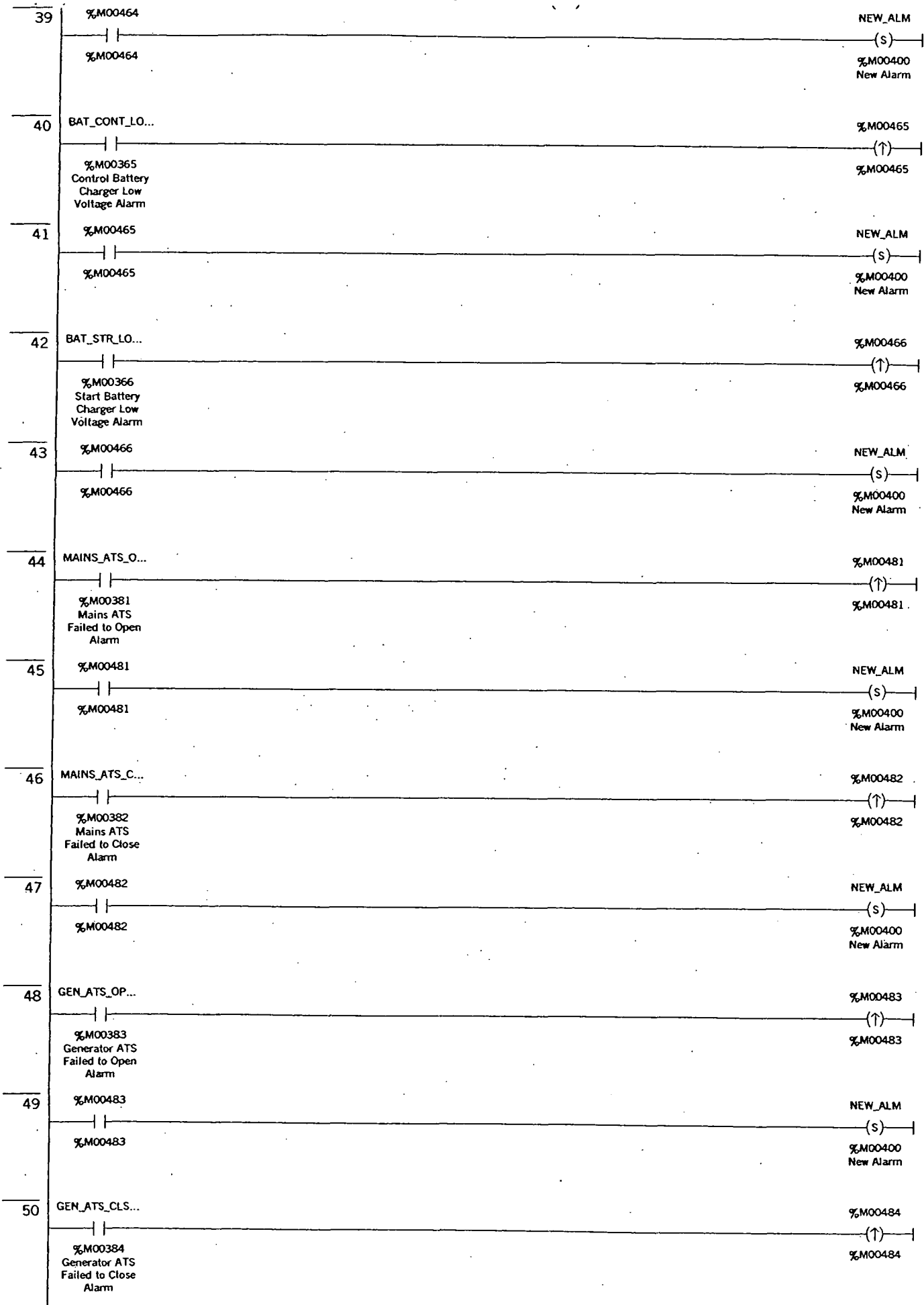
D:



1 am: BCC\_4000\_4

A:

AUD\_



Program: BCC\_4000\_4

A:

A

P-----m: BCC\_4000\_4

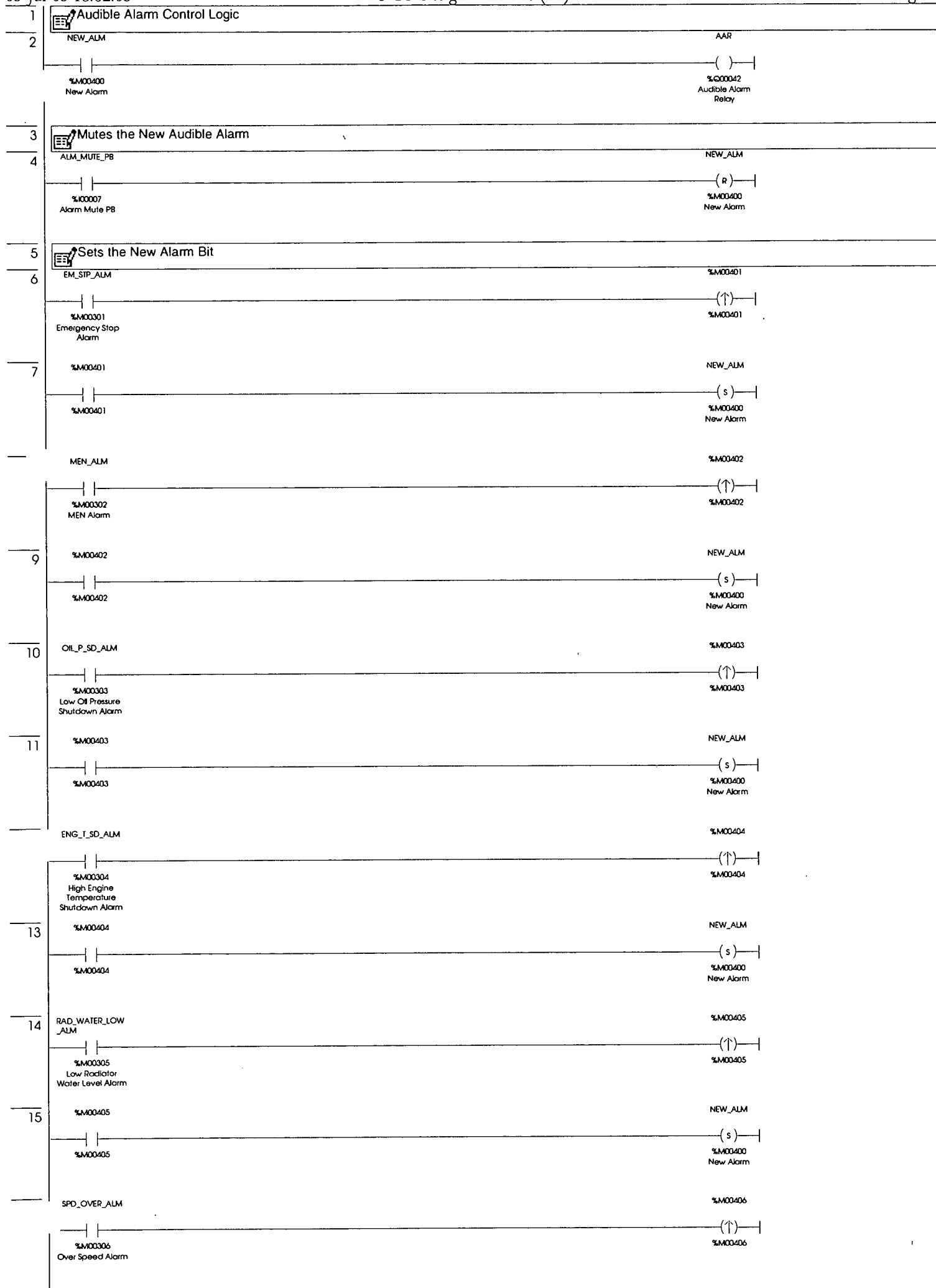
A:

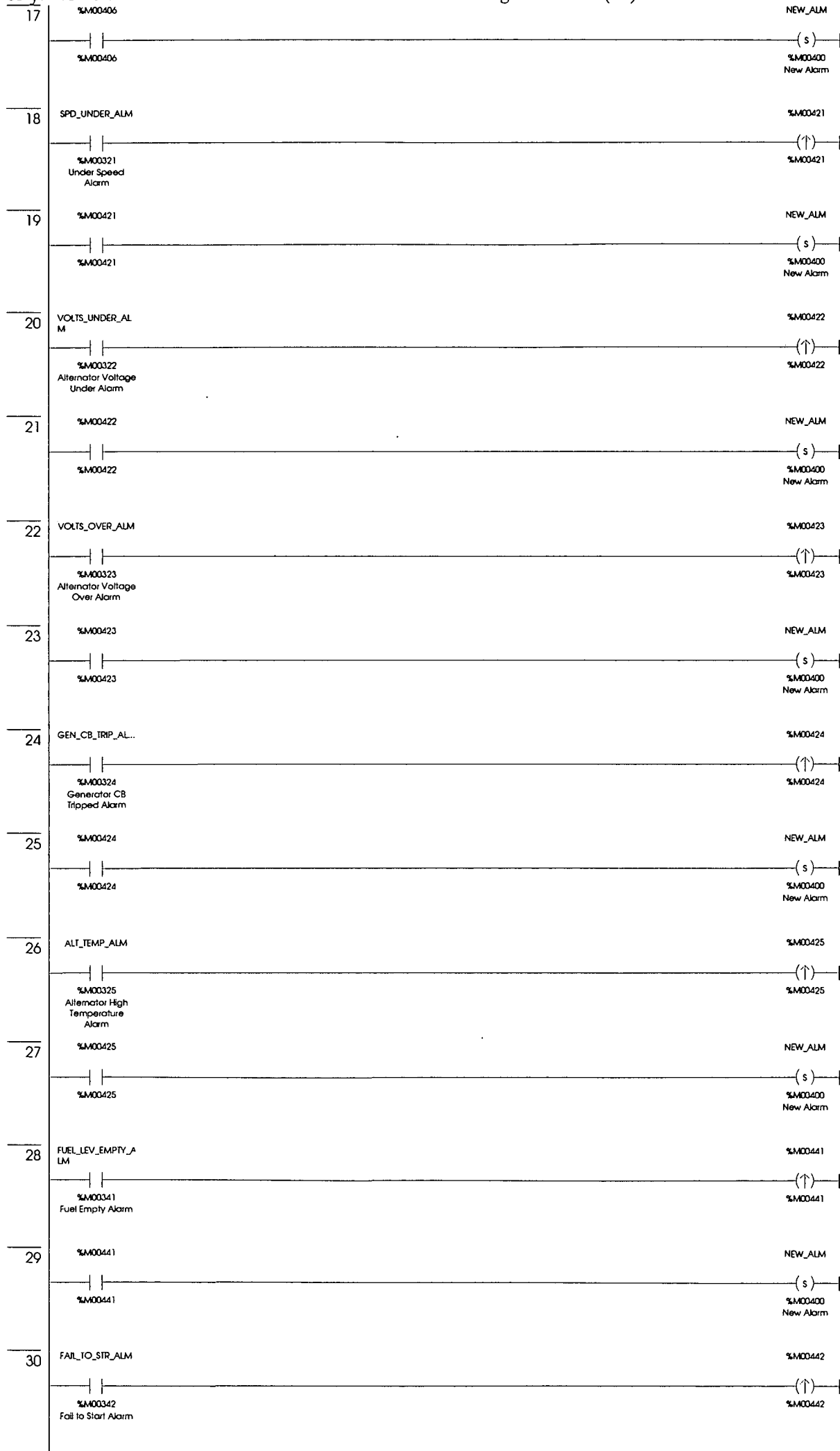
AUD\_/\_

# NTB Design

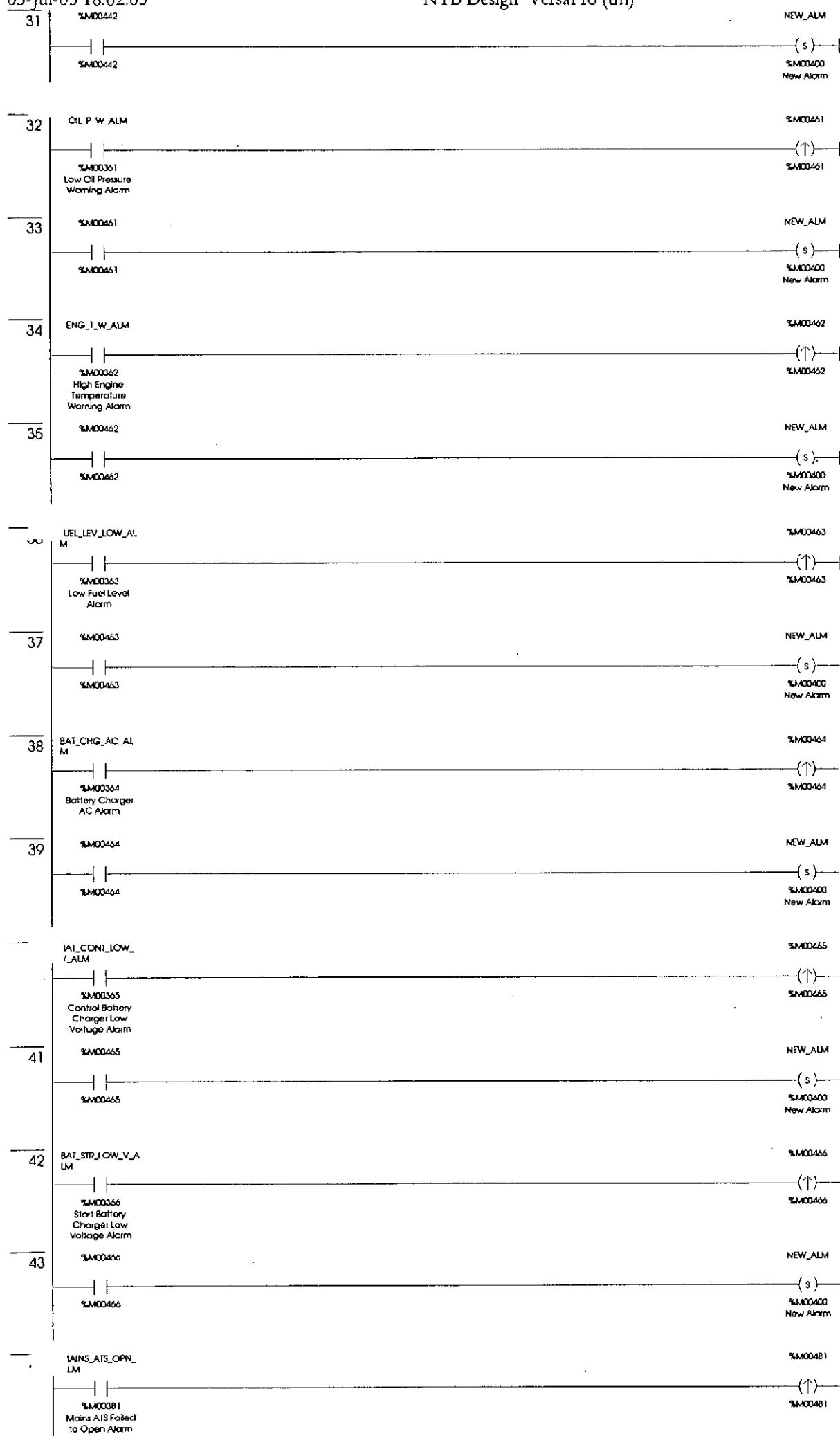
Folder Name..... BCC\_4000\_2  
Nickname..... C4000\_2  
Location..... C:\Program Files\GE Fanuc Automation\VersaPro  
                  \Project\BCC\_4000\_2  
Created..... 27-Jun-03, 16:36:03  
Modified..... 03-Jul-03, 18:02:02  
Description..... BCC, Standby Generator, 4000

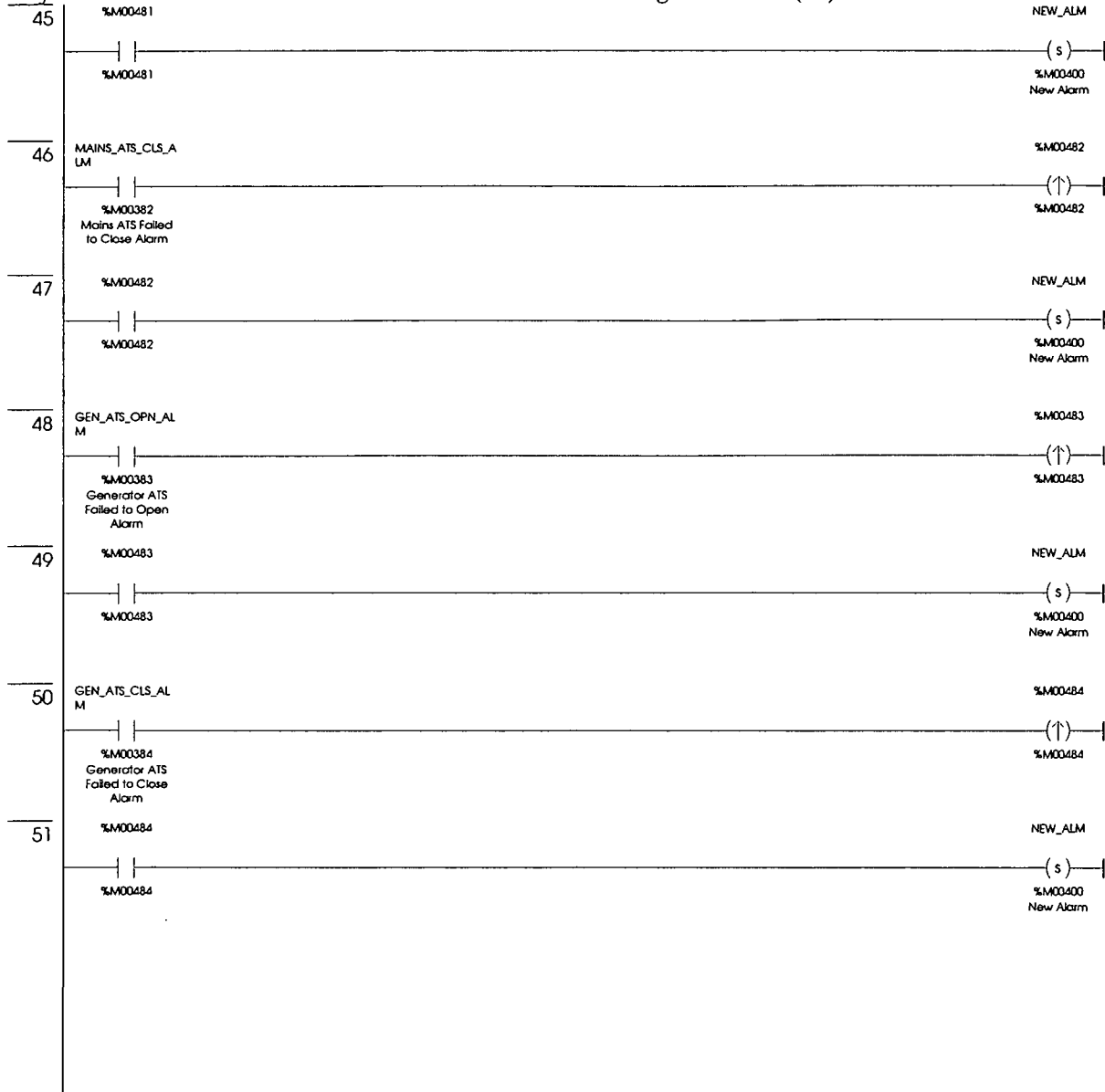
Block Name:..... AUD\_ALM.blk  
Description:..... Control Logic for the Audiable Alarm Logic.  
Block Type:..... Ladder



