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Systems Interaction Results from the Digraph Matrix Analysis of a Nuclear Power Plant's High Pressure Safety Injection Systems
Volume 2

I. J. Sacks, B. C. Ashmore, and H. P. Alesso

Prepared for
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Systems Interaction Results from the Digraph Matrix Analysis of a Nuclear Power Plant's High Pressure Safety Injection Systems
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ABSTRACT

Spatial and functional coupling (including human actions) of nuclear power plant systems that lead to interdependencies are called Systems Interactions. At present, the U.S. Nuclear Regulatory Commission (NRC) is investigating ways of identifying and evaluating systems interactions. One approach is based on graph-theoretic methods utilizing matrix representations of logic diagrams called Digraph Matrix Analysis (DMA).

Our objective in this report is to demonstrate the capabilities of Digraph Matrix Analysis to model an accident sequence (including front-line systems, support systems and human actions) as a continuous, well-integrated logic model in order to identify and evaluate functional systems interactions.

The selected accident sequence, loss of high pressure safety injection during a LOCA, was modeled and qualitative and quantitative comparisons were made to the Reactor Safety Study (WASH 1400) and other studies. The results demonstrate that: (1) DMA is highly capable of modeling and evaluating an accident sequence (including front-line systems, support systems, and human actions) as a continuous and well-integrated logic model in order to identify and evaluate systems interactions; (2) numerous, non-intuitive systems interactions were found between front-line and support systems that collectively contributed significantly to the overall failure probability, and (3) the reactor operators can provide a significant improvement in safety if they correctly respond to the failure of an automatic system.

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PREFACE

This volume, the second of a two-volume report, contains:

Appendix B - the complete set of digraphs for the High Pressure Safety Injection System;

Appendix C - the corresponding adjacency listings; and

Appendix D - the data base used for the quantitative analysis.

Volume I included the main report and Appendix A.

APPENDIX B

COMPLETE SET OF FAILURE-ORIENTED DIGRAPHS FOR SIPIS.

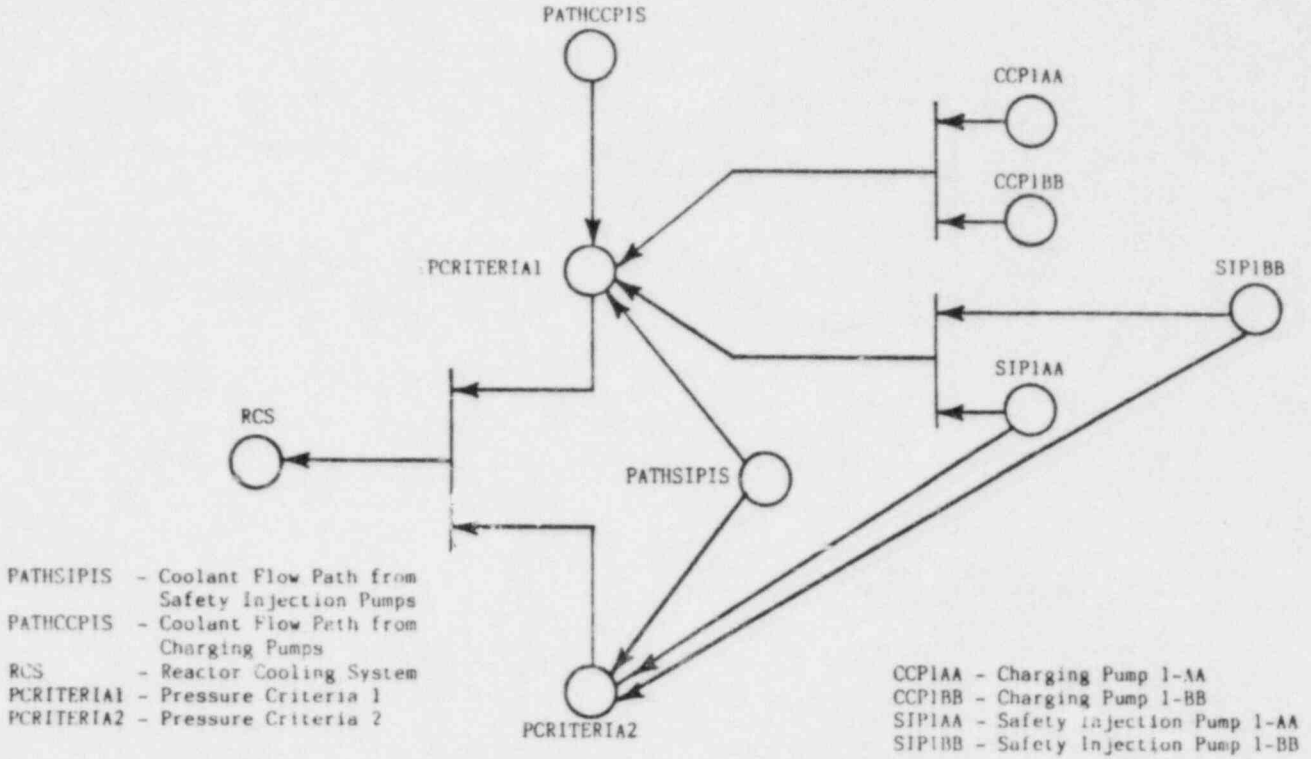


Figure B-1. RCS.DAT System Success Criteria For S1 LOCA

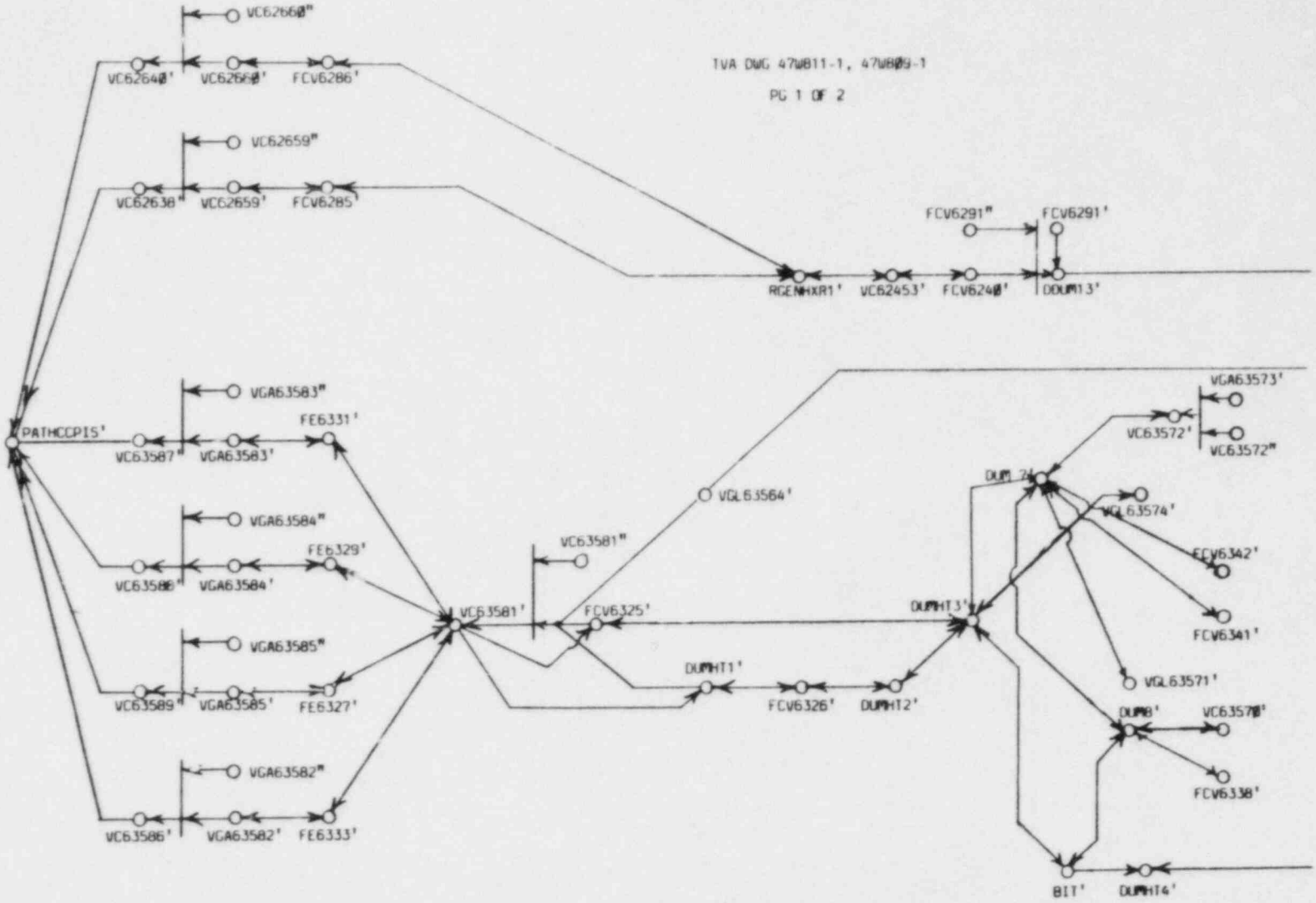
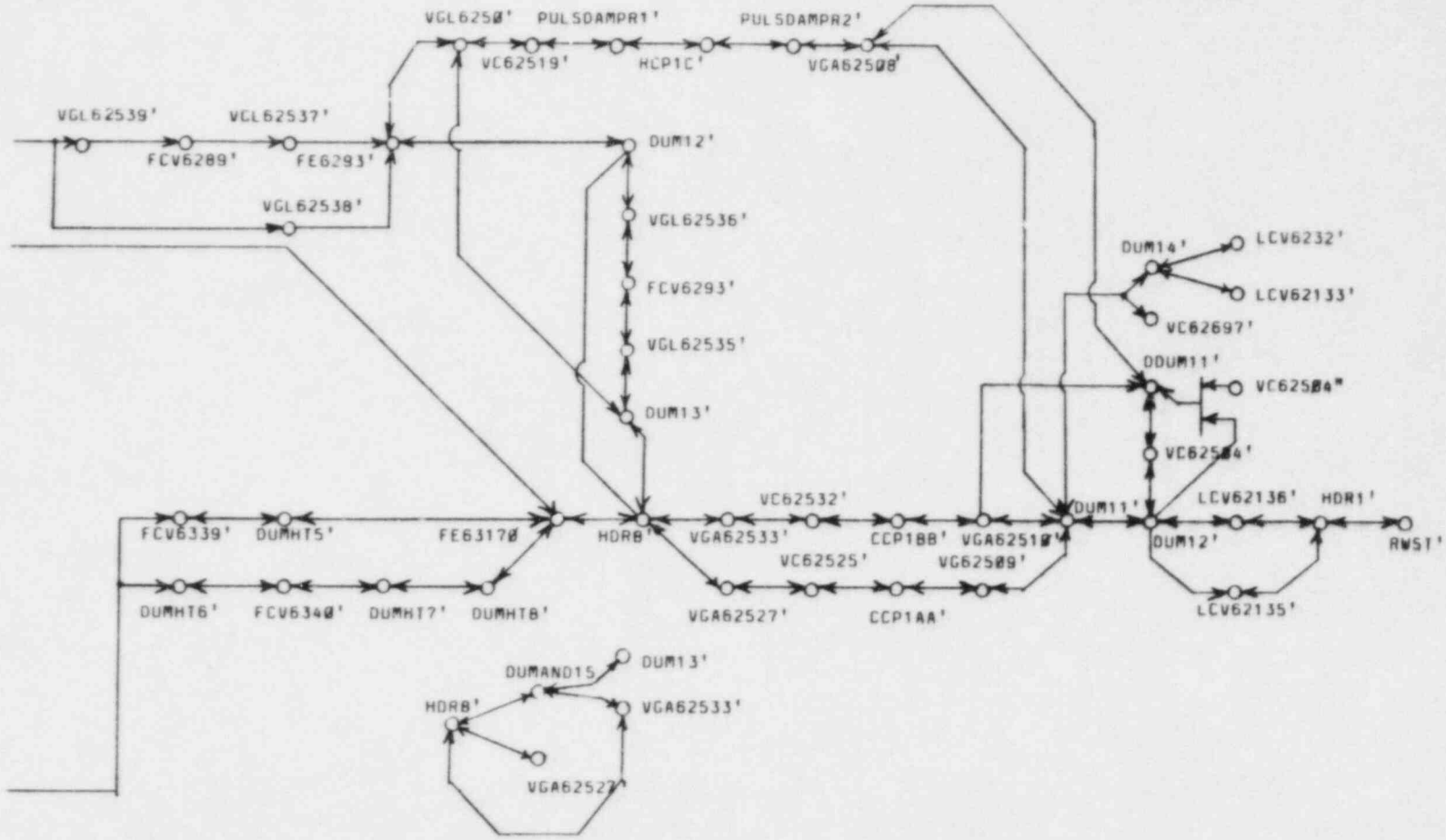


Figure B-2. CBREAK.DAT Break Model for CCPIS


VGL62539'
VGL62537'
FCV6289'
FE6293'
VGL62538'
VGL6250'
PULSDAMPR1'
VC62519'
HCP1C'
PULSDAMPR2'
VGA62508'
DUM12'
VGL62536'
FCV6293'
VGL62535'
DUM13'
DUM14'
LCV6232'
LCV62133'
VC62697'
DDUM11'
VC62504"
VC62504'
VC62532'
DUM11'
LCV62136'
HDR1'
FCV6339'
DUMHT5'
FE63170
HDR8'
VGA62533'
CCP1BB'
VGA62510'
VC62525'
VG62509'
DUM12'
RWST'
DUMHT6'
FCV6340'
DUMHT7'
DUMHT8'
VGA62527'
CCP1AA'
LCV62135'
DUMAND15
DUM13'
HDR8'
VGA62533'
VGA62527'

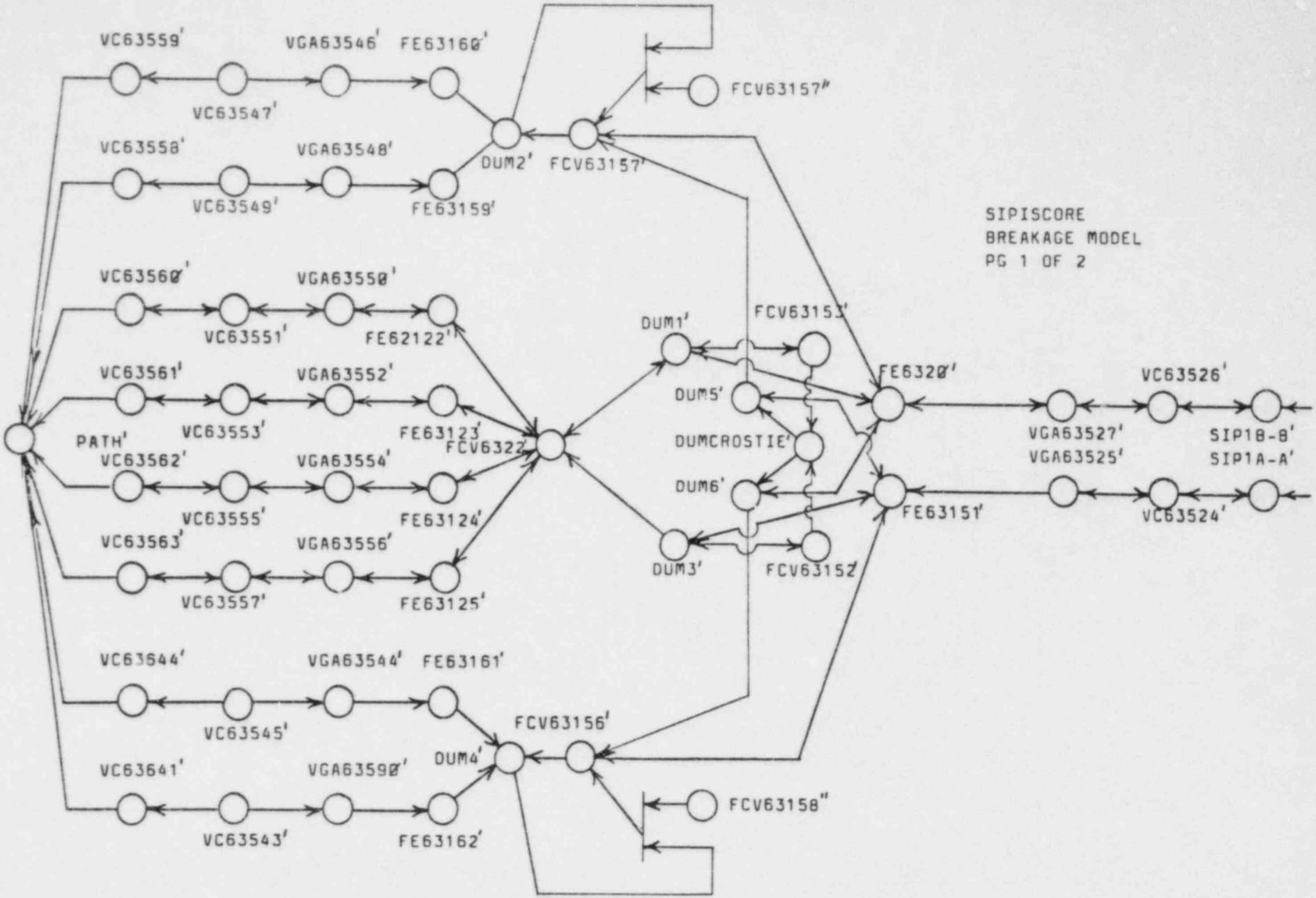
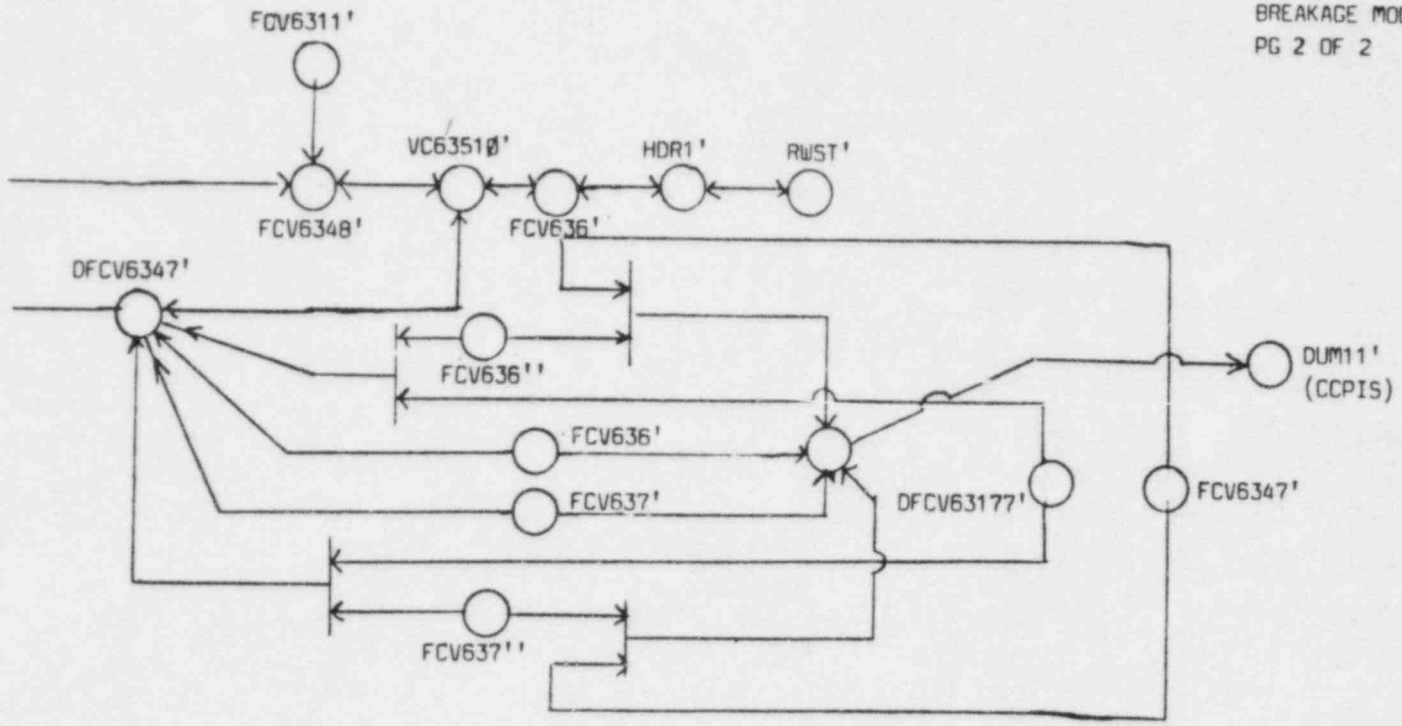


