title: 34ID Equipment Protection System PLC Program
author: Pete R. Jemian
created: 7 February 2001
PLC: Koyo DL250

read the CPU ID from the hardwired input ports (4 bits, values 0-15)

1

_FirstScan
SP0

LD
Kf

AND
CPU/Prog Code
VX0

OUT
CPU ID
V2000

Read the software revision number from the hardwired input (4 bits, values 0-15)

2

_FirstScan
SP0

LD
Kf0

AND
CPU/Prog Code
VX0

SHFR
K4

OUT
Prog Rev #
V2001

STOP if we are not using the correct CPU ID #

3

_FirstScan
SP0

CPU ID
V2000

K5

FAULT
K1

STOP

STOP if we are not using the correct Program Revision Number

4

_FirstScan
SP0

Prog Rev #
V2001

K1

FAULT
K2

STOP

34ID-D microbeam monochromator limit switch
defines a region where no white beam is permitted
(Note that this is a normally closed operation)

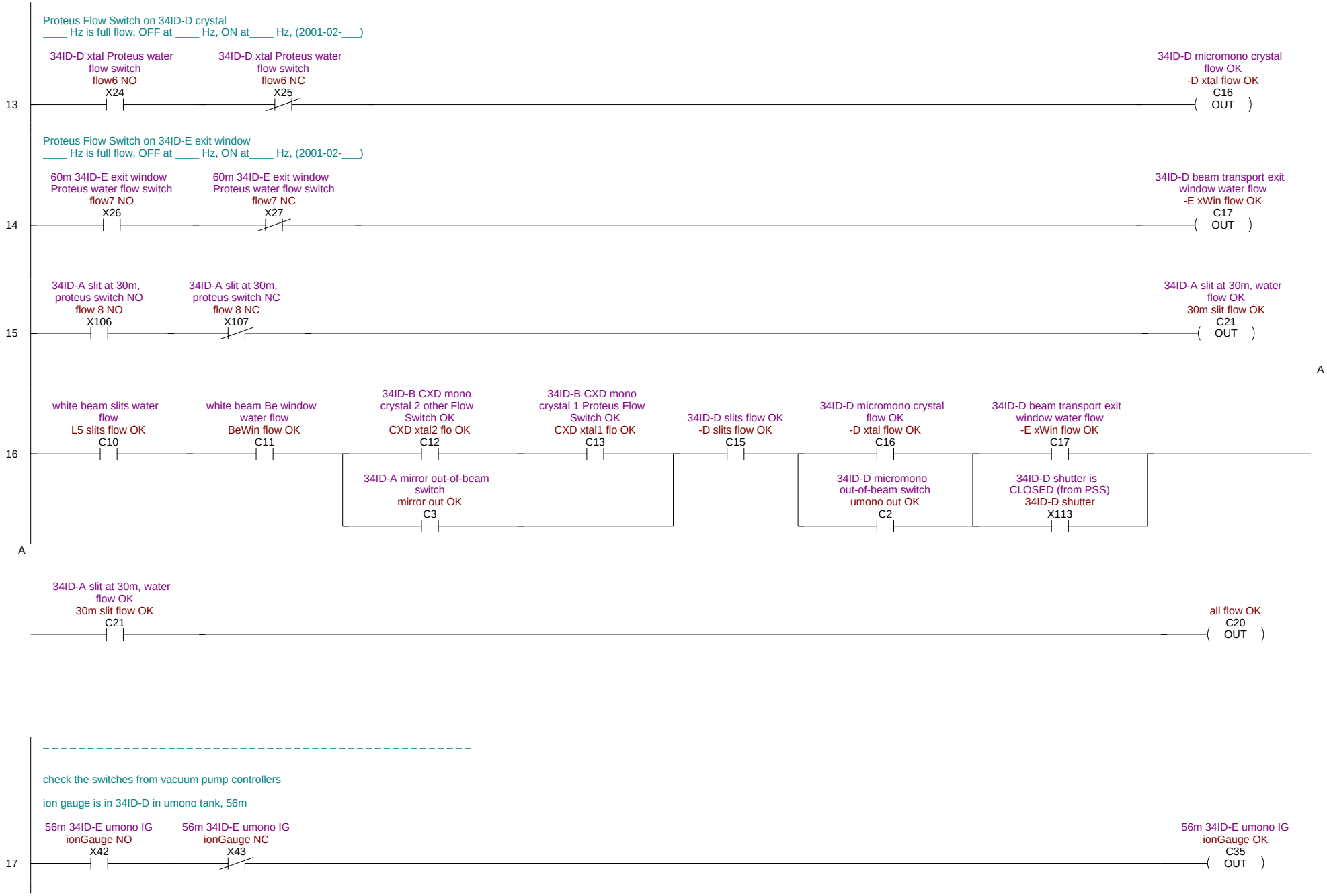
5

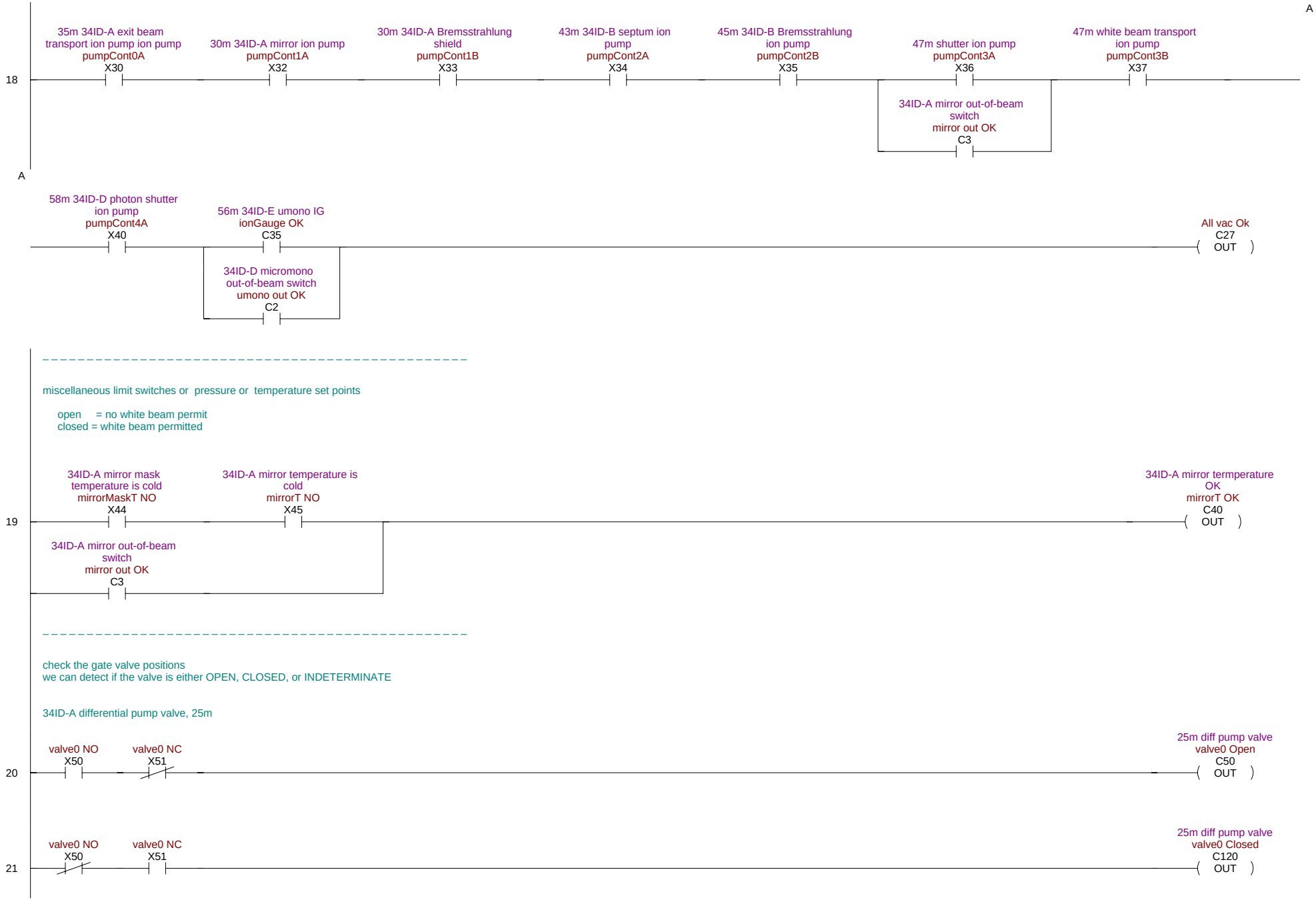
umono lim NO
X100

umono lim NC
X101

34ID-D micromono limit switch - white beam OK
umono lim OK
C1
OUT


34ID-D microbeam monochromator out-of-beam switch
umono out NO
X102
umono out NC
X103
34ID-D micromono out-of-beam switch umono out OK
C2
OUT
6
34ID-A mirror out-of-beam switch
mirror out NO
X104
mirror out NC
X105
34ID-A mirror out-of-beam switch mirror out OK
C3
OUT
7
water flow
Proteus Flow Switch on L5 slits