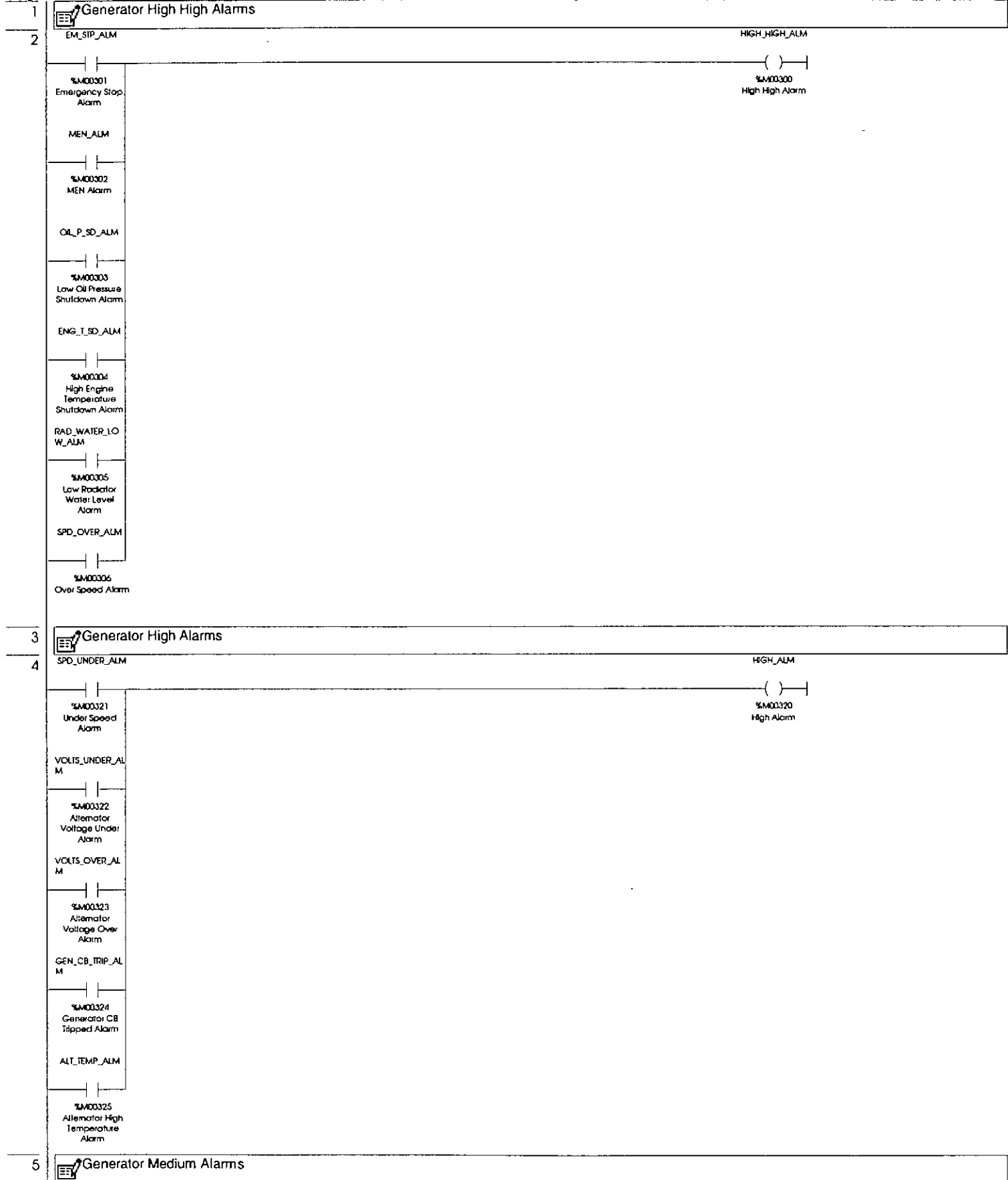


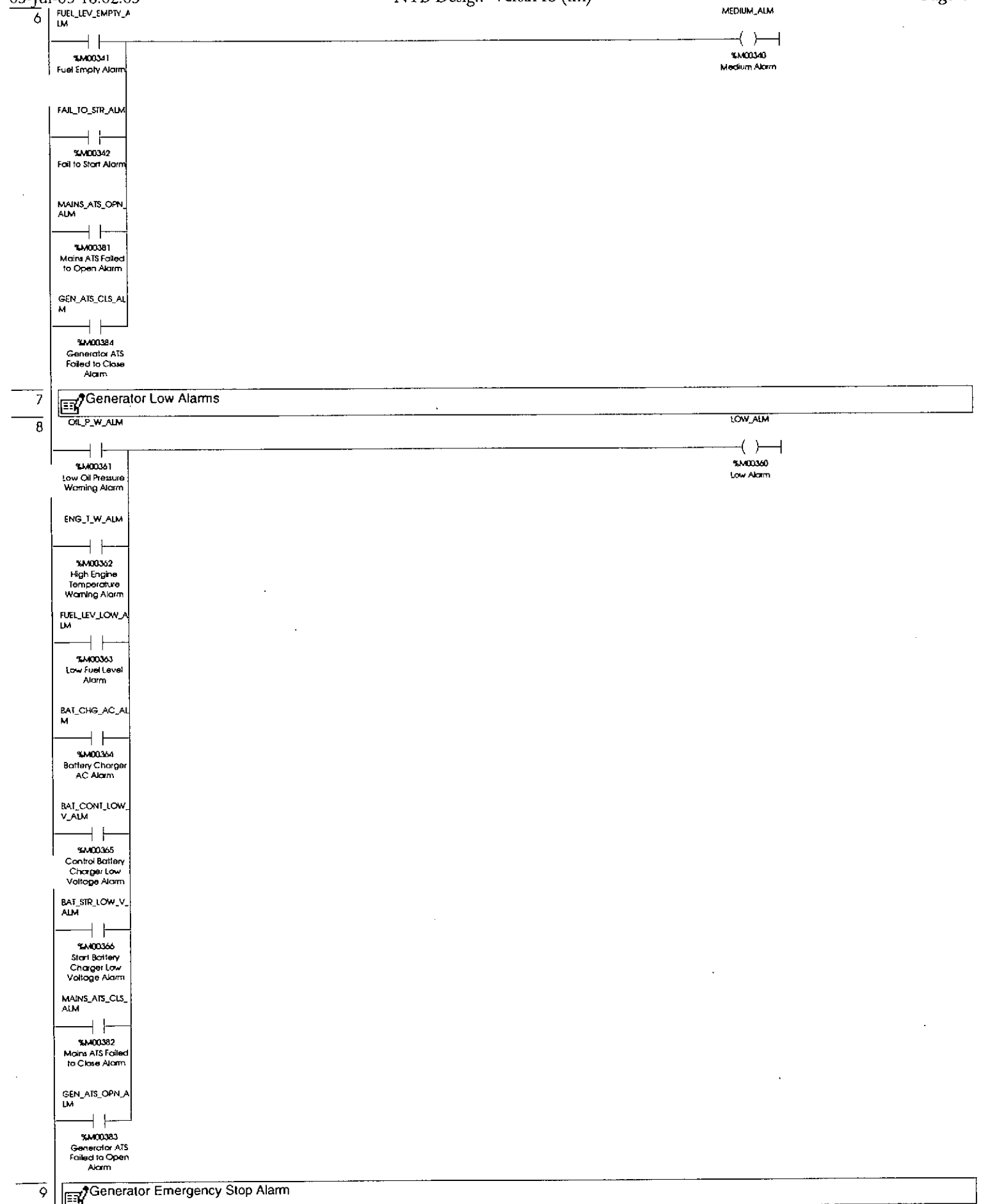


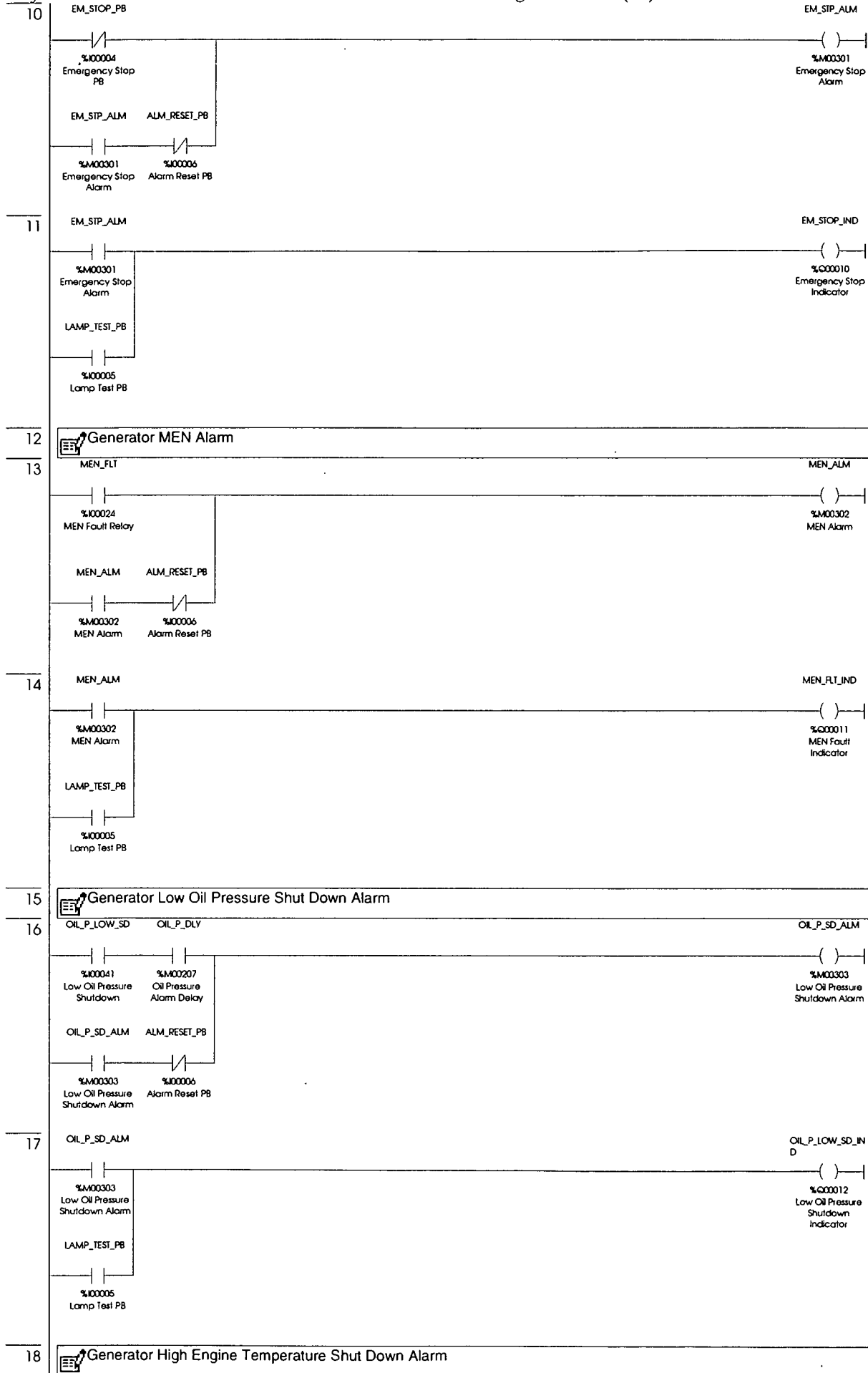


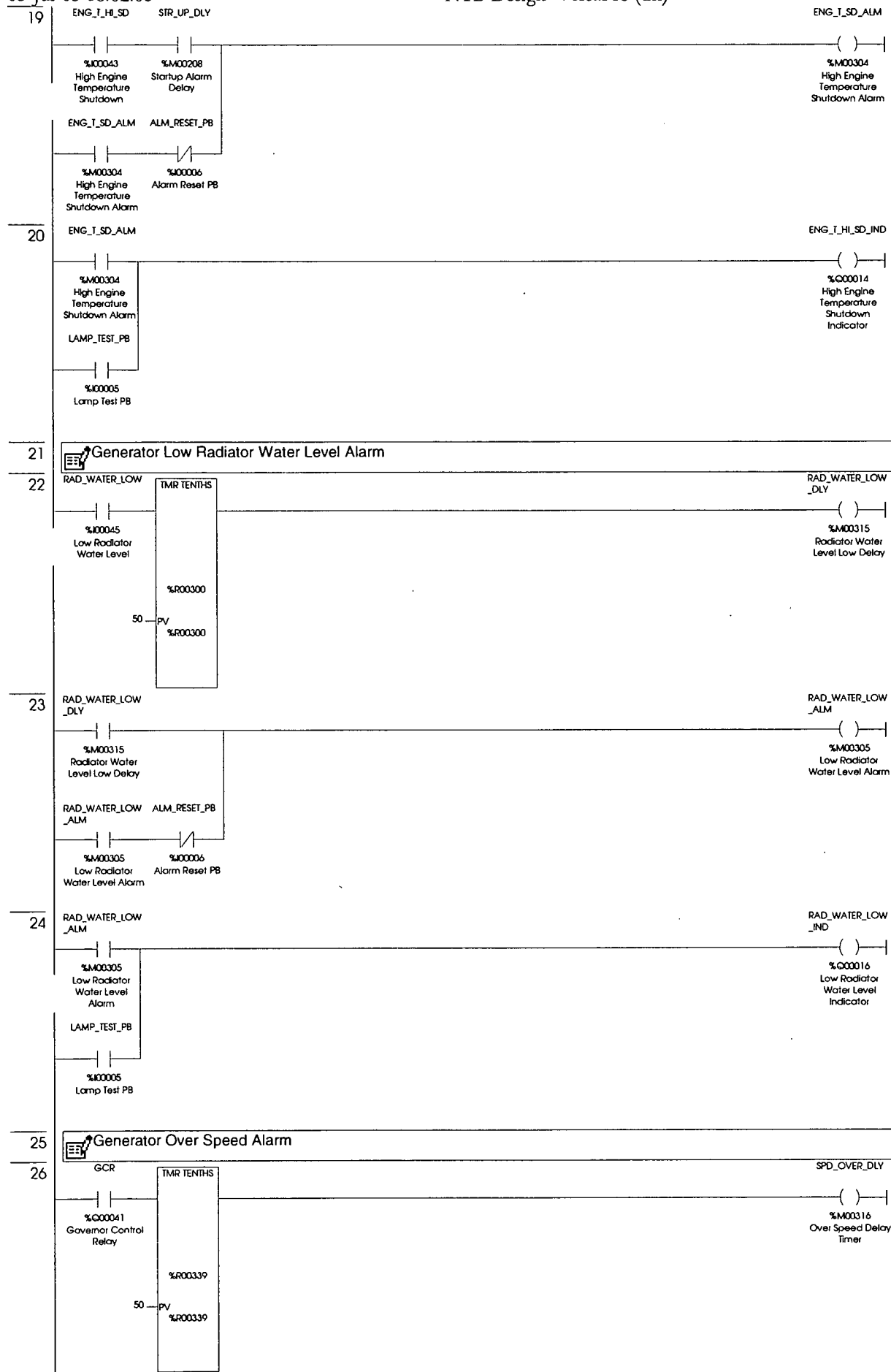


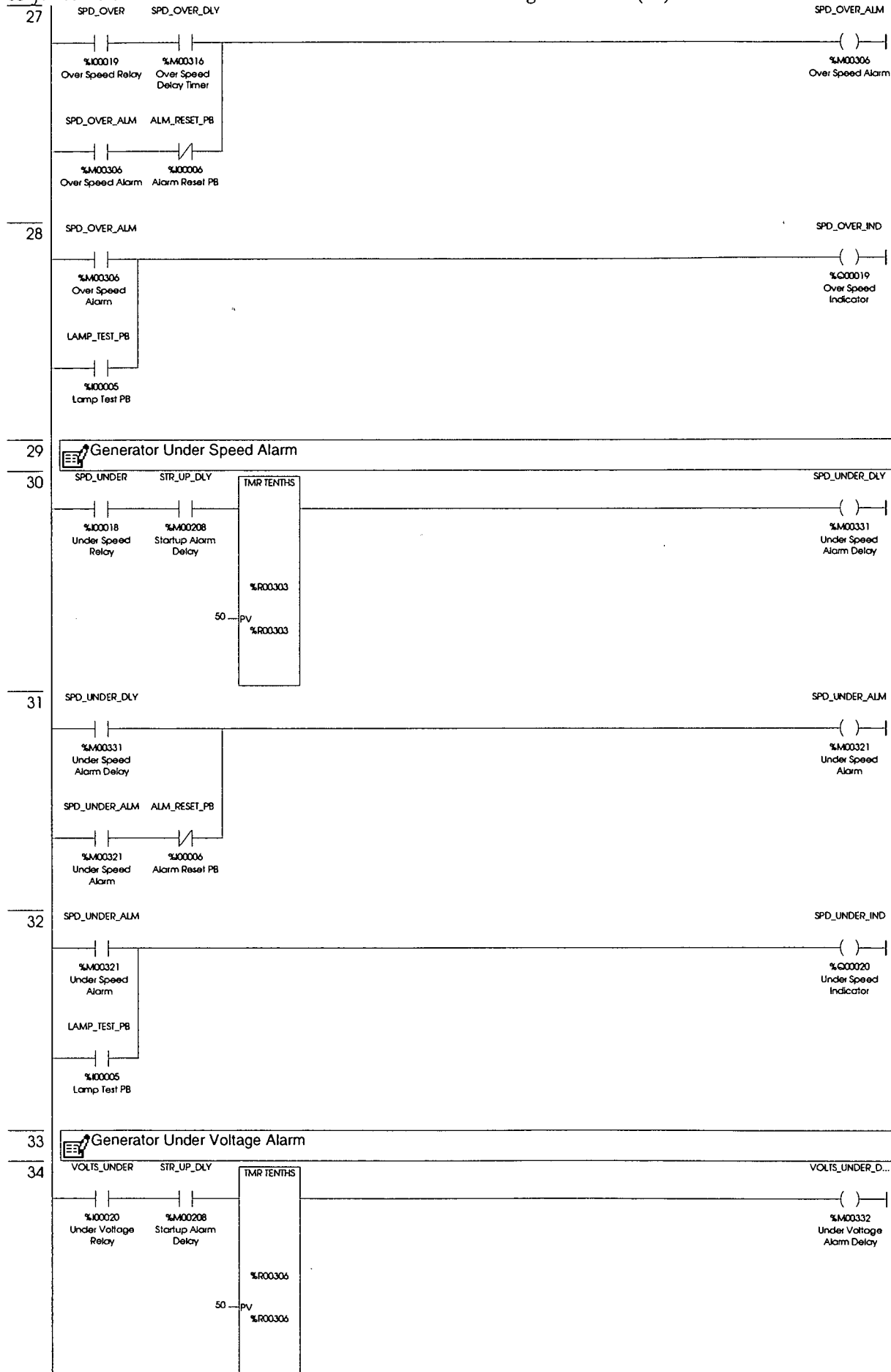
Block Name:.....ALARM.blk  
Description:.....Control Logic for the Generator Alarms.  
Block Type:.....Ladder