Figure B-3. SBREAK.DAT Break Model for SIPIS

SIPISCORE
BREAKAGE MODEL
PG 2 OF 2



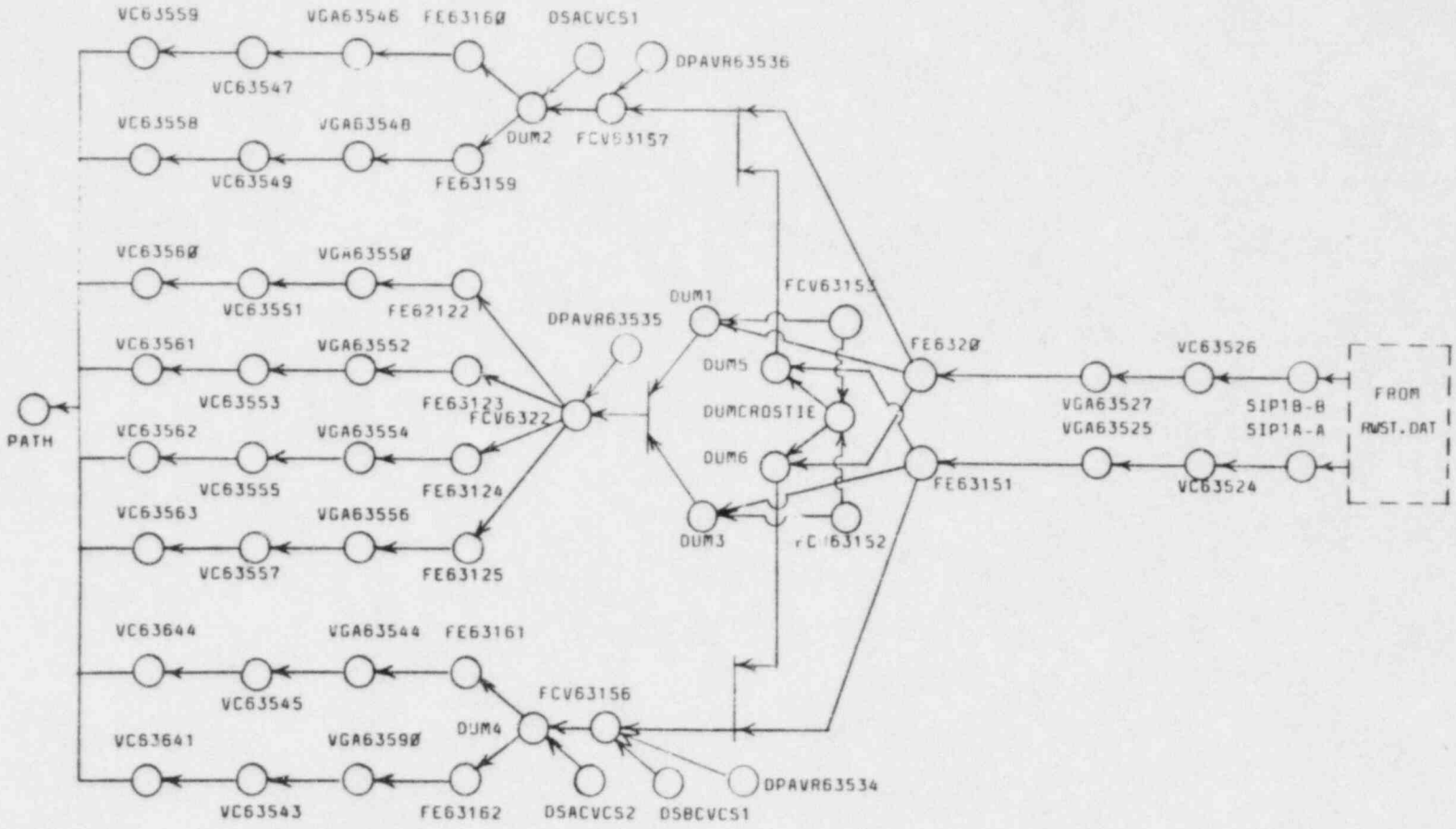


Figure B-4. SIPISCORE.DAT Front-Line Injection System SIPIS

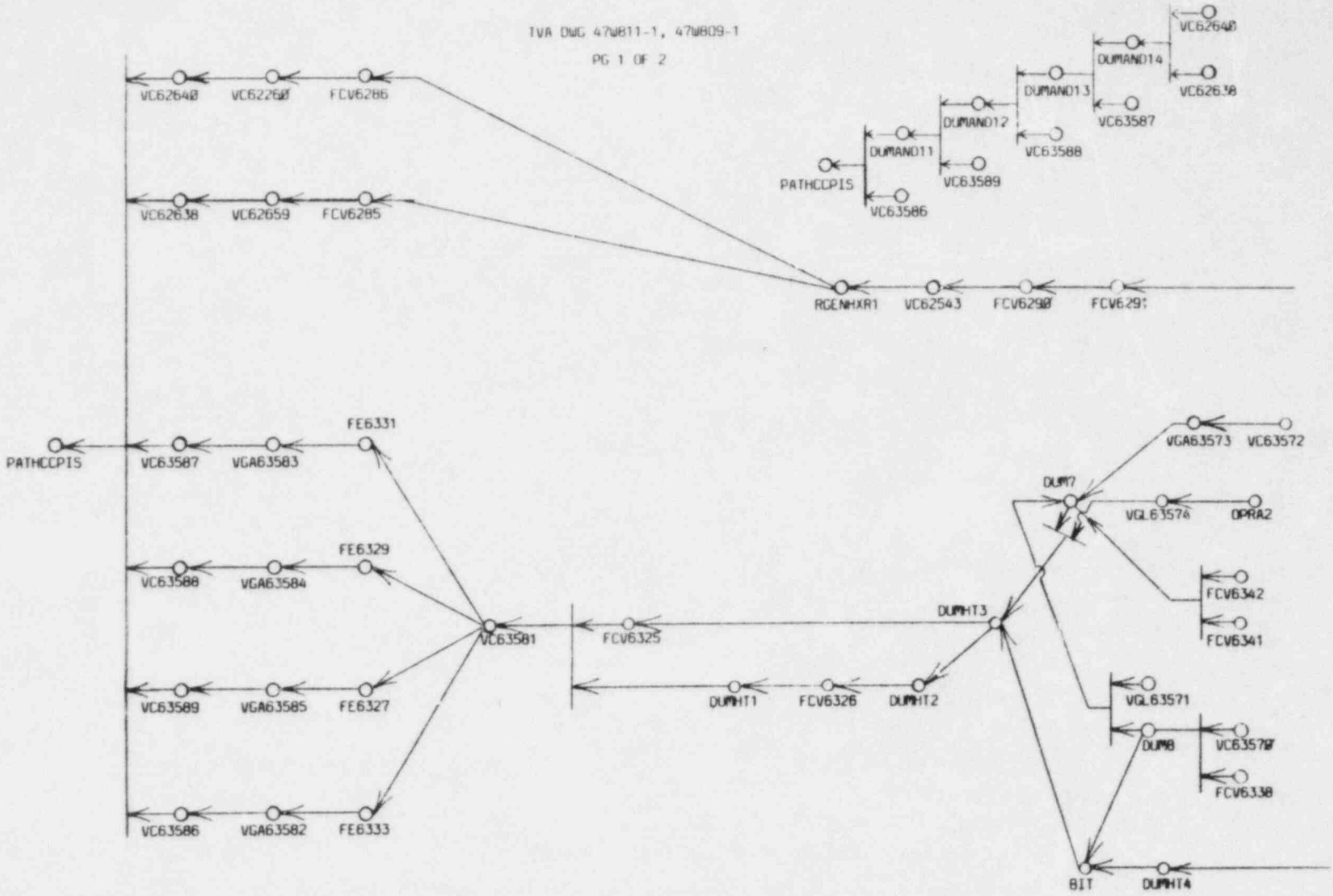
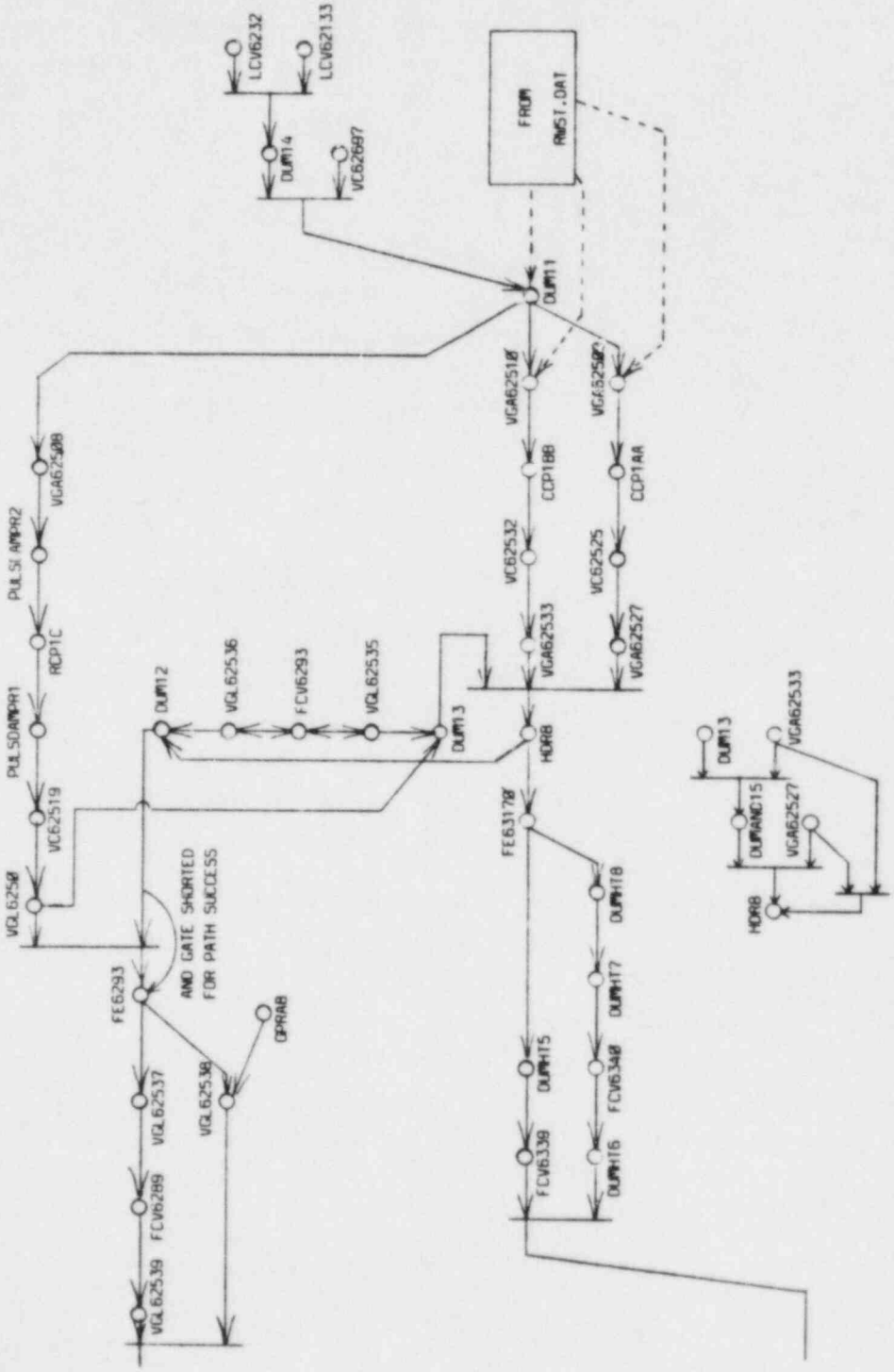


Figure B-5. CCPISCORE.DAT Front-Line Injection System CCPIS


LCV6232
LCV621133
DUM14
VC626897
FROM
RMST.DAT
DUM11
VGA625188
VGA625188
CCP1BB
CCP1AA
VC625332
VC625325
VGA625333
VGA625327
PULSE AMPAR2
VGA625188
PULSE AMPAR1
RCP1C
VC625319
VGL62588
DUM12
VGL625336
FCV6293
VGL625335
DUM13
HDR8
FE631788
AND GATE SHORTED
FOR PATH SUCCESS
FE6293
OPRAB
VGL625337
VGL625338
VGL625339
FCV6289
FCV6338
FCV6340
DUMH15
DUMH16
DUMH17
DUMH18
DUM13
VGA625333
DUMRANC15
VGA625527
HDR8