____ Hz is full flow, OFF at ____ Hz, ON at____ Hz, (2001-02-___)
L5 slits Proteus water flow switch flow0 NO
X10
L5 slits Proteus water flow switch flow0 NC
X11
white beam slits water flow L5 slits flow OK
C10
OUT
8
Proteus Flow Switch on Be window (white beam window in 34ID-B)
____ Hz is full flow, OFF at ____ Hz, ON at____ Hz, (2001-02-___)
WB window Proteus water flow switch flow1 NO
X12
WB window Proteus water flow switch flow1 NC
X13
white beam Be window water flow BeWin flow OK
C11
OUT
9
Proteus Flow Switch on CXD mono crystal 2 (in 34ID-B)
____ Hz is full flow, OFF at ____ Hz, ON at____ Hz, (2001-02-___)
CXD mono 2nd crystal (~46m) Proteus water flow switch flow2 NO
X14
CXD mono 2nd crystal (~46m) Proteus water flow switch flow2 NC
X15
34ID-B CXD mono crystal 2 other Flow Switch OK CXD xtal2 flo OK
C12
OUT
10
Proteus Flow Switch on CXD monochromator
____ Hz is full flow, OFF at ____ Hz, ON at____ Hz, (2001-02-___)
CXD mono 1st crystal Proteus water flow switch flow3 NO
X16
CXD mono 1st crystal Proteus water flow switch flow3 NC
X17
34ID-B CXD mono crystal 1 Proteus Flow Switch OK CXD xtal1 flo OK
C13
OUT
11
Proteus Flow Switch on all 34ID-D slits
____ Hz is full flow, OFF at ____ Hz, ON at____ Hz, (2001-02-___)
34ID-D slits Proteus water flow switch flow5 NO
X22
34ID-D slits Proteus water flow switch flow5 NC
X23
34ID-D slits flow OK -D slits flow OK
C15
OUT
12