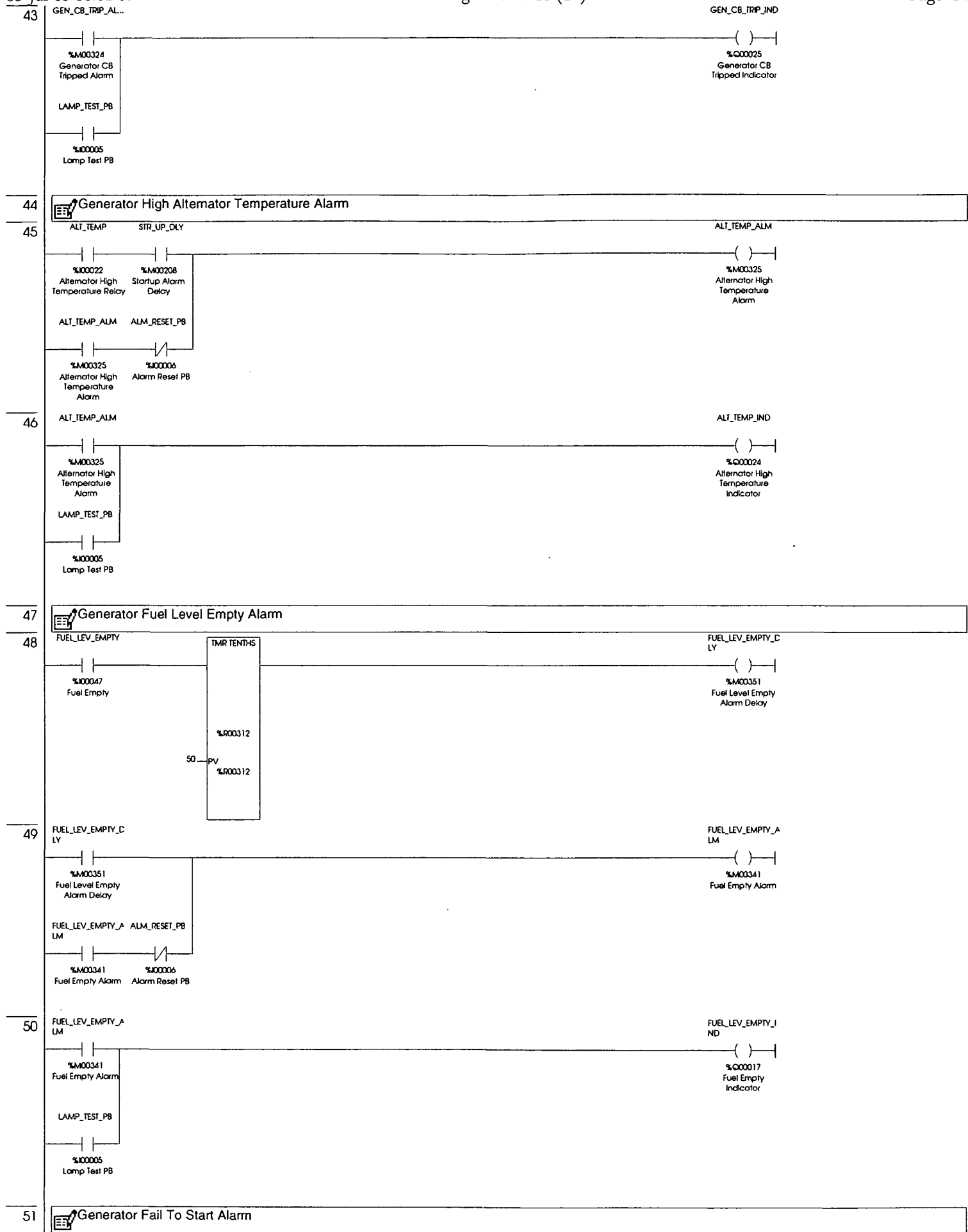


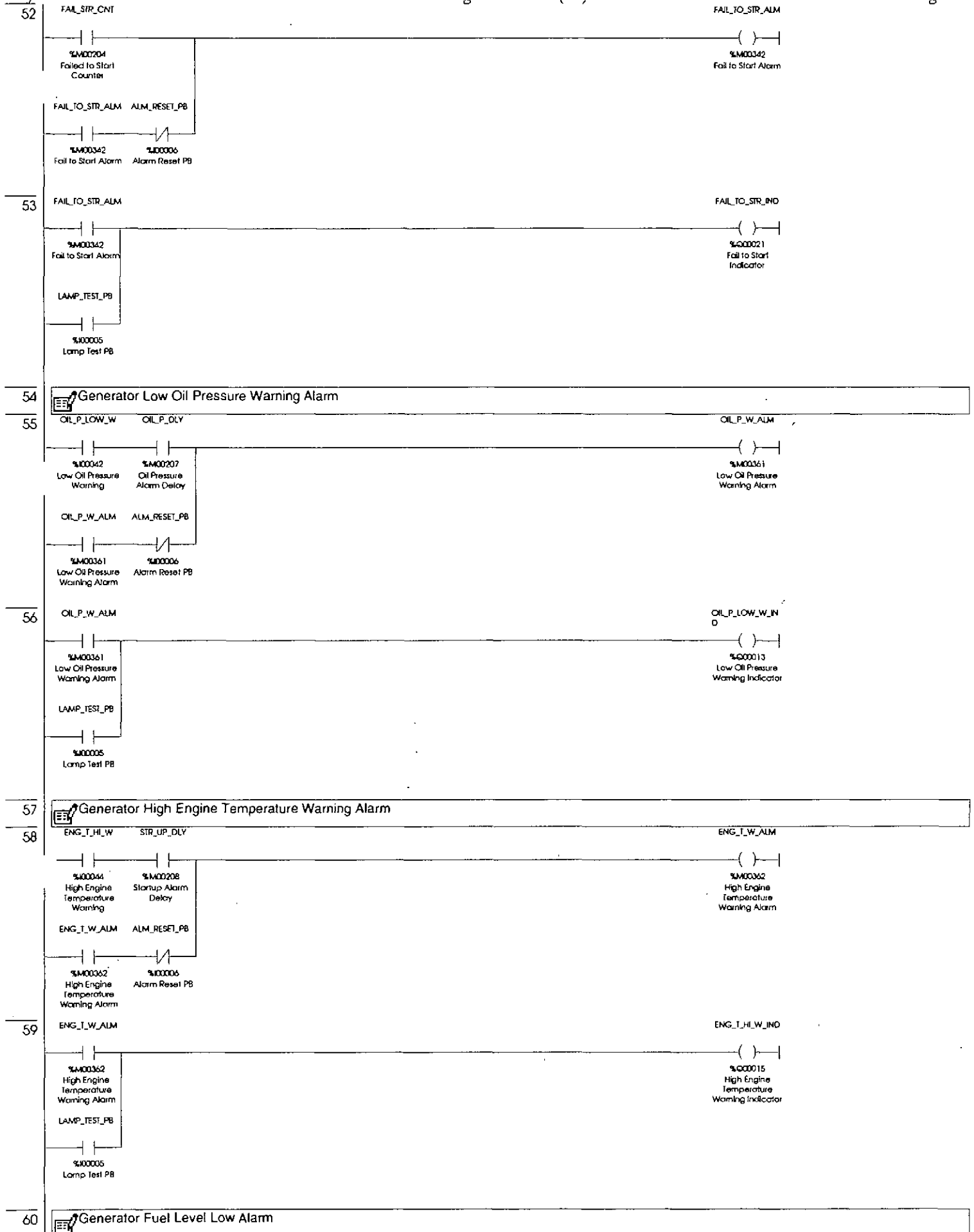


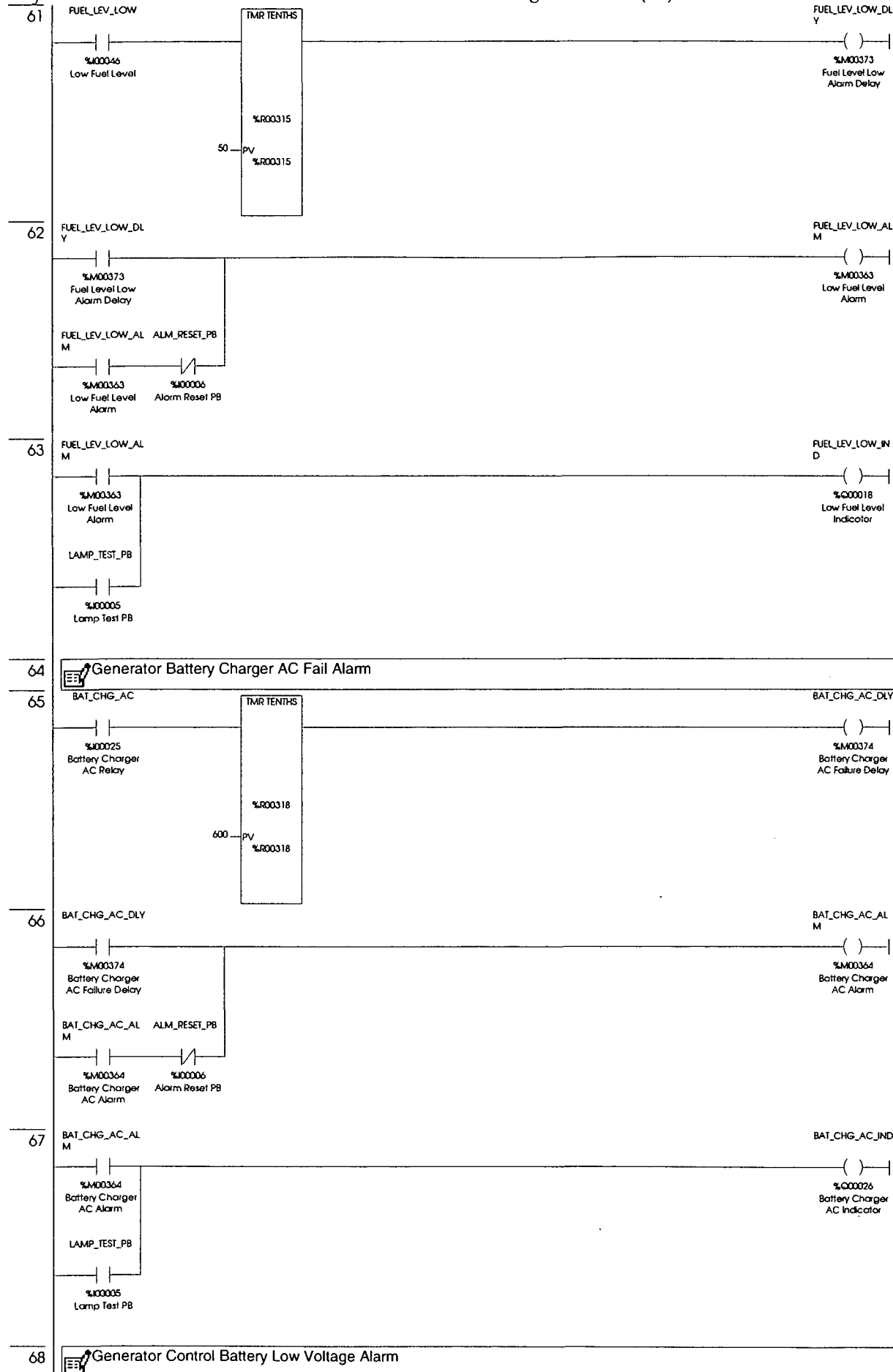


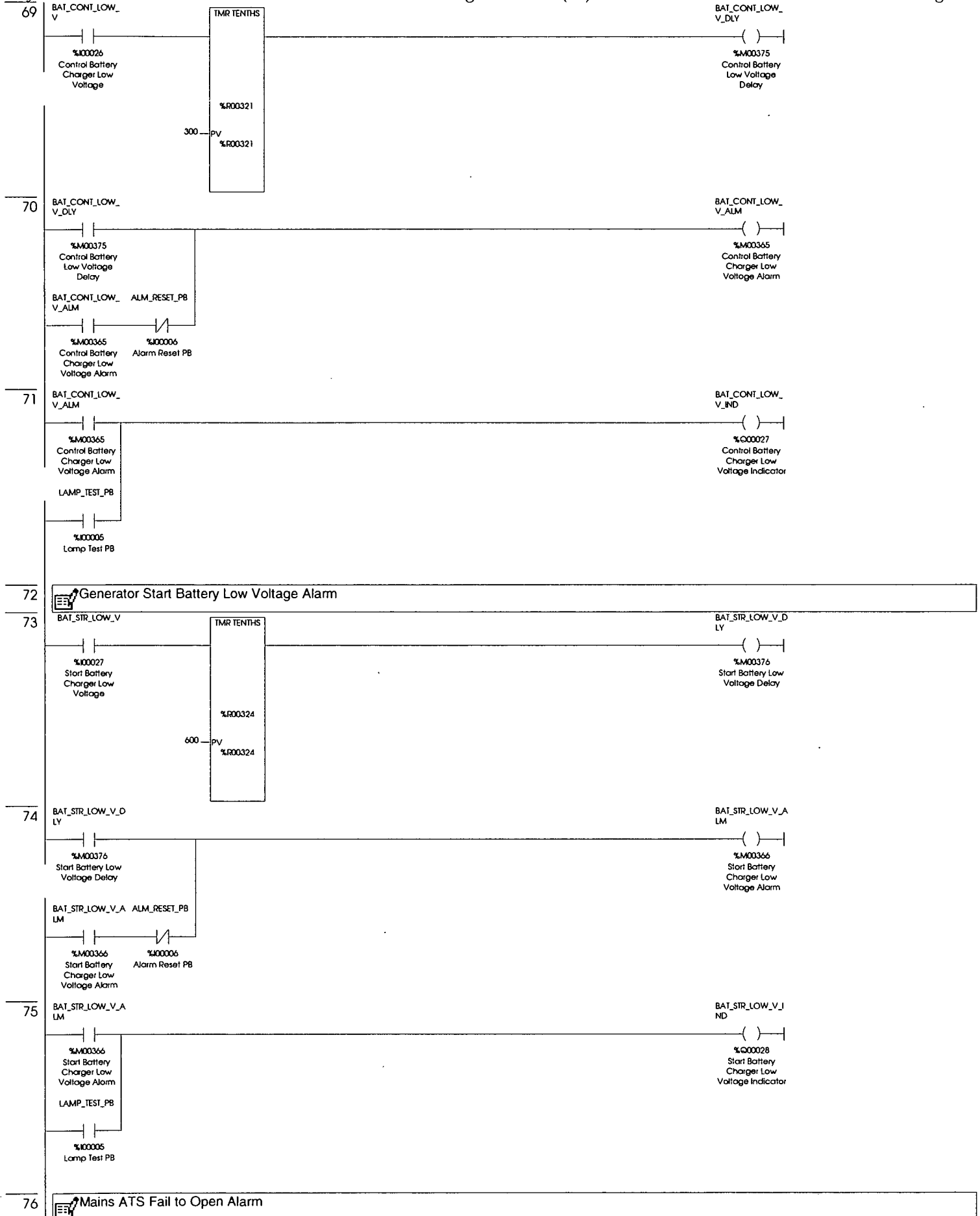


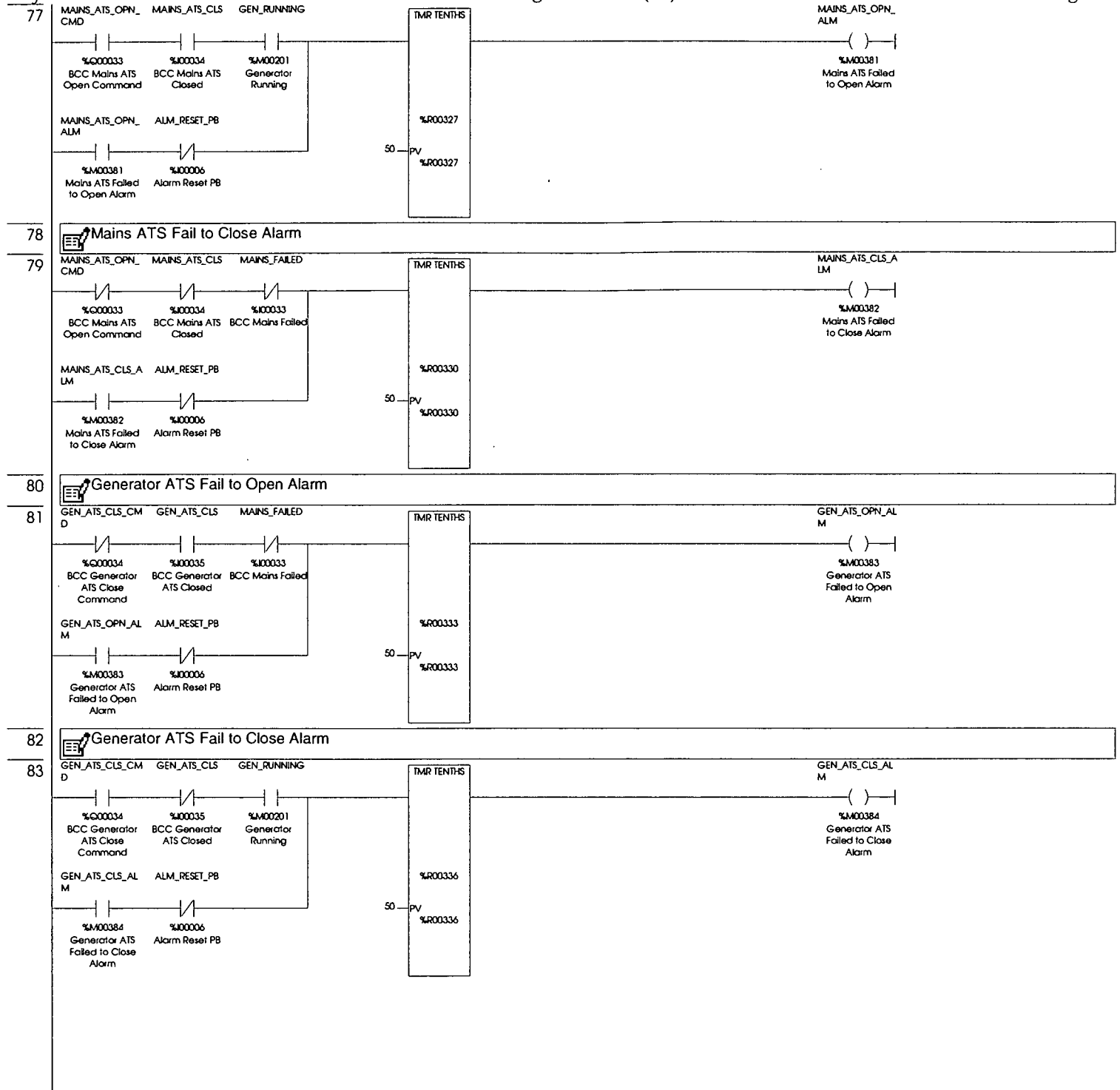




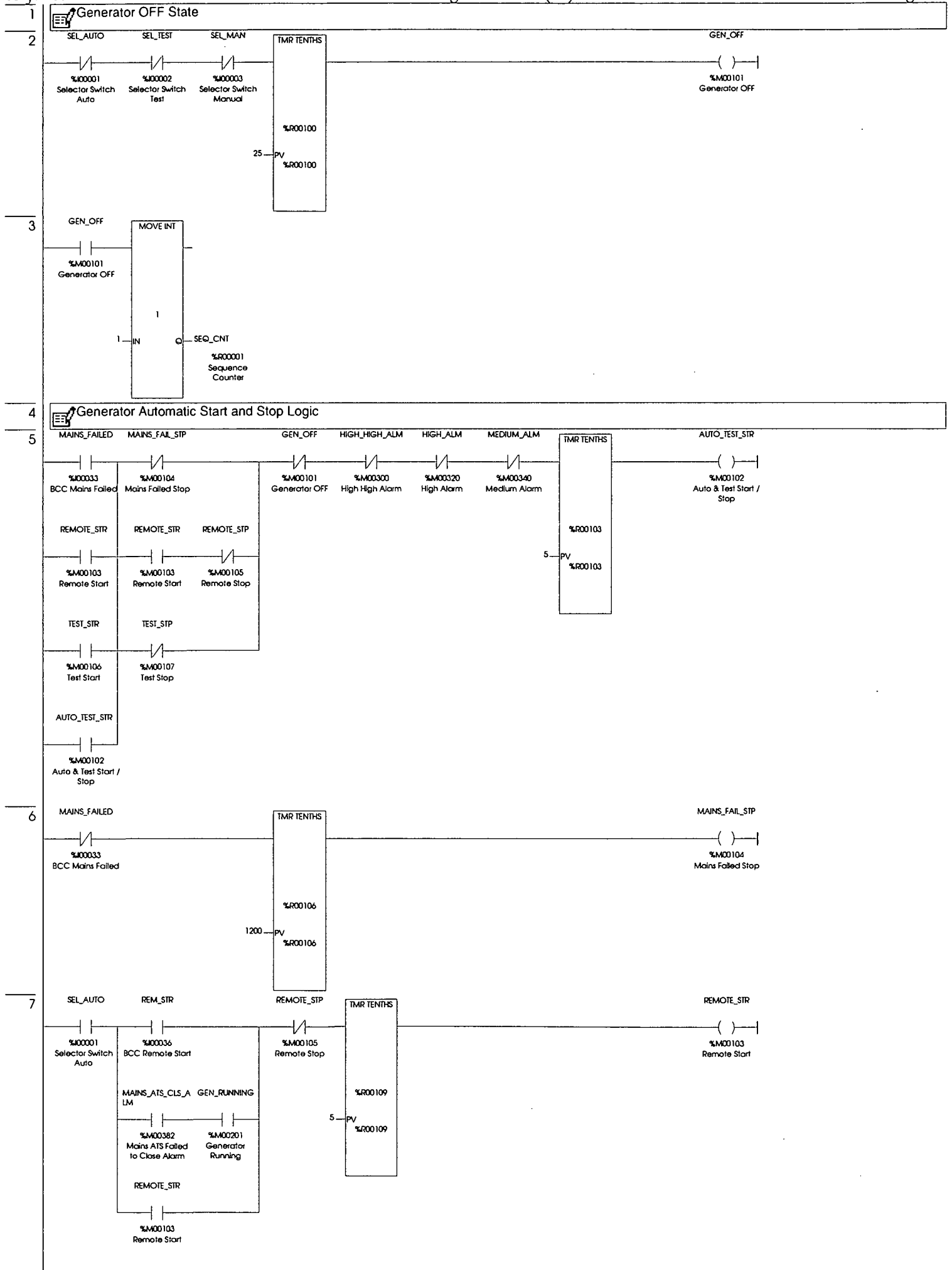




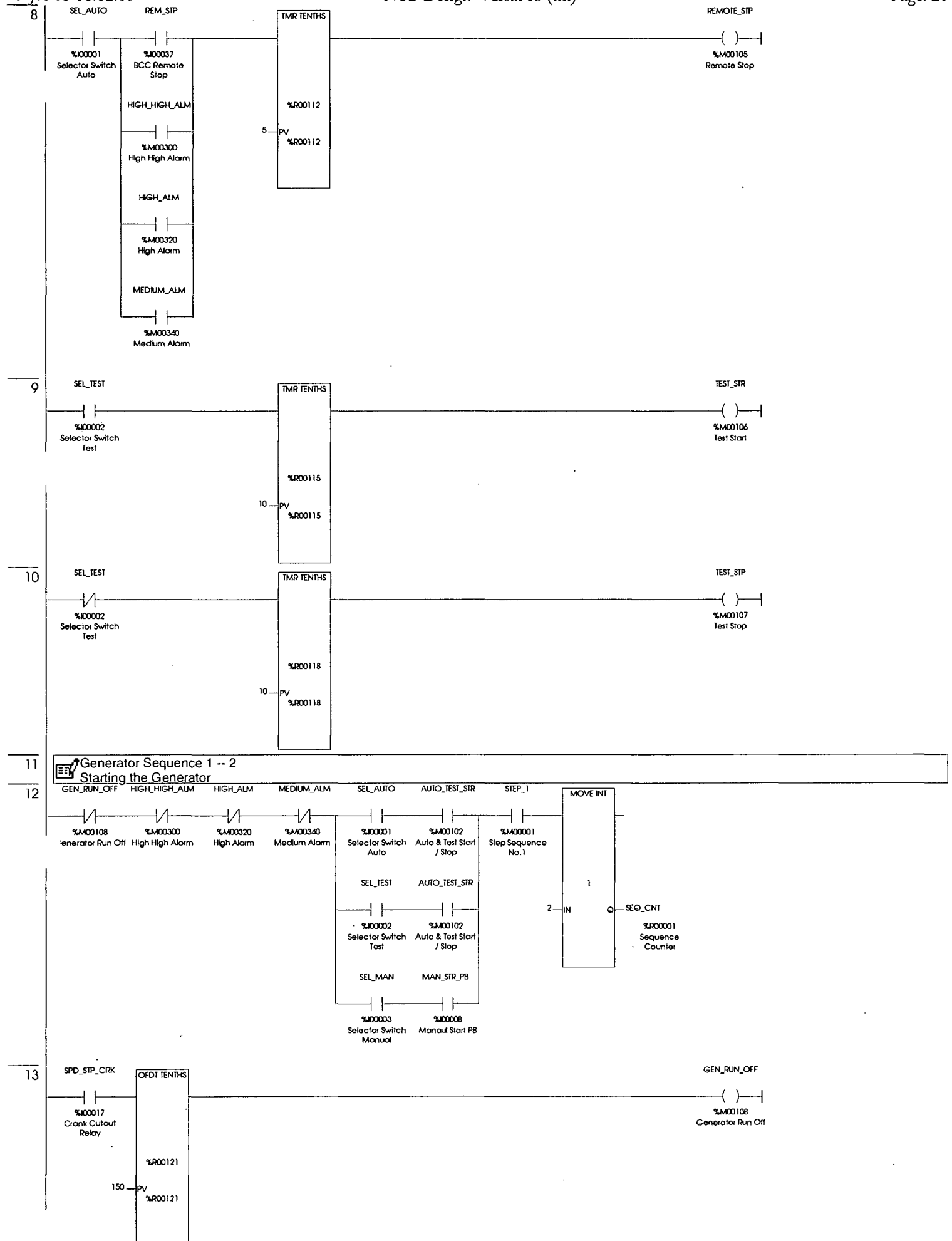


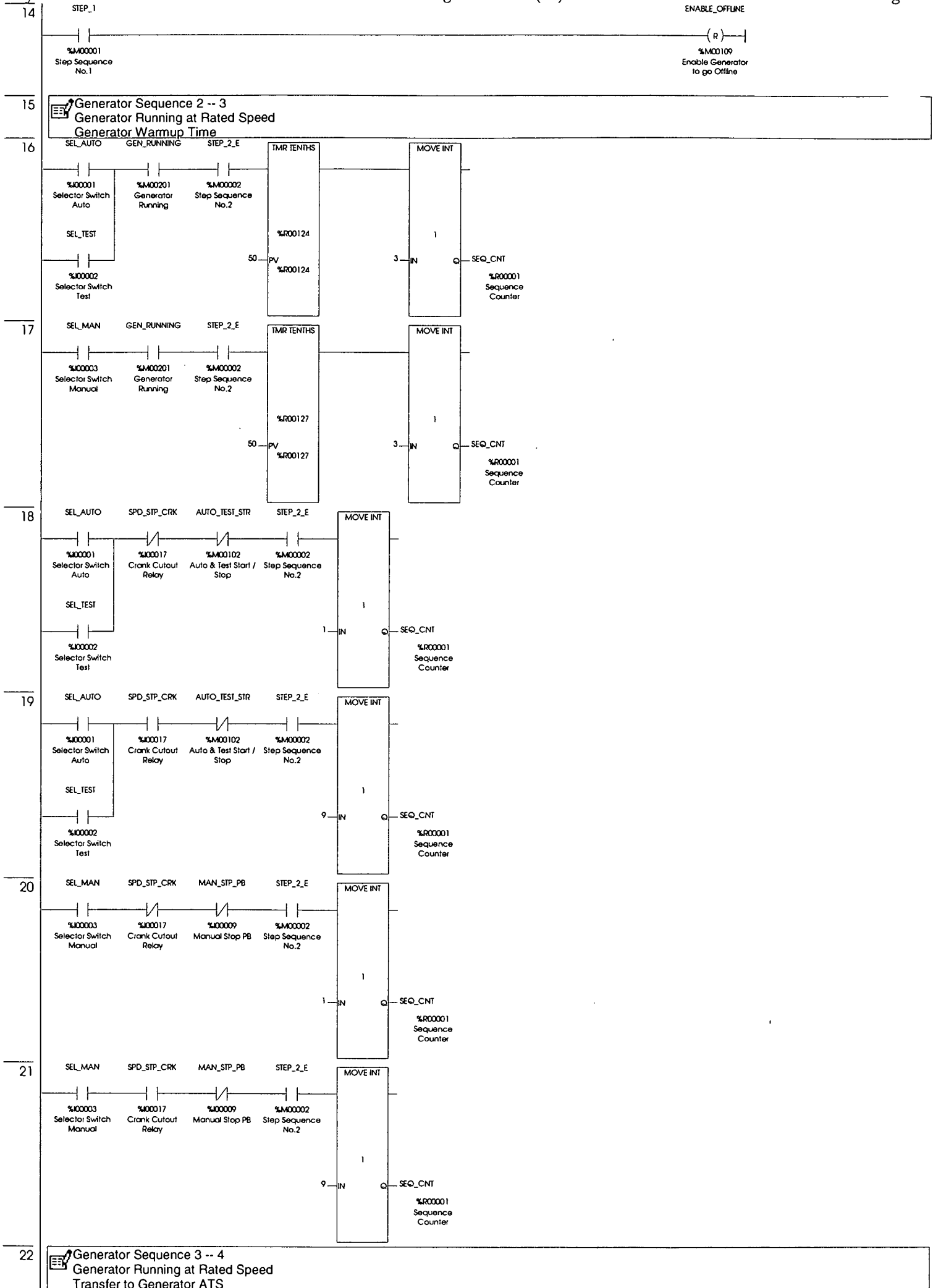


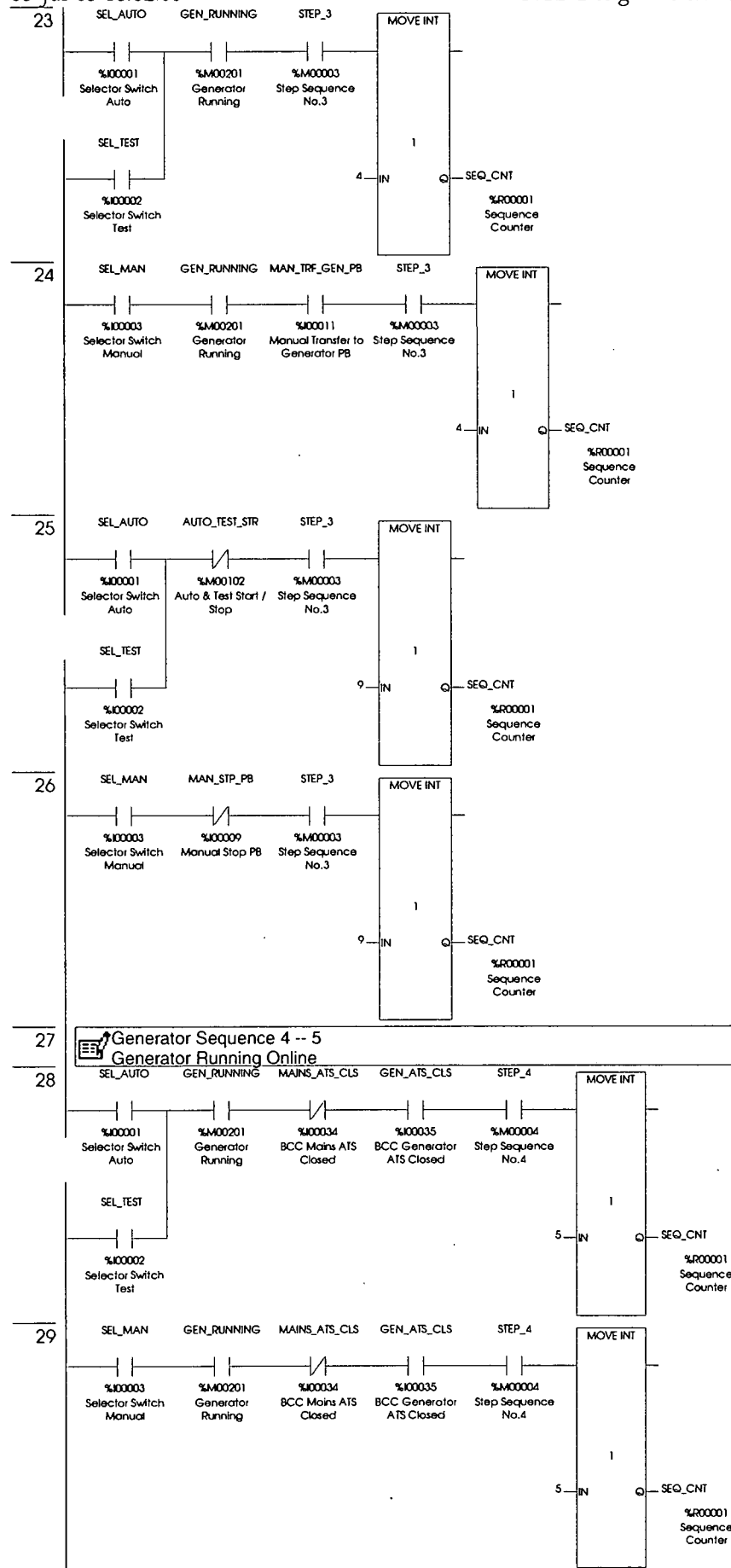
Block Name:.....SEQ.blk  
Description:.....Control Logic for the Generator Operation Sequences.  
Block Type:.....Ladder