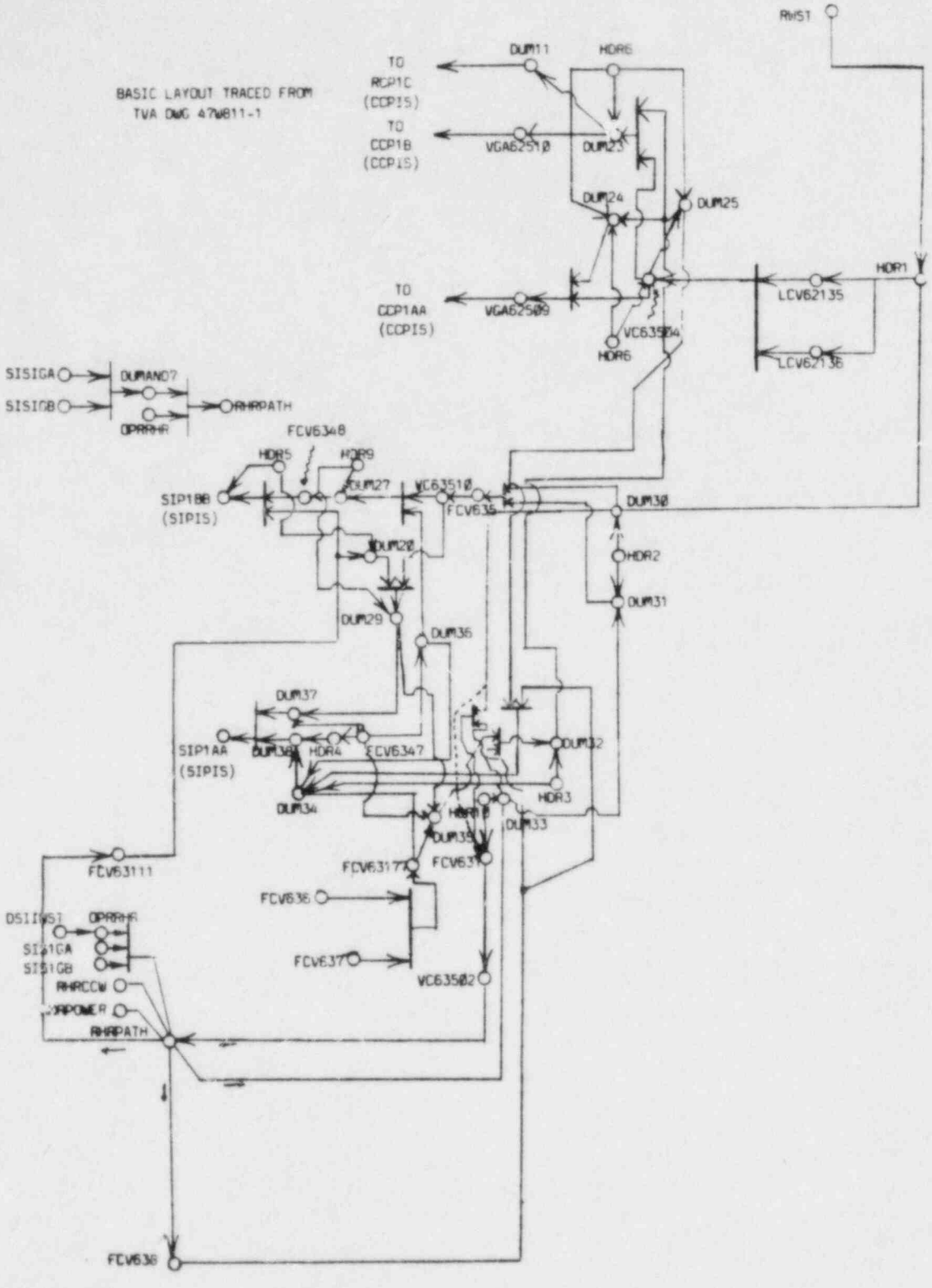


Figure B-6. RWST.DAT Network Connecting RWST to SIPIS & CCPIS

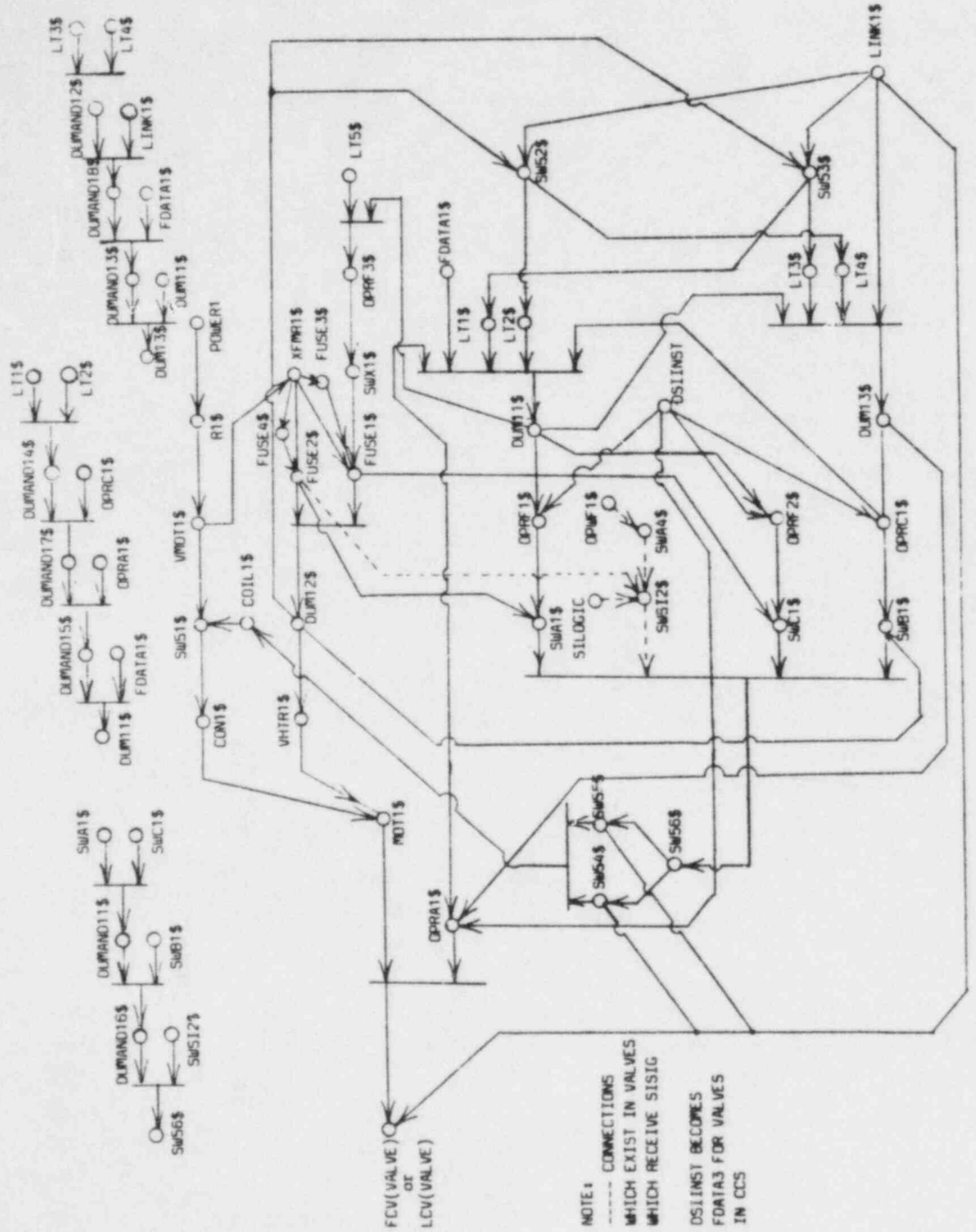


Figure B-7. FCV.DAT Flow Control Valve Unit Model

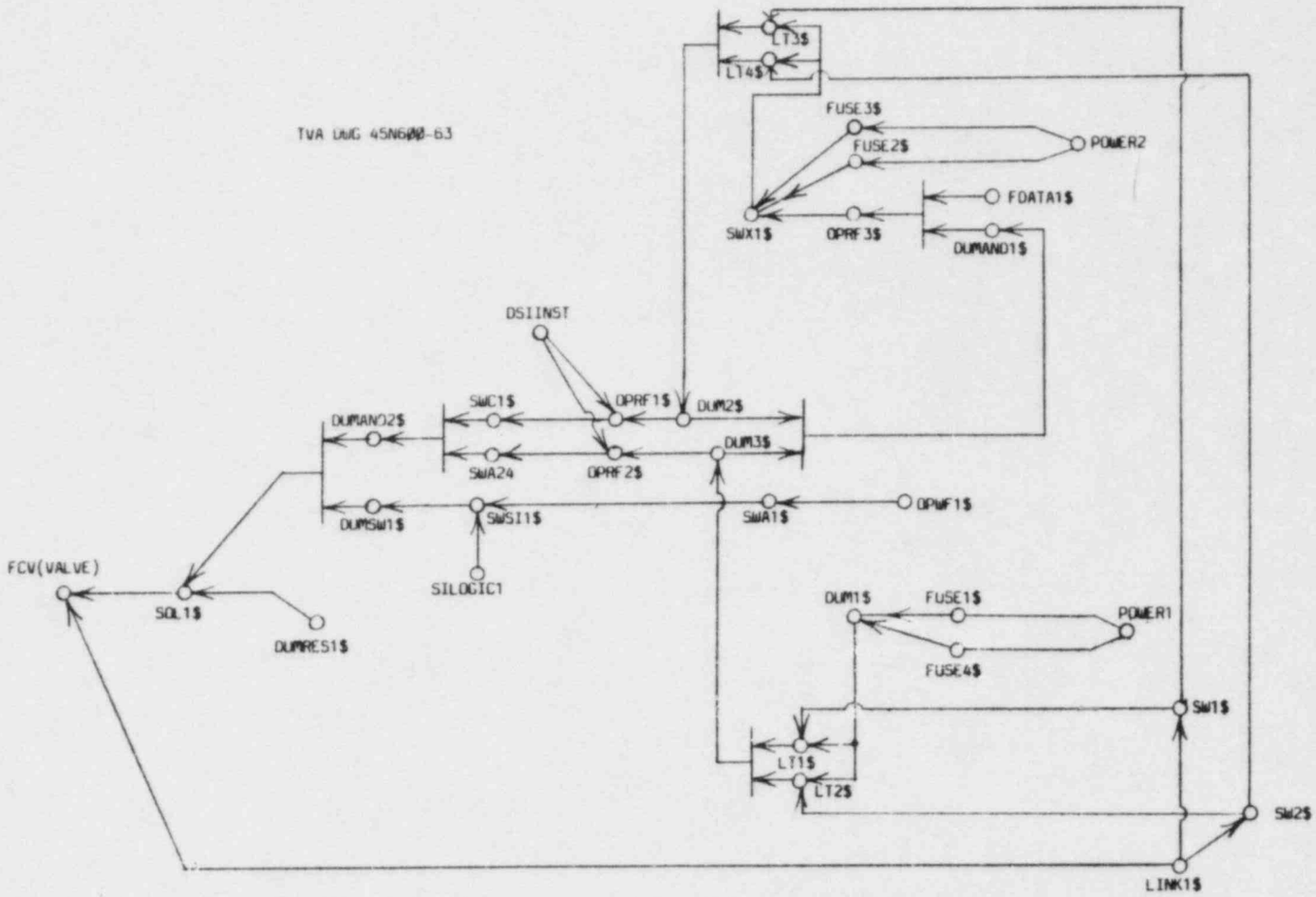


Figure B-8. SOLFCV.DAT Solenoid Flow Control Valve Unit Model

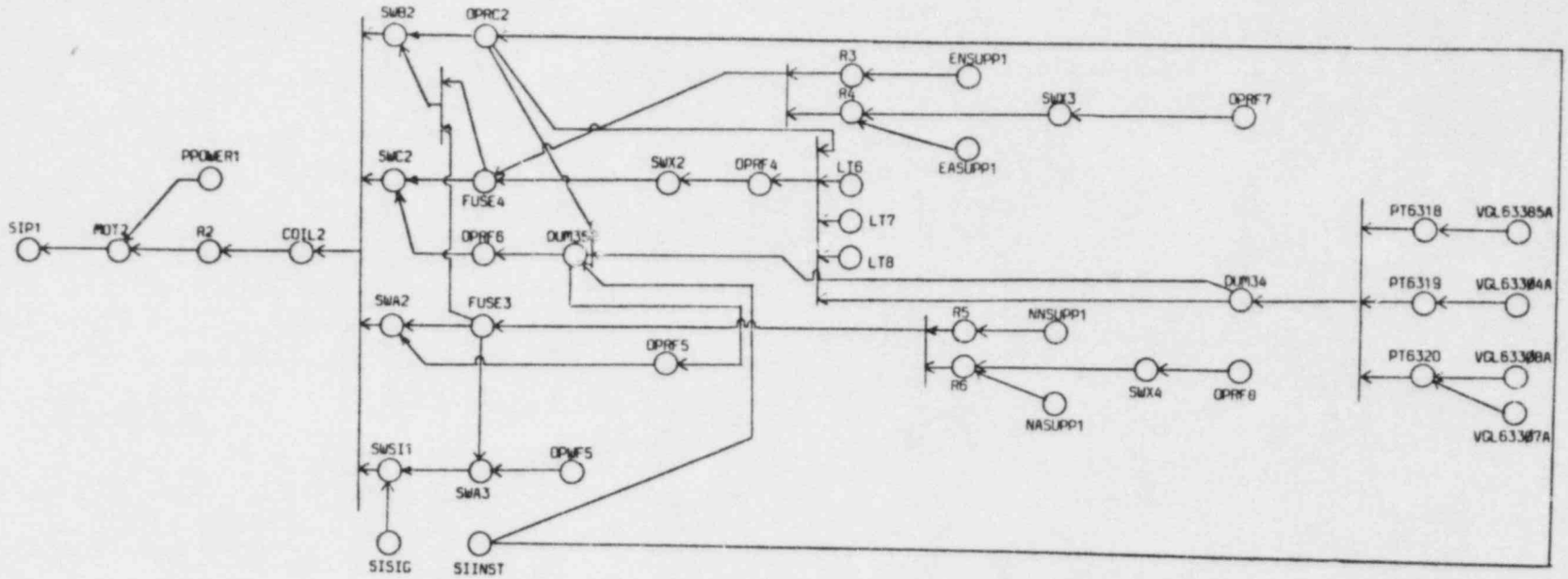


Figure B-9. PUMP.DAT Pump Unit Model

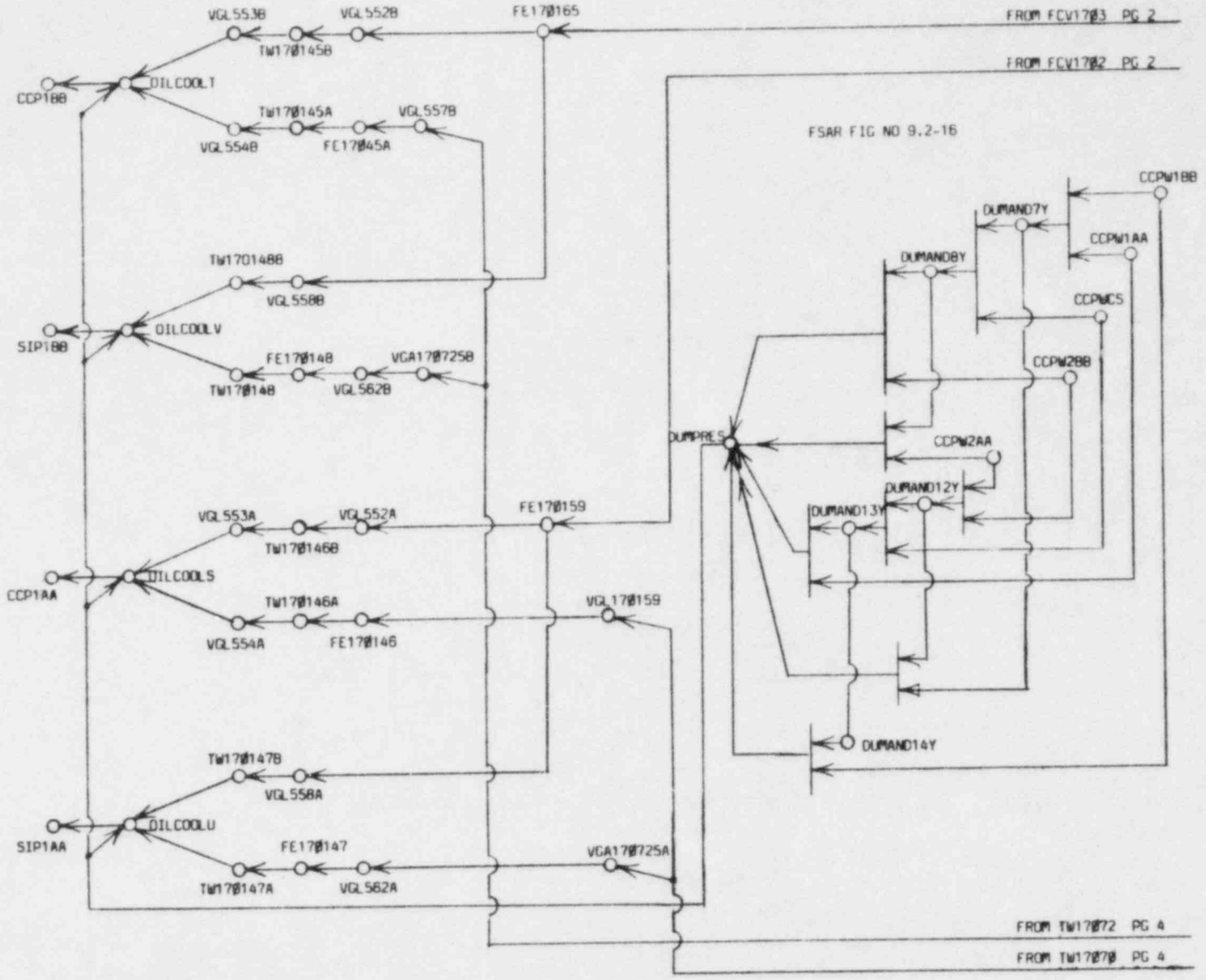
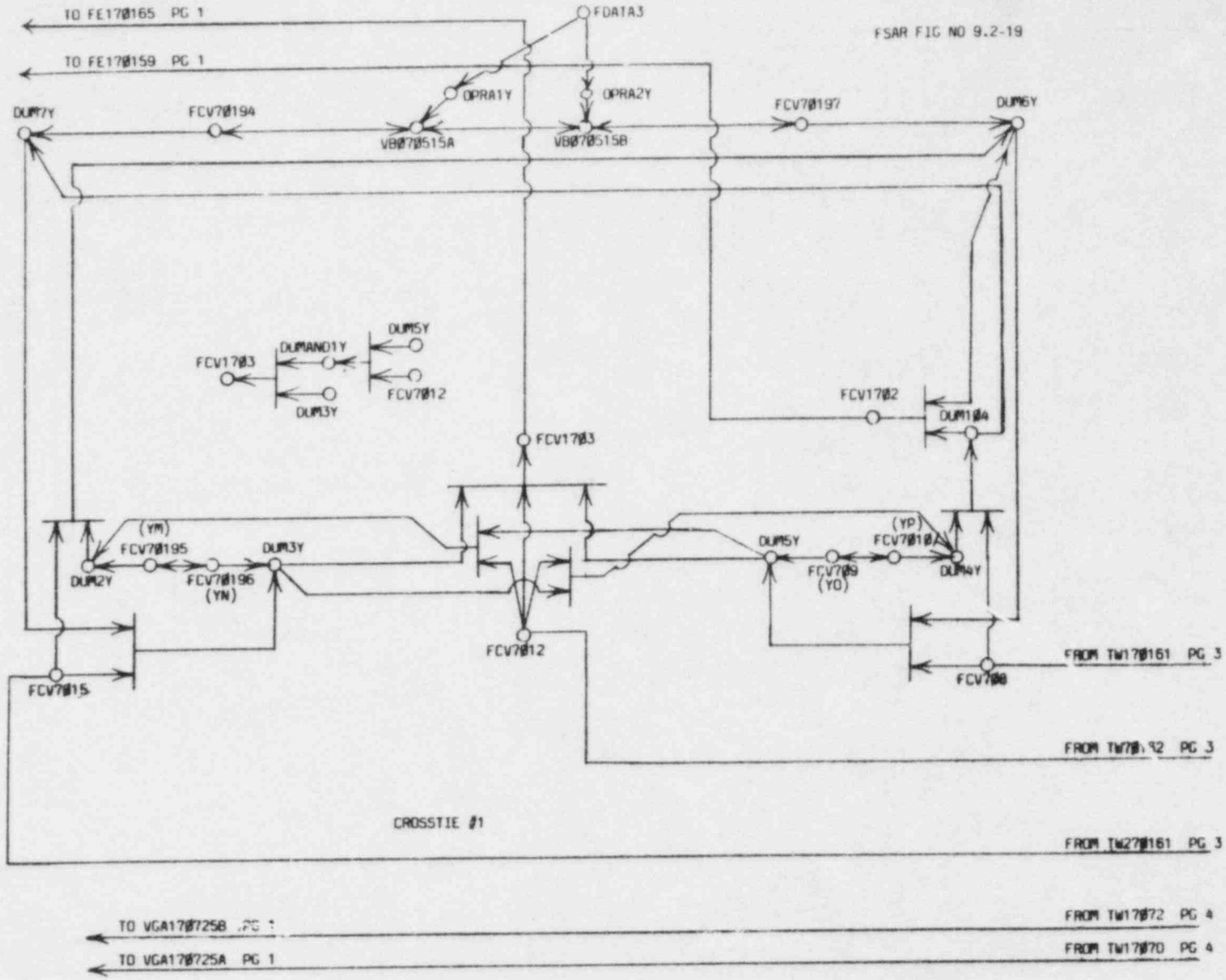
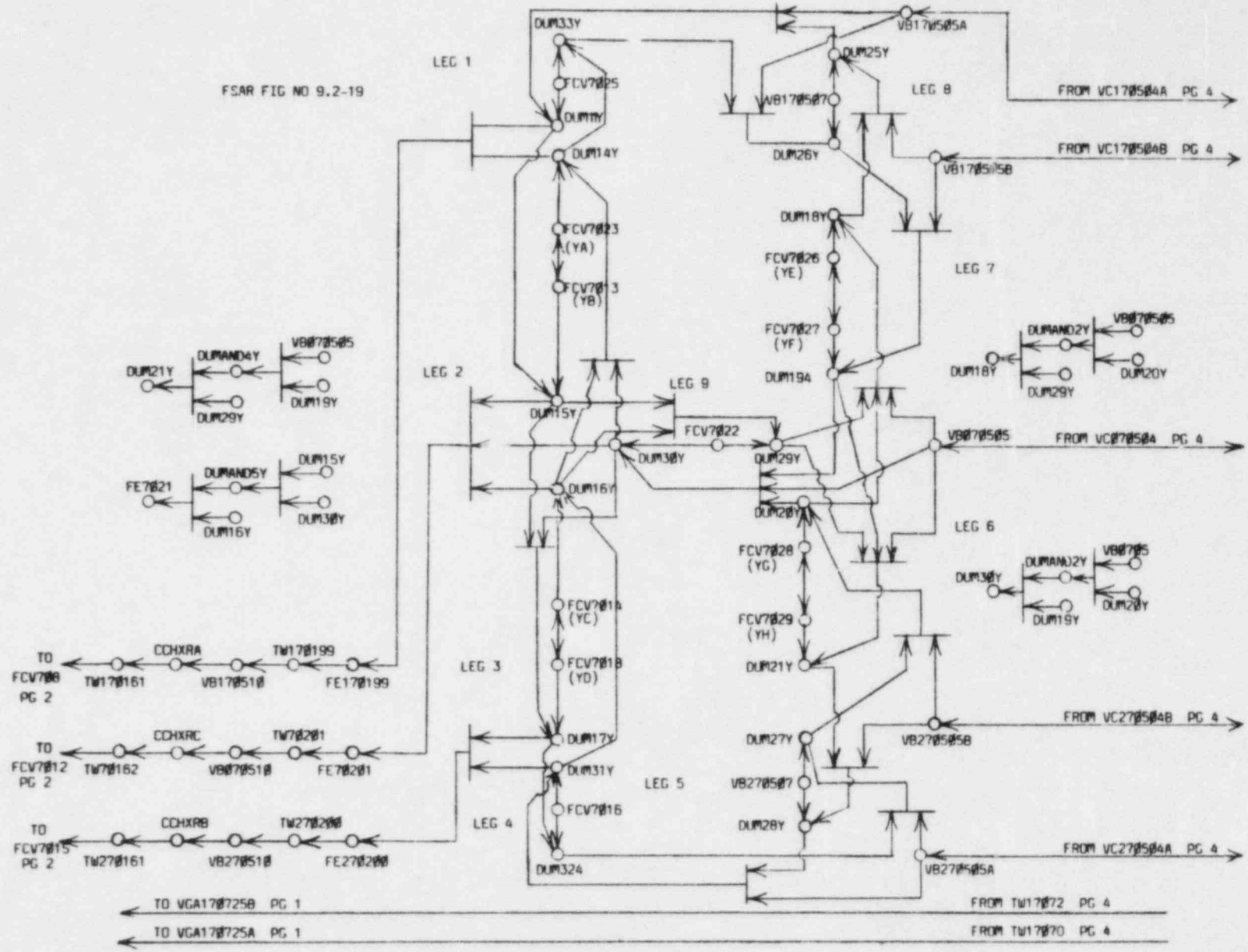
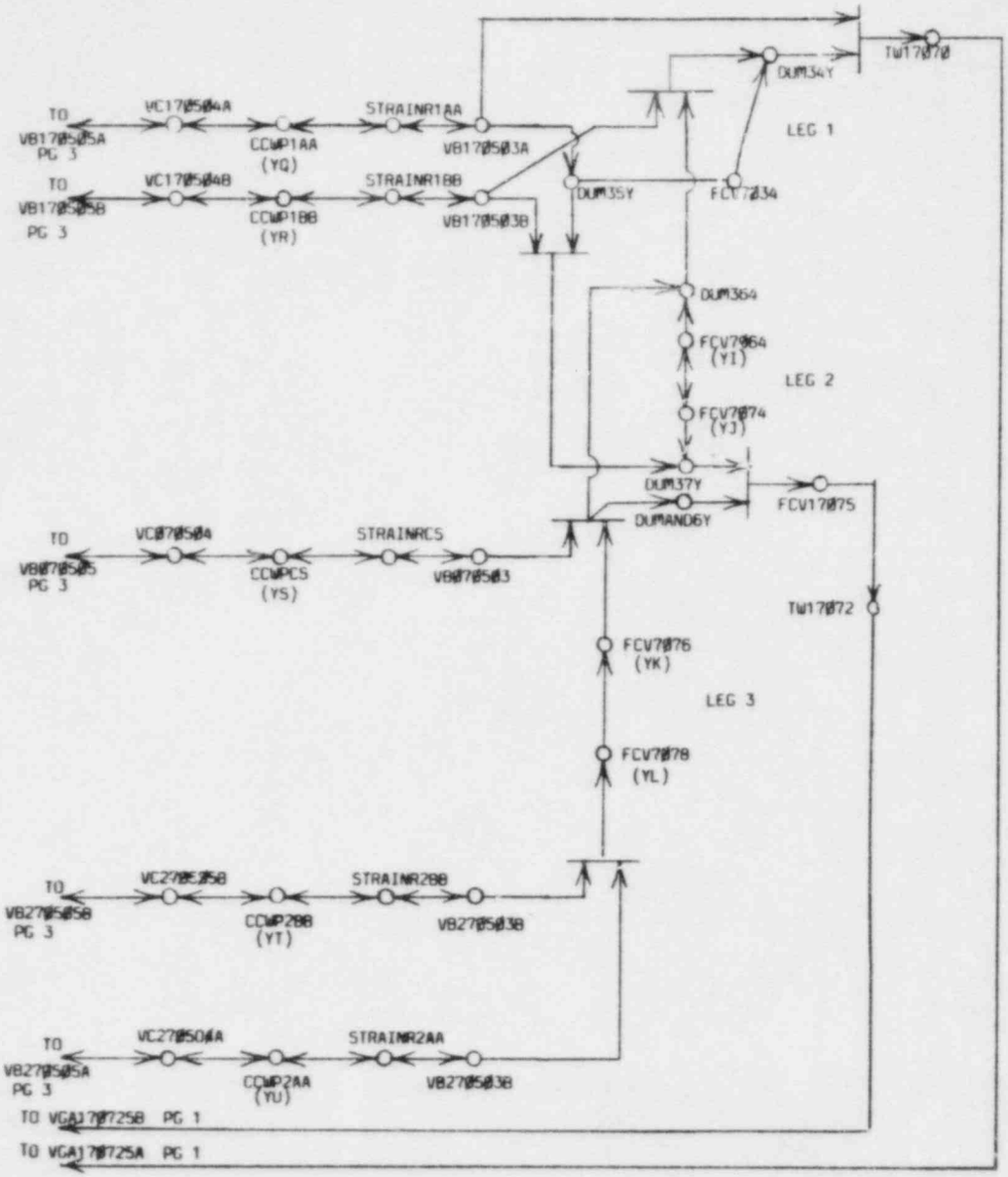


Figure B-10. CCS.DAT Component Coolant System


TO FE17Ø165 PG 1
TO FE17Ø159 PG 1
FDATA3
FSAR FIG NO 9.2-19
OPRA1Y
OPRA2Y
DUM7Y
FCV7Ø194
VB17Ø515A
VB17Ø515B
FCV7Ø197
DUM6Y
DUM5Y
DUMAND1Y
FCV17Ø3
FCV7Ø12
DUM3Y
FCV17Ø2
DUM1Ø4
FCV17Ø3
(YM)
FCV7Ø195
DUM2Y
FCV7Ø196
(YN)
DUM3Y
DUM5Y
(YP)
FCV7Ø198
FCV7Ø9
(YO)
DUM4Y
FCV7Ø12
FCV7Ø15
FCV7Ø8
FROM TW17Ø161 PG 3
FROM TW17Ø162 PG 3
CROSSTIE #1
FROM TW27Ø161 PG 3
TO VGA17Ø725B PG 1
TO VGA17Ø725A PG 1
FROM TW17Ø172 PG 4
FROM TW17Ø17Ø PG 4