Proteus Flow Switch on 34ID-D crystal
____ Hz is full flow, OFF at ____ Hz, ON at____ Hz, (2001-02-___)
34ID-D xtal Proteus water flow switch flow6 NO
X24
34ID-D xtal Proteus water flow switch flow6 NC
X25
34ID-D micromono crystal flow OK -D xtal flow OK
C16
OUT
13
Proteus Flow Switch on 34ID-E exit window
____ Hz is full flow, OFF at ____ Hz, ON at____ Hz, (2001-02-___)
60m 34ID-E exit window Proteus water flow switch flow7 NO
X26
60m 34ID-E exit window Proteus water flow switch flow7 NC
X27
34ID-D beam transport exit window water flow -E xWin flow OK
C17
OUT
14
34ID-A slit at 30m, proteus switch NO flow 8 NO
X106
34ID-A slit at 30m, proteus switch NC flow 8 NC
X107
34ID-A slit at 30m, water flow OK 30m slit flow OK
C21
OUT
15
A
white beam slits water flow L5 slits flow OK
C10
white beam Be window water flow BeWin flow OK
C11
34ID-B CXD mono crystal 2 other Flow Switch OK CXD xtal2 flo OK
C12
34ID-B CXD mono crystal 1 Proteus Flow Switch OK CXD xtal1 flo OK
C13
34ID-D slits flow OK -D slits flow OK
C15
34ID-D micromono crystal flow OK -D xtal flow OK
C16
34ID-D beam transport exit window water flow -E xWin flow OK
C17
34ID-A mirror out-of-beam switch mirror out OK
C3
34ID-D micromono out-of-beam switch umono out OK
C2
34ID-D shutter is CLOSED (from PSS) 34ID-D shutter
X113
16
A
34ID-A slit at 30m, water flow OK 30m slit flow OK
C21
all flow OK
C20
OUT
check the switches from vacuum pump controllers
ion gauge is in 34ID-D in umono tank, 56m
56m 34ID-E umono IG ionGauge NO
X42
56m 34ID-E umono IG ionGauge NC
X43
56m 34ID-E umono IG ionGauge OK
C35
OUT
17


A
18
35m 34ID-A exit beam transport ion pump ion pump pumpCont0A X30
30m 34ID-A mirror ion pump pumpCont1A X32
30m 34ID-A Bremsstrahlung shield pumpCont1B X33
43m 34ID-B septum ion pump pumpCont2A X34
45m 34ID-B Bremsstrahlung ion pump pumpCont2B X35
47m shutter ion pump pumpCont3A X36
47m white beam transport ion pump pumpCont3B X37
34ID-A mirror out-of-beam switch mirror out OK C3
A
58m 34ID-D photon shutter ion pump pumpCont4A X40
56m 34ID-E umono IG ionGauge OK C35
34ID-D micromono out-of-beam switch umono out OK C2
All vac Ok C27 OUT
miscellaneous limit switches or pressure or temperature set points
open = no white beam permit
closed = white beam permitted
19
34ID-A mirror mask temperature is cold mirrorMaskT NO X44
34ID-A mirror temperature is cold mirrorT NO X45
34ID-A mirror out-of-beam switch mirror out OK C3
34ID-A mirror termperature OK mirrorT OK C40 OUT
check the gate valve positions
we can detect if the valve is either OPEN, CLOSED, or INDETERMINATE
34ID-A differential pump valve, 25m
20
valve0 NO X50
valve0 NC X51
25m diff pump valve valve0 Open C50 OUT
21
valve0 NO X50
valve0 NC X51
25m diff pump valve valve0 Closed C120 OUT

34ID-A mirror entrance valve, 29m

22 valve1 NO X52 | valve1 NC X53 | 29m mirror entrance valve valve1 Open C51 OUT

23 valve1 NO X52 | valve1 NC X53 | 29m mirror entrance valve valve1 Closed C121 OUT