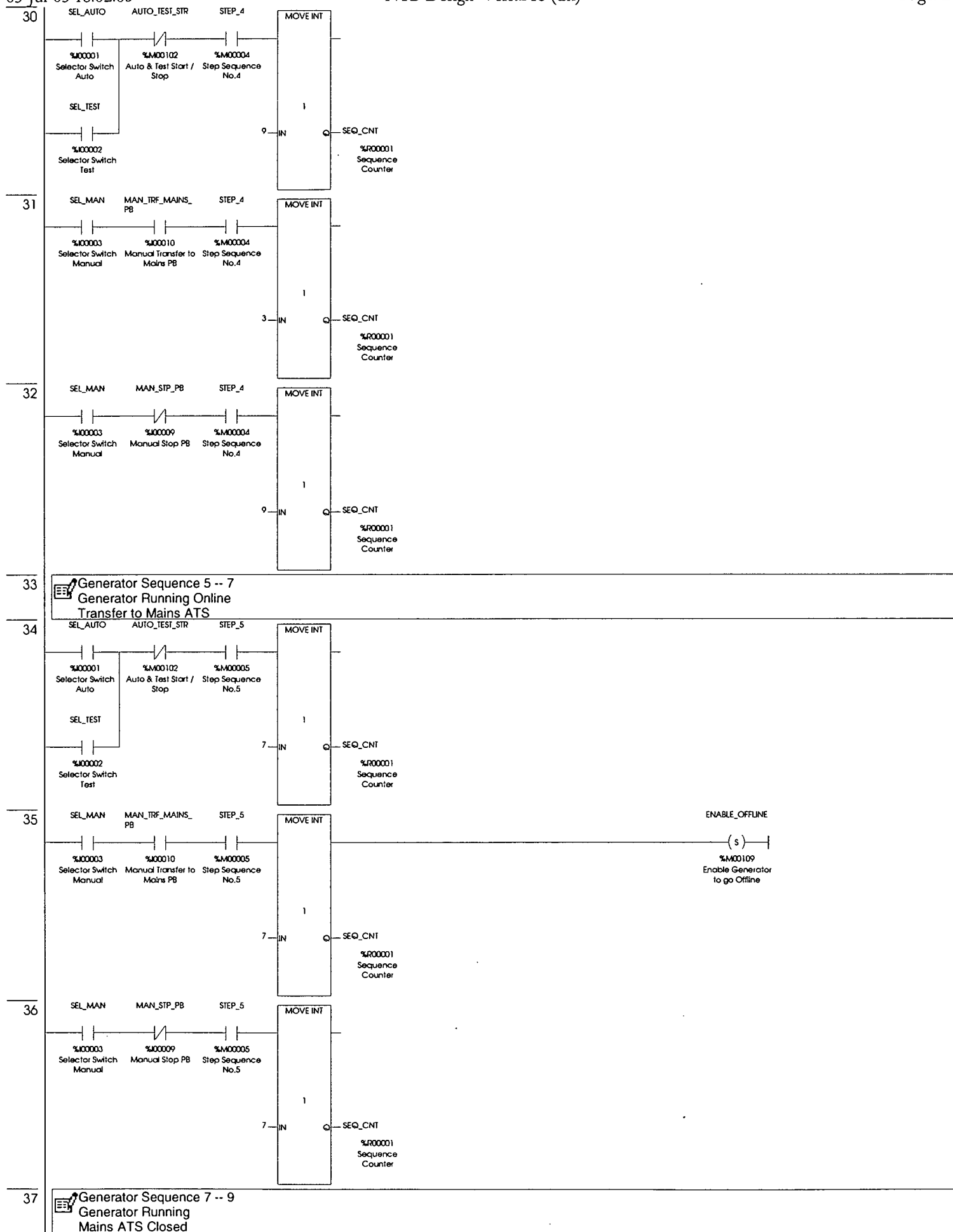


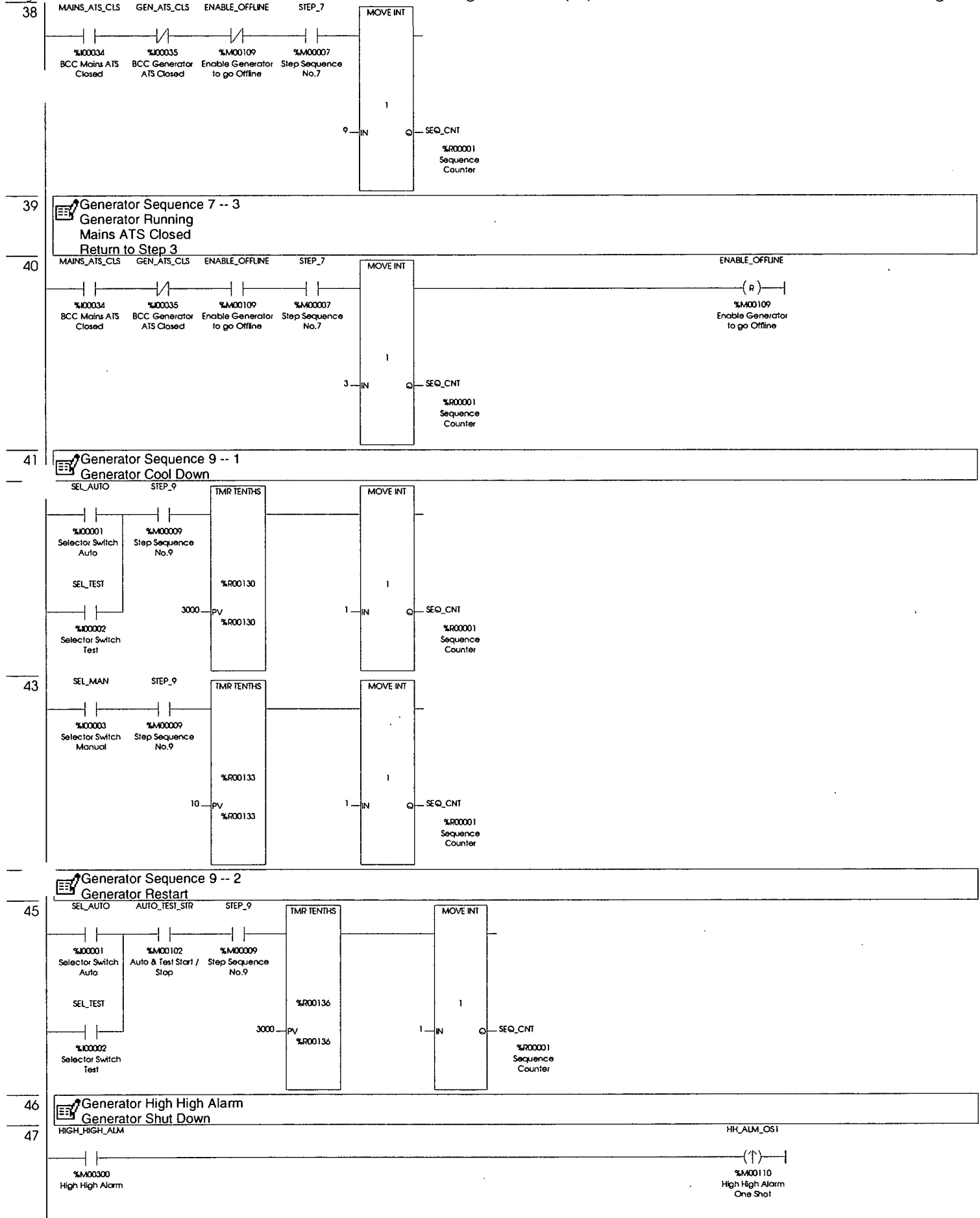


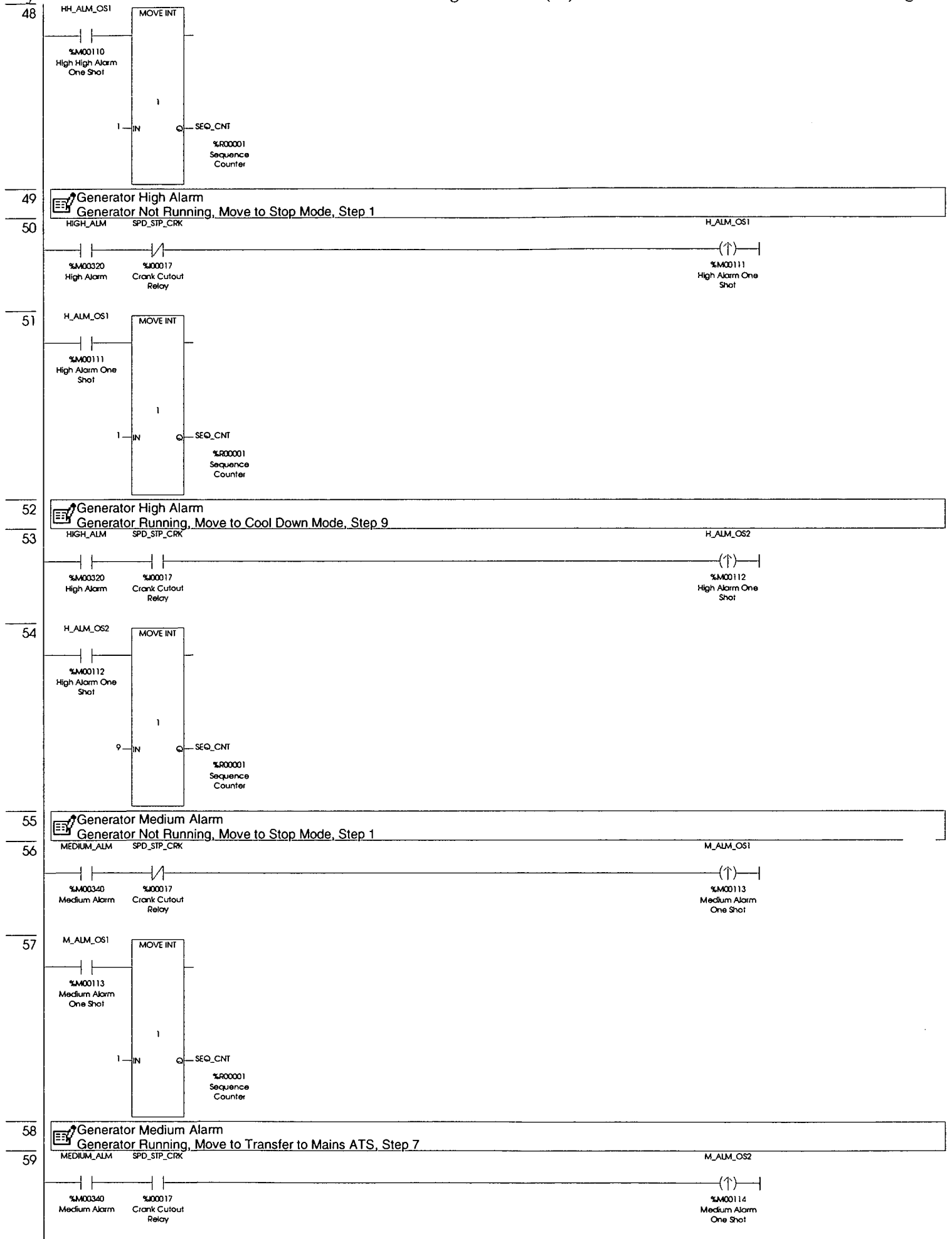


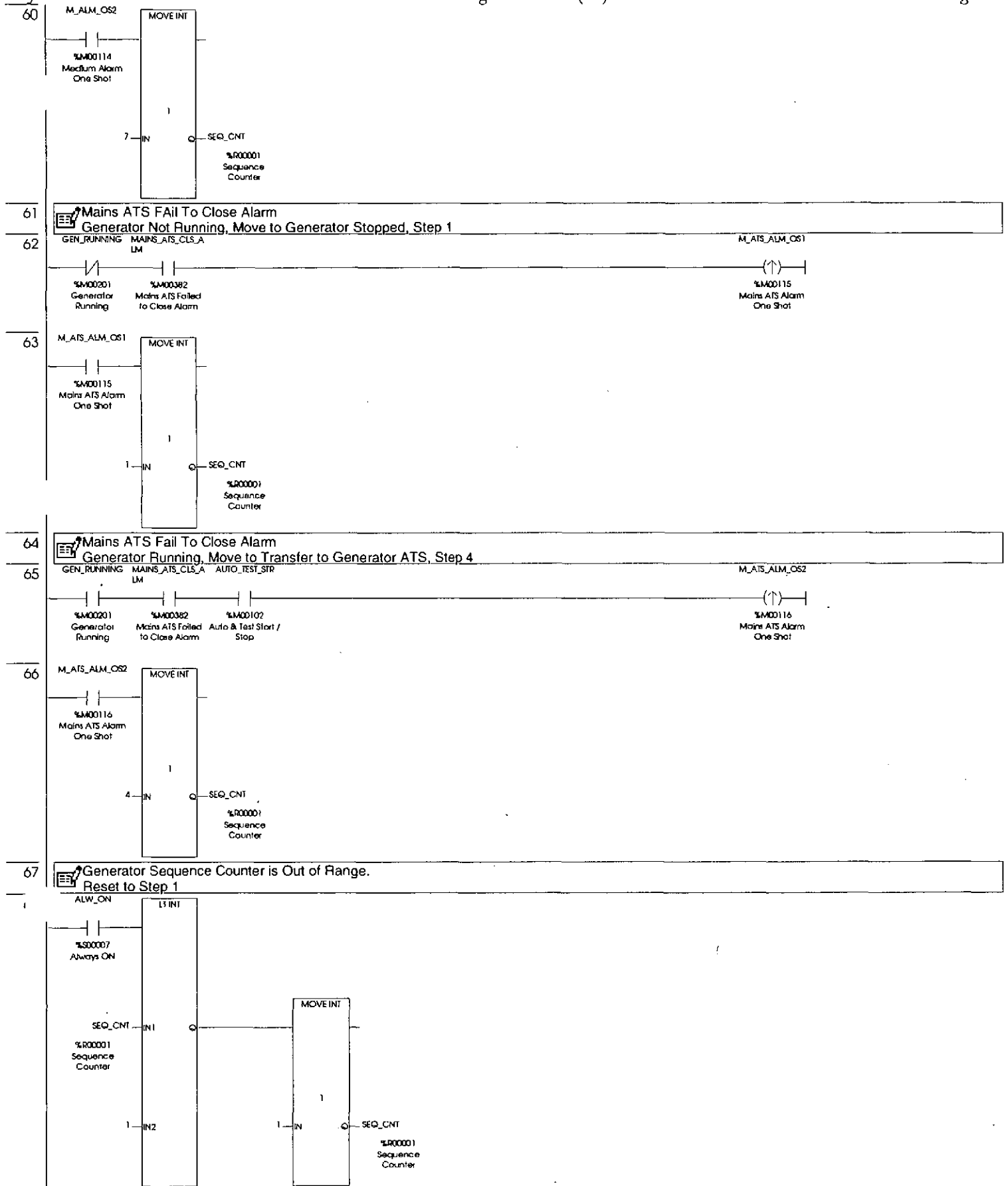


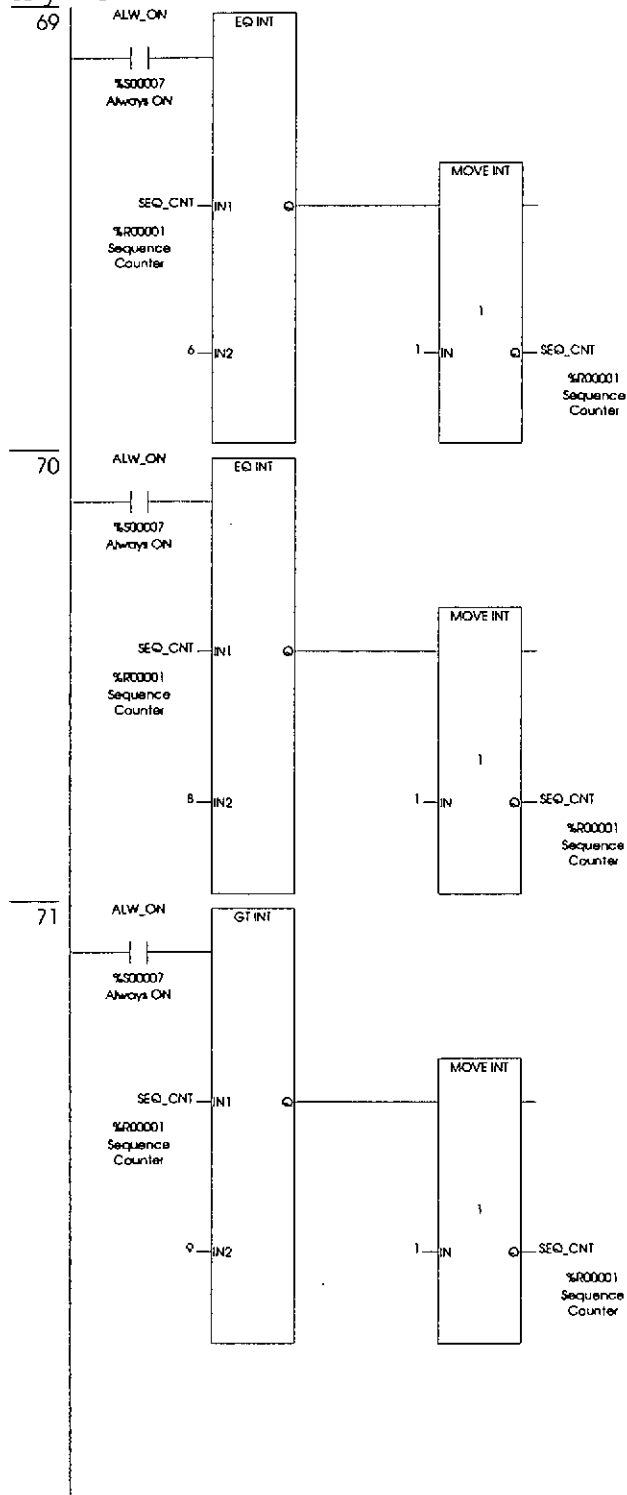






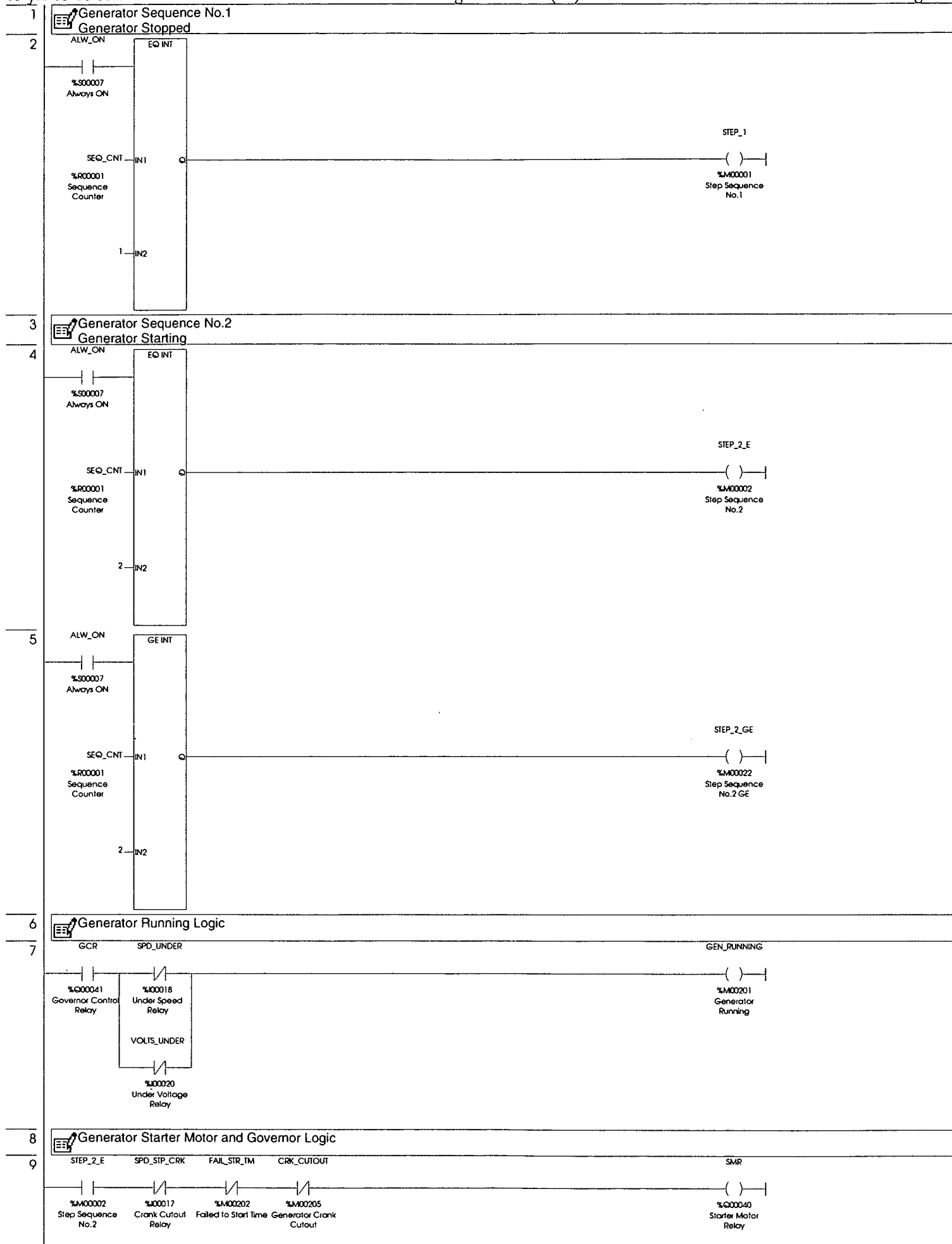


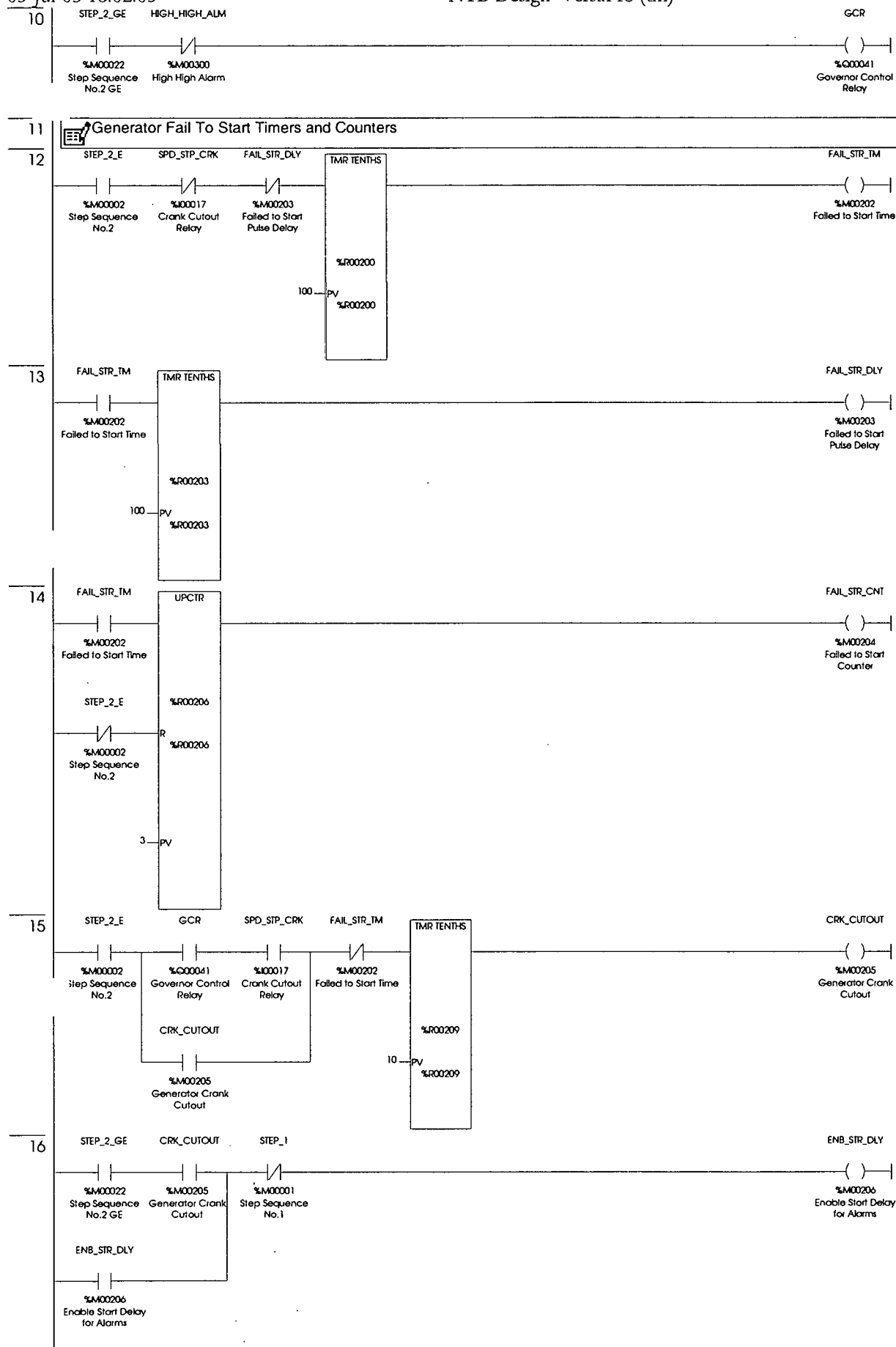


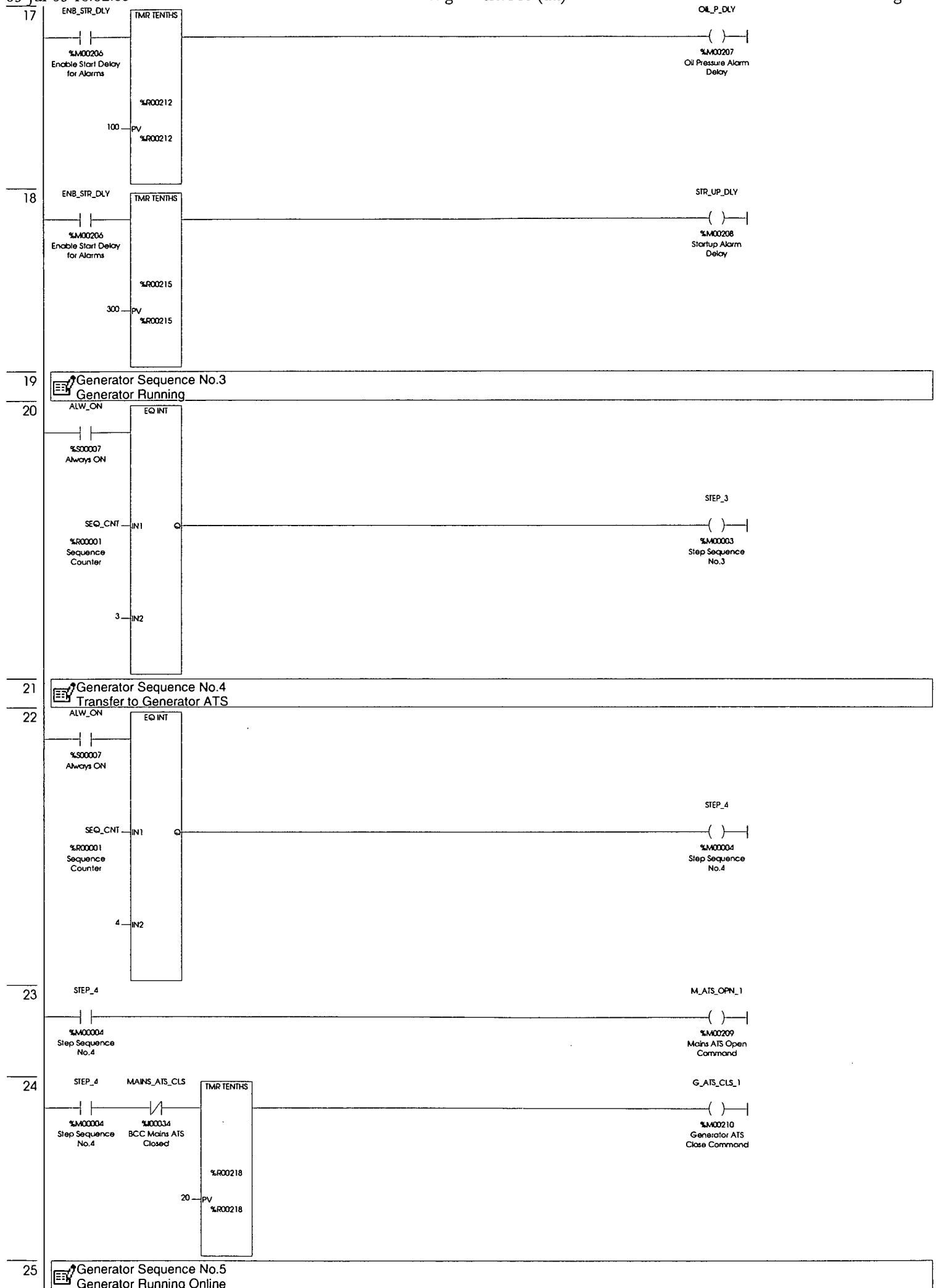


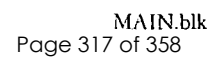


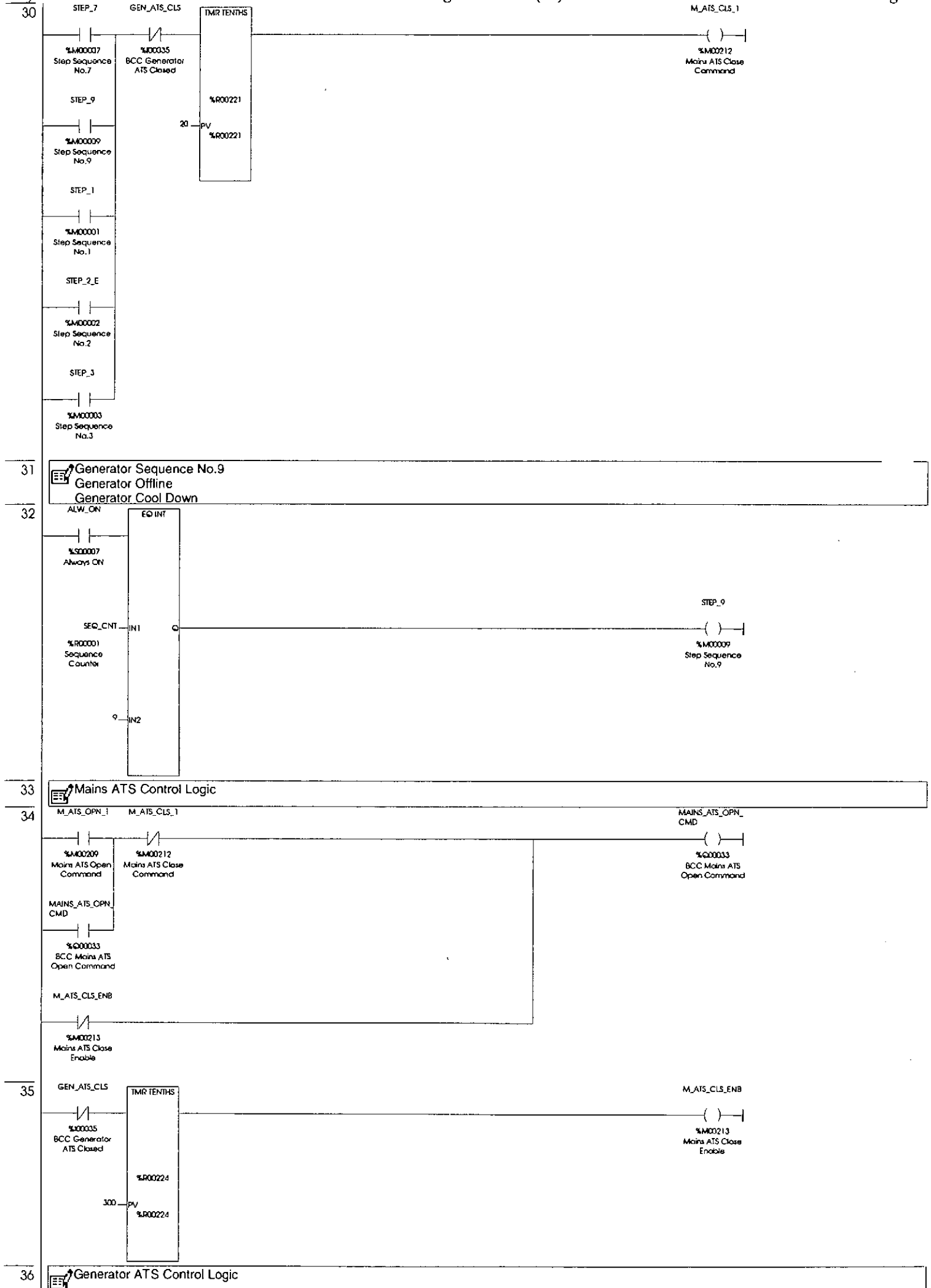
Block Name:..... MAIN.blk  
Description:..... Control Logic for the Generator Sequence Steps.  
Block Type:..... Ladder