FSAR FIG NO 9.2-19
LEG 1
LEG 2
LEG 3
LEG 4
LEG 5
LEG 6
LEG 7
LEG 8
LEG 9
DUM33Y
DUM11Y
DUM14Y
DUM15Y
DUM16Y
DUM17Y
DUM31Y
DUM324
DUM25Y
DUM26Y
DUM18Y
DUM19Y
DUM20Y
DUM21Y
DUM27Y
DUM28Y
DUM29Y
DUM30Y
FCV7025
FCV7023 (YA)
FCV7013 (YB)
FCV7026 (YE)
FCV7027 (YF)
FCV7022
FCV7028 (YG)
FCV7029 (YH)
FCV7018 (YC)
FCV7018 (YD)
FCV7016
VB17Ø5Ø5A
VB17Ø5Ø7
VB17Ø5Ø5B
VB27Ø5Ø7
VB27Ø5Ø5B
VB27Ø5Ø5A
DUMAND4Y
DUMAND5Y
DUMAND2Y
FE7021
FROM VC17Ø5Ø4A PG 4
FROM VC17Ø5Ø4B PG 4
FROM VC27Ø5Ø4B PG 4
FROM VC27Ø5Ø4A PG 4
TO FCV7Ø8 PG 2
TO FCV7Ø12 PG 2
TO FCV7Ø15 PG 2
CCHXRA
CCHXRC
CCHXRB
TW17Ø199
TW17Ø161
VB17Ø51Ø
FE17Ø199
TW7Ø2Ø1
TW7Ø162
VB27Ø51Ø
FE27Ø2Ø0
TO VGA17Ø725B PG 1
TO VGA17Ø725A PG 1
FROM TW17Ø72 PG 4
FROM TW17Ø7O PG 4



FSAR FIG NO 9.2-19

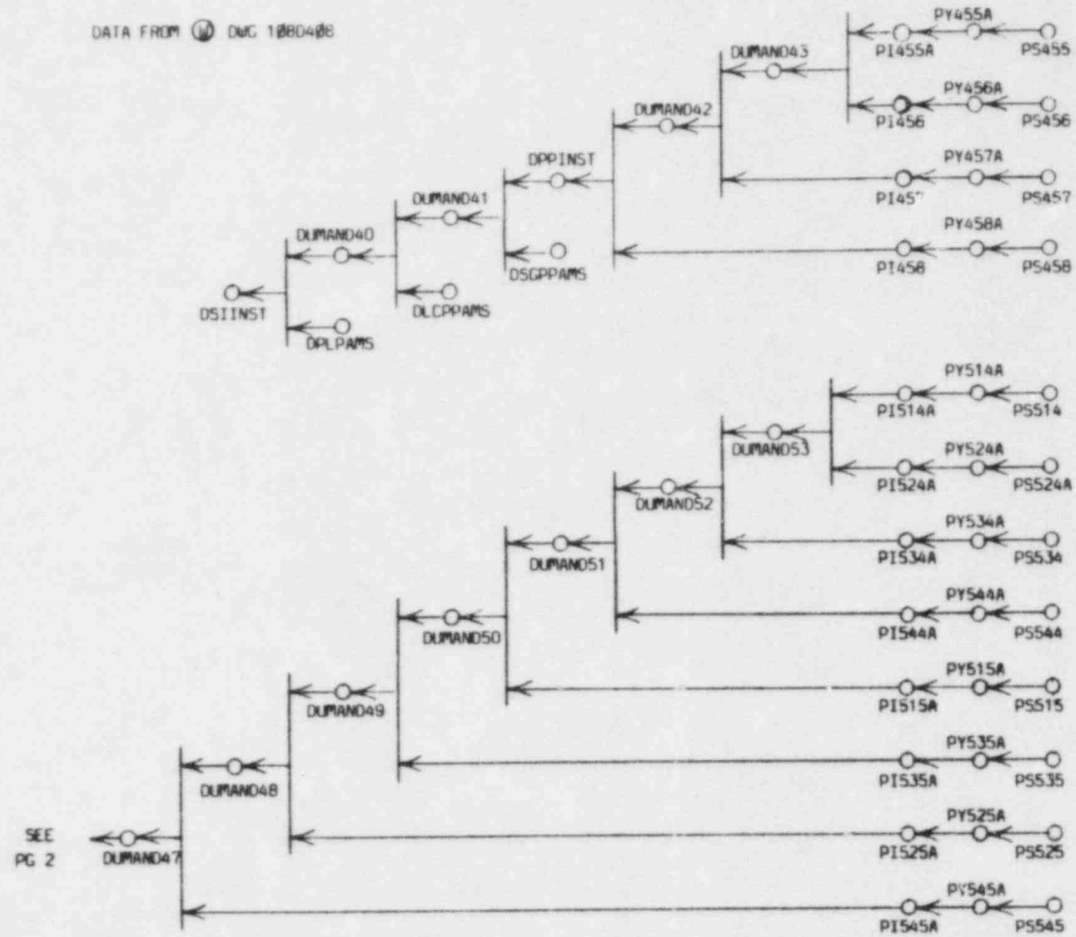
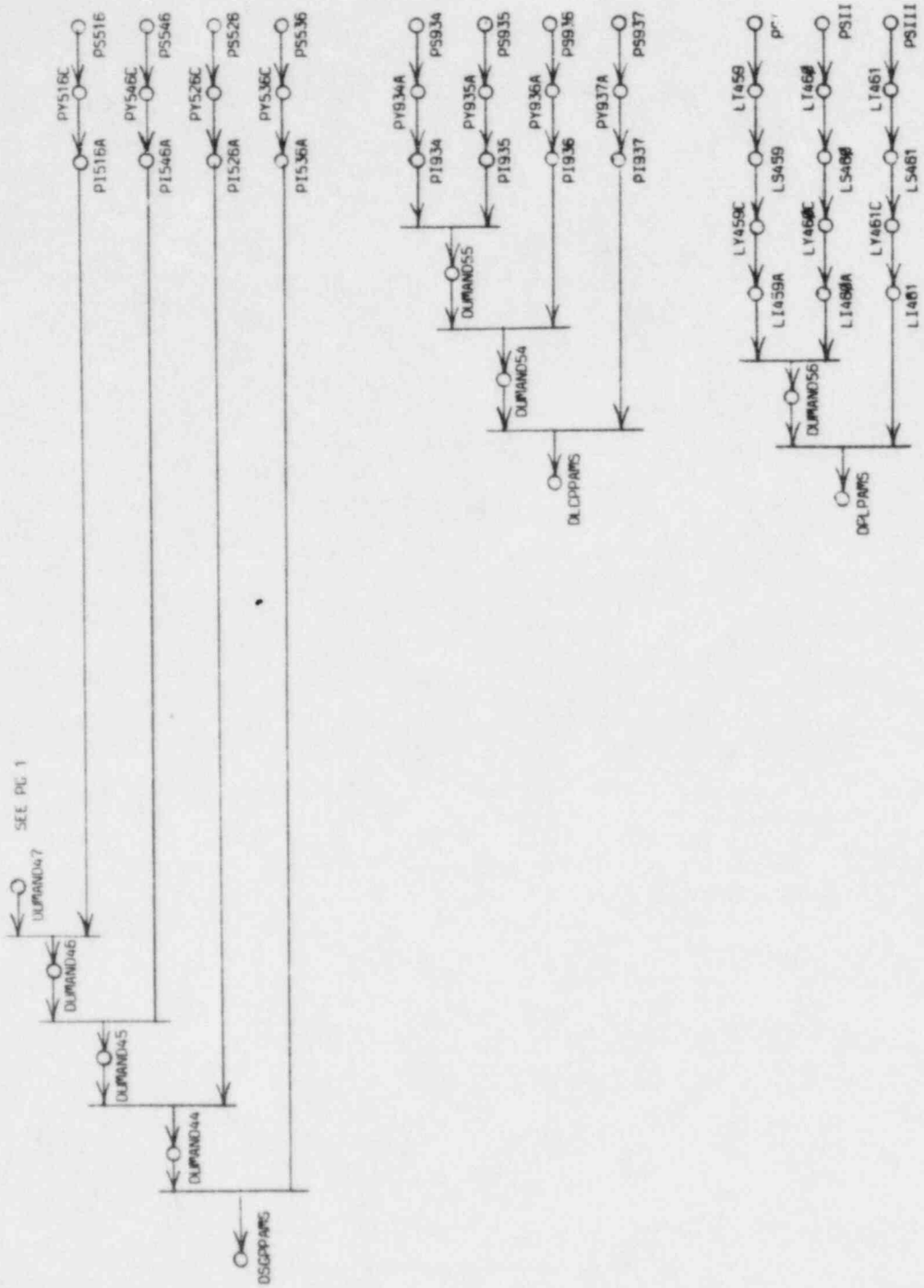


Figure B-11. DSIINST.DAT Safeguards Actuation Instrumentation


SEE PG 1
DUMMY047
DUMMY046
DUMMY045
DUMMY044
DSGPPAMS
PY516C
PS516
PI516A
PY546C
PS546
PI546A
PY526C
PS526
PI526A
PY536C
PS536
PI536A
PY934A
PS934
PI934
PY935A
PS935
PI935
PY936A
PS936
PI936
PY937A
PS937
PI937
DUMMY055
DUMMY054
DLCPPAMS
LY459C
LT459
LI459A
LS459
LY461C
LT461
LI461
LS461
DUMMY056
DPLPAMS