34ID-A mirror exit valve, 31m

24 valve2 NO X54 | valve2 NC X55 | 31m mirror exit valve valve2 Open C52 OUT

25 valve2 NO X54 | valve2 NC X55 | 31m mirror exit valve valve2 Closed C122 OUT

34ID-A exit valve, 35m

26 valve3 NO X56 | valve3 NC X57 | 35m 34ID-A exit valve valve3 Open C53 OUT

27 valve3 NO X56 | valve3 NC X57 | 35m 34ID-A exit valve valve3 Closed C123 OUT

gate valve after CXD mono exit at 47m

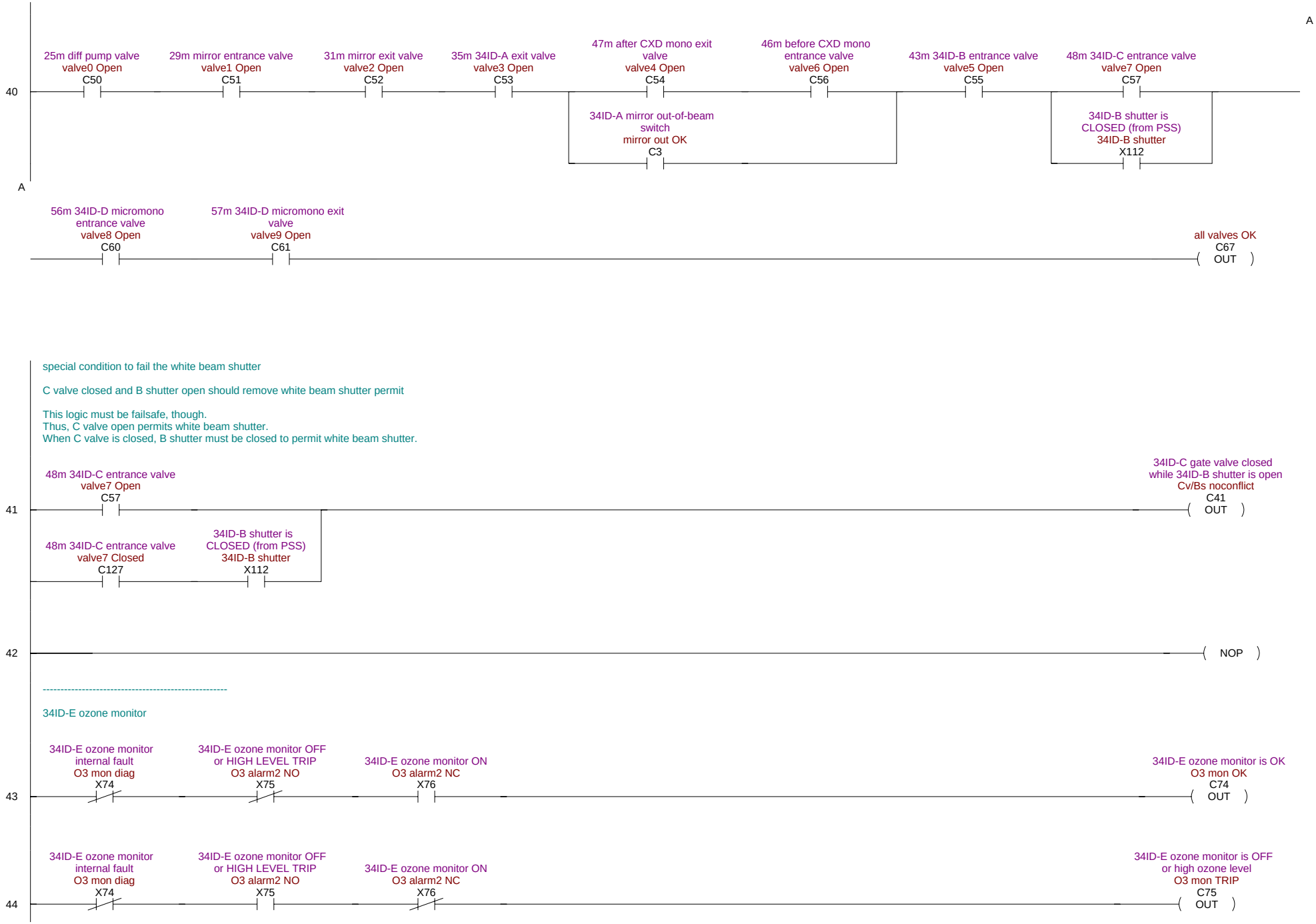
28 valve4 NO X60 | valve4 NC X61 | 47m after CXD mono exit valve valve4 Open C54 OUT

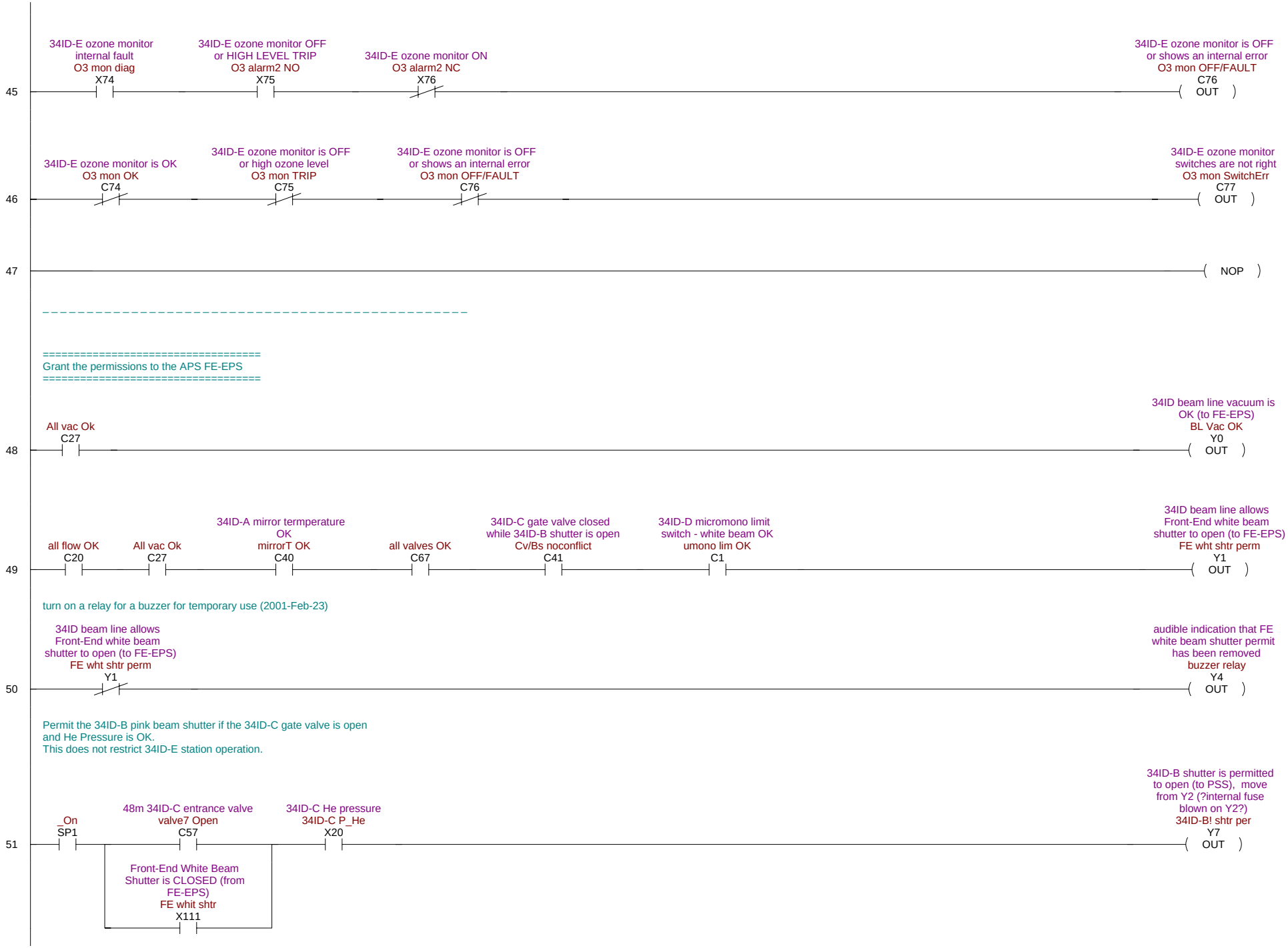
29 valve4 NO X60 | valve4 NC X61 | 47m after CXD mono exit valve valve4 Closed C124 OUT