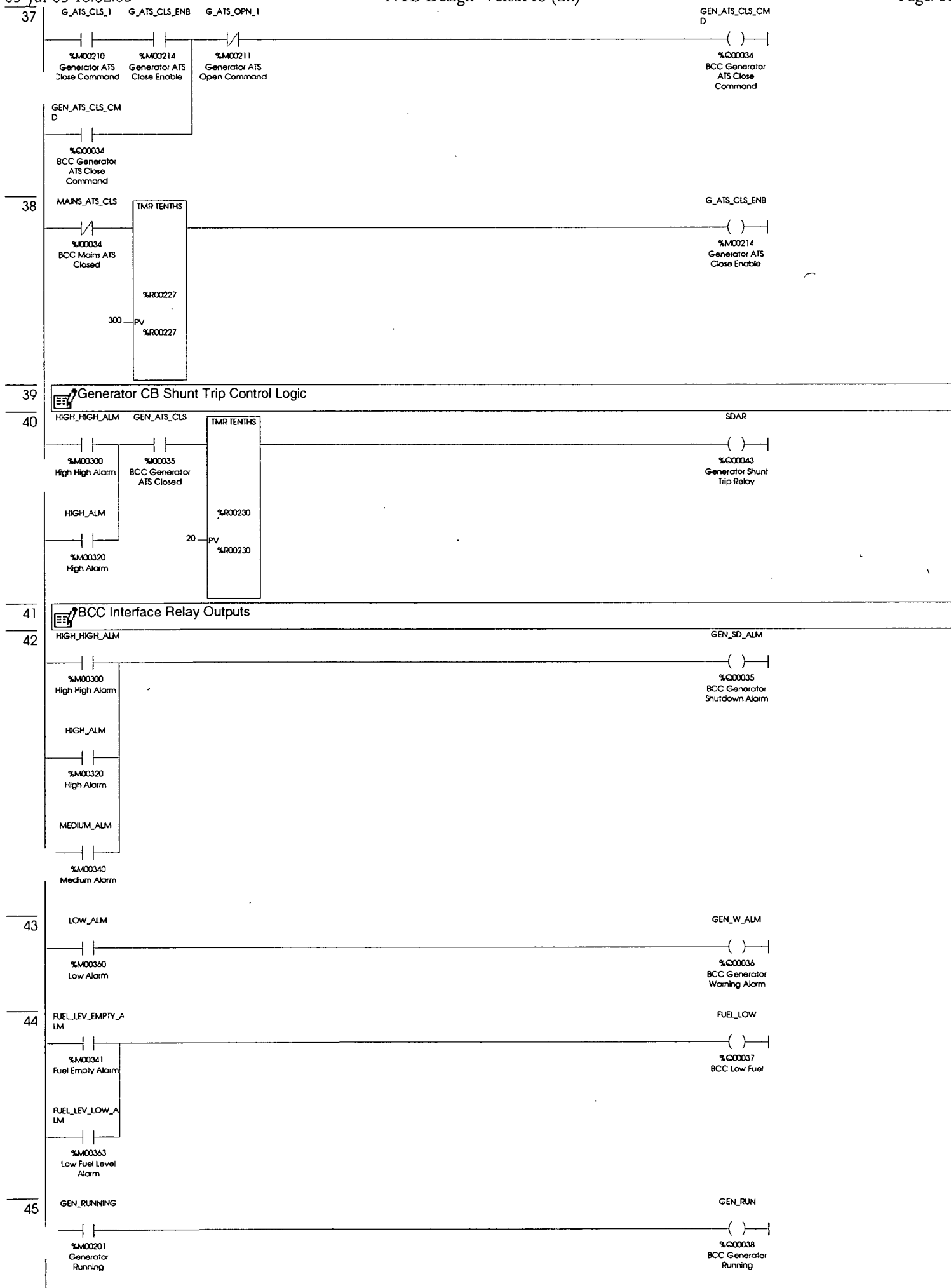


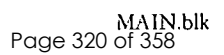




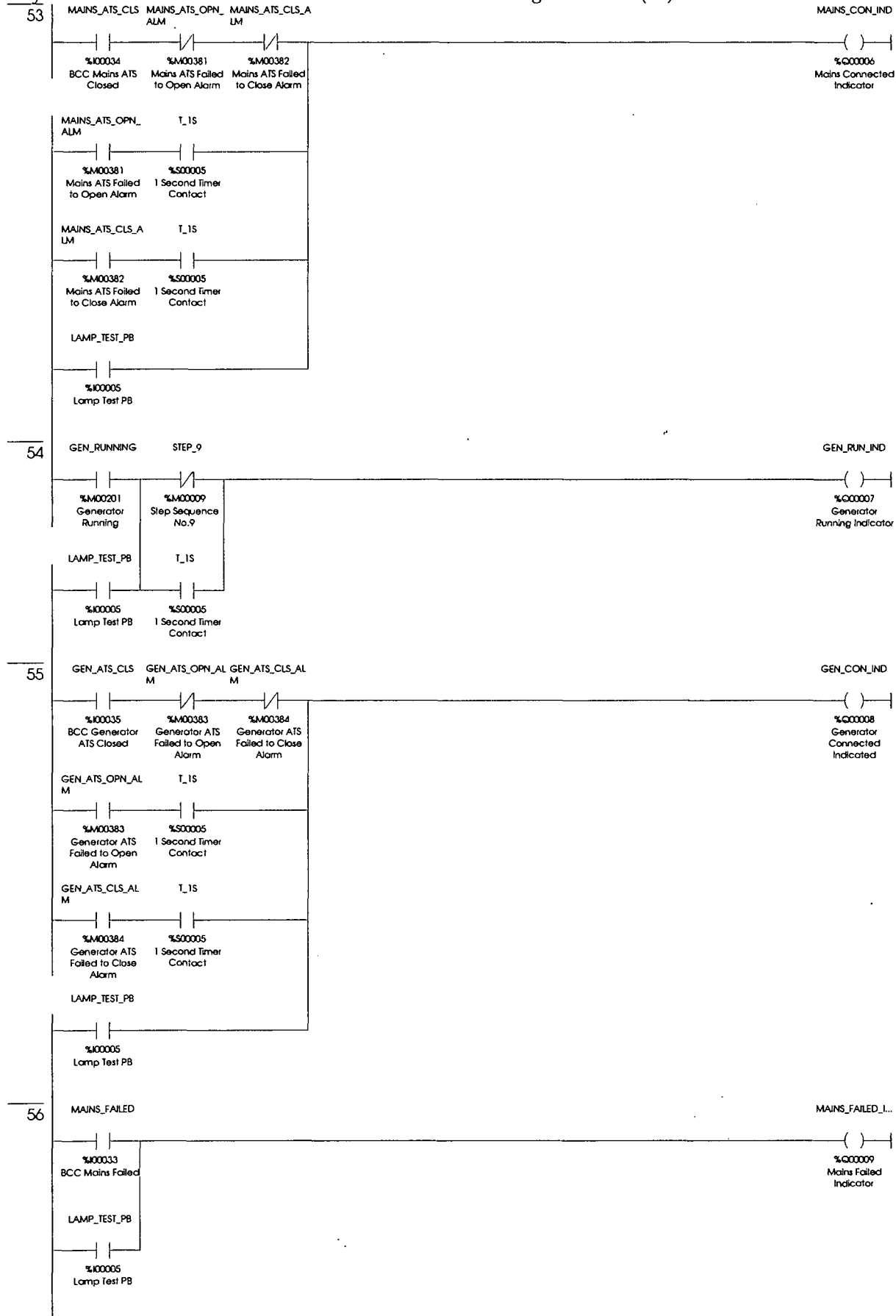


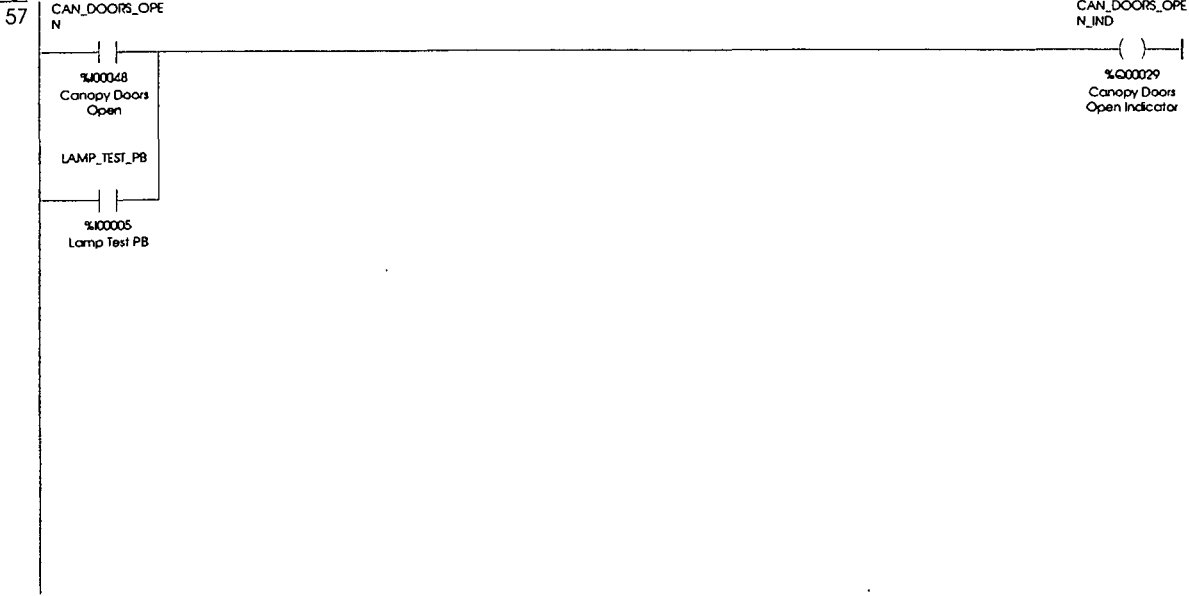




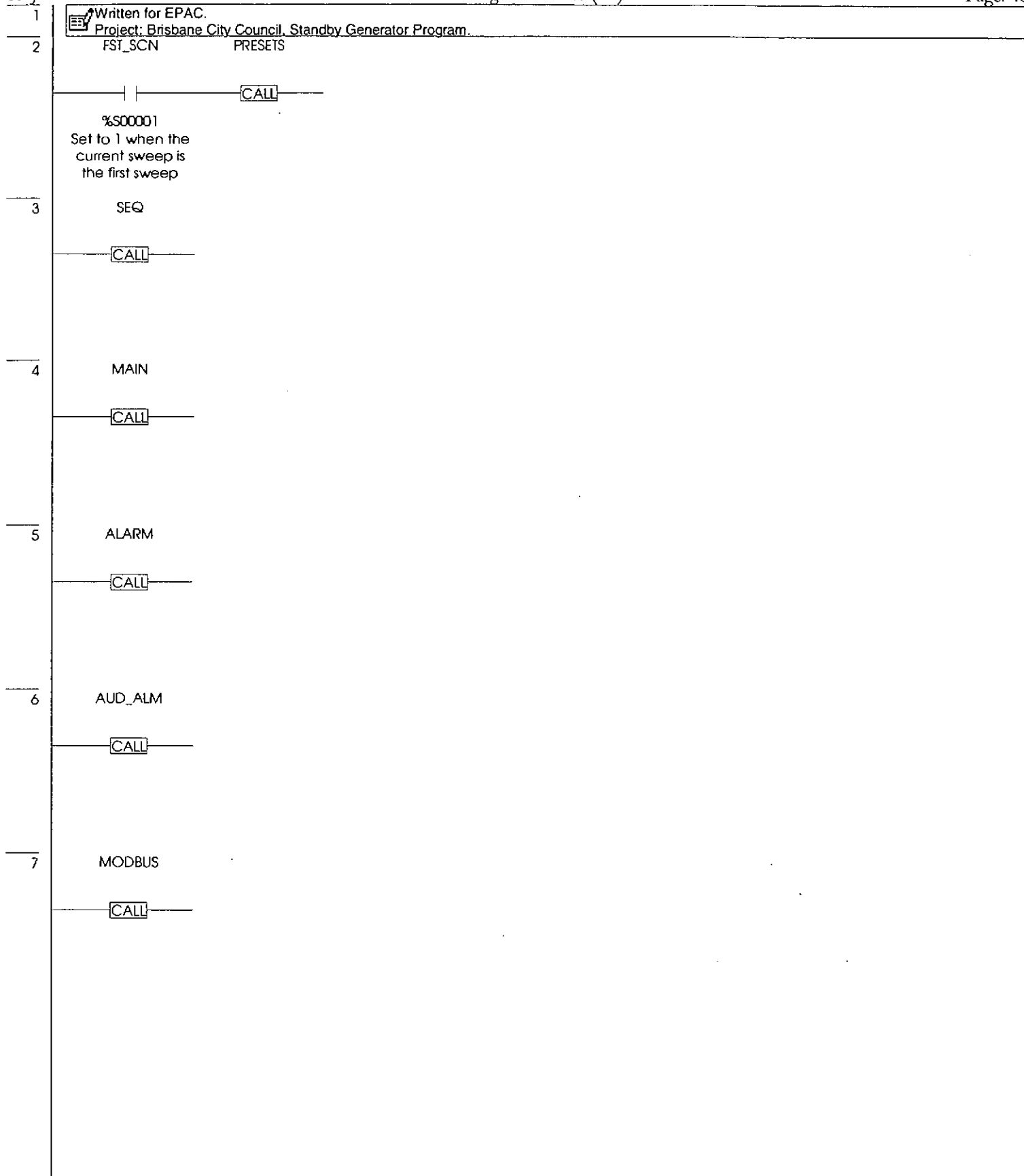




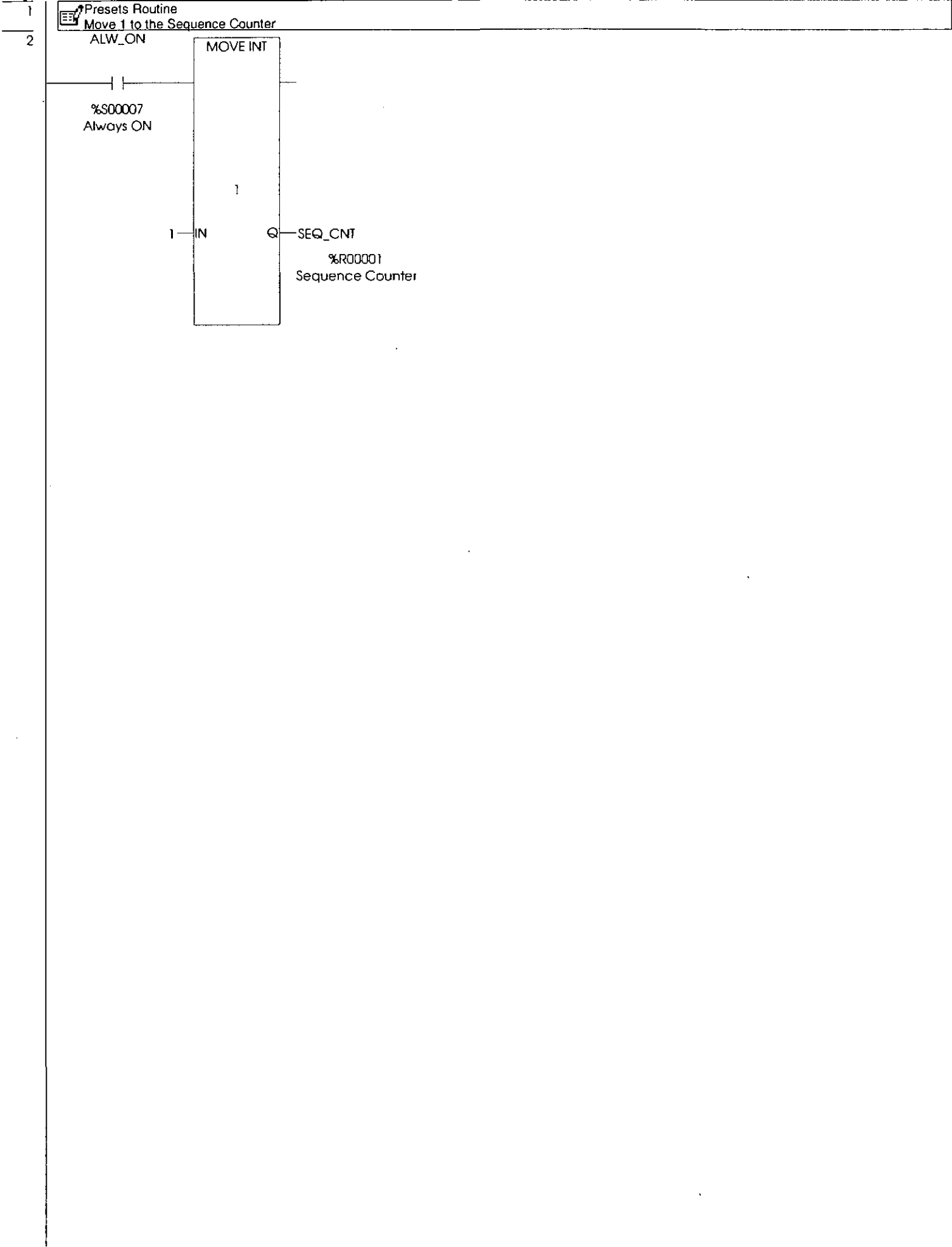




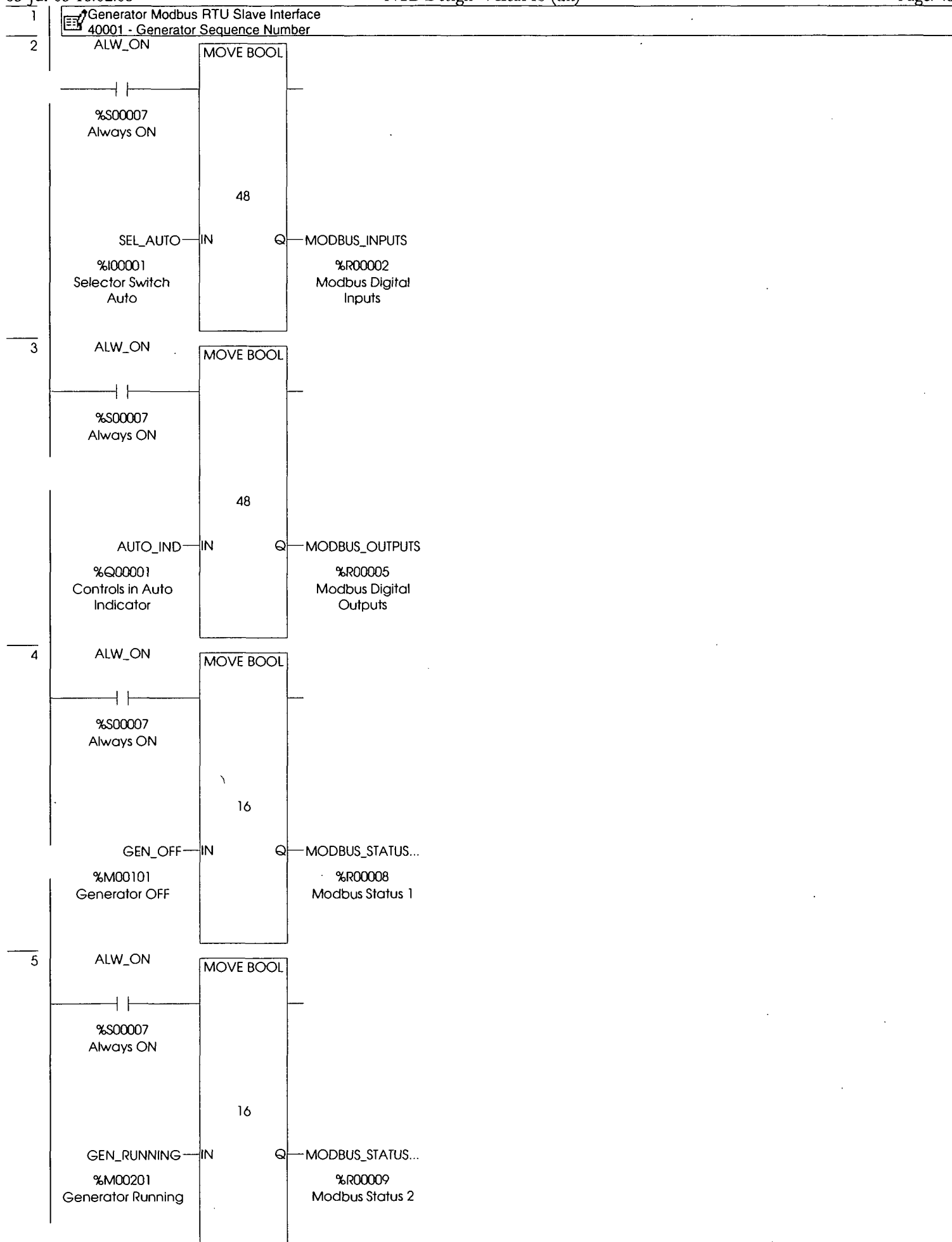
Block Name:.....\_MAIN.blk  
Description:.....Control Logic for the Call for Sub Routines.  
Block Type:.....Ladder



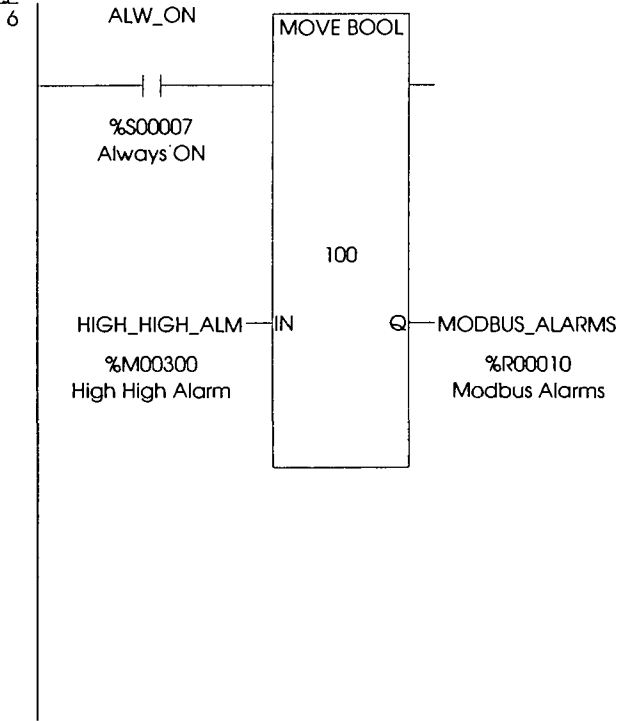
Block Name:.....PRESETS.blk  
Description:.....Control Logic Generator Presets.  
Block Type:.....Ladder



Block Name:.....MODBUS.blk  
Description:.....Control Logic for the Modbus RTU Communications Data.  
Block Type:.....Ladder







## GLOBAL VARIABLES

| Name             | Type | Len | Address | Description                         | Stored Val | Scope  | Ret | Ovr | Ext |
|------------------|------|-----|---------|-------------------------------------|------------|--------|-----|-----|-----|
| SE _JTO          | BIT  | 1   | %I00001 | Selector Switch Auto                |            | Global | R   |     |     |
| SE _EST          | BIT  | 1   | %I00002 | Selector Switch Test                |            | Global | R   |     |     |
| SEL_MAN          | BIT  | 1   | %I00003 | Selector Switch Manual              |            | Global | R   |     |     |
| EM_STOP_PB       | BIT  | 1   | %I00004 | Emergency Stop PB                   |            | Global | R   |     |     |
| LAMP_TEST_PB     | BIT  | 1   | %I00005 | Lamp Test PB                        |            | Global | R   |     |     |
| ALM_RESET_PB     | BIT  | 1   | %I00006 | Alarm Reset PB                      |            | Global | R   |     |     |
| ALM_MUTE_PB      | BIT  | 1   | %I00007 | Alarm Mute PB                       |            | Global | R   |     |     |
| MAN_STR_PB       | BIT  | 1   | %I00008 | Manual Start PB                     |            | Global | R   |     |     |
| MAN_STP_PB       | BIT  | 1   | %I00009 | Manual Stop PB                      |            | Global | R   |     |     |
| MAN_TRF_MAINS_PB | BIT  | 1   | %I00010 | Manual Transfer to Mains PB         |            | Global | R   |     |     |
| MAN_TRF_GEN_PB   | BIT  | 1   | %I00011 | Manual Transfer to Generator PB     |            | Global | R   |     |     |
| SPD_STP_CRK      | BIT  | 1   | %I00017 | Crank Cutout Relay                  |            | Global | R   |     |     |
| SPD_UNDER        | BIT  | 1   | %I00018 | Under Speed Relay                   |            | Global | R   |     |     |
| SPD_OVER         | BIT  | 1   | %I00019 | Over Speed Relay                    |            | Global | R   |     |     |
| VOLTS_UNDER      | BIT  | 1   | %I00020 | Under Voltage Relay                 |            | Global | R   |     |     |
| VOLTS_OVER       | BIT  | 1   | %I00021 | Over Voltage Relay                  |            | Global | R   |     |     |
| ALT_TEMP         | BIT  | 1   | %I00022 | Alternator High Temperature Relay   |            | Global | R   |     |     |
| GEN_CB_TRIP      | BIT  | 1   | %I00023 | Generator CB Tripped                |            | Global | R   |     |     |
| MEN_FLT          | BIT  | 1   | %I00024 | MEN Fault Relay                     |            | Global | R   |     |     |
| BAT_CHG_AC       | BIT  | 1   | %I00025 | Battery Charger AC Relay            |            | Global | R   |     |     |
| BAT_CONT_LOW_V   | BIT  | 1   | %I00026 | Control Battery Charger Low Voltage |            | Global | R   |     |     |
| BAT_TR_LOW_V     | BIT  | 1   | %I00027 | Start Battery Charger Low Voltage   |            | Global | R   |     |     |
| MAINS_FAILED     | BIT  | 1   | %I00033 | BCC Mains Failed                    |            | Global | R   |     |     |
| MAINS_ATS_CLS    | BIT  | 1   | %I00034 | BCC Mains ATS Closed                |            | Global | R   |     |     |
| GEN_ATS_CLS      | BIT  | 1   | %I00035 | BCC Generator ATS Closed            |            | Global | R   |     |     |
| REM_STR          | BIT  | 1   | %I00036 | BCC Remote Start                    |            | Global | R   |     |     |
| REM_STP          | BIT  | 1   | %I00037 | BCC Remote Stop                     |            | Global | R   |     |     |
| OIL_P_LOW_SD     | BIT  | 1   | %I00041 | Low Oil Pressure Shutdown           |            | Global | R   |     |     |
| OIL_P_LOW_W      | BIT  | 1   | %I00042 | Low Oil Pressure Warning            |            | Global | R   |     |     |
| ENG_T_HI_SD      | BIT  | 1   | %I00043 | High Engine Temperature Shutdown    |            | Global | R   |     |     |
| ENG_T_HI_W       | BIT  | 1   | %I00044 | High Engine Temperature Warning     |            | Global | R   |     |     |
| RAD_WATER_LOW    | BIT  | 1   | %I00045 | Low Radiator Water Level            |            | Global | R   |     |     |
| FUEL_LEV_LOW     | BIT  | 1   | %I00046 | Low Fuel Level                      |            | Global | R   |     |     |
| FUEL_LEV_EMPTY   | BIT  | 1   | %I00047 | Fuel Empty                          |            | Global | R   |     |     |
| CAN_DOORS_OPEN   | BIT  | 1   | %I00048 | Canopy Doors Open                   |            | Global | R   |     |     |
| STEP_1           | BIT  | 1   | %M00001 | Step Sequence No.1                  |            | Global |     |     |     |
| STEP_2_E         | BIT  | 1   | %M00002 | Step Sequence No.2                  |            | Global |     |     |     |
| STEP_3           | BIT  | 1   | %M00003 | Step Sequence No.3                  |            | Global |     |     |     |
| STEP_4           | BIT  | 1   | %M00004 | Step Sequence No.4                  |            | Global |     |     |     |
| STEP_5           | BIT  | 1   | %M00005 | Step Sequence No.5                  |            | Global |     |     |     |
| STEP_6           | BIT  | 1   | %M00006 | Step Sequence No.6                  |            | Global |     |     |     |
| ST_7             | BIT  | 1   | %M00007 | Step Sequence No.7                  |            | Global |     |     |     |
| ST_3             | BIT  | 1   | %M00008 | Step Sequence No.8                  |            | Global |     |     |     |
| STEP_9           | BIT  | 1   | %M00009 | Step Sequence No.9                  |            | Global |     |     |     |
| STEP_2_GE        | BIT  | 1   | %M00022 | Step Sequence No.2 GE               |            | Global |     |     |     |
| GEN_OFF          | BIT  | 1   | %M00101 | Generator OFF                       |            | Global |     |     |     |
| AUTO_TEST_STR    | BIT  | 1   | %M00102 | Auto_Test Start / Stop              |            | Global |     |     |     |
| REMOTE_STR       | BIT  | 1   | %M00103 | Remote Start                        |            | Global |     |     |     |
| MAINS_FAIL_STP   | BIT  | 1   | %M00104 | Mains Failed Stop                   |            | Global |     |     |     |
| REMOTE_STP       | BIT  | 1   | %M00105 | Remote Stop                         |            | Global |     |     |     |
| TEST_STR         | BIT  | 1   | %M00106 | Test Start                          |            | Global |     |     |     |
| TEST_STP         | BIT  | 1   | %M00107 | Test Stop                           |            | Global |     |     |     |
| GEN_RUN_OFF      | BIT  | 1   | %M00108 | Generator Run Off                   |            | Global |     |     |     |
| ENABLE_OFFLINE   | BIT  | 1   | %M00109 | Enable Generator to go Offline      |            | Global |     |     |     |
| HH_ALM_OS1       | BIT  | 1   | %M00110 | High High Alarm One Shot            |            | Global |     |     |     |
| H_ALM_OS1        | BIT  | 1   | %M00111 | High Alarm One Shot                 |            | Global |     |     |     |
| H_ALM_OS2        | BIT  | 1   | %M00112 | High Alarm One Shot                 |            | Global |     |     |     |
| M_ALM_OS1        | BIT  | 1   | %M00113 | Medium Alarm One Shot               |            | Global |     |     |     |
| M_ALM_OS2        | BIT  | 1   | %M00114 | Medium Alarm One Shot               |            | Global |     |     |     |
| M_ATS_ALM_OS1    | BIT  | 1   | %M00115 | Mains ATS Alarm One Shot            |            | Global |     |     |     |
| M_ATS_ALM_OS2    | BIT  | 1   | %M00116 | Mains ATS Alarm One Shot            |            | Global |     |     |     |
| GEN_RUNNING      | BIT  | 1   | %M00201 | Generator Running                   |            | Global |     |     |     |
| FAIL_STR_TM      | BIT  | 1   | %M00202 | Failed to Start Time                |            | Global |     |     |     |
| FA _TR_DLY       | BIT  | 1   | %M00203 | Failed to Start Pulse Delay         |            | Global |     |     |     |
| FA _TR_CNT       | BIT  | 1   | %M00204 | Failed to Start Counter             |            | Global |     |     |     |
| CRK_CUTOUT       | BIT  | 1   | %M00205 | Generator Crank Cutout              |            | Global |     |     |     |
| ENB_STR_DLY      | BIT  | 1   | %M00206 | Enable Start Delay for Alarms       |            | Global |     |     |     |
| OIL_P_DLY        | BIT  | 1   | %M00207 | Oil Pressure Alarm Delay            |            | Global |     |     |     |
| STR_UP_DLY       | BIT  | 1   | %M00208 | Startup Alarm Delay                 |            | Global |     |     |     |