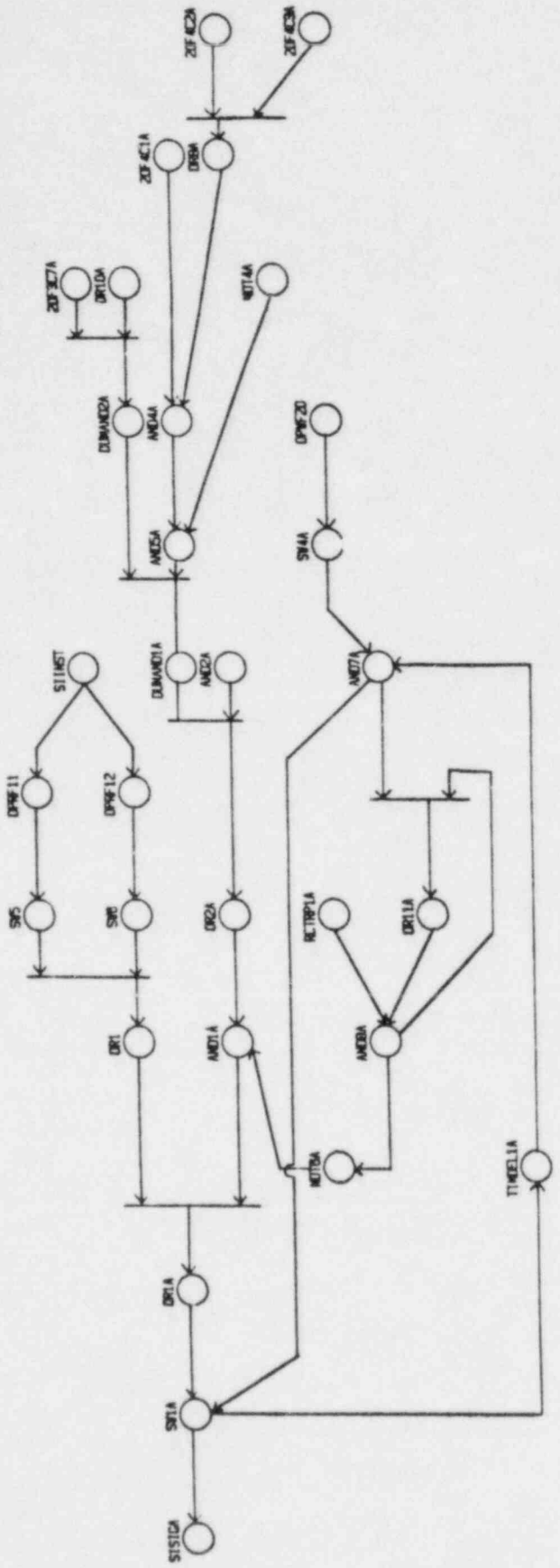


Figure B-12. SILOG1.DAT Output Logic for Automatic SISIG System

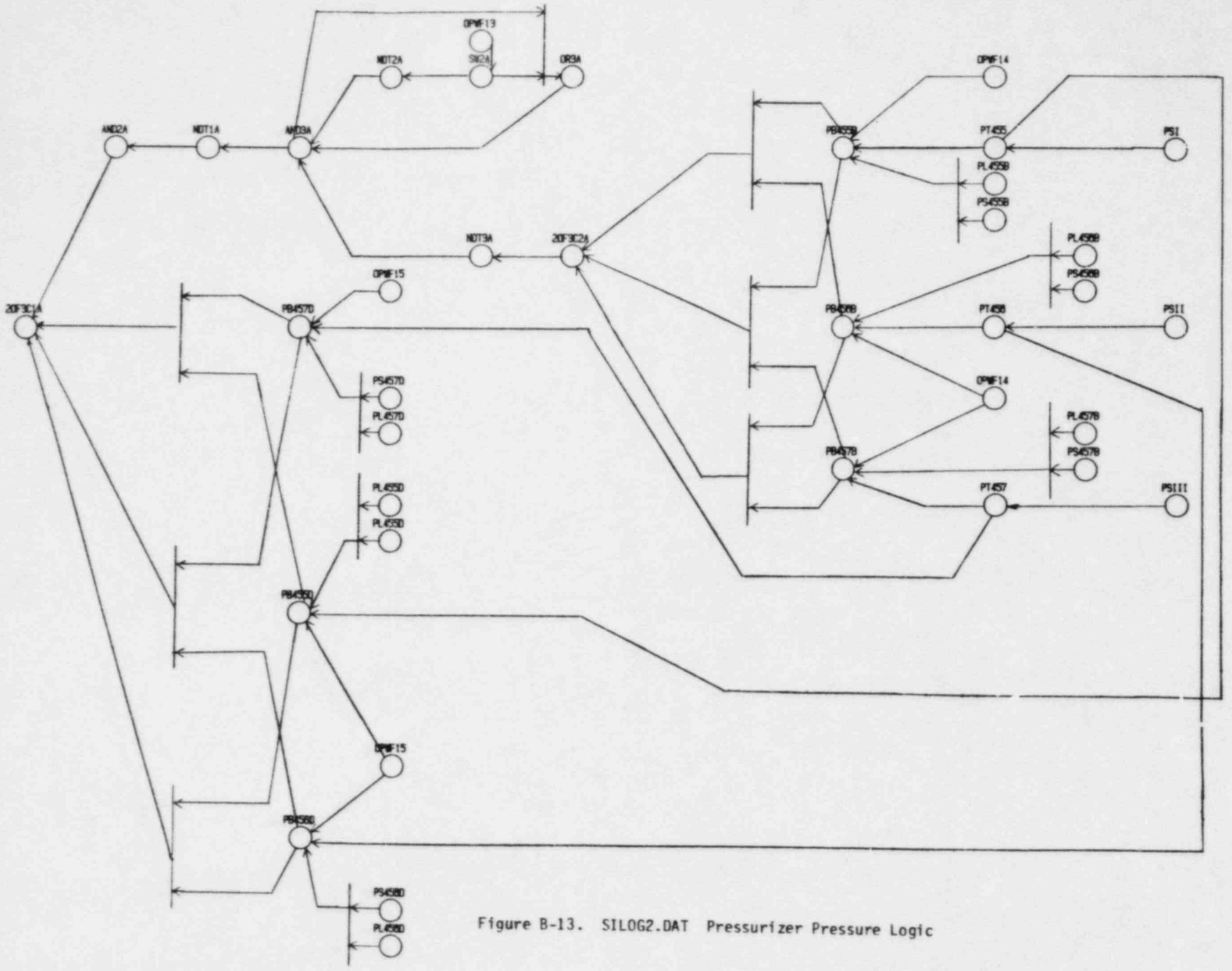


Figure B-13. SILOG2.DAT Pressurizer Pressure Logic

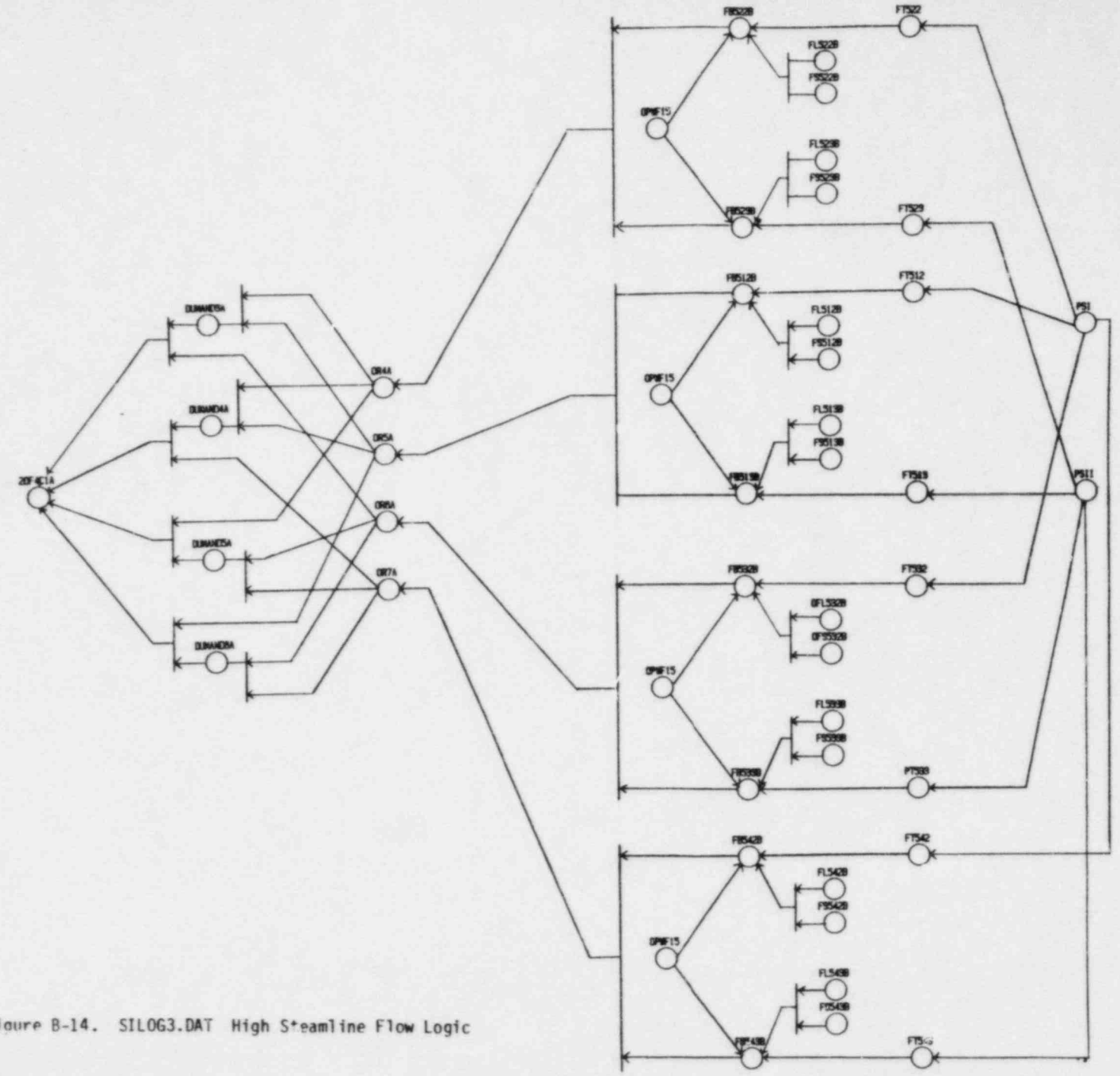


Figure B-14. SILOG3.DAT High Steamline Flow Logic

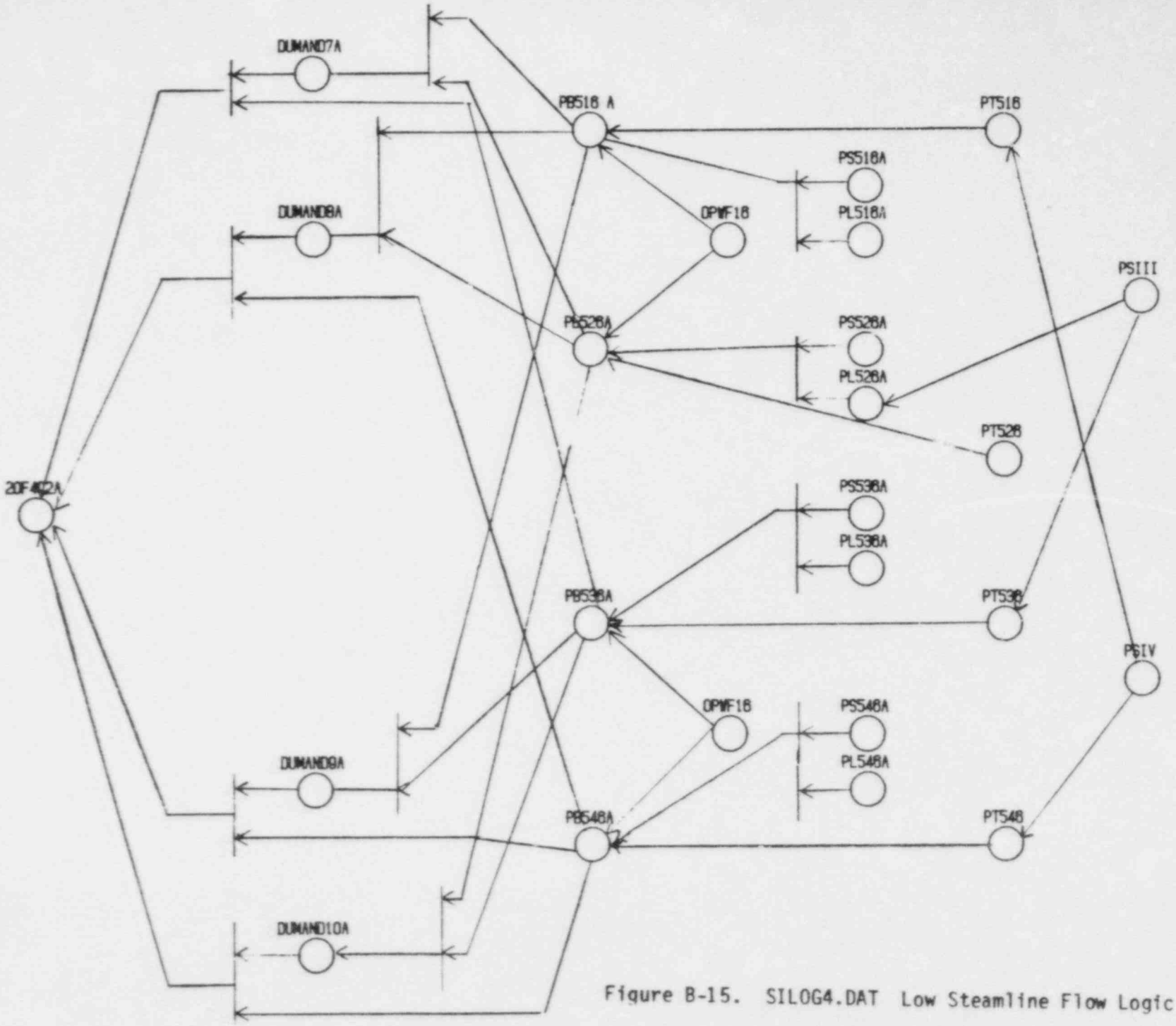


Figure B-15. SILOG4.DAT Low Steamline Flow Logic

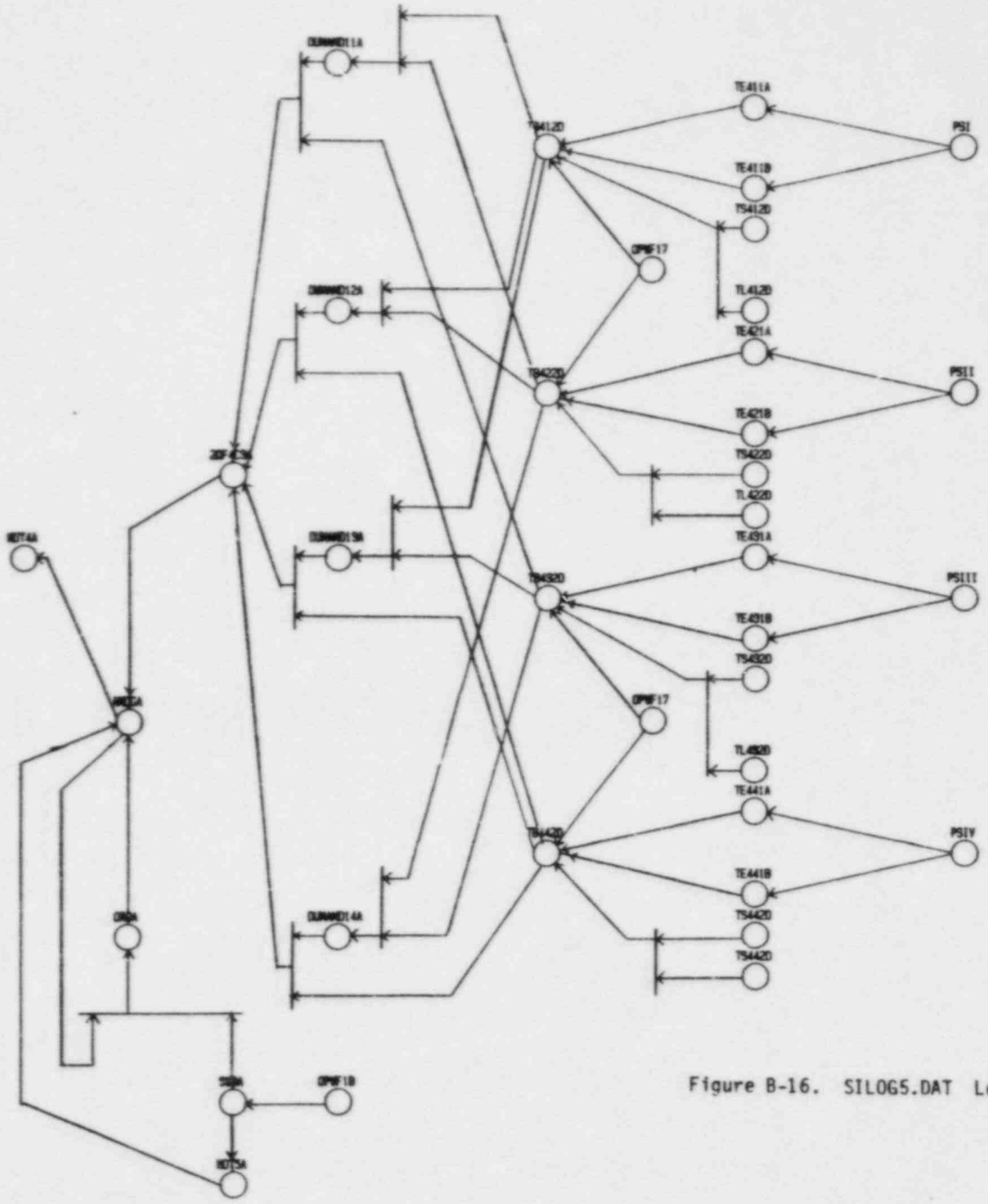


Figure B-16. SILOG5.DAT Low Low T_{avg} Logic

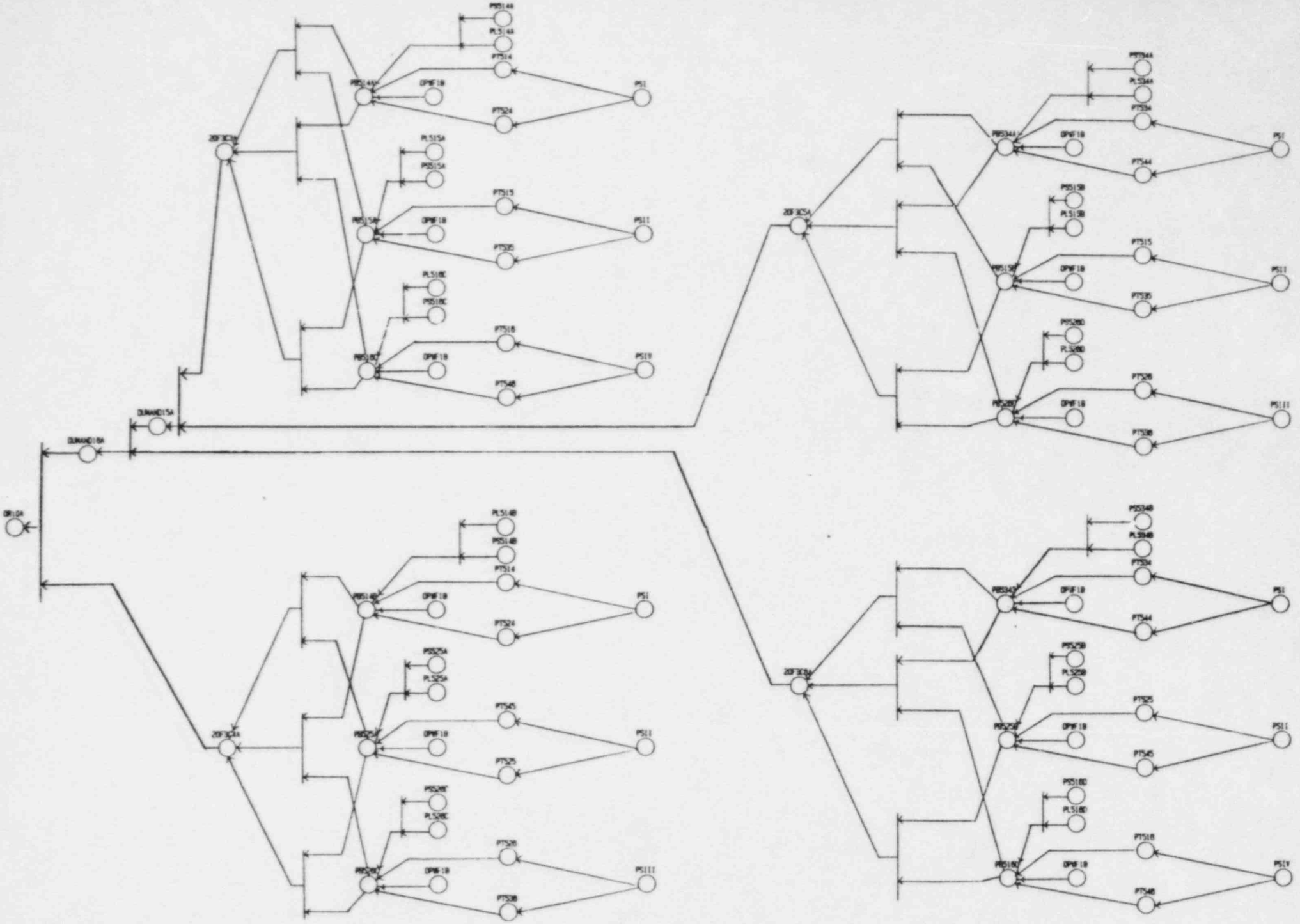


Figure B-17. SILOG6.DAT Steamline Differential Pressure Logic

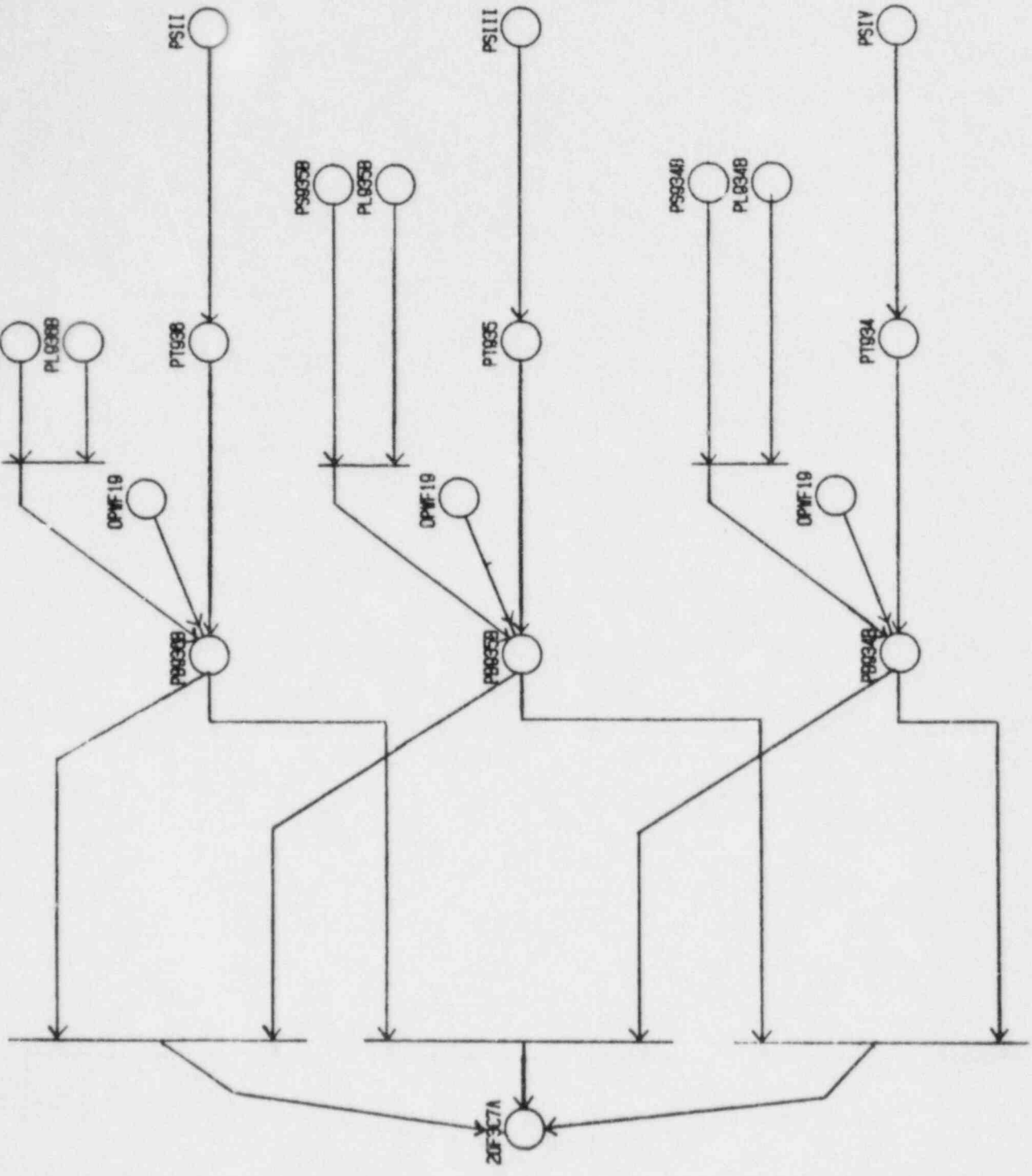


Figure B-18. SILOG7.DAT High Containment Pressure Logic

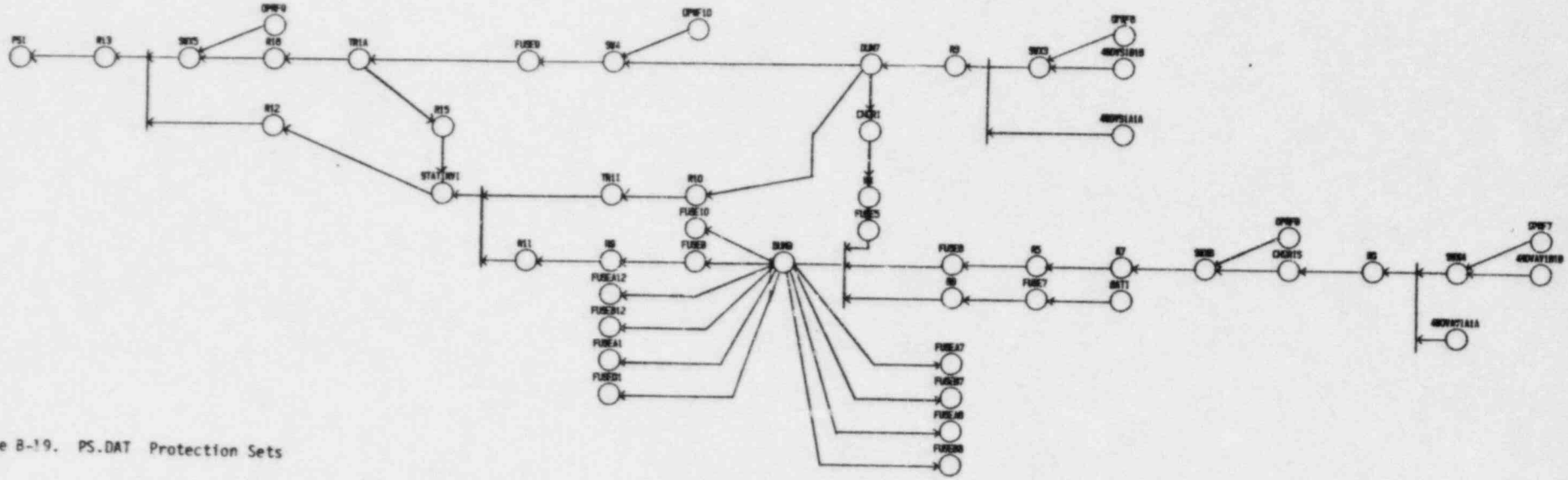


Figure B-19. PS.DAT Protection Sets

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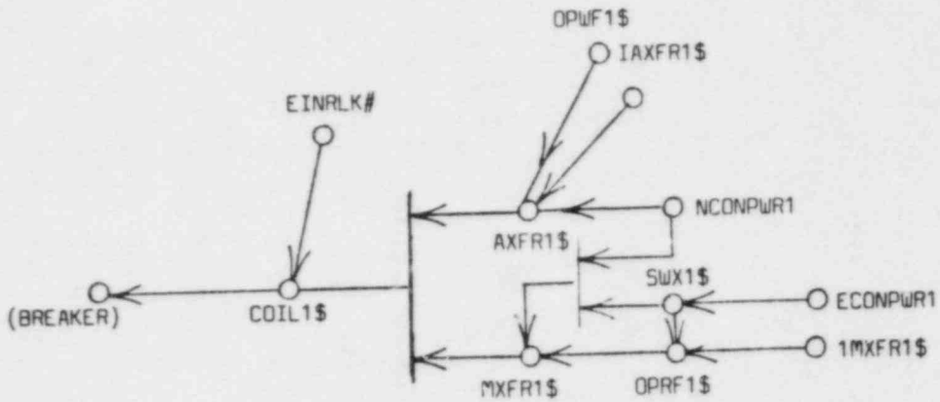

Figure B-21. BREAKER.DAT Breaker Interlock Connections

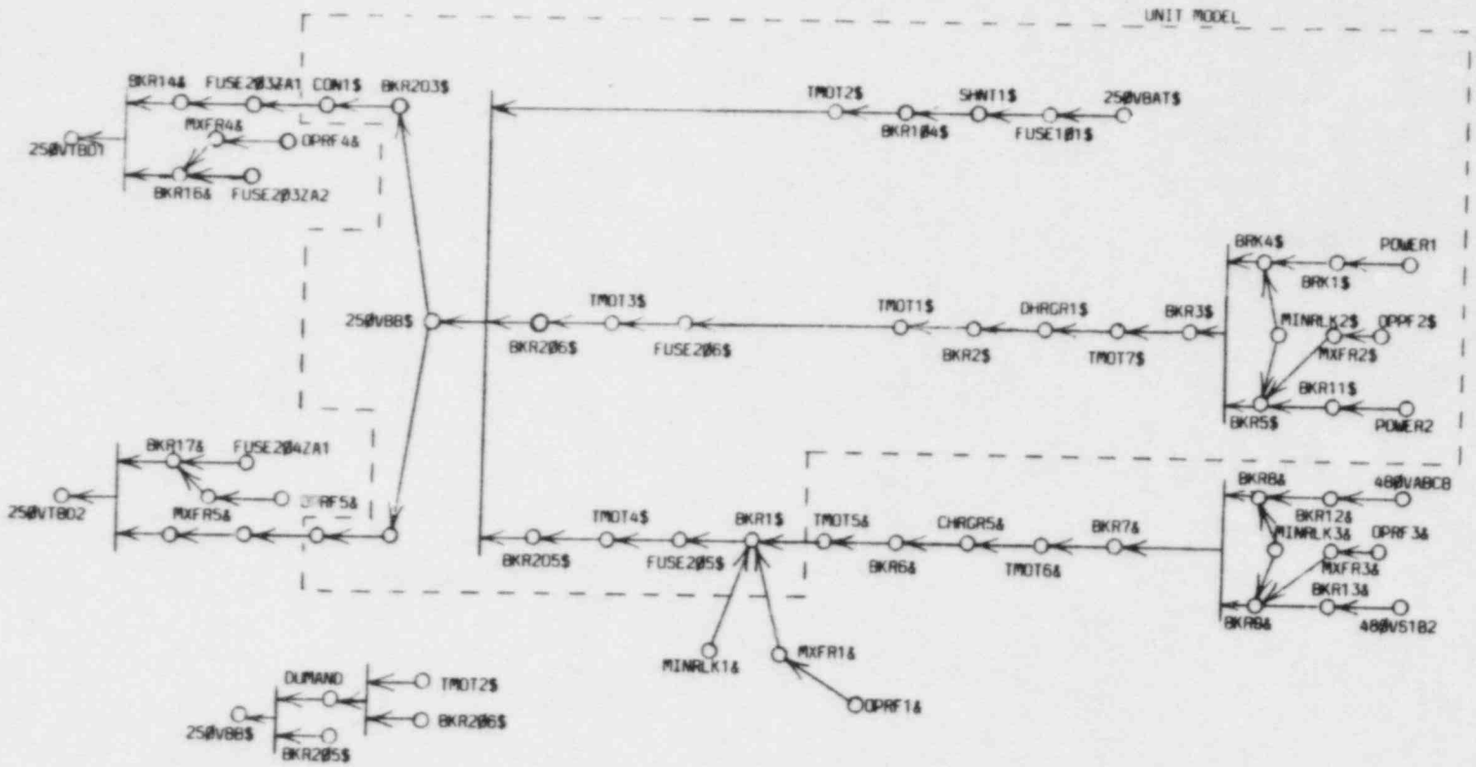

Figure B-22. 250VBAT.DAT 250 volt Battery Boards

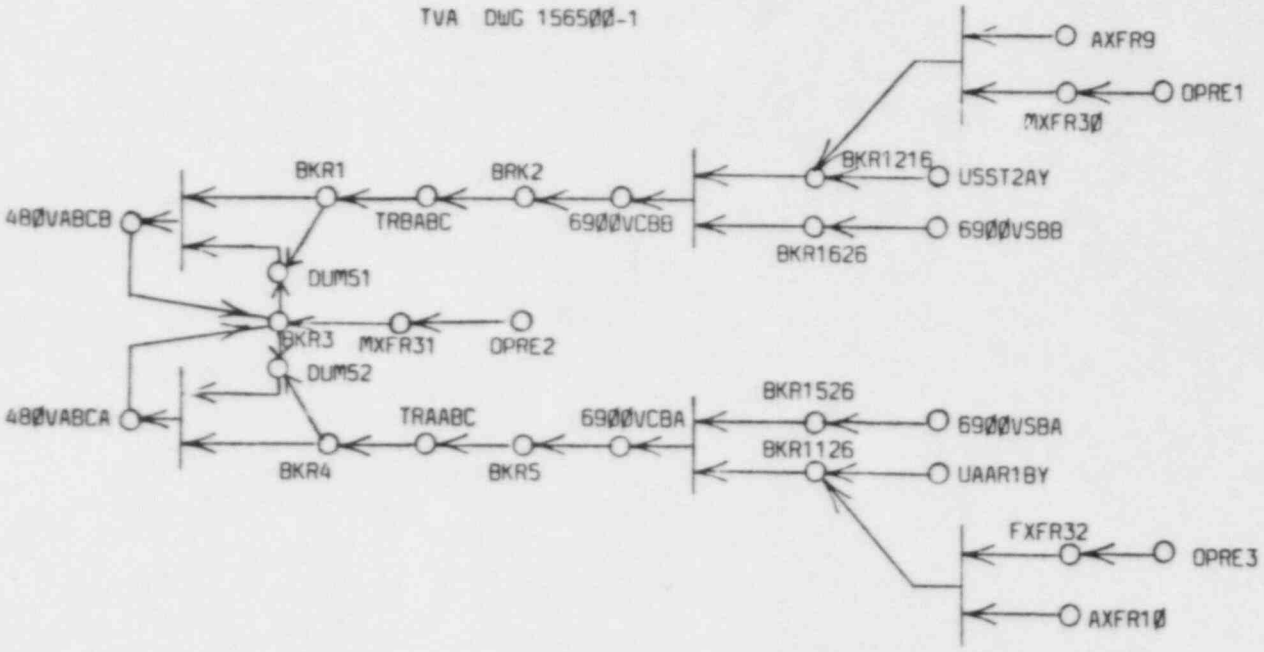

Figure B-23. 480VABC.DAT 480 volt Auxiliary Building Common Board

APPENDIX C

COMPLETE ADJACENCY INPUT FOR SAFETY INJECTION PUMP SYSTEM

THE FOLLOWING ADJACENCY INPUT LISTING HAS BEEN PARTITIONED. THE PARTITIONS WERE GENERATED FROM THE UNIT MODELS LISTED ON PAGES C-5 THROUGH C-93.