34ID-B entrance valve, 43m

30 valve5 NO X62 | valve5 NC X63 | 43m 34ID-B entrance valve valve5 Open C55 OUT


31
valve5 NO
X62
valve5 NC
X63
43m 34ID-B entrance valve
valve5 Closed
C125
OUT
gate valve before CXD mono entrance at 46m
32
valve6 NO
X64
valve6 NC
X65
46m before CXD mono
entrance valve
valve6 Open
C56
OUT
33
valve6 NO
X64
valve6 NC
X65
46m before CXD mono
entrance valve
valve6 Closed
C126
OUT
34ID-C entrance valve, 48m
34
valve7 NO
X66
valve7 NC
X67
48m 34ID-C entrance valve
valve7 Open
C57
OUT
35
valve7 NO
X66
valve7 NC
X67
48m 34ID-C entrance valve
valve7 Closed
C127
OUT
34ID-D umono entrance valve, 56m
36
valve8 NO
X70
valve8 NC
X71
56m 34ID-D micromono
entrance valve
valve8 Open
C60
OUT
37
valve8 NO
X70
valve8 NC
X71
56m 34ID-D micromono
entrance valve
valve8 Closed
C130
OUT
34ID-D umono exit valve, 57m
38
valve9 NO
X72
valve9 NC
X73
57m 34ID-D micromono exit
valve
valve9 Open
C61
OUT
39
valve9 NO
X72
valve9 NC
X73
57m 34ID-D micromono exit
valve
valve9 Closed
C131
OUT


A
40
25m diff pump valve
valve0 Open
C50
29m mirror entrance valve
valve1 Open
C51
31m mirror exit valve
valve2 Open
C52
35m 34ID-A exit valve
valve3 Open
C53
47m after CXD mono exit
valve
valve4 Open
C54
46m before CXD mono
entrance valve
valve6 Open
C56
43m 34ID-B entrance valve
valve5 Open
C55
48m 34ID-C entrance valve
valve7 Open
C57
34ID-A mirror out-of-beam
switch
mirror out OK
C3
34ID-B shutter is
CLOSED (from PSS)
34ID-B shutter
X112
A
56m 34ID-D micromono
entrance valve
valve8 Open
C60
57m 34ID-D micromono exit
valve
valve9 Open
C61
all valves OK
C67
OUT
special condition to fail the white beam shutter
C valve closed and B shutter open should remove white beam shutter permit
This logic must be failsafe, though.
Thus, C valve open permits white beam shutter.
When C valve is closed, B shutter must be closed to permit white beam shutter.
41
48m 34ID-C entrance valve
valve7 Open
C57
34ID-C gate valve closed
while 34ID-B shutter is open
Cv/Bs noconflict
C41
OUT
48m 34ID-C entrance valve
valve7 Closed
C127
34ID-B shutter is
CLOSED (from PSS)
34ID-B shutter
X112
42
NOP
34ID-E ozone monitor
43
34ID-E ozone monitor
internal fault
O3 mon diag
X74
34ID-E ozone monitor OFF
or HIGH LEVEL TRIP
O3 alarm2 NO
X75
34ID-E ozone monitor ON
O3 alarm2 NC
X76
34ID-E ozone monitor is OK
O3 mon OK
C74
OUT
44
34ID-E ozone monitor
internal fault
O3 mon diag
X74
34ID-E ozone monitor OFF
or HIGH LEVEL TRIP
O3 alarm2 NO
X75
34ID-E ozone monitor ON
O3 alarm2 NC
X76
34ID-E ozone monitor is OFF
or high ozone level
O3 mon TRIP
C75
OUT