## GLOBAL VARIABLES

| Name               | Type | Len | Address | Description                               | Stored Val | Scope  | Ret | Ovr | Ext |
|--------------------|------|-----|---------|---|------------|--------|-----|-----|-----|
| M_ATS_OPN_1        | BIT  | 1   | %M00209 | Mains ATS Open Command                    |            | Global |     |     |     |
| G_ATS_CLS_1        | BIT  | 1   | %M00210 | Generator ATS Close Command               |            | Global |     |     |     |
| G_ATS_OPN_1        | BIT  | 1   | %M00211 | Generator ATS Open Command                |            | Global |     |     |     |
| M_ATS_CLS_1        | BIT  | 1   | %M00212 | Mains ATS Close Command                   |            | Global |     |     |     |
| M_ATS_CLS_ENB      | BIT  | 1   | %M00213 | Mains ATS Close Enable                    |            | Global |     |     |     |
| G_ATS_CLS_ENB      | BIT  | 1   | %M00214 | Generator ATS Close Enable                |            | Global |     |     |     |
| HIGH_HIGH_ALM      | BIT  | 1   | %M00300 | High High Alarm                           |            | Global |     |     |     |
| EM_STP_ALM         | BIT  | 1   | %M00301 | Emergency Stop Alarm                      |            | Global |     |     |     |
| MEN_ALM            | BIT  | 1   | %M00302 | MEN Alarm                                 |            | Global |     |     |     |
| OIL_P_SD_ALM       | BIT  | 1   | %M00303 | Low Oil Pressure Shutdown Alarm           |            | Global |     |     |     |
| ENG_T_SD_ALM       | BIT  | 1   | %M00304 | High Engine Temperature Shutdown Alarm    |            | Global |     |     |     |
| RAD_WATER_LOW_ALM  | BIT  | 1   | %M00305 | Low Radiator Water Level Alarm            |            | Global |     |     |     |
| SPD_OVER_ALM       | BIT  | 1   | %M00306 | Over Speed Alarm                          |            | Global |     |     |     |
| RAD_WATER_LOW_DLY  | BIT  | 1   | %M00315 | Radiator Water Level Low Delay            |            | Global |     |     |     |
| SPD_OVER_DLY       | BIT  | 1   | %M00316 | Over Speed Delay Timer                    |            | Global |     | R   |     |
| HIGH_ALM           | BIT  | 1   | %M00320 | High Alarm                                |            | Global |     |     |     |
| SPD_UNDER_ALM      | BIT  | 1   | %M00321 | Under Speed Alarm                         |            | Global |     |     |     |
| VOLTS_UNDER_ALM    | BIT  | 1   | %M00322 | Alternator Voltage Under Alarm            |            | Global |     |     |     |
| VOLTS_OVER_ALM     | BIT  | 1   | %M00323 | Alternator Voltage Over Alarm             |            | Global |     |     |     |
| GEN_CB_TRIP_ALM    | BIT  | 1   | %M00324 | Generator CB Tripped Alarm                |            | Global |     |     |     |
| ALT_TEMP_ALM       | BIT  | 1   | %M00325 | Alternator High Temperature Alarm         |            | Global |     |     |     |
| SPD_UNDER_DLY      | BIT  | 1   | %M00331 | Under Speed Alarm Delay                   |            | Global |     |     |     |
| VOLTS_UNDER_DLY    | BIT  | 1   | %M00332 | Under Voltage Alarm Delay                 |            | Global |     |     |     |
| VOLTS_OVER_DLY     | BIT  | 1   | %M00333 | Over Voltage Alarm Delay                  |            | Global |     |     |     |
| MEDIUM_ALM         | BIT  | 1   | %M00340 | Medium Alarm                              |            | Global |     |     |     |
| FUEL_LEV_EMPTY_ALM | BIT  | 1   | %M00341 | Fuel Empty Alarm                          |            | Global |     |     |     |
| FAIL_TO_STR_ALM    | BIT  | 1   | %M00342 | Fail to Start Alarm                       |            | Global |     |     |     |
| FUEL_LEV_EMPTY_DLY | BIT  | 1   | %M00351 | Fuel Level Empty Alarm Delay              |            | Global |     |     |     |
| LOW_ALM            | BIT  | 1   | %M00360 | Low Alarm                                 |            | Global |     |     |     |
| OIL_P_W_ALM        | BIT  | 1   | %M00361 | Low Oil Pressure Warning Alarm            |            | Global |     |     |     |
| ENG_T_W_ALM        | BIT  | 1   | %M00362 | High Engine Temperature Warning Alarm     |            | Global |     |     |     |
| FUEL_LEV_LOW_ALM   | BIT  | 1   | %M00363 | Low Fuel Level Alarm                      |            | Global |     |     |     |
| BAT_CHG_AC_ALM     | BIT  | 1   | %M00364 | Battery Charger AC Alarm                  |            | Global |     |     |     |
| BAT_CONT_LOW_V_ALM | BIT  | 1   | %M00365 | Control Battery Charger Low Voltage Alarm |            | Global |     |     |     |
| BAT_STR_LOW_V_ALM  | BIT  | 1   | %M00366 | Start Battery Charger Low Voltage Alarm   |            | Global |     |     |     |
| FUEL_LEV_LOW_DLY   | BIT  | 1   | %M00373 | Fuel Level Low Alarm Delay                |            | Global |     | R   |     |
| BAT_CHG_AC_DLY     | BIT  | 1   | %M00374 | Battery Charger AC Failure Delay          |            | Global |     | R   |     |
| BAT_CONT_LOW_V_DLY | BIT  | 1   | %M00375 | Control Battery Low Voltage Delay         |            | Global |     | R   |     |
| BAT_STR_LOW_V_DLY  | BIT  | 1   | %M00376 | Start Battery Low Voltage Delay           |            | Global |     | R   |     |
| MAINS_ATS_OPN_ALM  | BIT  | 1   | %M00381 | Mains ATS Failed to Open Alarm            |            | Global |     |     |     |
| MAINS_ATS_CLS_ALM  | BIT  | 1   | %M00382 | Mains ATS Failed to Close Alarm           |            | Global |     |     |     |
| GEN_ATS_OPN_ALM    | BIT  | 1   | %M00383 | Generator ATS Failed to Open Alarm        |            | Global |     |     |     |
| GEN_ATS_CLS_ALM    | BIT  | 1   | %M00384 | Generator ATS Failed to Close Alarm       |            | Global |     |     |     |
| NEW_ALM            | BIT  | 1   | %M00400 | New Alarm                                 |            | Global |     | R   |     |
| %M00401            | BIT  | 1   | %M00401 | **No Description**                        |            | Global |     | R   |     |
| %M00402            | BIT  | 1   | %M00402 | **No Description**                        |            | Global |     | R   |     |
| %M00403            | BIT  | 1   | %M00403 | **No Description**                        |            | Global |     | R   |     |
| %M00404            | BIT  | 1   | %M00404 | **No Description**                        |            | Global |     | R   |     |
| %M00405            | BIT  | 1   | %M00405 | **No Description**                        |            | Global |     | R   |     |
| %M00406            | BIT  | 1   | %M00406 | **No Description**                        |            | Global |     | R   |     |
| %M00421            | BIT  | 1   | %M00421 | **No Description**                        |            | Global |     | R   |     |
| %M00422            | BIT  | 1   | %M00422 | **No Description**                        |            | Global |     | R   |     |
| %M00423            | BIT  | 1   | %M00423 | **No Description**                        |            | Global |     | R   |     |
| %M00424            | BIT  | 1   | %M00424 | **No Description**                        |            | Global |     | R   |     |
| %M00425            | BIT  | 1   | %M00425 | **No Description**                        |            | Global |     | R   |     |

## GLOBAL VARIABLES

| Name               | Type | Len | Address | Description                                      | Stored Val | Scope  | Ret | Ovr | Ext |
|--------------------|------|-----|---------|--|------------|--------|-----|-----|-----|
| %A 41              | BIT  | 1   | %M00441 | **No Description**                               |            | Global | R   |     |     |
| %A 42              | BIT  | 1   | %M00442 | **No Description**                               |            | Global | R   |     |     |
| %M00461            | BIT  | 1   | %M00461 | **No Description**                               |            | Global | R   |     |     |
| %M00462            | BIT  | 1   | %M00462 | **No Description**                               |            | Global | R   |     |     |
| %M00463            | BIT  | 1   | %M00463 | **No Description**                               |            | Global | R   |     |     |
| %M00464            | BIT  | 1   | %M00464 | **No Description**                               |            | Global | R   |     |     |
| %M00465            | BIT  | 1   | %M00465 | **No Description**                               |            | Global | R   |     |     |
| %M00466            | BIT  | 1   | %M00466 | **No Description**                               |            | Global | R   |     |     |
| %M00481            | BIT  | 1   | %M00481 | **No Description**                               |            | Global | R   |     |     |
| %M00482            | BIT  | 1   | %M00482 | **No Description**                               |            | Global | R   |     |     |
| %M00483            | BIT  | 1   | %M00483 | **No Description**                               |            | Global | R   |     |     |
| %M00484            | BIT  | 1   | %M00484 | **No Description**                               |            | Global | R   |     |     |
| AUTO_IND           | BIT  | 1   | %Q00001 | Controls in Auto Indicator                       |            | Global |     |     |     |
| TEST_IND           | BIT  | 1   | %Q00002 | Controls in Test Indicator                       |            | Global |     |     |     |
| MAN_IND            | BIT  | 1   | %Q00003 | Controls in Manual Indicator                     |            | Global |     |     |     |
| REM_STR_IND        | BIT  | 1   | %Q00004 | Remote Start Indicator                           |            | Global |     |     |     |
| MAINS_AVAIL_IND    | BIT  | 1   | %Q00005 | Mains Available Indicator                        |            | Global |     |     |     |
| MAINS_CON_IND      | BIT  | 1   | %Q00006 | Mains Connected Indicator                        |            | Global |     |     |     |
| GEN_RUN_IND        | BIT  | 1   | %Q00007 | Generator Running Indicator                      |            | Global |     |     |     |
| GEN_CON_IND        | BIT  | 1   | %Q00008 | Generator Connected<br>Indicated                 |            | Global |     |     |     |
| MAINS_FAILED_IND   | BIT  | 1   | %Q00009 | Mains Failed Indicator                           |            | Global |     |     |     |
| EM_STOP_IND        | BIT  | 1   | %Q00010 | Emergency Stop Indicator                         |            | Global |     |     |     |
| MEN_FAULT_IND      | BIT  | 1   | %Q00011 | MEN Fault Indicator                              |            | Global |     |     |     |
| OIL_LOW_SD_IND     | BIT  | 1   | %Q00012 | Low Oil Pressure Shutdown<br>Indicator           |            | Global |     |     |     |
| OIL_P_LOW_W_IND    | BIT  | 1   | %Q00013 | Low Oil Pressure Warning<br>Indicator            |            | Global |     |     |     |
| ENG_T_HI_SD_IND    | BIT  | 1   | %Q00014 | High Engine Temperature<br>Shutdown Indicator    |            | Global |     |     |     |
| ENG_T_HI_W_IND     | BIT  | 1   | %Q00015 | High Engine Temperature<br>Warning Indicator     |            | Global |     |     |     |
| RAD_WATER_LOW_IND  | BIT  | 1   | %Q00016 | Low Radiator Water Level<br>Indicator            |            | Global |     |     |     |
| FUEL_LEV_EMPTY_IND | BIT  | 1   | %Q00017 | Fuel Empty Indicator                             |            | Global |     |     |     |
| FUEL_LEV_LOW_IND   | BIT  | 1   | %Q00018 | Low Fuel Level Indicator                         |            | Global |     |     |     |
| SPD_OVER_IND       | BIT  | 1   | %Q00019 | Over Speed Indicator                             |            | Global |     |     |     |
| SPD_UNDER_IND      | BIT  | 1   | %Q00020 | Under Speed Indicator                            |            | Global |     |     |     |
| FAIL_TO_STR_IND    | BIT  | 1   | %Q00021 | Fail to Start Indicator                          |            | Global |     |     |     |
| VOLTS_UNDER_IND    | BIT  | 1   | %Q00022 | Alternator Voltage Under<br>Indicator            |            | Global |     |     |     |
| VOLTS_OVER_IND     | BIT  | 1   | %Q00023 | Alternator Voltage Over<br>Indicator             |            | Global |     |     |     |
| ALT_TEMP_IND       | BIT  | 1   | %Q00024 | Alternator High Temperature<br>Indicator         |            | Global |     |     |     |
| GEN_CB_TRIP_IND    | BIT  | 1   | %Q00025 | Generator CB Tripped<br>Indicator                |            | Global |     |     |     |
| BATT_CHG_AC_IND    | BIT  | 1   | %Q00026 | Battery Charger AC Indicator                     |            | Global |     |     |     |
| BATT_CHG_LOW_V_IND | BIT  | 1   | %Q00027 | Control Battery Charger Low<br>Voltage Indicator |            | Global |     |     |     |
| BATT_STR_LOW_V_IND | BIT  | 1   | %Q00028 | Start Battery Charger Low<br>Voltage Indicator   |            | Global |     |     |     |
| CAN_DOORS_OPEN_IND | BIT  | 1   | %Q00029 | Canopy Doors Open Indicator                      |            | Global |     |     |     |
| MAINS_ATS_OPN_CMD  | BIT  | 1   | %Q00033 | BCC Mains ATS Open<br>Command                    |            | Global |     |     |     |
| GEN_ATS_CLS_CMD    | BIT  | 1   | %Q00034 | BCC Generator ATS Close<br>Command               |            | Global |     |     |     |
| GEN_SD_ALM         | BIT  | 1   | %Q00035 | BCC Generator Shutdown<br>Alarm                  |            | Global |     |     |     |
| GEN_W_ALM          | BIT  | 1   | %Q00036 | BCC Generator Warning<br>Alarm                   |            | Global |     |     |     |
| FUEL_LOW           | BIT  | 1   | %Q00037 | BCC Low Fuel                                     |            | Global |     |     |     |
| GEN_RUN            | BIT  | 1   | %Q00038 | BCC Generator Running                            |            | Global |     |     |     |
| GEN_CON            | BIT  | 1   | %Q00039 | BCC Generator Connected                          |            | Global |     |     |     |
| SMR                | BIT  | 1   | %Q00040 | Starter Motor Relay                              |            | Global |     |     |     |
| GCR                | BIT  | 1   | %Q00041 | Governor Control Relay                           |            | Global |     |     |     |
| AAR                | BIT  | 1   | %Q00042 | Audible Alarm Relay                              |            | Global |     |     |     |
| SDAR               | BIT  | 1   | %Q00043 | Generator Shunt Trip Relay                       |            | Global |     |     |     |
| SEQ_CNT            | WORD | 1   | %R00001 | Sequence Counter                                 |            | Global |     |     | R   |
| MODBUS_INPUTS      | WORD | 1   | %R00002 | Modbus Digital Inputs                            |            | Global |     |     | R   |
| MC_IS_OUTPUTS      | WORD | 1   | %R00005 | Modbus Digital Outputs                           |            | Global |     |     | R   |
| MC_IS_STATUS_1     | WORD | 1   | %R00008 | Modbus Status 1                                  |            | Global |     |     | R   |
| MODBUS_STATUS_2    | WORD | 1   | %R00009 | Modbus Status 2                                  |            | Global |     |     | R   |
| MODBUS_ALARMS      | WORD | 1   | %R00010 | Modbus Alarms                                    |            | Global |     |     | R   |
| %R00100            | WORD | 3   | %R00100 | **No Description**                               |            | Global |     |     | R   |
| %R00103            | WORD | 3   | %R00103 | **No Description**                               |            | Global |     |     | R   |

## GLOBAL VARIABLES

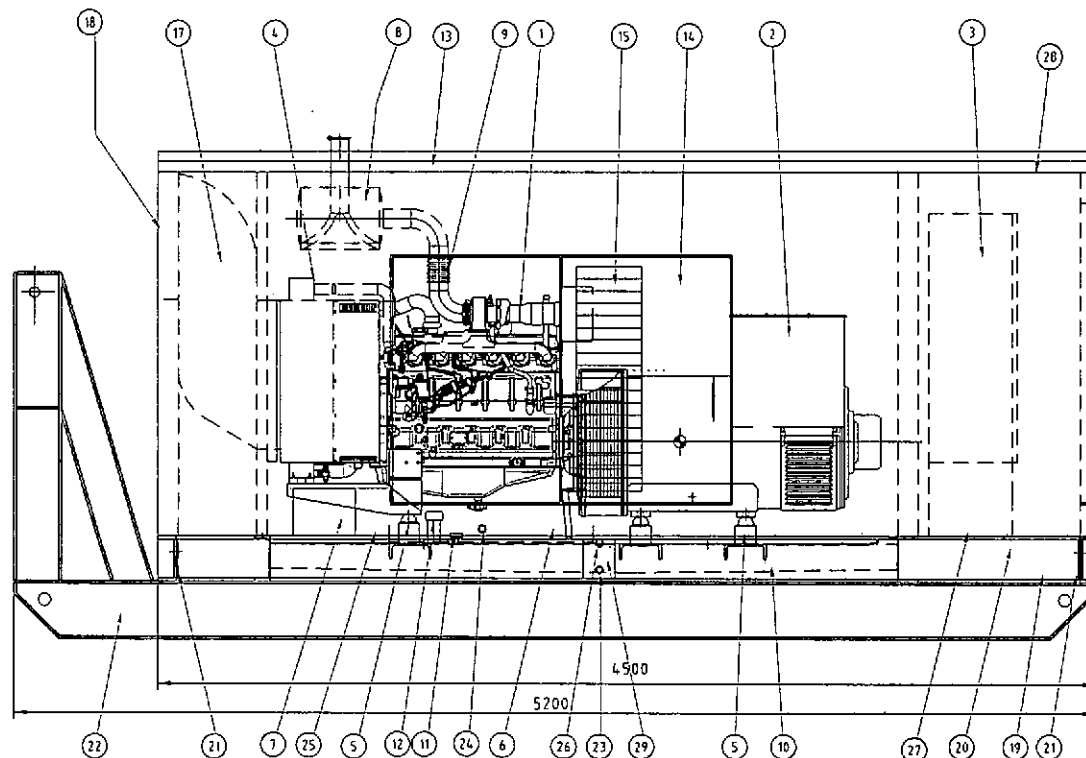
| Name     | Type | Len | Address | Description  | Stored Val | Scope  | Ret | Ovr | Ext |
|----------|------|-----|---------|--|------------|--------|-----|-----|-----|
| %R00106  | WORD | 3   | %R00106 | **No Description**   |            | Global | R   |     |     |
| %R00109  | WORD | 3   | %R00109 | **No Description**   |            | Global | R   |     |     |
| %R00112  | WORD | 3   | %R00112 | **No Description**   |            | Global | R   |     |     |
| %R00115  | WORD | 3   | %R00115 | **No Description**   |            | Global | R   |     |     |
| %R00118  | WORD | 3   | %R00118 | **No Description**   |            | Global | R   |     |     |
| %R00121  | WORD | 3   | %R00121 | **No Description**   |            | Global | R   |     |     |
| %R00124  | WORD | 3   | %R00124 | **No Description**   |            | Global | R   |     |     |
| %R00127  | WORD | 3   | %R00127 | **No Description**   |            | Global | R   |     |     |
| %R00130  | WORD | 3   | %R00130 | **No Description**   |            | Global | R   |     |     |
| %R00200  | WORD | 3   | %R00200 | **No Description**   |            | Global | R   |     |     |
| %R00203  | WORD | 3   | %R00203 | **No Description**   |            | Global | R   |     |     |
| %R00206  | WORD | 3   | %R00206 | **No Description**   |            | Global | R   |     |     |
| %R00209  | WORD | 3   | %R00209 | **No Description**   |            | Global | R   |     |     |
| %R00212  | WORD | 3   | %R00212 | **No Description**   |            | Global | R   |     |     |
| %R00215  | WORD | 3   | %R00215 | **No Description**   |            | Global | R   |     |     |
| %R00218  | WORD | 3   | %R00218 | **No Description**   |            | Global | R   |     |     |
| %R00221  | WORD | 3   | %R00221 | **No Description**   |            | Global | R   |     |     |
| %R00224  | WORD | 3   | %R00224 | **No Description**   |            | Global | R   |     |     |
| %R00227  | WORD | 3   | %R00227 | **No Description**   |            | Global | R   |     |     |
| %R00230  | WORD | 3   | %R00230 | **No Description**   |            | Global | R   |     |     |
| %R00300  | WORD | 3   | %R00300 | **No Description**   |            | Global | R   |     |     |
| %R00303  | WORD | 3   | %R00303 | **No Description**   |            | Global | R   |     |     |
| %R00306  | WORD | 3   | %R00306 | **No Description**   |            | Global | R   |     |     |
| %R00309  | WORD | 3   | %R00309 | **No Description**   |            | Global | R   |     |     |
| %R00312  | WORD | 3   | %R00312 | **No Description**   |            | Global | R   |     |     |
| %R00315  | WORD | 3   | %R00315 | **No Description**   |            | Global | R   |     |     |
| %R00318  | WORD | 3   | %R00318 | **No Description**   |            | Global | R   |     |     |
| %R00321  | WORD | 3   | %R00321 | **No Description**   |            | Global | R   |     |     |
| %R00324  | WORD | 3   | %R00324 | **No Description**   |            | Global | R   |     |     |
| %R00327  | WORD | 3   | %R00327 | **No Description**   |            | Global | R   |     |     |
| %R00330  | WORD | 3   | %R00330 | **No Description**   |            | Global | R   |     |     |
| %R00333  | WORD | 3   | %R00333 | **No Description**   |            | Global | R   |     |     |
| %R00336  | WORD | 3   | %R00336 | **No Description**   |            | Global | R   |     |     |
| %R00339  | WORD | 3   | %R00339 | **No Description**   |            | Global | R   |     |     |
| FST_SCN  | BIT  | 1   | %S00001 | Set to 1 when the current sweep is the first sweep         |            | Global | R   |     |     |
| LST_SCAN | BIT  | 1   | %S00002 | Reset from 1 to 0 when the current sweep is the last sweep |            | Global | R   |     |     |
| T_10MS   | BIT  | 1   | %S00003 | 0.01 Second Timer Contact                                  |            | Global | R   |     |     |
| T_100MS  | BIT  | 1   | %S00004 | 0.1 Second Timer Contact                                   |            | Global | R   |     |     |
| T_1S     | BIT  | 1   | %S00005 | 1 Second Timer Contact                                     |            | Global | R   |     |     |
| T_1M     | BIT  | 1   | %S00006 | 1 Minute Timer Contact                                     |            | Global | R   |     |     |
| ALW_ON   | BIT  | 1   | %S00007 | Always ON  |            | Global | R   |     |     |
| ALW_OFF  | BIT  | 1   | %S00008 | Always OFF   |            | Global | R   |     |     |
| PLC_BAT  | BIT  | 1   | %S00014 | Set to indicate a bad battery in the CPU                   |            | Global | R   |     |     |
| %R00133  | WORD | 3   | %R00133 | **No Description**   |            | Global | R   |     |     |
| %R00136  | WORD | 3   | %R00136 | **No Description**   |            | Global | R   |     |     |

**GLOBAL SUMMARY OF HIGHEST USED REFERENCE ADDRESSES**

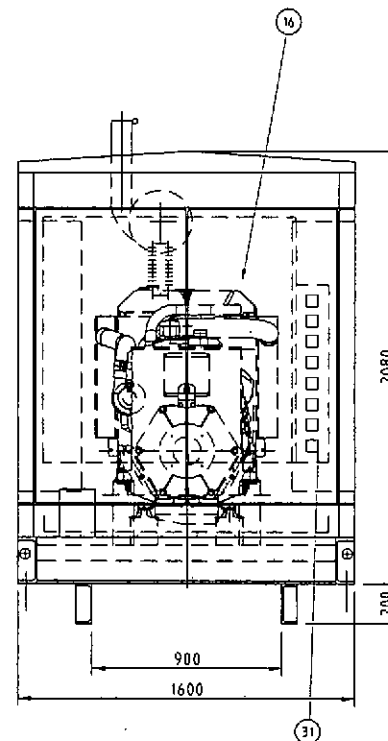
| <b>MEMORY AREA</b>   | <b>ADDRESS</b> |
|----------------------|----------------|
| Analog Input (%AI)   | None Used      |
| Analog Output (%AQ)  | None Used      |
| Input (%I)           | %I00048        |
| Output (%Q)          | %Q00048        |
| Internal Memory (%M) | %M00484        |
| Register (%R)        | %R00341        |
| Genius Global (%G)   | None Used      |
| Genius Global (%GA)  | None Used      |
| Genius Global (%GB)  | None Used      |
| Genius Global (%GC)  | None Used      |
| Genius Global (%GD)  | None Used      |
| Genius Global (%GE)  | None Used      |
| Temporary (%T)       | None Used      |
| System (%S)          | %S00007        |
| System (%SA)         | None Used      |
| System (%SB)         | None Used      |
| System (%SC)         | None Used      |
| Program (%P)         | None Used      |

## Table of Contents

|  |    |
|--|----|
| Block: AUD_ALM.blk                               |    |
| Properties.....                                  | 2  |
| Logic.....                                       | 3  |
| Block: ALARM.blk                                 |    |
| Properties.....                                  | 7  |
| Logic.....                                       | 8  |
| Block: SEQ.blk                                   |    |
| Properties.....                                  | 19 |
| Logic.....                                       | 20 |
| Block: MAIN.blk                                  |    |
| Properties.....                                  | 29 |
| Logic.....                                       | 30 |
| Block: _MAIN.blk                                 |    |
| Properties.....                                  | 39 |
| Logic.....                                       | 40 |
| Block: PRESETS.blk                               |    |
| Properties.....                                  | 41 |
| Logic.....                                       | 42 |
| Block: MODBUS.blk                                |    |
| Properties.....                                  | 44 |
| Logic.....                                       | 45 |
| Variable Declarations Table.....                 | 47 |
| Summary of Highest Used Reference Addresses..... | 51 |



SIDE ELEVATION



ALTERNATOR END ELEVATION

| LEGEND |                                    |
|--------|------------------------------------|
| ITEM   | DESCRIPTION                        |
| 1      | ENGINE DEUTZ JOHN DEERE 6068A      |
| 2      | ALTERNATOR STAMFORD HCS34F         |
| 3      | CONTROL SWITCHBOARD                |
| 4      | RADIATOR                           |
| 5      | A/V MOUNTS (6 OFF)                 |
| 6      | ENGINE DRIP TRAY                   |
| 7      | STARTING BATTERY (382)             |
| 8      | EXHAUST SILENCER                   |
| 9      | EXHAUST PIPE FLEXIBLE Ø75          |
| 10     | FUEL TANK BASE FRAME 1000 L        |
| 11     | FUEL GAUGE (MECHANICAL)            |
| 12     | FUEL FILL POINT (INSIDE ENCLOSURE) |
| 13     | ACOUSTIC ENCLOSURE (70dba @ 7m)    |
| 14     | SIDE ACCESS DOORS (2 OFF)          |
| 15     | AIR INLET GRILL                    |
| 16     | SWITCHBOARD ACCESS DOORS           |
| 17     | PLENUM CHAMBER                     |
| 18     | AIR OUTLET GRILL                   |
| 19     | CABLE ENTRY ZONE                   |
| 20     | ANCHOR POINT                       |
| 21     | LIFTING POINTS                     |
| 22     | TRANSPORT SKID                     |
| 23     | FUEL TANK DRAIN (LOCKABLE)         |
| 24     | OIL DRAIN (LOCKABLE)               |
| 25     | RADIATOR DRAIN HOSE                |
| 26     | CATCHMENT TRAY DRAIN               |
| 27     | CONTROL BATTERIES (12x12 VOLT)     |
| 28     | BATTERY CHARGING SOLAR PANEL       |
| 29     | DRAIN POINT LOCKABLE COVER         |
| 30     | INSECT SCREEN                      |
| 31     | OUTPUT & CONTROL SOCKETS T.B.A.    |