EXPLANATION OF DMA SYMBOL FORMAT

The symbols used to represent components in this DMA of the High Pressure Safety Injection System follow a consistent format. In general, the symbols contain the component identification used in the piping and instrumentation diagrams, and electrical line drawings. In some cases, a prefix has been added to indicate the type of component being modeled. For example, the prefix FCV has been used to identify flow control valves. The following list explains the prefix symbols used throughout this report.

125VVB	- 125 volt dc Vital Battery Board
480MOV	- 480 volt ac Motor Operated Valve Electrical Power Bus
480VS	- 480 volt ac Shutdown Board
6900VS	- 6900 volt ac Electrical Power Bus
BIT	- Boron Injection Tank
CCHXR	- Component Cooling Heat Exchanger
CCP	- Centrifugal Charging Pump
CCPISCORE	- Charging Pump Portion of Safety Injection System
CCS	- Component Cooling System
CCWP	- Component Cooling Water Pump
COIL	- Breaker Actuating Coil
EINRLK	- Electrical Interlock Transfer Device
EPS	- Electrical Power System (500 kvac to 480 vac)
FCV	- Flow Control Valve
FE	- In-line Flow Meter Orifice
FUSE	- Electrical Fuse
HDR	- Pipe Header
LCV	- Level Control Valve
MINRLK	- Mechanical Interlock Transfer Device
MOT	- Motor
OILCOOL	- Component Oil Cooler Interface with Component Cooling System
OFFSITE	- Master Node connected to all Offsite Power Sources
ONSITE	- Master Node connected to all Onsite Power Sources

OPR	- Operator Action to Override failed Component (Operator Right)
OPRMASTER	- Master Node connected to all OPR's
OPW	- Operator taking incorrect action (Operator Wrong)
PS	- Protection Set System (Vital Instrumentation and Control Power)
R	- Relay
RCS	- Reactor Cooling System (the Terminal Node)
RHR	- Residual Heat Removal System
RWST	- Refueling Water Storage Tank
SILOGIC	- Safety Injection Logic Actuation System
SIP	- Safety Injection Pump
SIPISCORE	- Safety Injection Pump Portion of Safety Injection System
SISIG	- Safety Injection Signal
STRAINR	- Strainer
SW	- Control Power Switch
TR	- Electrical Transformer
TW	- In-line Temperature Sensor
VB	- Butterfly Valve
VC	- Check Valve
VGA	- Gate Valve
VGL	- Globe Valve
X	- Component whose type could not be determined from the available documentation

****

Model configured for total dependence on automatic systems by unit model partitioning FCV's and SILOGIC as follows:

1) FCV's replaced by an OR gate with power and signal as inputs.
2) SILOGIC is replaced with a 3/4 coincidence gate with the protection sets as inputs.

OPNF2B is not connected to SW4- which can suppress SISIG-.

Break models for both injections systems inserted after success critieria.

BCA 6/24/83

Unit model partitions configured for 1 local OP and 1 remote OP.

BCA 7/17/83

RWST crosstie enable'.

BCA 7/27/83

****

ADJACENCY INPUT FOR FAILURE CRITERIA OF REACTOR COOLANT SYSTEM
FOR A SMALL LOCA

DATA FROM WATTS BAR OPERATORS

Failure of reactor coolant system (RCS) is the result of failure of sufficient pressure OR the failure of an open path from the refueling water storage tank (RWST) to the RCS.

Failure criteria follow. There are two criteria, PCRITERIA1 and PCRITERIA2. Sufficient pressure is generated if at least one of these criteria succeeds along with success of corresponding path(s).

PCRITERIA1,RCS,PCRITERIA2	PCRITERIA1 fails if there isn't at least 1
CCP1AA,PCRITERIA1,CCP1BB	charging pump AND at least 1 safety inj. pump.
CCP1BB,PCRITERIA1,CCP1AA	
PATHCCPIS,PCRITERIA1,1	If PATHCCPIS fails, pressure from CCP's
SIP1AA,PCRITERIA1,SIP1BB	cannot propogate.
SIP1BB,PCRITERIA1,SIP1AA	
PATHSIPIS,PCRITERIA1,1	If PATHSIPIS fails, pressure from SIP's cannot propogate.
PCRITERIA2,RCS,PCRITERIA1	PCRITERIA2 fails if both safety inj. pumps
SIP1AA,PCRITERIA2,1	fail.
SIP1BB,PCRITERIA2,1	
PATHSIPIS,PCRITERIA2,1	If PATHSIPIS fails, pressure from SIP's cannot propgate.

****

BREAK MODEL FOR SIPIS AND CCPIS

This model assumes that NO actions are taken by operators which would serve to keep the system from degrading. All components can fail by operators doing incorrect things.

This model is for break propogation without any mitigation except for check valves and normally closed valves. An unprimed node is true is it is blocking flow. A primed node is true if that component has ruptured. A double primed node is true if it cannot block flow.

The effect of a break can propogate across a pump regardless of whether it is pumping.

If a break can become detrimental only if 2 or more other independent (not unit modelled) events occur, effects of that break are not modelled.

\- - - - - -

Adjacency input is in two blocks. The first is the connections of the 100-190 primed components to the 45-50 DBREAK nodes. The grouping is the result of pre-processing with STRONG, FCOND, and COMPRS. The second block of adjacency data is the "effective" digraph for the break case. This digraph is the output of COMPRS with the prefix DBREAK- attached to each node number. After removing spaces and inserting commas, the resulting digraph complements the first block and represents the interaction of the groups of primed nodes.

****

Grouping of primed nodes

```
^PATHSIPIS',DBREAK2,1
^DBREAK2,PATHSIPIS,1
^VC63641',DBREAK2,1
^DUMAND26',DBREAK2,1
^VC63644',DBREAK2,1
^DUMAND25',DBREAK2,1
^DUMAND24',DBREAK2,1
^DUMAND23',DBREAK2,1
^DUMAND22',DBREAK2,1
^VC63560',DBREAK2,1
^DUMAND21',DBREAK2,1
^VC63558',DBREAK2,1
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^VC63559',DBREAK2,1
^VC63563',DBREAK3,1
^VC63562',DBREAK3,1
^VC63561',DBREAK3,1
^FCV63157',DBREAK3,1
^FE6320',DBREAK3,1
^DUM5',DBREAK3,1
^DUM1',DBREAK3,1
^FCV63153',DBREAK3,1
^FCV6322',DBREAK3,1
^DUM3',DBREAK3,1
^FE63151',DBREAK3,1
^DUMCRSTIE',DBREAK3,1
^FCV63152',DBREAK3,1
^DUM6',DBREAK3,1
^FCV63156',DBREAK3,1
^VC63526',DBREAK3,1
^VGA63527',DBREAK3,1
^SIP1BB',DBREAK3,1
^FCV6348',DBREAK3,1
^FCV6311',DBREAK3,1
^VC63551',DBREAK3,1
^VGA63550',DBREAK3,1
^FE63122',DBREAK3,1
^VGA63525',DBREAK3,1
^VC63524',DBREAK3,1
^SIP1AA',DBREAK3,1
^FCV6347',DBREAK3,1
^DFCV6347',DBREAK3,1
^VC63510',DBREAK3,1
^FCV635',DBREAK3,1
^HDR1',DBREAK3,1
^RWST',DBREAK3,1
^VC63553',DBREAK3,1
^VGA63552',DBREAK3,1
^FE63123',DBREAK3,1
^VC63555',DBREAK3,1
^VGA63554',DBREAK3,1
^FE63124',DBREAK3,1
^VC63557',DBREAK3,1
^VGA63556',DBREAK3,1
^FE63125',DBREAK3,1
^DDUM12',DBREAK3,1
^LCV62136',DBREAK3,1
^LCV62135',DBREAK3,1
^RHRPATH1',DBREAK3,1
^RHRPATH2',DBREAK3,1
^VC63559'',DBREAK4,1
^VC63547',DBREAK5,1
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```
^VGA63546',DBREAK6,1
^FE63160',DBREAK6,1
^DUM2',DBREAK6,1
^VGA63548',DBREAK6,1
^FE63159',DBREAK6,1
^VC63549',DBREAK7,1
^VC63558'',DBREAK8,1
^FCV63157'',DBREAK9,1
^DBREAK10,SIP1BB,1
^DBREAK11,SIP1AA,1
^FCV636',DBREAK12,1
^DFCV63177',DBREAK13,1
^DUM11',DBREAK13,1
^FCV6325',DBREAK13,1
^DUMHT3',DBREAK13,1
^DUMHT1',DBREAK13,1
^FCV6326',DBREAK13,1
^DUMHT2',DBREAK13,1
^DUM7',DBREAK13,1
^VGL63574',DBREAK13,1
^FE6343',DBREAK13,1
^VC63572',DBREAK13,1
^FCV6342',DBREAK13,1
^FCV6341',DBREAK13,1
^VGL63571',DBREAK13,1
^DUM8',DBREAK13,1
^VC63570',DBREAK13,1
^FCV6338',DBREAK13,1
^BIT',DBREAK13,1
^DUMHT4',DBREAK13,1
^FCV6339',DBREAK13,1
^DUMHT6',DBREAK13,1
^DUMHT5',DBREAK13,1
^FE63170',DBREAK13,1
^FCV6340',DBREAK13,1
^DUMHT7',DBREAK13,1
^DUMHT8',DBREAK13,1
^HDR8',DBREAK13,1
^DUM13',DBREAK13,1
^DUMAND15',DBREAK13,1
^VGA62533',DBREAK13,1
^VC62532',DBREAK13,1
^CCP1BB',DBREAK13,1
^VGA62510',DBREAK13,1
^VGA62527',DBREAK13,1
^VC62525',DBREAK13,1
^CCP1AA',DBREAK13,1
^VGA62509',DBREAK13,1
^DDUM11',DBREAK13,1
```

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^V6A62508',DBREAK13,1
^VC62697',DBREAK13,1
^DUM14',DBREAK13,1
^LCV62132',DBREAK13,1
^LCV62133',DBREAK13,1
^DDUM13',DBREAK13,1
^V6L62539',DBPEAK13,1
^FCV6291',DBREAK13,1
^FCV6289',DBREAK13,1
^V6L62537',DBREAK13,1
^FE6293',DBREAK13,1
^V6L62538',DBREAK13,1
^V6L62508',DBREAK13,1
^VC62519',DBREAK13,1
^V6L62536',DBREAK13,1
^PULSDMPR1',DBREAK13,1
^RCP1C',DBREAK13,1
^PULSDMPR2',DBREAK13,1
^DUM12',DBREAK13,1
^FCV6293',DBREAK13,1
^V6L62535',DBREAK13,1
^FCV636'',DBREAK14,1
^FCV637',DBREAK15,1
^FCV637'',DBREAK16,1
^FCV63177',DBREAK17,1
^DBREAK18,RWST,1
^VC63545',DBREAK19,1
^VC63644'',DBREAK20,1
^V6A63544',DBREAK21,1
^FE63161',DBREAK21,1
^DUM4',DBREAK21,1
^V6A63590',DBREAK21,1
^FE63162',DBREAK21,1
^FCV63156'',DBREAK22,1
^VC63543',DBREAK23,1
^VC63641'',DBREAK24,1
^PATHCCPIS',DBREAK25,1
^DBREAK25,PATHCCPIS,1
^DUMAND11',DBREAK25,1
^DUMAND12',DBREAK25,1
^DUMAND13',DBREAK25,1
^DUMAND14',DBREAK25,1
^VC62638',DBREAK25,1
^VC62640',DBREAK25,1
^VC63586',DBREAK26,1
^VC63589',DBREAK27,1
^VC63588',DBREAK28,1
^VC63587',DBREAK29,1
^V6A63583',DBREAK30,1
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^FE6331',DBREAK30,1
^VC63581',DBREAK30,1
^VGA63584',DBREAK30,1
^FE6329',DBREAK30,1
^VGA63585',DBREAK30,1
^FE6327',DBREAK30,1
^VGA63582',DBREAK30,1
^FE6333',DBREAK30,1
^VC63587'',DBREAK31,1
^VC63588'',DBREAK32,1
^VC63589'',DBREAK33,1
^VC63586'',DBREAK34,1
^VC63581'',DBREAK35,1
^VGL63564',DBREAK36,1
^VGA63573',DBREAK37,1
^VC63572'',DBREAK38,1
^DBREAK39,CCP1BB,1
^DBREAK40,CCP1AA,1
^VC6250'4',DBREAK41,1
^VC6250'4'',DBREAK42,1
^VC62660',DBREAK43,1
^VC62640'',DBREAK44,1
^VC62659',DBREAK45,1
^VC62638'',DBREAK46,1
^FCV6290',DBREAK47,1
^FCV6291'',DBREAK48,1
^DBREAK49,RCP1C,1
^
^      Effective digraph of break propogation
^DBREAK3,DBREAK2,1
^DBREAK5,DBREAK6,1
^DBREAK7,DBREAK6,1
^DBREAK3,DBREAK10,1
^DBREAK3,DBREAK2,1
^DBREAK3,DBREAK11,1
^DBREAK12,DBREAK3,1
^DBREAK15,DBREAK3,1
^DBREAK12,DBREAK13,1
^DBREAK15,DBREAK13,1
^DBREAK13,DBREAK17,1
^DBREAK3,DBREAK18,1
^DBREAK19,DBREAK21,1
^DBREAK23,DBREAK21,1
^DBREAK26,DBREAK25,1
^DBREAK27,DBREAK25,1
^DBREAK28,DBREAK25,1
^DBREAK29,DBREAK25,1
^DBREAK29,DBREAK30,1
^DBREAK28,DBREAK30,1
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^DBREAK27,DBREAK30,1
^DBREAK26,DBREAK30,1
^DBREAK36,DBREAK13,1
^DBREAK13,DBREAK39,1
^DBREAK13,DBREAK40,1
^DBREAK41,DBREAK3,1
^DBREAK41,DBREAK13,1
^DBREAK13,DBREAK3,1
^DBREAK13,DBREAK49,1
^DBREAK4,DBREAK2,DBREAK5
^DBREAK5,DBREAK2,DBREAK4
^DBREAK6,DBREAK3,DBREAK9
^DBREAK9,DBREAK3,DBREAK6
^DBREAK3,DBREAK13,DBREAK14
^DBREAK14,DBREAK13,DBREAK3
^DBREAK43,DBREAK25,DBREAK44
^DBREAK44,DBREAK25,DBREAK43
^DBREAK30,DBREAK26,DBREAK34
^DBREAK34,DBREAK26,DBREAK30
^DBREAK30,DBREAK27,DBREAK33
^DBREAK33,DBREAK27,DBREAK30
^DBREAK30,DBREAK28,DBREAK32
^DBREAK32,DBREAK28,DBREAK30
^DBREAK30,DBREAK29,DBREAK31
^DBREAK31,DBREAK29,DBREAK30
^DBREAK13,DBREAK30,DBREAK35
^DBREAK35,DBREAK30,DBREAK13
^DBREAK7,DBREAK2,DBREAK8
^DBREAK8,DBREAK2,DBREAK7
^DBREAK3,DBREAK13,DBREAK16
^DBREAK16,DBREAK13,DBREAK3
^DBREAK17,DBREAK3,DBREAK14
^DBREAK14,DBREAK3,DBREAK17
^DBREAK17,DBREAK3,DBREAK16
^DBREAK16,DBREAK3,DBREAK17
^DBREAK19,DBREAK2,DBREAK20
^DBREAK20,DBREAK2,DBREAK19
^DBREAK21,DBREAK3,DBREAK22
^DBREAK22,DBREAK3,DBREAK21
^DBREAK23,DBREAK2,DBREAK24
^DBREAK24,DBREAK2,DBREAK23
^DBREAK36,DBREAK30,DBREAK35
^DBREAK35,DBREAK30,DBREAK36
^DBREAK37,DBREAK13,DBREAK38
^DBREAK38,DBREAK13,DBREAK37
^DBREAK3,DBREAK13,DBREAK42
^DBREAK42,DBREAK13,DBREAK3
^DBREAK45,DBREAK25,DBREAK46
^DBREAK46,DBREAK25,DBREAK45
^DBREAK47,DBREAK13,DBREAK48
^DBREAK48,DBREAK13,DBREAK47
^
```

^
^ ADJACENCY INPUT FOR CENTRAL SIPIS
^

DATA FROM TVA DWG. 47W811-1

Expanded AND-gate input to PATHSIPIS

```
VC63641,PATHSIPIS,DUMAND26
DUMAND26,PATHSIPIS,VC63641
VC63644,DUMAND26,DUMAND25
DUMAND25,DUMAND26,VC63644
VC63563,DUMAND25,DUMAND24
DUMAND24,DUMAND25,VC63563
VC63562,DUMAND24,DUMAND23
DUMAND23,DUMAND24,VC63562
VC63561,DUMAND23,DUMAND22
DUMAND22,DUMAND23,VC63561
VC63560,DUMAND22,DUMAND21
DUMAND21,DUMAND22,VC63560
VC63558,DUMAND21,VC63559
VC63559,DUMAND21,VC63558
```

VC- is a check valve.

There are normal and alternate paths to the core. The normal paths consist of one group of 4 branches which channel flow from pump trains A and/or B. The alternate paths consist of two groups of 2 branches. One group channels flow from pump train A through flow control valve FCV63156. The other group channels flow from pump train B through flow control valve FCV63157. Both FCV-'s are normally closed and require manual actuation and their models follow SIPIS.DAT. Models of the two safety injection pumps SIP1AA and SIP1BB follow FCV- models.

Train B and alternate paths through FCV63157.

```
VC63547,VC63559,1
DSA63165,VC63559,1
VGA63546,VC63547,1
FE63160,VGA63546,1
DTA63650,FE63160,1
DTA63314A,FE63160,1
BTA63313A,DUM2,1
DTA63649,DUM2,1
DUM2,FE63160,1
DSA63167,DUM2,1
DSDCVCS1,VC63558,1
VC63549,VC63558,1
DSA63166,VC63558,1
VGA63548,VC63549,1
FE63159,VGA63548,1
DTA63318A,FE63159,1
DTA6317A,FE63159,1
```

VGA- is a gate valve.
FE- is a primary element flowmeter orifice.
DT- is a tertiary degradation node. It represents flow diversion path upon breakage or disconnection of hardware.

DS- is a secondary degradation node. It represents a flow diversion upon opening of at least 2 offline valves in series.
DP- (from 5 lines down) is a primary deg. node. It represents flow diversion upon opening of a single valve, such as relief valve.