34ID-E ozone monitor internal fault O3 mon diag X74
34ID-E ozone monitor OFF or HIGH LEVEL TRIP O3 alarm2 NO X75
34ID-E ozone monitor ON O3 alarm2 NC X76
34ID-E ozone monitor is OFF or shows an internal error O3 mon OFF/FAULT C76 OUT
45
34ID-E ozone monitor is OK O3 mon OK C74
34ID-E ozone monitor is OFF or high ozone level O3 mon TRIP C75
34ID-E ozone monitor is OFF or shows an internal error O3 mon OFF/FAULT C76
34ID-E ozone monitor switches are not right O3 mon SwitchErr C77 OUT
46
47
NOP
Grant the permissions to the APS FE-EPS
All vac Ok C27
34ID beam line vacuum is OK (to FE-EPS) BL Vac OK Y0 OUT
48
all flow OK C20
All vac Ok C27
34ID-A mirror termperature OK mirrorT OK C40
all valves OK C67
34ID-C gate valve closed while 34ID-B shutter is open Cv/Bs noconflict C41
34ID-D micromono limit switch - white beam OK umono lim OK C1
34ID beam line allows Front-End white beam shutter to open (to FE-EPS) FE wht shtr perm Y1 OUT
49
turn on a relay for a buzzer for temporary use (2001-Feb-23)
34ID beam line allows Front-End white beam shutter to open (to FE-EPS) FE wht shtr perm Y1
audible indication that FE white beam shutter permit has been removed buzzer relay Y4 OUT
50
Permit the 34ID-B pink beam shutter if the 34ID-C gate valve is open and He Pressure is OK.
This does not restrict 34ID-E station operation.
_On SP1
48m 34ID-C entrance valve valve7 Open C57
34ID-C He pressure 34ID-C P_He X20
34ID-B shutter is permitted to open (to PSS), move from Y2 (?internal fuse blown on Y2?) 34ID-B! shtr per Y7 OUT
Front-End White Beam Shutter is CLOSED (from FE-EPS) FE whit shtr X111
51

Permit the 34ID-D white beam shutter to operate.
Need He Pressure and exit window water flow to grant the permit.
Nothing to protect if the FE white shutter is closed.
(Thus, closing the FE white shutter will not force the 34ID-D shutter to close.)
This does not restrict C station operation.

52

34ID-E He pressure
34ID-E P_He
X46

34ID-D beam transport exit window water flow
-E xWin flow OK
C17

34ID-E ozone monitor is OK
O3 mon OK
C74

34ID-E He pressure
34ID-E P_He
X46

34ID-D shutter is permitted to open (to PSS)
34ID-D shtr perm
Y3
OUT

Front-End White Beam Shutter is CLOSED (from FE-EPS)
FE whit shtr
X111

==========
trigger the event log
==========

trigger event log entry when beam line vacuum status changes

53

34ID beam line vacuum is OK (to FE-EPS)
BL Vac OK
Y0

old BL vac OK
C100

record a new EPS event
record EPS event
C0
SET

34ID beam line vacuum is OK (to FE-EPS)
BL Vac OK
Y0

old BL vac OK
C100

trigger event log entry when front end white beam shutter permit status changes

54

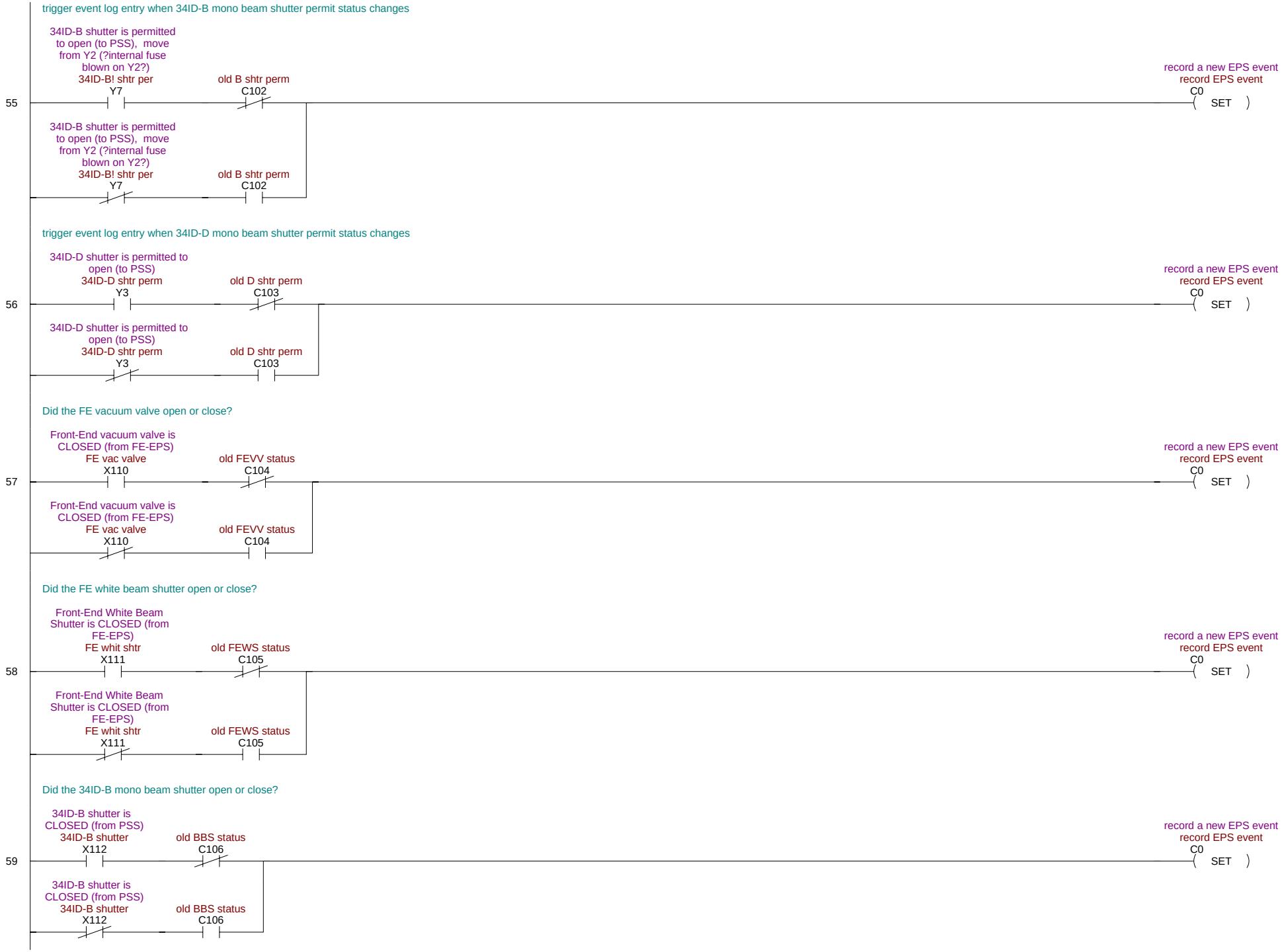
34ID beam line allows Front-End white beam shutter to open (to FE-EPS)
FE wht shtr perm
Y1