## NOTE

ENCLOSURE COLOUR : MIST GREEN

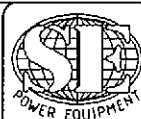
BASE TANK COLOUR : MIST GREEN

SKID BASE COLOUR : MIST GREEN

**APPROVED FOR  
CONSTRUCTION**

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| Rev. | Date   | DESIGN REVIEW | REVISION | APPROVAL | AMENDMENT              |
|------|--------|---------------|----------|----------|------------------------|
| C    | 1.8.03 |               |          |          | ENGINE CHANGED TO 6068 |
| D    | 2.6.03 |               |          |          | ISSUE FOR CONSTRUCTION |
| A    | 2.5.03 |               |          |          | APPROVAL ISSUE         |

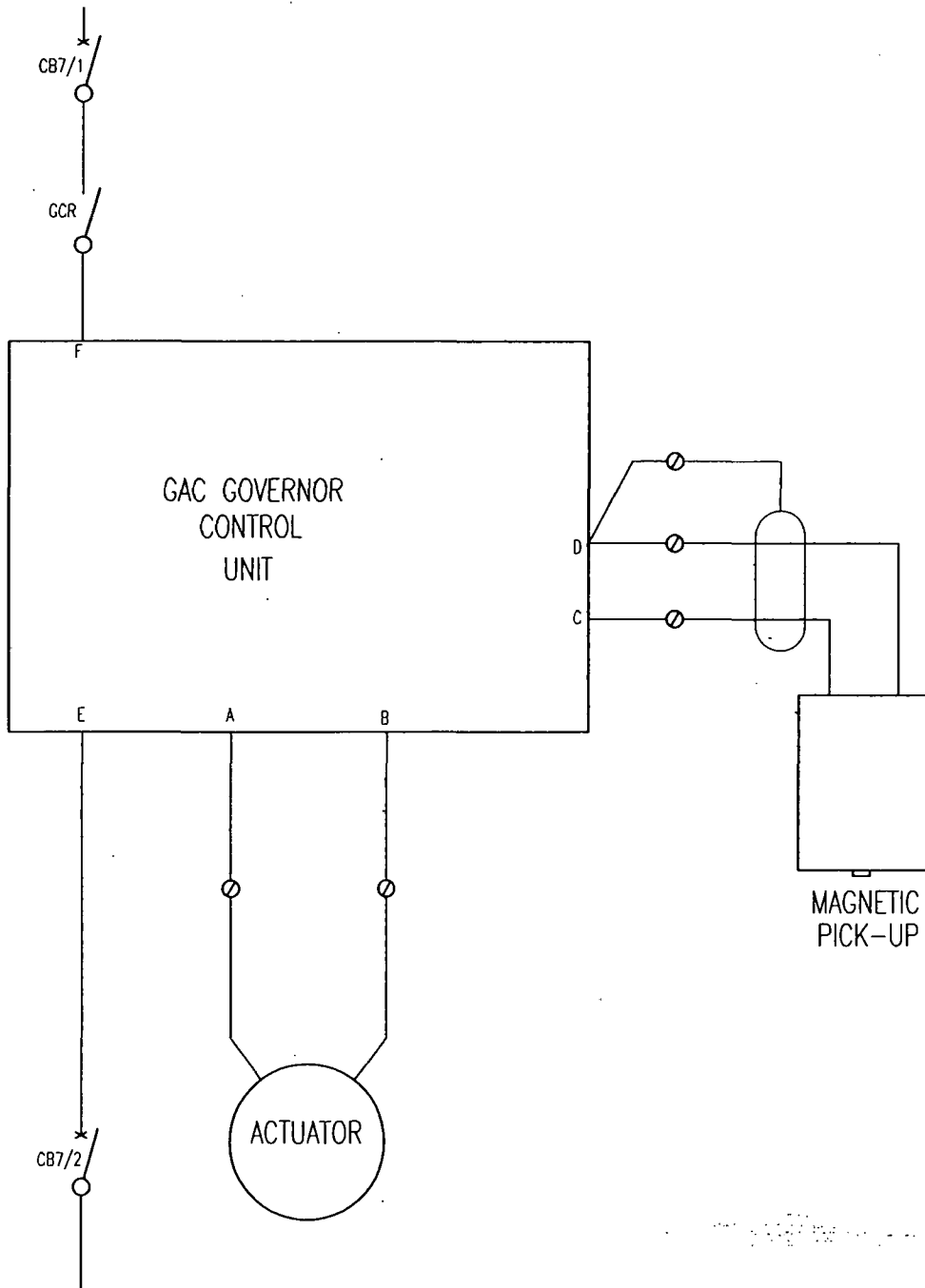


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BRISBANE, QLD. 4173  
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Facsimile: (07) 3390 4631

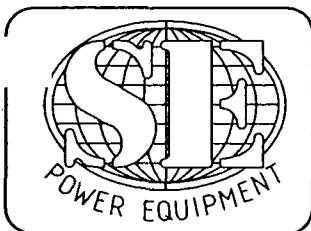
| Client                             |                    |                             |                              |
|------------------------------------|--------------------|-----------------------------|------------------------------|
| BRISBANE WATER                     |                    |                             |                              |
| Project                            |                    |                             |                              |
| SEWAGE PUMP STATION BACKUP GENSETS |                    |                             |                              |
| Drafter<br>RSL                     | Draft Check<br>RSL | Reviewed<br>Project Manager | Approved<br>Project Director |

| Title                          |                |                               |            |                               |           |
|--------------------------------|----------------|-------------------------------|------------|-------------------------------|-----------|
| SP174 JESMOND ROAD ARRANGEMENT |                |                               |            |                               |           |
| Scale<br>E30                   | No in set<br>1 | SE Ref No.<br>14291           | SE Job No. | S.E. Drawing No.<br>14291-013 | AMDT<br>1 |
| Engineer's Ref. No.            |                | Client Ref. No.<br>2010-02/03 |            |                               |           |





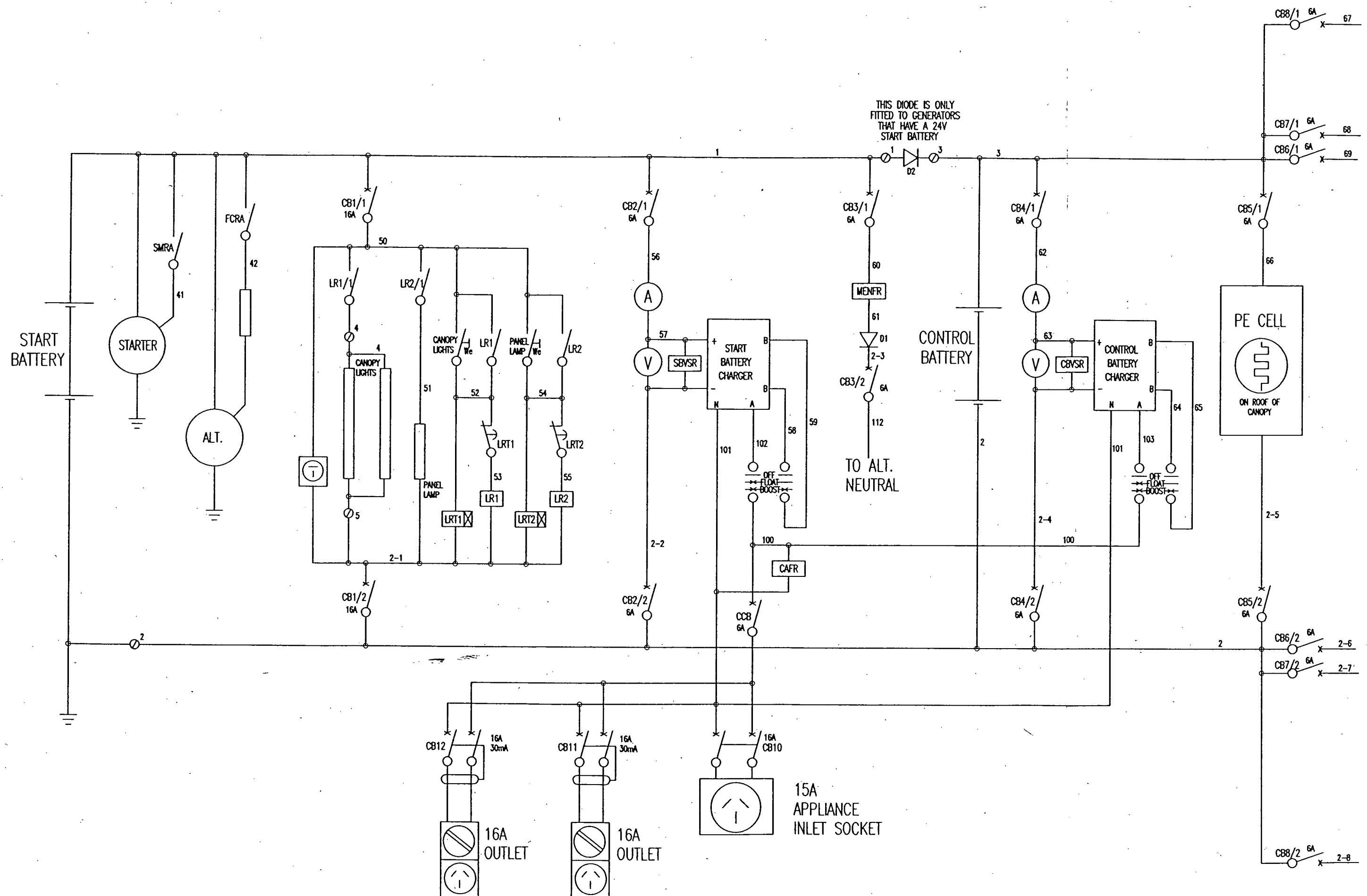
0 1.8.03 AS BUILT



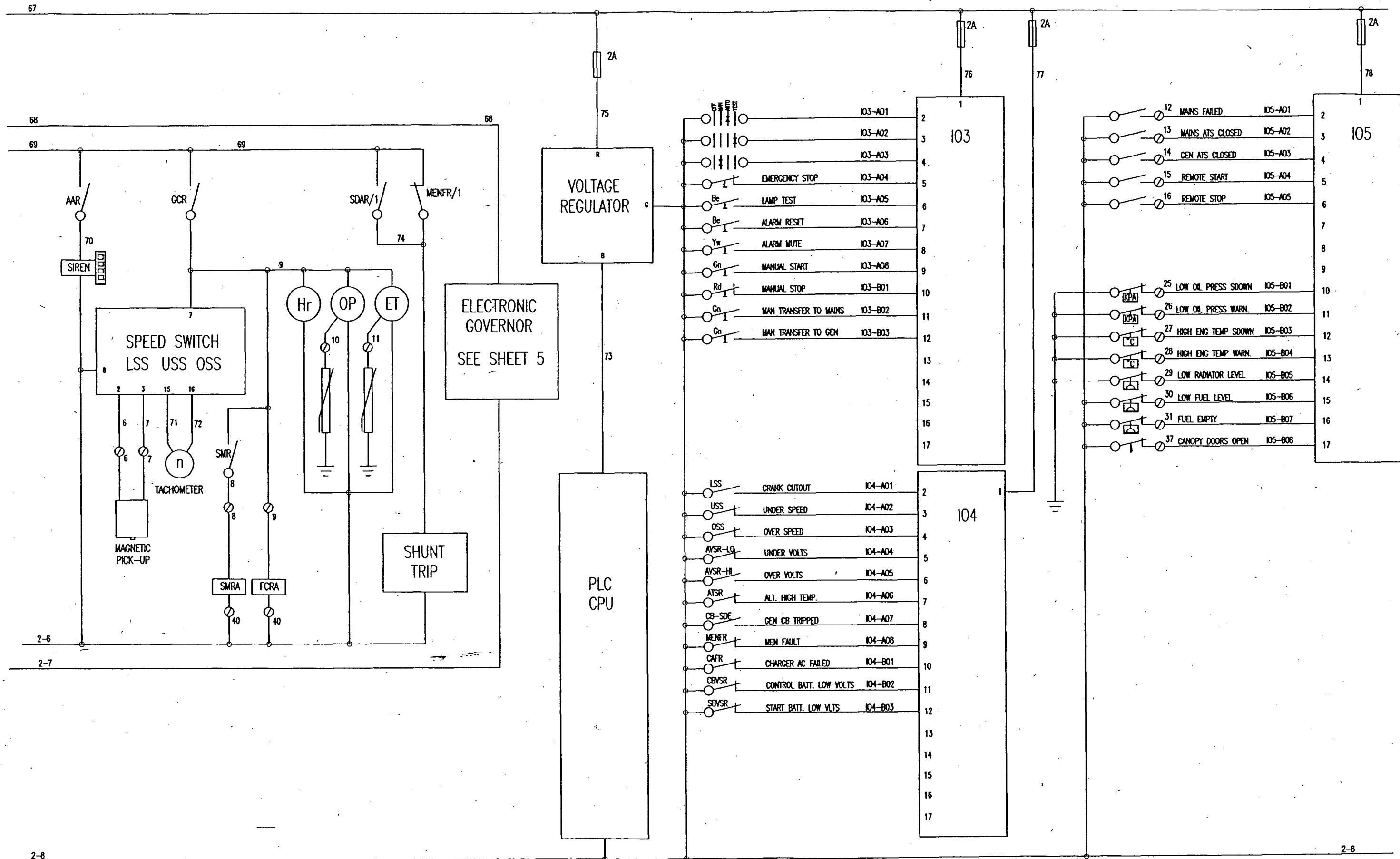
|  |  |              |                          |                           |
|--|--|--------------|--------------------------|---------------------------|
| EQUIPMENT DATA SHEET   |  | REV No:<br>0 | PROJECT No:<br>14291-605 | DATE:<br>1.08.03          |
| TITLE: BCC BRISBANE WATER<br>PUMP STATION BACKUP GENSET<br>GAC GOVERNOR CONTROLS |  |              | REF:                     | PREPARED<br>BY: HJR / RSL |
|  |  |              | CHECKED<br>BY:           |                           |
| APPROVED FOR ISSUE<br>JP   |  |              | SCALE:<br>1:1            |                           |

Active 10/12/2014

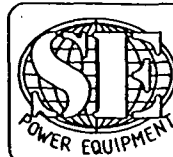
|                                   |            |           |      |
|-----------------------------------|------------|-----------|------|
| TITLE                             |            |           |      |
| GENERATOR<br>ELECTRICAL SCHEMATIC |            |           |      |
| SCALE                             | DRAWING NO | NO IN SET | AMDT |
| NTS                               | 14291-02   | 1 of 25   | 0    |







| No | DATE     | DESIGN REVIEW | REV'D P.25R | APP'D P.25R | AMENDMENT        |
|----|----------|---------------|-------------|-------------|------------------|
| C  | 1-8-03   |               |             |             | AS BUILT         |
| B  | 15-05-03 |               |             |             | DRAWING FINISHED |
| A  | 08-05-03 |               |             |             | NEW DRAWING      |

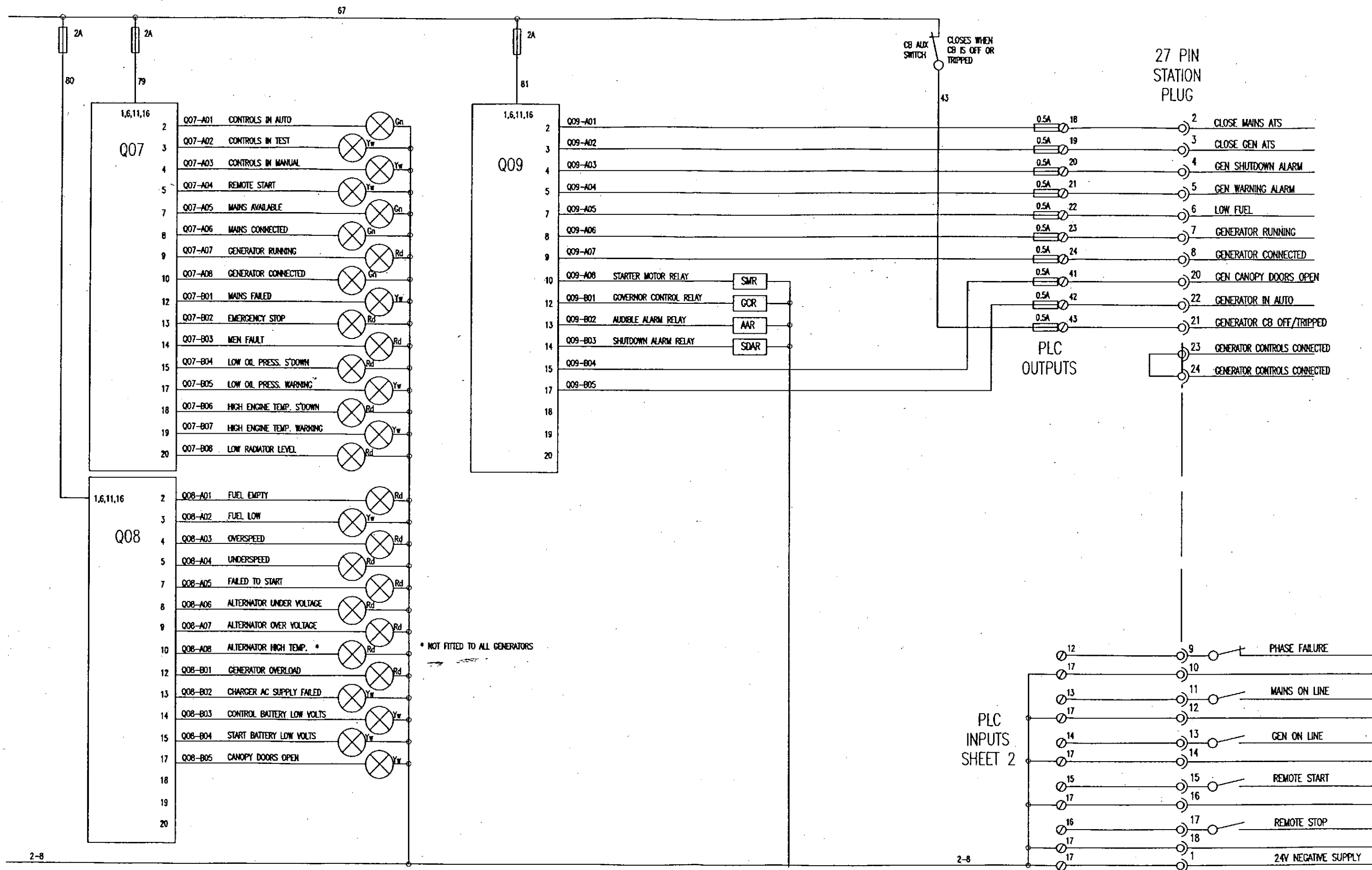


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|                |                        |
|----------------|------------------------|
| CLIENT         | B.C.C. BRISBANE WATER  |
| PROJECT        | PUMP STATION GENERATOR |
| DRAFTER        | HJR                    |
| DESIGNED       | HJR                    |
| DRAFTING CHECK | EPAC                   |
| JOB NUMBER     | 4000                   |
| SE POWER       | JOB NUMBER             |
|                | 28396                  |

|            |                                |
|------------|--------------------------------|
| TITLE      | GENERATOR ELECTRICAL SCHEMATIC |
| SCALE      | NTS                            |
| DRAWING No | 14291-02                       |
| No IN SET  | 2 of 5                         |
| AMDT       | C                              |





|     |          |               |              |              |  |
|-----|----------|---------------|--------------|--------------|--|
| E   | 10-05-04 |               |              |              | 27 PIN PLUG REMOTE CONNECTIONS WERE CHANGED TO MATCH SEE DRAWING |
| D   | 01-08-03 |               |              |              | AS BUILT   |
| C   | 23-07-03 |               |              |              | EXTRA REMOTE ALARMS WERE ADDED                                   |
| B   | 15-05-03 |               |              |              | DRAWING FINALISED  |
| A   | 08-05-03 |               |              |              | NEW DRAWING  |
| Rev | DATE     | DESIGN REVIEW | REV'D P. NO. | APP'D P. NO. | AMENDMENT  |

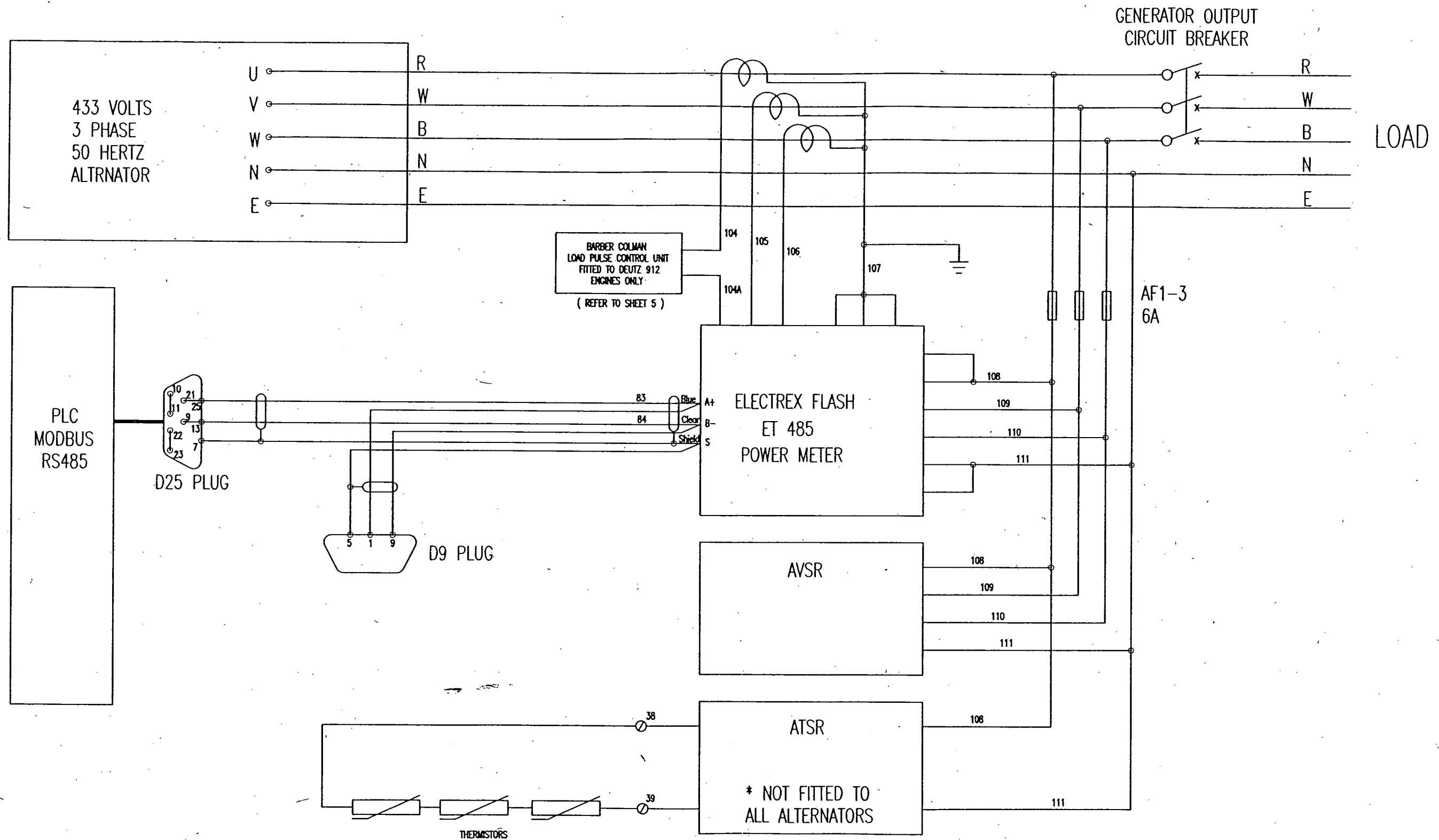


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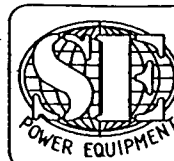
|                     |                        |
|---------------------|------------------------|
| CLIENT              | B.C.C. BRISBANE WATER  |
| PROJECT             | PUMP STATION GENERATOR |
| DRAFTER             | HJR                    |
| DESIGNED            | HJR                    |
| DRAFTING CHECK      | DESIGN REVIEW          |
| EPAC JOB NUMBER     | 4000                   |
| SE POWER JOB NUMBER | 28396                  |

|            |                                |
|------------|--------------------------------|
| TITLE      | GENERATOR ELECTRICAL SCHEMATIC |
| SCALE      | NTS                            |
| DRAWING No | 14291-02                       |
| No IN SET  | 3 of 5                         |
| AMDT       | E                              |





|    |           |               |             |             |                   |
|----|-----------|---------------|-------------|-------------|-------------------|
|    |           |               |             |             |                   |
| C  | 1-4-03    |               |             |             | AS BUILT          |
| B  | 15-05-03  |               |             |             | DRAWING FINALISED |
| A  | 108-05-03 |               |             |             | REV. DRAWING      |
| No | DATE      | DESIGN REVIEW | REV'D P.M.R | APP'D P.M.R | AMENDMENT         |