```
DUM2,FE63159,1
FCV63157,DUM2,1                 FCV- is flow control valve.  ADJ input for
DPAVR63536,FCV63157,1           this valve follows SIPIS.DAT.
DTA63504,FCV63157,1
DTA63682,FCV63157,1

        Crosstie connection between train A and train B
FE6320,FCV63157,DUM5
DUM5,FCV63157,FE6320
FE6320,DUM1,1
FCV63153,DUM1,1
DUM1,FCV6322,DUM3               FCV6322 is valve through which all flow passes
DUM3,FCV6322,DUM1               to reach normal injection paths.
FE63151,DUM3,1
FE63151,DUM5,1
DUMCROSTIE,DUM5,1               If DUMCROSTIE fails, there is no open path
FCV63153,DUMCROSTIE,1           between the two trains thus keeping one pump
FCV63152,DUMCROSTIE,1           train from being able to inject into the
DUMCROSTIE,DUM6,1               other's alternate injection paths.
FCV63152,DUM3,1
FE6320,DUM6,1
DUM6,FCV63156,FE63151
FE63151,FCV63156,DUM6

VGA63527,FE6320,1
DTA63308A,FE6320,1
DTA63307A,FE6320,1
DTA63304A,FE6320,1
VC63526,VGA63527,1
DTA63385A,VC63526,1
SIP1BB,VC63526,1                SIP- is a safety injection pump.  Inputs to
DTA63512,SIP1BB,1               this are from RWST crosstie network.
DTA63514,SIP1BB,1
DTA63302A,SIP1BB,1
DTAMISC1,SIP1BB,1

        Train A and paths through normal branches.
VC63551,VC63560,1
VGA63550,VC63551,1
FE63122,VGA63550,1
DTA63319A,FE63122,1
DTA63320A,FE63122,1
FCV6322,FE63122,1
DPAVR63535,FCV6322,1
DTA63539,FCV6322,1
DTA63653,FCV6322,1
FCV63153,FCV6322,FCV63152
FCV63152,FCV6322,FCV63153
VGA63525,FE63151,1
```

```
DTA63303A,FE63151,1
DTA63305A,FE63151,1
DTA63306A,FE63151,1
VC63524,VGA63525,1
DTA63386A,VC63524,1
SIP1AA,VC63524,1                Connections to SIP- are from RWST crosstie
DTA63517,SIP1AA,1               network.


DTA63519,SIP1AA,1
DTA63301A,SIP1AA,1
DTAM1SC2,SIP1AA,1
VC63553,VC63561,1
VGA63552,VC63553,1
FE63123,VGA63552,1
DTA63321A,FE63123,1
DTA63322A,FE63123,1
FCV6322,FE63123,1
VC63555,VC63562,1
VGA63554,VC63555,1
FE63124,VGA63554,1
DTA63323A,FE63124,1
DTA63324A,FE63124,1
FCV6322,FE63124,1
VC63557,VC63563,1
VGA63556,VC63557,1
FE63125,VGA63556,1
DTA63325A,FE63125,1
DTA63326A,FE63125,1
FCV6322,FE63125,1

      Alternate paths from Train A through FCV63156.
VC63545,VC63644,1
DSA63164,VC63644,1
VGA63544,VC63545,1
FE63161,VGA63544,1
DTA63315A,FE63161,1
DTA63316A,FE63161,1
DTA63658,FE63161,1
DUM4,FE63161,1
DSA6321,DUM4,1
DTA63657,DUM4,1
FCV63156,DUM4,1
DSB6323,FCV63156,1
DPAVR63534,FCV63156,1
DTA63541,FCV63156,1
DTA63538,FCV63156,1
VC63543,VC63641,1
DSA63163,VC63641,1
```

VGA63590,VC63543,1
FE63162,VGA63590,1
DTA63311A,FE63162,1
DTA63312A,FE63162,1
DUM4,FE63162,1

ADJACENCY INPUT FOR CCPISCORE

DATA FROM TVA DWG's 47W811-1, 47W809-1

Expanded AND-gate input to PATHCCPIS

VC63586,PATHCCPIS,DUMAND11
DUMAND11,PATHCCPIS,VC63586
VC63589,DUMAND11,DUMAND12
DUMAND12,DUMAND11,VC63589
VC63588,DUMAND12,DUMAND13
DUMAND13,DUMAND12,VC63588
VC63587,DUMAND13,DUMAND14
DUMAND14,DUMAND13,VC63587
VC62638,DUMAND14,VC62640
VC62640,DUMAND14,VC62638

In CCPIS there is are normal and alternate injection paths to the core. The normal path is through the boron injection tank and then through 4 branches into the RCS. The alternate path is through the regenerative heat exchanger and then through 2 branches into RCS.

Four normal branches into RCS

VGA63583,VC63587,1
FE6331,VGA63583,1
DTA63332A,FE6331,1
DTA63331A,FE6331,1
VC63581,FE6331,1
VGA63584,VC63588,1
FE6329,VGA63584,1
DTA63329A,FE6329,1
DTA63330A,FE6329,1
VC63581,FE6329,1
VGA63585,VC63589,1
FE6327,VGA63585,1
DTA63327A,FE6327,1
DTA63328A,FE6327,1
VC63581,FE6327,1
VGA63582,VC63586,1
FE6333,VGA63582,1
DTA6333A,FE6333,1
DTA6334A,FE6333,1

FE- is an inline flow element for a differential pressure transducer.

```
VC63581,FE6333,1

       Normal injection path

DSBBITB1,VC63581,1
DTA63515,VC63581,1
DSB63174,VC63581,1
DTA63651,VC63581,1
DSB6324,VC63581,1
DTA63652,VC63581,1
DTA63513,VC63581,1
FCV6325,VC63581,DUMHT1  DUMHT- is heat tracing for which a unit model exists.
DUMHT3,FCV6325,1
DUMHT1,VC63581,FCV6325
FCV6326,DUMHT1,1
DUMHT2,FCV6326,1
DUMHT3,DUMHT2,1
DPA63578,DUMHT3,1       Valve 63578 is used for local sampling.

       Inputs to DUMHT3 follow.  These represent shutoff of part of the
       recirculation phase of the boron recycle system.  During safety
       injection, this shutoff must occur for the injection path to be
       successfully aligned.
DTA63576,DUMHT3,1
DPAVR63577,DUMHT3,1
DTA63341A,DPAVR63577,1
DUM7,DUMHT3,VGL63574
VGL63574,DUMHT3,DUM7    VGL63574 is a normally open valve which can be shut by
OPRA2,VGL63574,1        local operator OPRA2.
FE6343,DUM7,1
DTA63335A,FE6343,1
DTA63336A,FE6343,1
VGA63573,DUM7,1
VC63572,VGA63573,1
FCV6342,DUM7,FCV6341
FCV6341,DUM7,FCV6342
VGL63571,DUM7,DUM8
DUM8,DUM7,VGL63571
VC63570,DUM8,FCV6338
FCV6338,DUM8,VC63570

BIT,DUMHT3,1    BIT is Boron Injection Tank
DPA63569,BIT,1  Valve 63569 is used for local sampling.
DUM8,BIT,1      DUM8 is the connection to the other part of the recirc. path
DUMHT4,BIT,1    back to the boron recycling system.
FCV6339,DUMHT4,DUMHT6
DUMHT6,DUMHT4,FCV6339
DUMHT5,FCV6339,1
FE63170,DUMHT5,1
```

```
FCV63402,DUMHT6,1
DUMHT7,FCV63402,1
DUMHT8,DUMHT7,1
FE63172,DUMHT8,1
DSA63342A,FE63172,1
DSA63343A,FE63172,1
DSBBIT2,FE63172,1
DPCRCP1C2,FE63172,1     DPCRCP1C2 is degradation when RCP1C runs backwards.
HDR8,FE63172,1

DUM12,FE6293,1
VGA62533,HDR8,VGA62527
VGA62527,HDR8,VGA62533

        HDR8 is the junction of the normal and alternate injection paths.
        Expanded AND-gate input to HDR8 follows.  Input is from each of
        the three pump trains in the system.  There are 2 centrifugal charging
        pumps and 1 reciprocating charging pump.  The reciprocating charging
        pump train connects to the normal injection path by way of a series
        of 3 valves which comprise a crosstie connection.  Flow from the
        charging pumps to the alternate injection path also passes through
        this crosstie.
DUM13,DUMAND15,VGA62533 DUM13 is flow from reciprocating charging pump (RCP1C)
VGA62533,DUMAND15,DUM13
DUMAND15,HDR8,VGA62527
VGA62527,HDR8,DUMAND15

VC62525,VGA62527,1
DSC62526,VGA62527,1
CCP1AA,VC62525,1        CCP1AA is Centrifugal Charging Pump 1AA.
DTA62522,VC62525,1
DTA62353A,VC62525,1
VGA62509,CCP1AA,1

VC62504,VGA62509,1      Inserted to disable crosstie from RWST.
VC62504,VGA62510,1
LCV62136,VC62504,LCV62135
LCV62135,VC62504,LCV62136
RWST,LCV62135,1
RWST,LCV62136,1

DPB62512,CCP1AA,1
DTATC2,CCP1AA,1         DTATC- is a test connection.
DTA62352A,CCP1AA,1
DSB62521,CCP1AA,1
DUM11,VGA62509,1        DUM11 is coolant input from RWST through 2 paths.

VC62532,VGA62533,1
DSC62534,VGA62533,1
```

```
CCP1BB,VC62532,1        CCP1BB is Centrifugal Charging Pump 1BB.
DTA62529.CCP1BB,1
DTA62351A,CCP1BB,1
VGA62510,CCP13B,1
DTATC1,CCP1BB,1
DTA62350A,CCP1BB,1
DSB62528,CCP1BB,1
DPB62513,CCP1BB,1
DUM11,VGA62510,1

DSBALTBRS1,DUM11,1
DPB62699,DUM11,1
DPAVR62505,DUM11,1
DSCBRS1,DUM11,1
VC62697,DUM11,DUM14  VC62697 is in path to Chem. Vol. & Control Sys. (CVCS)
DUM14,DUM11,VC62697
DTC62653,DUM14,1
LCV62132,DUM14,LCV62133    Both LCV's close upon receipt of SILOGIC signal.
LCV62133,DUM14,LCV62132
DTB62507,DUM11,1


       Two alternate branches into RCS
VC62660,VC62640,1
FCV6286,VC62660,1
DTA62704,FCV6286,1
RGENHXR1,FCV6286,1      RGENHXR1 is regenerative heat exchanger.
VC62659,VC62638,1
FCV6285,VC62659,1
RGENHXR1,FCV6285,1

       Alternate injection path

DTA62545,RGENHXR1,1
DTA6287,RGENHXR1,1
DSB6284,RGENHXR1,1
VC62543,RGENHXR1,1
DTA62544,VC62543,1
DSD62709,VC62543,1
FCV6290,VC62543,1
DTA6290,FCV6290,1
FCV6291,FCV6290,1
VGL62539,FCV6291,VGL62538
FCV6289,VGL62539,1
DSA62542,VGL62539,1
VGL62537,FCV6289,1
DSA62541,FCV6289,1
FE6293,VGL62537,1
VGL62538,FCV6291,VGL62539
```

```
OPRA8,VGL62538,1          VGL62538 is a normally closed valve which must be
FE6293,VGL62538,1         opened by local operator OPRA8.
DTA62342A,FE6293,1
DTA62343A,FE6293,1
DPCRCP1C1,FE6293,1        DPCRCP1C1 is degradation when RCP1C runs backwards.
VGL6250,FE6293,DUM12      VGL6250 is input from recip. charging pump train.
DTA62344A,VGL6250,1
VGL6250,DUM13,1           DUM13 is flow from RCP train to CCP train via crosstie
VC62519,VGL6250,1
PULSDAMPR1,VC62519,1      PULSDAMPR- is pulse damper (one on each side of RCP1C)
DTA62517,VC62519,1
DPAVR62518,VC62519,1
DSCUHI1,VC62519,1         DSCUHI- are connections to upper head injection system
DSB62516,VC62519,1
DTA62716,VC62519,1
RCP1C,PULSDAMPR1,1        RCP1C is reciprocating charging pump.
DSB62515,RCP1C,1
PULSDAMPR2,RCP1C,1
VGA62500,PULSDAMPR2,1
DSB62514,PULSDAMPR2,1
DTATC3,PULSDAMPR2,1
DTA62712,PULSDAMPR2,1
DTA62349A,PULSDAMPR2,1
DTB62511,PULSDAMPR2,1
DUM11,VGA62500,1
DUM12,FE6293,VGL6250
```

Crosstie between normal and alternate injection paths and between CCP's and RCP trains follows. The crosstie consists of 3 valves in series, all of which are normally open. Flow through these valves passes either to or from the RCP or CCP trains hence the connections between these valves are bidirectional. Output of the crosstie is DUM12, the path to RCP, and DUM13, the path from RCP.

```
VGL62536,DUM12,1
FCV6293,VGL62536,1
VGL62536,FCV6293,1
VGL62535,FCV6293,1
FCV6293,VGL62535,1
VGL62535,DUM13,1

HDR8,DUM12,1    HDR8 is junction of normal and alternate injection paths.
```

ADJACENCY INPUT FOR CROSSTIE CONNECTION BETWEEN THE RWST
AND THE TWO INJECTION SYSTEMS

DATA FROM TVA DWG. 47W811-1

This data models the connection of the refueling water storage tank (RWST) to the centrfugal charging pump injection system (CCPIS) and to the safety injection pump injection system (SIPIS) as well as crosstie connections between the injection systems. The modeling procedure is described below.
At each header, flow can exit through each of the pipes which form the junction (unless a check valve or pump constrains flow from flowing away from the header in a given pipe). Considering each exit path independently, the possible sources of flow to it are AND-ed together and input a dummy node. The sources are nodes adjacent to the header. The node representing the header OR's into this dummy and represents the necessity of an open path through the header to enable flow through the exit path being considered. This is repeated for each output from the header and the entire scheme is is repeated at each header throughout the crosstie network.

Network that inputs to CCPIS

```
DUM23,DUM11,1
DUM23,V6A62510,1        DUM11 is connection to CCPIS.
HDR6,DUM23,1            HDR- is a header (junction of 3 or more pipe lengths).
DUM32,DUM23,VC6350 4
VC6350 4,DUM23,DUM32
HDR6,DUM24,1
DUM32,DUM24,1           DUM24 is flow from SIPIS to CCPIS through HDR's 6 & 7.
DUM24,V6A62509,VC6350 4
VC6350 4,V6A62509,DUM24 V6A62509 is flow to CCPIS from either the LCV's or SIPIS.
HDR7,DUM24,1
HDR7,VC6350 4,1
VC6350 4,DUM25,1
HDR6,DUM25,1    DUM25 is flow from CCPIS to SIPIS through HDR's 6 and 7.
LCV62135,VC6350 4,LCV62136
LCV62136,VC6350 4,LCV62135
HDR1,LCV62135,1 HDR1 is adjacent to the RWST and outputs to CCPIS and SIPIS.
HDR1,LCV62136,1
RWST,HDR1,1
```

Network that inputs to SIPIS

```
DUM27,SIP1BB,FCV6311    SIP- is safety injection pump.
HDR5,SIP1BB,1
FCV6311,SIP1BB,DUM27
HDR9,DUM27,1
VC63510,DUM27,DUM36
```

```
DUM36,DUM27,VC6351@
DUM34,DUM36,1          DUM36 is flow through HDR4/FCV6347 from HDR3.
FCV6347,DUM36,1
FCV635,VC6351@,1
DUM3@,FCV635,DUM31
DUM31,FCV635,DUM3@
HDR1,DUM3@,1
HDR2,DUM3@,1
HDR2,DUM31,1
DUM33,DUM31,1
HDR1@,DUM33,1
HDR1@,FCV631,1
DUM33,FCV631,DUM3@
DUM3@,FCV631,DUM33
DUM3@,FCV631,1         Short circuit to break recirulation path.
FCV631,VC6352,1
VC6352,RHRPATH,1       RHRPATH represents paths through RHR system enabled
RHRPOWER,RHRPATH,1     by power to the RHR pumps, component cooling water
RHRCCW,RHRPATH         to the pumps, and safety injection actuation to
OPRRHR,RHRPATH,DUMAND7 the pumps.
DSIINST,OPRRHR,1
DUMAND7,RHRPATH,OPRRHR
SISI6B,DUMAND7,SISI6A
SISI6A,DUMAND7,SISI63
RHRPATH,FCV6311,1
FCV6311,DUM28,1        DUM28 represents flow up from RHRPATH, through HDR5,
HDR5,DUM28,1           and to HDR9.
DUM28,DUM29,VC6351@    DUM29 is flow from HDR9 down to HDR4.
VC6351@,DUM29,DUM28
HDR9,DUM29,1
DUM29,DUM37,1
DUM37,SIP1AA,DUM38
DUM38,SIP1AA,DUM37
HDR4,DUM38,1
DUM34,DUM38,1
HDR4,FCV6347,1
FCV6347,DUM37,1
FCV636,FCV63177,FCV637 !
FCV637,FCV63177,FCV636 ! These 4 lines represent path availability between
FCV63177,DUM35,1       ! HDR3 and HDR4.  DUM35 is flow to HDR3 and DUM34 is
FCV63177,DUM34,1       ! flow from HDR3.
HDR3,DUM34,1
DUM29,DUM35,1
FCV6347,DUM35,1
DUM35,DUM32,FCV638
FCV638,DUM32,DUM35
RHRPATH,FCV638,1
FCV638,DUM34,DUM25
DUM25,DUM34,FCV638
HDR3,DUM32,1
RHRPATH,DUM33,1
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

```
      ** FCV6311 **
480MOV1B1B,FCV6311,OPRA1RA
OPRA1RA,FCV6311,480MOV1B1B
OPRF1RA,FCV6311,OPRA1RA
OPRA1RA,FCV6311,OPRF1RA
```

DATA FROM TVA DWG 45W760-63-8

```
      ** FCV636 **
OPRA1RB,FCV636,480MOV1B1B
480MOV1B1B,FCV636,OPRA1RB
OPRA1RB,FCV636,OPRF1RB
OPRF1RB,FCV636,OPRA1RB
```

DATA FROM TVA DWG 45W760-63-8

```
      ** FCV637 **
LINK1RC,FCV637,1        LINK1RC is connection from MOT1RC to FCV637.  MOT1RC
POWER1RC,FCV637,OPRA1RC
OPRA1RC,FCV637,POWER1RC
OPRF1RC,FCV637,OPRA1RC
OPRA1RC,FCV637,OPRF1RC
```

DATA FROM TVA DWG 45W760-63-8

This valve cannot actuate electrically unless valve FCV637 is closed (data from TVA Dwg. 45W751-2). The feedback/feed-forward transmission link LINKRC from FCV637 inputs to SW57RD in this valve.

```
      ** FCV638 **
LINK1RC,DUM13RD,1
480MOV1A1A,DUM13RD,1
DUM13RD,FCV638,OPRA1RD
OPRA1RD,FCV638,DUM13RD
OPRF1RD,FCV638,OPRA1RD
OPRA1RD,FCV638,OPRF1RD
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

** FCV6325 **

OPRA6325,FCV6325,480MOV1B1B — LINK1C is connection from MOT1C to FCV6325. MOT1C
480MOV1B1B,FCV6325,OPRA6325 — 480MOV1B1B is process electrical power.

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

** FCV6326 **

OPRA6326,FCV6326,480MOV1A1A — LINK1D is connection from MOT1D to FCV6326. MOT1D
480MOV1A1A,FCV6326,OPRA6326 — 480MOV1A1A is process electrical power.

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

** FCV6339 **

OPRA6339,FCV6339,480MOV1A1A — LINK1E is connection from MOT1E to FCV6339. MOT1E
480MOV1A1A,FCV6339,OPRA6339 — 480MOV1A1A is process electrical power.

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

** FCV6340 **

OPRA6340,FCV6340,480MOV1B1B — LINK1F is connection from MOT1F to FCV6340. MOT1F
480MOV1B1B,FCV6340,OPRA6340 — 480MOV1B1B is process electrical power.

ADJACENCY INPUT FOR SOLENOID FLOW CONTROL VALVE

DATA FROM TVA DWG. 45W600-63

No motive power is needed, only signal and actuation. No local operator. Remote OP ANDs with SISI6.

This unit model is for those solenoid valves which are closed for safety injection. Their closure is effected by cutting power to the solenoid.

** FCV6338 **

OPRA6338,FCV6338,SISI6B SOL16 is solenoid which, when de-energized, allows
SISI6B,FCV6338,OPRA6338 ^LINK16

ADJACENCY INPUT FOR SOLENOID FLOW CONTROL VALVE

DATA FROM TVA DWG. 45W600-63

No motive power is needed, only signal and actuation. No local operator. Remote OP ANDs with SISI6.

This unit model is for those solenoid valves which are closed for safety injection. Their closure is effected by cutting power to the solenoid.

** FCV6342 **

OPRA6342,FCV6342,SISI6A SOL1H is solenoid which, when de-energized, allows
SISI6A,FCV6342,OPRA6342

DATA FROM TVA DWG. 45W600-63

No motive power is needed, only signal and actuation. No local operator. Remote OP ANDs with SISI6.

This unit model is for those solenoid valves which are closed for safety injection. Their closure is effected by cutting power to the solenoid.

** FCV6341 **

OPRA6341,FCV6341,SISI6B SOL1R is solenoid which, when de-energized, allows
SISI6B,FCV6341,OPRA6341

ADJACENCY INPUT FOR MOTOR OPERATED LEVEL CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-62-7

** LCV62135 **

OPRA62135.LCV62135,480MOV1A1A LINK1J is connection from MOT1J to LCV62135. MOT1J
480MOV1A1A,LCV62135,OPRA62135 480MOV1A1A is process electrical power.

ADJACENCY INPUT FOR MOTOR OPERATED LEVEL CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-62-7

```
      ** LCV62136 **
OPRA62136,LCV62136,480MOV1B1B       LINK1K is connection from MOT1K to LCV62136.  MOT1K
480MOV1B1B,LCV62136,OPRA62136   480MOV1B1B is process electrical power.
```

ADJACENCY INPUT FOR MOTOR OPERATED LEVEL CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-62-7

```
      ** LCV62133 **
OPRA62133,LCV62133,480MOV1B1B       LINK1L is connection from MOT1L to LCV62133.  MOT1L
480MOV1B1B,LCV62133,OPRA62133   480MOV1B1B is process electrical power.
```

ADJACENCY INPUT FOR MOTOR OPERATED LEVEL CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-62-7

```
      ** LCV62132 **
OPRA62132,LCV62132,480MOV1A1A       LINK1M is connection from MOT1M to LCV62132.  MOT1M
480MOV1A1A,LCV62132,OPRA62132   480MOV1A1A is process electrical power.
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This valve shuts off the alternate injection paths upon receipt of SILOGIC, hence, its successful operation causes the alternate paths to fail. For the alternate paths to succeed, either this valve must fail to close or, if it has closed, it must be successfully opened manually. For the first case, the valve node is false even though it has failed to function as designed. Modelling this would require use of a NOT gate which isn't in any code now. This model will be for the second case, the ability of the valve to be successfully opened manually. FCV6290 is handled the same way.

```
      ** FCV6291 **
OPRR6291,FCV6291,OPRL6291
OPRL6291,FCV6291,OPRR6291
480MOV1B1B,FCV6291,OPRL6291     480MOV1B1B is process electrical power.
OPRL6291,FCV6291,480MOV1B1B
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This valve shuts off the alternate injection paths upon receipt of SILOGIC, hence, its successful operation causes the alternate paths to fail. For the alternate paths to succeed, either this valve must fail to close or, if it has closed, it must be successfully opened manually. For the first case, the valve node is false even though it has failed to function as designed. Modelling this would require use of a NOT gate which isn't in any code now. This model will be for the second case, the ability of the valve to be successfully opened manually. FCV6291 is handled the same way.