old W shtr perm
C101

record a new EPS event
record EPS event
C0
SET

34ID beam line allows Front-End white beam shutter to open (to FE-EPS)
FE wht shtr perm
Y1

old W shtr perm
C101


trigger event log entry when 34ID-B mono beam shutter permit status changes
34ID-B shutter is permitted to open (to PSS), move from Y2 (?internal fuse blown on Y2??)
34ID-B! shtr per
Y7
old B shtr perm
C102
55
record a new EPS event
record EPS event
C0
SET
34ID-B shutter is permitted to open (to PSS), move from Y2 (?internal fuse blown on Y2??)
34ID-B! shtr per
Y7
old B shtr perm
C102
trigger event log entry when 34ID-D mono beam shutter permit status changes
34ID-D shutter is permitted to open (to PSS)
34ID-D shtr perm
Y3
old D shtr perm
C103
56
record a new EPS event
record EPS event
C0
SET
34ID-D shutter is permitted to open (to PSS)
34ID-D shtr perm
Y3
old D shtr perm
C103
Did the FE vacuum valve open or close?
Front-End vacuum valve is CLOSED (from FE-EPS)
FE vac valve
X110
old FEVV status
C104
57
record a new EPS event
record EPS event
C0
SET
Front-End vacuum valve is CLOSED (from FE-EPS)
FE vac valve
X110
old FEVV status
C104
Did the FE white beam shutter open or close?
Front-End White Beam Shutter is CLOSED (from FE-EPS)
FE whit shtr
X111
old FEWS status
C105
58
record a new EPS event
record EPS event
C0
SET
Front-End White Beam Shutter is CLOSED (from FE-EPS)
FE whit shtr
X111
old FEWS status
C105
Did the 34ID-B mono beam shutter open or close?
34ID-B shutter is CLOSED (from PSS)
34ID-B shutter
X112
old BBS status
C106
59
record a new EPS event
record EPS event
C0
SET
34ID-B shutter is CLOSED (from PSS)
34ID-B shutter
X112
old BBS status
C106


Did the 34ID-D mono beam shutter open or close?
34ID-D shutter is CLOSED (from PSS)
34ID-D shutter
X113
old DBS status
C107
60
record a new EPS event
record EPS event
C0
SET
34ID-D shutter is CLOSED (from PSS)
34ID-D shutter
X113
old DBS status
C107
start updating the event log
record a new EPS event
record EPS event
C0
61
INC
event number
V3120
when the event log counter wraps around,
force it to wrap at an even multiple of 32 (number of entries in event table):
(32*(9999%32)=9984) where 9999%32=312
record a new EPS event
record EPS event
C0
event number
V3120
≥
K9984
62
LD
K0
OUT
event number
V3120
for the time stamp: 0.01 s clock
record a new EPS event
record EPS event
C0
63
LD
V7747
OUT
evt ms clock
V3121
for the time stamp: S:M:H (0059 0059 0023)
record a new EPS event
record EPS event
C0
64
LD
K3
LDA
O7766
MOV
evt SMH
V3122

for the time stamp: D/M/Y (0031 0012 0099)

record a new EPS event
record EPS event
65 C0

LD K3
LDA O7772
MOV evt DMY V3125

copy the inputs X00-X117

record a new EPS event
record EPS event
66 C0

LD K5
LDA O40400
MOV evt VX0 V3130

copy the control relays C00-C137

record a new EPS event
record EPS event
67 C0

LD K6
LDA O40600
MOV evt VC0 V3135

copy the outputs Y00-Y17

record a new EPS event
record EPS event
68 C0

LD K1
LDA O40500
MOV V3143

locate next entry index in event table
32 table entries (V3160 = V3120 % 32)

record a new EPS event
record EPS event
C0
69

LD
event number
V3120
DIV
K32
POP
OUT
evTab index
V3160

event table structure
each entry takes 24 words
table base address is v4000

word	description
00	event number
01-04	time stamp
05-07	date stamp
10-14	X00-X117 relays
15-22	C00-C137 relays
23	Y00-Y17 relays
24-27	unused

determine the offset address in the event table at which to store this entry
V3161 = V(4000 + 24 * V3160)