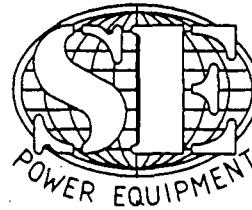
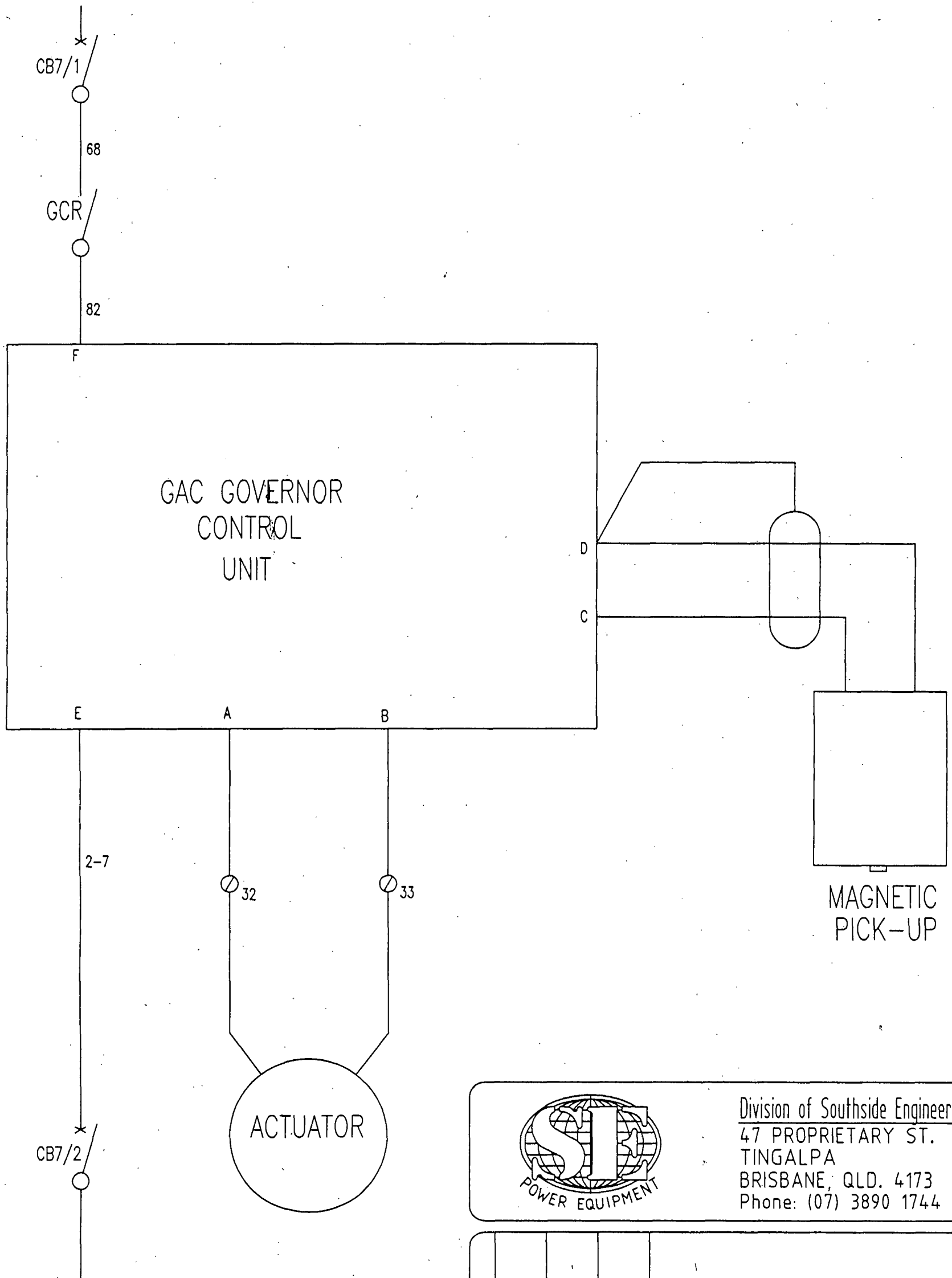
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|          |                        |                 |                     |
|----------|------------------------|-----------------|---------------------|
| CLIENT   | B.C.C. BRISBANE WATER  |                 |                     |
| PROJECT  | PUMP STATION GENERATOR |                 |                     |
| DRAFTER  | DRAFTING CHECK         | EPAC JOB NUMBER | SE POWER JOB NUMBER |
| HJR      |                        |                 |                     |
| DESIGNED | DESIGN REVIEW          | 4000            | 28396               |
| HJR      |                        |                 |                     |

|       |                      |            |           |
|-------|----------------------|------------|-----------|
| TITLE | ELECTRICAL SCHEMATIC |            |           |
| SCALE | NTS                  | DRAWING No | No IN SET |
|       |                      | 14291-02   | 4 of 5    |
|       |                      |            | AMDT C    |







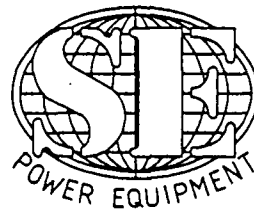
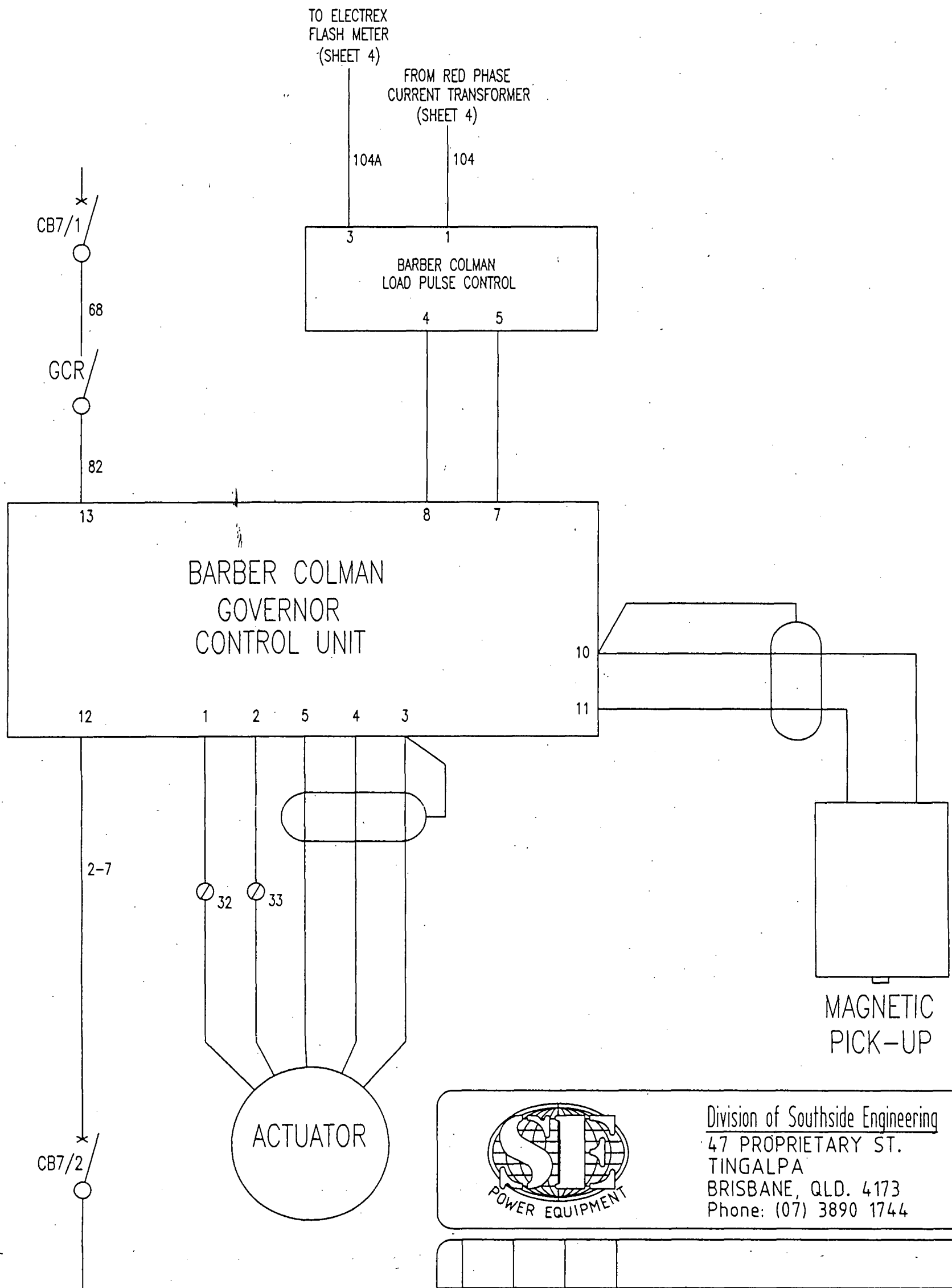
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| No | DATE     | DESIGN REVIEW | REV'D. P.MGR | AMENDMENT         |
|----|----------|---------------|--------------|-------------------|
| C  | 1-9-03   |               |              | AS BUILT          |
| B  | 15-05-03 |               |              | DRAWING FINALISED |
| A  | 08-05-03 |               |              | NEW DRAWING       |

|                 |                        |                         |                              |
|-----------------|------------------------|-------------------------|------------------------------|
| CLIENT          | B.C.C. BRISBANE WATER  |                         |                              |
| PROJECT         | PUMP STATION GENERATOR |                         |                              |
| DRAFTER<br>HJR  | DRAFTING CHECK         | EPAC JOB NUMBER<br>4000 | SE POWER JOB NUMBER<br>28396 |
| DESIGNED<br>HJR | DESIGN REVIEW          |                         |                              |

|              |                        |                     |           |
|--------------|------------------------|---------------------|-----------|
| TITLE        | GAC GOVERNOR CONTROLS  |                     |           |
| SCALE<br>NTS | DRAWING No<br>14291-02 | No IN SET<br>5 of 5 | AMDT<br>C |





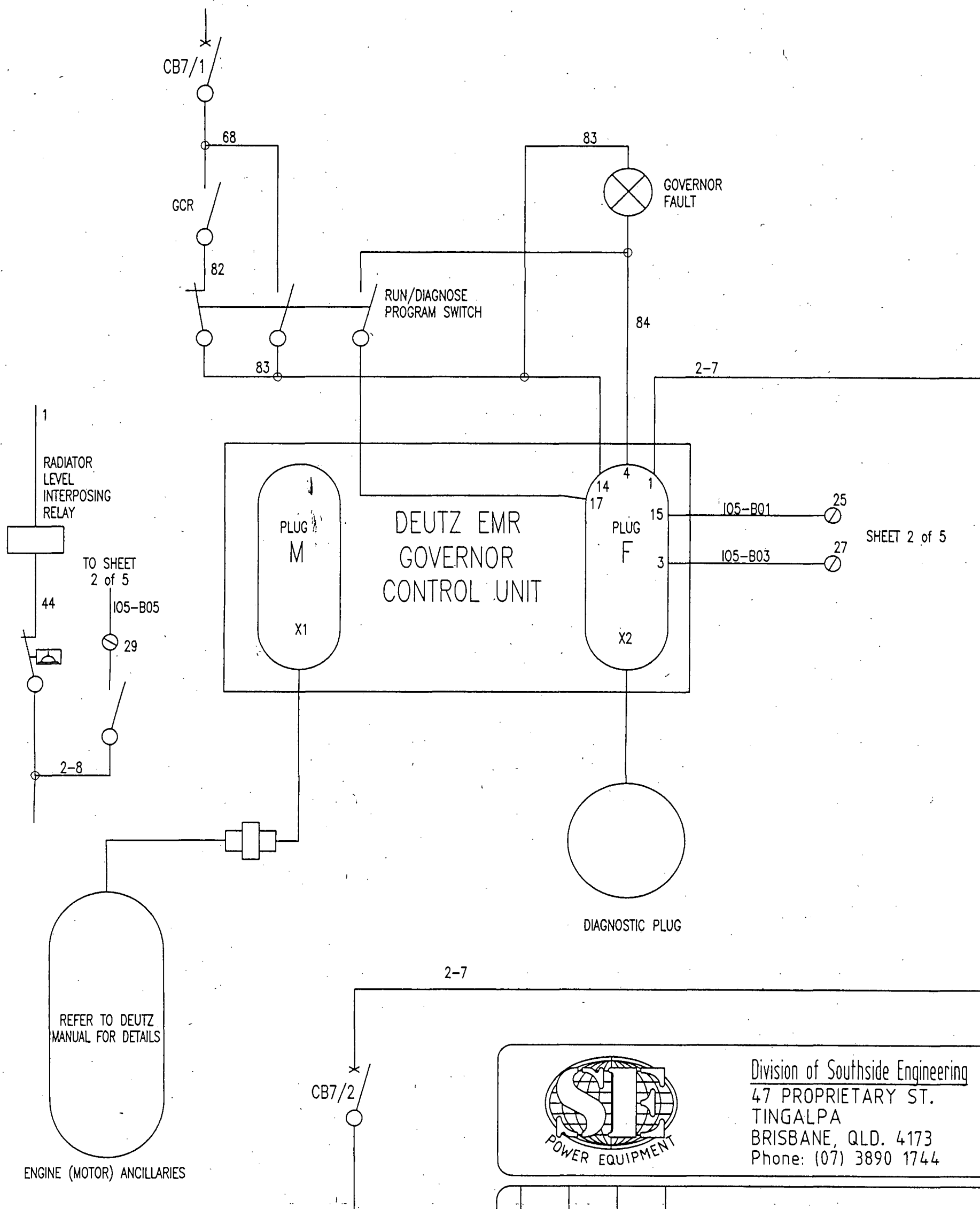
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| No | DATE     | DESIGN REVIEW | REV'D P.MGR | AMENDMENT                         |
|----|----------|---------------|-------------|-----------------------------------|
| D  | 1-9-03   |               |             | AS BUILT                          |
| C  | 14-06-03 |               |             | LOAD PULSE CONTROL UNIT WAS ADDED |
| B  | 15-05-03 |               |             | DRAWING FINALISED                 |
| A  | 08-05-03 |               |             | NEW DRAWING                       |

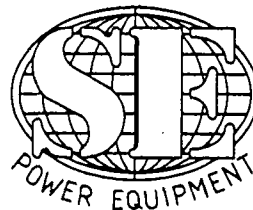
|                 |                        |                            |                                 |
|-----------------|------------------------|----------------------------|---------------------------------|
| CLIENT          | B.C.C. BRISBANE WATER  |                            |                                 |
| PROJECT         | PUMP STATION GENERATOR |                            |                                 |
| DRAFTER<br>HJR  | DRAFTING CHECK         | EPAC<br>JOB NUMBER<br>4000 | SE POWER<br>JOB NUMBER<br>28396 |
| DESIGNED<br>HJR | DESIGN REVIEW          |                            |                                 |

|              |                                    |                     |           |
|--------------|------------------------------------|---------------------|-----------|
| TITLE        | BARBER COLMAN<br>GOVERNOR CONTROLS |                     |           |
| SCALE<br>NTS | DRAWING No<br>14291-02             | No IN SET<br>5 of 5 | AMDT<br>D |





SHEET 2 of 5



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| No | DATE     | DESIGN REVIEW | REV'D P.MGR | AMENDMENT                                  |
|----|----------|---------------|-------------|--|
| D  | 1-9-03   |               |             | AS BUILT                                   |
| C  | 15-08-03 |               |             | RADIATOR LEVEL INTERPOSING RELAY WAS ADDED |
| B  | 15-05-03 |               |             | DRAWING FINALISED                          |
| A  | 08-05-03 |               |             | NEW DRAWING                                |

|          |                |                 |                     |                        |  |
|----------|----------------|-----------------|---------------------|------------------------|--|
| CLIENT   |                |                 |                     | B.C.C. BRISBANE WATER  |  |
| PROJECT  |                |                 |                     | PUMP STATION GENERATOR |  |
| DRAFTER  | DRAFTING CHECK | EPAC JOB NUMBER | SE POWER JOB NUMBER |                        |  |
| HJR      |                |                 |                     |                        |  |
| DESIGNED | DESIGN REVIEW  | 4000            | 28396               |                        |  |
| HJR      |                |                 |                     |                        |  |

|       |            |           |      |                             |  |
|-------|------------|-----------|------|-----------------------------|--|
| TITLE |            |           |      | DEUTZ EMR GOVERNOR CONTROLS |  |
| SCALE | DRAWING No | No IN SET | AMDT |                             |  |
| NTS   | 14291-02   | 4 of 5    | D    |                             |  |



**SE Power Equipment**

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**DIESEL GENERATOR SET  
 CONTROL FUNCTION TEST REPORT**

**SEP 009/B**

CLIENT: BUS. WATER SP 174  
 SERIAL NO: 0308011  
 ENGINE TYPE: 606842  
 ALTERNATOR TYPE: HCI534F

DATE: 30.08.03  
 JOB NO: 14291  
 ENG. SERIAL NO: 726317  
 ALT. SERIAL NO: 27303/1

| GENSET CONTROL FUNCTIONS   | FUNCTION | LAMP | REMARKS                   |
|--|----------|------|---------------------------|
| Engine High Temp. Alarm  | ✓        | ✓    |                           |
| Engine High Temp. Shutdown   | ✓        | ✓    |                           |
| Low Water Level Alarm  | ✓        | ✓    |                           |
| CB Tripped/Alt., Overload  | ✓        | ✓    | BUSTED SHUNT TRIP         |
| Low Oil Pressure Alarm   | ✓        | ✓    |                           |
| Low Oil Pressure Shutdown  | ✓        | ✓    |                           |
| Emergency Stop   | ✓        | ✓    |                           |
| Start Fail Alarm   | ✓        | ✓    |                           |
| Genset Running   | ✓        | ✓    |                           |
| MEN Fault  | ✓        | ✓    |                           |
| Starter Motor Relay  | ✓        | ✓    |                           |
| Fuel Low   | ✓        | ✓    |                           |
| Fuel Empty   | ✓        | ✓    |                           |
| Engine Gauges  | ✓        | ✓    |                           |
| Status Lamps/Controls  | ✓        | ✓    |                           |
| Underspeed Shutdown  | ✓        | ✓    |                           |
| Overspeed Shutdown   | ✓        | ✓    |                           |
| Remote Start/Stop  | ✓        | ✓    |                           |
| Lamp Test  | ✓        | ✓    |                           |
| Alarm Shutdown   | ✓        | ✓    |                           |
| Alt Undervolts   | ✓        | ✓    |                           |
| Alt Overvolts  | ✓        | ✓    |                           |
| Charger AC Failed  | ✓        | ✓    |                           |
| Control Batt. Low Volts  | ✓        | ✓    |                           |
| Start Batt. Low volts  | ✓        | ✓    | BUSTED SENSING RELAY O.K. |
| Canopy doors Open  | ✓        | ✓    |                           |
| Audible Alarm/Mute   | ✓        | ✓    |                           |
| Remote ATS Controls  | ✓        | ✓    |                           |
| Alternator High Temperature  | N/A      | N/A  |                           |
| <del>CHECK TACHO (NOT READING 1500) READING 1350 @ 50HZ O.K.</del> |          |      |                           |
|  |          |      |                           |
|  |          |      |                           |
|  |          |      |                           |

CUSTOMER TESTING OFFICER: \_\_\_\_\_

TESTING OFFICER: Hayden





# DIESEL GENERATOR SET LOAD TEST REPORT

SEP 0064/D

47 Proprietary Street  
Tingalpa Q 4173  
BRISBANE AUSTRALIA

CLIENT: BUS WATER SP174 DATE: 30.08.03  
 SERIAL NO: 0308011 JOB NO/CONTRACT NO: 14291  
 ENGINE TYPE: 6068H2 ENG. SERIAL NO: 726317  
 ALTERNATOR TYPE: HCI534F ALT. SERIAL NO: 27303/1  
 GOVERNOR TYPE: G.A.C. STARTER MOTOR: JOHN DEERE  
 OVERSPEED TYPE: " UNDERSPEED TYPE: PLC  
 SHUTDOWN SOLENOID: " HIGH WATER: VDO  
 LOW OIL PRESSURE SHUTDOWN: HOEBBS

A: 208 + 10% KW: 150 + 10%

TECHNICIAN: PAUL HLAVKA INSPECTOR: \_\_\_\_\_

| TIME                     | 0:05    | 0:20 | 1:00 | 1:30 | 2:00 | 2:30 | 2:35 |  |  |  |
|--------------------------|---------|------|------|------|------|------|------|--|--|--|
| OIL PRESSURE KPA         | 400     | 350  | 280  | 250  | 230  | 220  | 250  |  |  |  |
| OIL TEMPERATURE          | N/A     | -    | -    | -    | -    | -    | -    |  |  |  |
| JACKET WATER TEMPERATURE | 60      | 80   | 85   | 88   | 89   | 90   | 82   |  |  |  |
| VOLTS                    | 240/415 | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    |  |  |  |
| VOLTS AMPS               | 0       | 110  | 209  | 209  | 209  | 227  | 0    |  |  |  |
| AMBIENT TEMPERATURE      | 22      | 22   | 22   | 22   | 22   | 22   | 22   |  |  |  |
| HZ                       | 50      | 50   | 50   | 50   | 50   | 50   | 50   |  |  |  |
| KW                       | 0       | 19   | 149  | 148  | 148  | 164  | 0    |  |  |  |
| D%                       | 0       | 50%  | 100% | 100% | 100% | 110% | 0    |  |  |  |
| REMARKS                  |         |      |      |      |      |      |      |  |  |  |



## GENERATOR SET

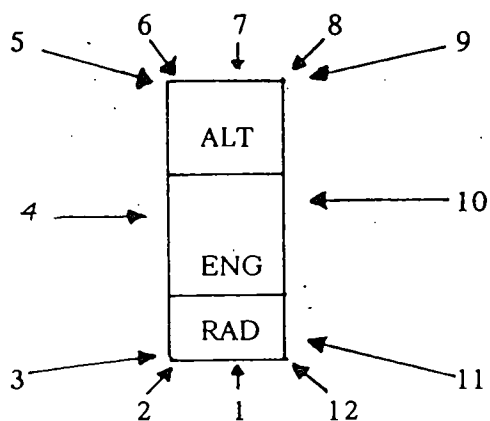
SEP 0023/D

## SOUND PRESSURE LEVEL TEST REPORT

47 Proprietary Street  
Tingalpa Q 4173  
BRISBANE AUSTRALIA

CLIENT: BUS WATER SP174 DATE: 30.08.03  
SERIAL NO: 0308011 JOB NO: 14291  
ENGINE TYPE: 6068H2 ENG. SERIAL NO: 726317  
ALTERNATOR TYPE: HCI534F ALT. SERIAL NO: 27303/1  
SOUND LEVEL INSTRUMENT: RION

## Remarks:

Distance: 1 mHeight: 1.5 m

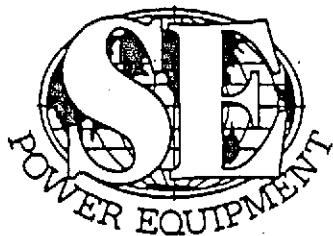
Position Layout

| POSITION | SOUND LEVEL<br>dB(A) | LOAD % |    |    |     |     |
|----------|----------------------|--------|----|----|-----|-----|
|          |                      | 25     | 50 | 75 | 100 | 110 |
| 1        | 68.2                 |        |    |    |     |     |
| 2        | 65.2                 |        |    |    |     |     |
| 3        |                      |        |    |    |     |     |
| 4        |                      |        |    |    |     |     |
| 5        |                      |        |    |    |     |     |
| 6        | 67.3                 |        |    |    |     |     |
| 7        |                      |        |    |    |     |     |
| 8        | 67.8                 |        |    |    |     |     |
| 9        |                      |        |    |    |     |     |
| 10       | 67.3                 |        |    |    |     |     |
| 11       |                      |        |    |    |     |     |
| 12       | 68.3                 |        |    |    |     |     |
| Average  |                      |        |    |    |     |     |

QUALITY ASSURANCE OFFICER: \_\_\_\_\_

CUSTOMER TESTING OFFICER: \_\_\_\_\_

TESTING OFFICER: PAUL HLAVKAWITNESS TESTING OFFICER: DAVID COOPER



47 Proprietary Street  
Tingalpa Qld 4173  
PH: (07) 3890 1744

SEP0084

## TRANSIENT LOAD RESPONSE TEST SHEET

Transient response for load changes: Load PF 0.8

| % Change Electrical kW  | 0-25    | 0-50 | 0-75 | 0-100 | 100-0 | 75-0 | 50-0 | 25-0    |
|-------------------------|---------|------|------|-------|-------|------|------|---------|
| Change in Electrical kW |         |      |      |       |       |      |      |         |
| % Change HZ             | .3      | .5   | 1.0  | 4     | 2     | .9   | .4   | .2      |
| % Change Volts          | NIL     | NIL  | 2    | 10    | 3     | 1    | NIL  | NIL     |
| Recovery secs           | INSTANT | 1    | 2    | 5     | 2     | 2    | 1    | INSTANT |

CLIENT : BRIS WATER SP174

JOB No: 14291

S/N: 0308011

47 Proprietary Street  
Tingalpa Q 4173  
BRISBANE AUSTRALIA



SEP 0013

FINAL INSPECTION CHECKLIST

This form is to be completely filled out before any generating set leaves the factory.

It is to be signed by the person doing the inspection and by their immediate supervisor. In the case of a non-standard job it must also be signed by the Special Projects Manager or the Engineering Manager.

A copy of this form is to be sent out with the plant concerned.

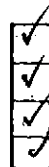
Please neatly tick in the boxes provided where applicable and note any comments in the space provided.

MODEL: B.W. SP174 SERIAL NO: 0308011 ENGINE NO: 726317

JOB NO: 14291 DATE: 01.09.03 CUSTOMER: B.W.

BASE

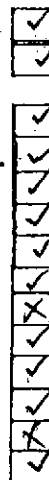
- (1) All welds continuous, neat and clean.
- (2) All bolts tightened.
- (3) Bearers completely secured.
- (4) No sharp corners.

RADIATOR

- (1) Radiator correctly mounted.
- (2) All pipework included and secure.
- (3) Drain plug in place.
- (4) Water removed from radiator.
- (5) Clamps on hoses tight.

ENGINE

- (1) Fan is correctly mounted.
- (2) All guards in place and secure.
- (3) Wiring loom is correct to drawing, securely fixed and marked and is terminated in an appropriate terminal box.
- (4) Battery leads attached and secure and long enough for termination to battery.
- (5) Air cleaner is properly mounted.
- (6) Magnetic pickup is fitted and set to correct depth.
- (7) Exhaust pipe and silencer (where required) are fitted correctly.
- (8) Dip stick in place.
- (9) Oil removed from engine.
- (10) All fuel and oil unions completely tightened.
- (11) All ordered options are fitted and function correctly.
- (12) All parts secure, no damage.
- (13) All earths less than 0.1 ohms.
- (14) Cables and hoses secure for transport.

CONTROL SYSTEM (where applicable)

- (1) Control functions as ordered.
- (2) Control is mounted correctly.
- (3) All leads, terminals, fuses, printed circuit boards and switchgear are completely secure and marked correctly.
- (4) Dust seals are fitted around doors.
- (5) Doors hinged correctly.
- (6) All earths less than 0.1 ohms.
- (7) Red Danger labels in cubicle.





FINAL INSPECTION CHECKLIST

PAGE 2

CONTROL SYSTEM (cont)

- (8) Perspex shield secure, clean and no sharp corners.
- (9) Cables correct, no damage.
- (10) Locks and keys satisfactory.

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ALTERNATOR

- (1) Alternator is correctly mounted.
- (2) Alternator leads are correctly mounted inside terminal box and marked correctly.
- (3) A.V.R. is mounted, connected properly and set to correct setting.
- (4) Coupling and adaptor are properly fastened between engine and alternator with correct size and tensile grade bolts.
- (5) All options ordered are fitted and function properly.
- (6) Alternator is correctly wired for the appropriate voltage as per either Order or Bills of Material.
- (7) Earth stud fitted.

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FINISH

- (1) Plant is painted to correct colour.
- (2) All blemishes in finish, especially paint runs, are completely removed.

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GENERAL INSPECTION

- (1) Genset is manufactured to correct engine/alternator/radiator/bases configuration as specified on Bill of Materials.
- (2) All documents are in a sealed plastic bag and secured inside alternator terminal box.
  - a) Engine Handbook
  - b) Alternator Handbook
  - c) Warranty Card
  - d) Packing List
  - e) Test Sheet
- (3) No Oil/No Water label is attached to positive battery lead.
- (4) All labels are straight and in correct location.

} WITH MANUALS

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SIGNED: \_\_\_\_\_ INSPECTOR

*J. Hughes*\_\_\_\_\_  
QUALITY ASSURANCE

COMMENTS: \_\_\_\_\_

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