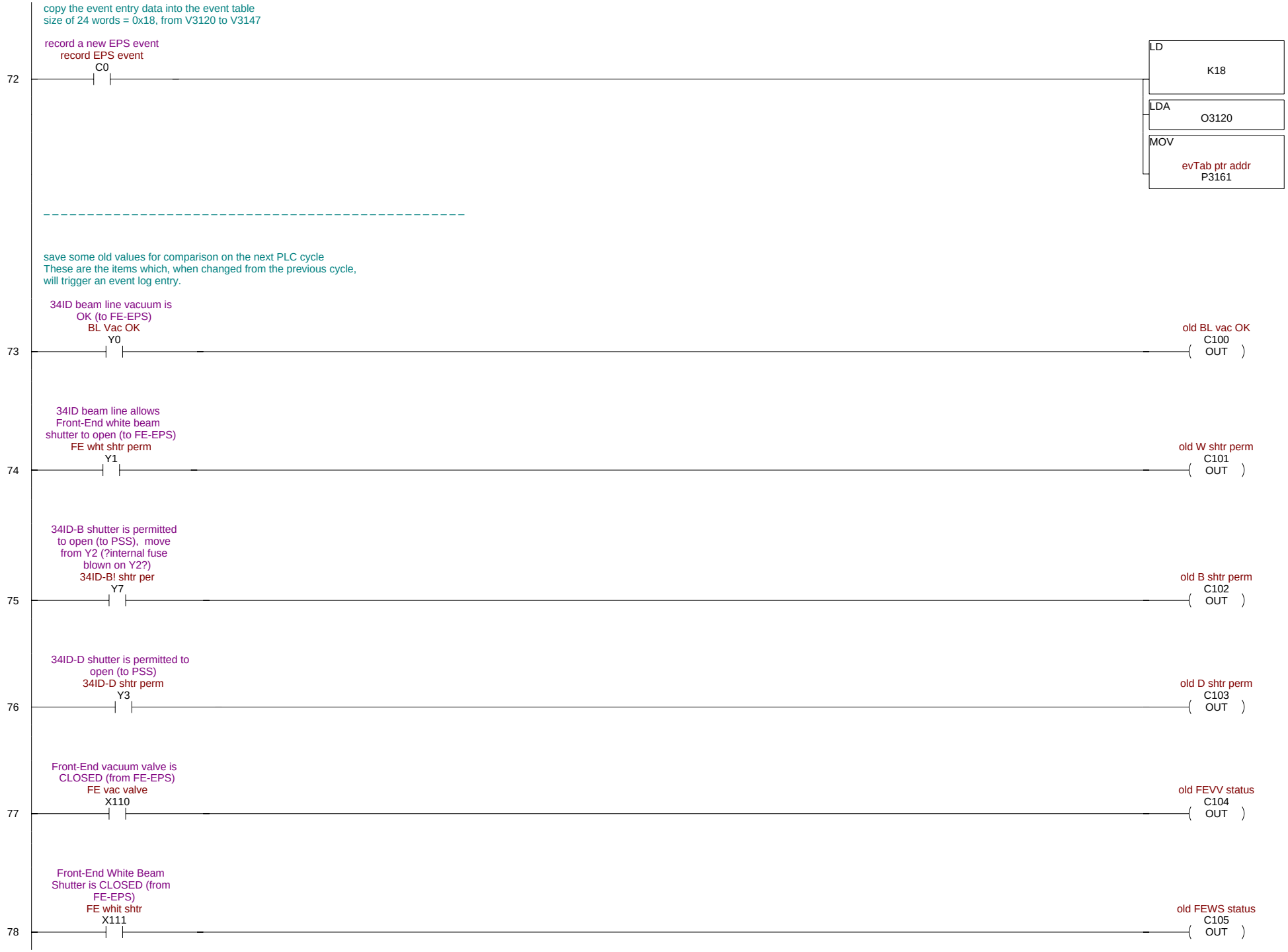
record a new EPS event
record EPS event
C0
70

LD
evTab index
V3160
MUL
K24
BIN
OUT
evTab ptr
V3161

add the base address of the event table (V4000)

record a new EPS event
record EPS event
C0
71

LDA
O4000
ADDB
evTab ptr
V3161
OUT
evTab ptr
V3161


copy the event entry data into the event table
size of 24 words = 0x18, from V3120 to V3147
record a new EPS event
record EPS event
C0
72
LD
K18
LDA
O3120
MOV
evTab ptr addr
P3161
save some old values for comparison on the next PLC cycle
These are the items which, when changed from the previous cycle,
will trigger an event log entry.
34ID beam line vacuum is
OK (to FE-EPS)
BL Vac OK
Y0
73
old BL vac OK
C100
OUT
34ID beam line allows
Front-End white beam
shutter to open (to FE-EPS)
FE wht shtr perm
Y1
74
old W shtr perm
C101
OUT
34ID-B shutter is permitted
to open (to PSS), move
from Y2 (?internal fuse
blown on Y2?)
34ID-B! shtr per
Y7
75
old B shtr perm
C102
OUT
34ID-D shutter is permitted to
open (to PSS)
34ID-D shtr perm
Y3
76
old D shtr perm
C103
OUT
Front-End vacuum valve is
CLOSED (from FE-EPS)
FE vac valve
X110
77
old FEVV status
C104
OUT
Front-End White Beam
Shutter is CLOSED (from
FE-EPS)
FE whit shtr
X111
78
old FEWS status
C105
OUT


34ID-B shutter is CLOSED (from PSS)
34ID-B shutter
X112
79
old BBS status
C106
OUT
34ID-D shutter is CLOSED (from PSS)
34ID-D shutter
X113
80
old DBS status
C107
OUT
done updating the event log
record a new EPS event
record EPS event
C0
81
record a new EPS event
record EPS event
C0
RST
82
END
DLBL
K1
84
ACON
wrong hardware CPU ID
DLBL
K2
86
ACON
wrong hardware program version
87
NOP