```
      ** FCV6290 **
480MOV1A1A,FCV6290,OPRL6290
OPRL6290,FCV6290,480MOV1A1A
OPRR6290,FCV6290,OPRL6290
OPRL6290,FCV6290,OPRR6290       LINK1P is connection from MOT1P to FCV6290.  MOT1P
```

ADJACENCY INPUT FOR SOLENOID FLOW CONTROL VALVE

DATA FROM TVA DWG. 45W600-63

This unit model is for those solenoid valves which are closed for safety injection. Their closure is effected by cutting power to the solenoid.

7/17: No singleton or doubleton OUTSIDE OF THE VALVE can keep this solenoid valve from working. It requires no motive power, only a signal to de-energize the coil. Since no singleton or doubleton can kill DSIINST, the remote OP who uses it is OR'ed into the valve.

```
      H** FCV6286 **
OPRR6286,FCV6286,1



MOT2S,CCP1AA,1          MOT2S is driving motor and CCP1AA is pump.
R2S,MOT2S,1             R2S is relay.
6900VS1AA,R2S,1         6900VS1AAS is process electrical power.
COIL2S,R2S,1            COIL2S, when energized, closes R2S.

      Multiple AND-gate for inputs of switches to COIL2S
SWSI1S,COIL2S,DUMAND8S  SWSI1S switches on receipt of SIS.
DUMAND8S,COIL2S,SWSI1S
SWA2S,DUMAND8S,DUMAND7S SWA2S uses normal control power to energize COIL2S.
DUMAND7S,DUMAND8S,SWA2S
SWC2S,DUMAND7S,SWB2S    SWC2S uses emergency control power to energize COIL2S.
SWB2S,DUMAND7S,SWC2S    SWB2S is local control and uses norm. or emerg. power.

OPRC2S,SWB2S,1          OPRC2S is local operator.
DSIINST,OPRC2S,1        DSIINST is control room SIS indicator instrumentation.
FDATA2S,OPRC2S,1


FUSE4S,SWC2S,1          FUSE4S is fuse for emergency control power.
R3S,DUM4S,R4S
R4S,DUM4S,R3S
DUM4S,FUSE4S,1
FUSE10III,R3S,1
FUSE10I,R4S,1
SWX3S,R4S,1
OPRF7S,SWX3S,1
ANNIII,OPRF7S,1 ANN- is annunciator to indicate need to switch to alt. pwr.
```

```
SWX2S,FUSE4S,1          SWX2S is switch from normal to energ. control power.
OPRF4S,SWX2S,1          OPRF4S operates SWX2S.

      Multiple AND-gate for inputs of transmitters/indicators to OPRF4S
FDATA2S,OPRF4S,DUMAND10S
DUMAND10S,OPRF4S,FDATA2S
LT8S,DUMAND10S,DUMAND9S LT8S indicates SWA2S status.
DUMAND9S,DUMAND10S,LT8S
LT7S,DUMAND9S,DUMAND6S  LT7S indicates SWA3S status.
DUMAND6S,DUMAND9S,LT7S
LT6S,DUMAND6S,OPRC2S    LT6S indicates control power status.
OPRC2S,DUMAND6S,LT6S

OPRF6S,SWC2S,1          OPRF6S operates auxillary control switch SWC2S.
DUM35S,OPRF6S,1

FDATA2S,DUM35S,OPRC2S
OPRC2S,DUM35S,FDATA2S
DSIINST,DUM35S,1

FUSE3S,SWA2S,1          FUSE3S is fuse for normal control power.
FUSE3S,LT7S,1           Indicator lights LT7S and LT8S use norm. con. power.
FUSE3S,LT8S,1
FUSE3S,SWB2S,FUSE4S
FUSE4S,SWB2S,FUSE3S
DUM3S,FUSE3S,1
R5S,DUM3S,R6S
R6S,DUM3S,R5S
FUSE10I,R5S,1
FUSE10III,R6S,1
SWX4S,R6S,1
ANNI,OPRF8S,1
OPRF8S,SWX4S,1
FUSE3S,SWA3S,1          SWA3S enables auto receipt of SIS.
DUM35S,OPRF5S,1
OPRF5S,SWA2S,1          OPRF5S operates SWA2SS, SWA3S which are both part of same actuator.
SWA3S,SWSI1S,1
OPWF5S,SWA3S,1          OPWF5SS fails by not enabling SISI6 receipt.
SISI6A,SWSI1S,1         SISI6A is input from Safeguards Actuation Logic.
```

ADJACENCY INPUT FOR SAFETY INJECTION OR CENTRIFUGAL CHARGING PUMP

DATA FROM TVA DWG's 45W760-62-1, 45W760-63-1

```
      ** CCP1BB **
MOT2T,CCP1BB,1          MOT2T is driving motor and CCP1BB is pump.
R2T,MOT2T,1             R2T is relay.
6900VS1BB,R2T,1         6900VS1BBT is process electrical power.
COIL2T,R2T,1            COIL2T, when energized, closes R2T.

      Multiple AND-gate for inputs of switches to COIL2T
SWSI1T,COIL2T,DUMAND8T  SWSI1T switches on receipt of SIS.
DUMAND8T,COIL2T,SWSI1T
SWA2T,DUMAND8T,DUMAND7T SWA2T uses normal control power to energize COIL2T.
DUMAND7T,DUMAND8T,SWA2T
SWC2T,DUMAND7T,SWB2T    SWC2T uses emergency control power to energize COIL2T.
SWB2T,DUMAND7T,SWC2T    SWB2T is local control and uses norm. or emerg. power.

OPRC2T,SWB2T,1          OPRC2T is local operator.
DSIINST,OPRC2T,1        DSIINST is control room SIS indicator instrumentation.
FDATA2T,OPRC2T,1


FUSE4T,SWC2T,1          FUSE4T is fuse for emergency control power.
R3T,DUM4T,R4T
R4T,DUM4T,R3T
DUM4T,FUSE4T,1
FUSE10IV,R3T,1
FUSE10II,R4T,1
SWX3T,R4T,1
OPRF7T,SWX3T,1
ANNIV,OPRF7T,1  ANN- is annunciator to indicate need to switch to alt. pwr.
SWX2T,FUSE4T,1          SWX2T is switch from normal to emerg. control power.
OPRF4T,SWX2T,1          OPRF4T operates SWX2T.

      Multiple AND-gate for inputs of transmitters/indicators to OPRF4T
FDATA2T,OPRF4T,DUMAND10T
DUMAND10T,OPRF4T,FDATA2T
LT8T,DUMAND10T,DUMAND9T LT8T indicates SWA2T status.
DUMAND9T,DUMAND10T,LT8T
LT7T,DUMAND9T,DUMAND6T  LT7T indicates SWA3T status.
DUMAND6T,DUMAND9T,LT7T
LT6T,DUMAND6T,OPRC2T    LT6T indicates control power status.
OPRC2T,DUMAND6T,LT6T

OPRF6T,SWC2T,1          OPRF6T operates auxillary control switch SWC2T.
DUM5T,OPRF6T,1
```

```
FDATA2T,DUM35T,OPRC2T
OPRC2T,DUM35T,FDATA2T
DSIINST,DUM35T,1

FUSE3T,SWA2T,1          FUSE3T is fuse for normal control power.
FUSE3T,LT7T,1           Indicator lights LT7T and LT8T use norm. con. power.
FUSE3T,LT8T,1
FUSE3T,SWB2T,FUSE4T
FUSE4T,SWB2T,FUSE3T
DUM3T,FUSE3T,1
R5T,DUM3T,R6T
R6T,DUM3T,R5T
FUSE1@II,R5T,1
FUSE1@IV,R6T,1
SWX4T,R6T,1
ANNII,OPRF8T,1
OPRF8T,SWX4T,1
FUSE3T,SWA3T,1          SWA3T enables auto receipt of SIS.
DUM35T,OPRF5T,1
OPRF5T,SWA2T,1          OPRF5T operates SWA2ST, SWA3T which are both part of same actuator.
SWA3T,SWSI1T,1
OPWF5T,SWA3T,1          OPWF5ST fails by not enabling SISI6 receipt.
SISI6B,SWSI1T,1         SISI6B is input from Safeguards Actuation Logic.
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

```
      H** FCV63156 **
480MOV1A1A,FCV63156,OPRL63156
OPRL63156,FCV63156,480MOV1A1A
OPRR63156,FCV63156,OPRL63156
OPRL63156,FCV63156,OPRR63156        LINK1W is connection from MOT1W to FCV63156.  MOT1W
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

```
      H** FCV63157 **
480MOV1B1B,FCV63157,OPRL63157
OPRL63157,FCV63157,480MOV1B1B
OPRR63157,FCV63157,OPRL63157
OPRL63157,FCV63157,OPRR63157        LINK1X is connection from MOT1X to FCV63157.  MOT1X
```

ADJACENCY INPUT FOR SAFETY INJECTION OR CENTRIFUGAL CHARGING PUMP

DATA FROM TVA DWG's 45W760-62-1, 45W760-63-1

```
        ** SIP1AA **
MOT2U,SIP1AA,1          MOT2U is driving motor and SIP1AA is pump.
R2U,MOT2U,1             R2U is relay.
6900VS1AA,R2U,1         6900VS1AAU is process electrical power.
COIL2U,R2U,1            COIL2U, when energized, closes R2U.

        Multiple AND-gate for inputs of switches to COIL2U
SWSI1U,COIL2U,DUMAND8U  SWSI1U switches on receipt of SIS.
DUMAND8U,COIL2U,SWSI1U
SWA2U,DUMAND8U,DUMAND7U SWA2U uses normal control power to energize COIL2U.
DUMAND7U,DUMAND8U,SWA2U
SWC2U,DUMAND7U,SWB2U    SWC2U uses emergency control power to energize COIL2U.
SWB2U,DUMAND7U,SWC2U    SWB2U is local control and uses norm. or emerg. power.

OPRC2U,SWB2U,1          OPRC2U is local operator.
DSIINST,OPRC2U,1        DSIINST is control room SIS indicator instrumentation.
FDATA2U,OPRC2U,1


FUSE4U,SWC2U,1          FUSE4U is fuse for emergency control power.
R3U,DUM4U,R4U
R4U,DUM4U,R3U
DUM4S,FUSE4U,1
SWX2U,FUSE4U,1          SWX2U is switch from normal to emerg. control power.
OPRF4U,SWX2U,1          OPRF4U operates SWX2U.

        Multiple AND-gate for inputs of transmitters/indicators to OPRF4U
FDATA2U,OPRF4U,DUMAND10U
DUMAND10U,OPRF4U,FDATA2U
LT8U,DUMAND10U,DUMAND9U LT8U indicates SWA2U status.
```

```
DUMAND9U,DUMAND10U,LT8U
LT7U,DUMAND9U,DUMAND6U  LT7U indicates SWA3U status.
DUMAND6U,DUMAND9U,LT7U
LT6U,DUMAND6U,OPRC2U    LT6U indicates control power status.
OPRC2U,DUMAND6U,LT6U

OPRF6U,SWC2U,1          OPRF6U operates auxillary control switch SWC2U.
DUM35U,OPRF6U,1

FDATA2U,DUM35U,OPRC2U
OPRC2U,DUM35U,FDATA2U
DSIINST,DUM35U,1

FUSE3U,SWA2U,1          FUSE3U is fuse for normal control power.
FUSE3U,LT7U,1           Indicator lights LT7U and LT8U use norm. con. power.
FUSE3U,LT8U,1
FUSE3U,SWB2U,FUSE4U
FUSE4U,SWB2U,FUSE3U
DUM3S,FUSE3U,1
FUSE3U,SWA3U,1          SWA3U enables auto receipt of SIS.
DUM35U,OPRF5U,1
OPRF5U,SWA2U,1          OPRF5U operates SWA2SU, SWA3U which are both part of same actuator.
SWA3U,SWSI1U,1
OPWF5U,SWA3U,1          OPWF5SU fails by not enabling SISI6 receipt.
SISI6A,SWSI1U,1         SISI6A is input from Safeguards Actuation Logic.
```

ADJACENCY INPUT FOR SAFETY INJECTION OR CENTRIFUGAL CHARGING PUMP
DATA FROM TVA DWG's 45W760-62-1, 45W760-63-1

```
      ** SIP1BB **
MOT2V,SIP1BB,1          MOT2V is driving motor and SIP1BB is pump.
R2V,MOT2V,1             R2V is relay.
6900VS1BB,R2V,1         6900VS1BBV is process electrical power.
COIL2V,R2V,1            COIL2V, when energized, closes R2V.

      Multiple AND-gate for inputs of switches to COIL2V
SWSI1V,COIL2V,DUMAND8V  SWSI1V switches on receipt of SIS.
DUMAND8V,COIL2V,SWSI1V
SWA2V,DUMAND8V,DUMAND7V SWA2V uses normal control power to energize COIL2V.
DUMAND7V,DUMAND8V,SWA2V
SWC2V,DUMAND7V,SWB2V    SWC2V uses emergency control power to energize COIL2V.
SWB2V,DUMAND7V,SWC2V    SWB2V is local control and uses norm. or emerg. power.

OPRC2V,SWB2V,1          OPRC2V is local operator.
DSIINST,OPRC2V,1        DSIINST is control room SIS indicator instrumentation.
FDATA2V,OPRC2V,1
```

```
FUSE4V,SWC2V,1          FUSE4V is fuse for emergency control power.
R3V,DUM4V,R4V
R4V,DUM4V,R3V
DUM4T,FUSE4V,1
SWX2V,FUSE4V,1          SWX2V is switch from normal to emerg. control power.
OPRF4V,SWX2V,1          OPRF4V operates SWX2V.

       Multiple AND-gate for inputs of transmitters/indicators to OPRF4V
FDATA2V,OPRF4V,DUMAND10V
DUMAND10V,OPRF4V,FDATA2V
LT8V,DUMAND10V,DUMAND9V LT8V indicates SWA2V status.
DUMAND9V,DUMAND10V,LT8V
LT7V,DUMAND9V,DUMAND6V  LT7V indicates SWA3V status.
DUMAND6V,DUMAND9V,LT7V
LT6V,DUMAND6V,OPRC2V    LT6V indicates control power status.
OPRC2V,DUMAND6V,LT6V

OPRF6V,SWC2V,1          OPRF6V operates auxillary control switch SWC2V.
DUM35V,OPRF6V,1

FDATA2V,DUM35V,OPRC2V
OPRC2V,DUM35V,FDATA2V
DSIINST,DUM35V,1

FUSE3V,SWA2V,1          FUSE3V is fuse for normal control power.
FUSE3V,LT7V,1           Indicator lights LT7V and LT8V use norm. con. power.
FUSE3V,LT8V,1
FUSE3V,SWB2V,FUSE4V
FUSE4V,SWB2V,FUSE3V
DUM3T,FUSE3V,1
FUSE3V,SWA3V,1          SWA3V enables auto receipt of SIS.
DUM35V,OPRF5V,1
OPRF5V,SWA2V,1          OPRF5V operates SWA2SV, SWA3V which are both part of same actuator.
SWA3V,SWSI1V,1
OPWF5V,SWA3V,1          OPWF5SV fails by not enabling SISI6 receipt.
SISIGB,SWSI1V,1         SISIGB is input from Safeguards Actuation Logic.
```

ADJACENCY INPUT FOR COMPONENT COOLING SYSTEM

DATA FROM FSAR FIG.'s 9.2-16,19

This system is shared by both units but some components are designated to unit 1, unit 2, or to both units. In the figure, there is a prefix of 1-, 2-, or 0-, respectively, for the above cases. In the digraph, the numerical prefix is moved to after the component type specification. For example, 1-FCV-703 becomes FCV1703. For those cases where there is no numerical prefix, the type specification is directly translated as usual.

Pressure failure criteria follow. Sufficient pressure (flow rate) is based upon at least two pumps succeeding. Failure to generate sufficient pressure therefore results when at least four pumps fail. Data from FSAR table 9.2-7.

```
DUMPRES,OILCOOLT,1      DUMPRS is failure of pumps to generate sufficient
DUMPRES,OILCOOLV,1      pressure.  This fails all oil coolers.
DUMPRES,OILCOOLS,1
DUMPRES,OILCOOLU,1
CCWP1BB,DUMPRES,DUMAND14Y       CCWP- is component cooling water pump.
DUMAND14Y,DUMPRES,CCWP1BB
DUMAND13Y,DUMAND14Y,1
CCWPCS,DUMAND13Y,DUMAND12Y
DUMAND12Y,DUMAND13Y,CCWPCS
CCWP2BB,DUMAND12Y,CCWP2AA
CCWP2AA,DUMAND12Y,CCWP2BB
DUMAND8Y,DUMPRES,CCWP2BB
CCWP2BB,DUMPRES,DUMAND8Y
DUMAND7Y,DUMAND8Y,CCWPCS
CCWPCS,DUMAND8Y,DUMAND7Y
CCWP1AA,DUMAND7Y,CCWP1BB
CCWP1BB,DUMAND7Y,CCWP1AA
CCWP1AA,DUMPRES,DUMAND13Y
DUMAND13Y,DUMPRES,CCWP1AA
DUMAND7Y,DUMPRES,DUMAND12Y
DUMAND12Y,DUMPRES,DUMAND7Y
DUMAND8Y,DUMPRES,CCWP2AA
CCWP2AA,DUMPRES,DUMAND8Y
```

Injection pump train 1BB

```
OILCOOLT,CCP1BB,1       OILCOOLT is the oil heat exchanger for CCP1BB.
VGL553B,OILCOOLT,1
TW1701458,VGL553B,1     TW- is an in-line temperature sensor.
VGL552B,TW1701458,1
FE1701658,VGL552B,1     FE- is an in-line flow meter orifice.
FCV1703,FE1701658,1
```

```
VGL554B,OILCOOLT,1
TW17@145A,VGL554B,1
FE17@145,TW17@145A,1
VGL557B,FE17@145,1
TW17@72,VGL557B,1

OILCOOLV,SIP1BB,1
TW17@148B,OILCOOLV,1
VGL558B,TW17@148B,1
FE17@165,VGL558B,1
TW17@148A,OILCOOLV,1

VGL562B,FE17@148,1
VGA17@725B,VGL562B,1
TW17@72,VGA17@725B,1
FCV17@75,TW17@72,1
```

Injection pump train 1AA

```
OILCOOLS,CCP1AA,1
VGL553A,OILCOOLS,1
TW17@146B,VGL553A,1
VGL552A,TW17@146B,1
FE17@159,VGL552A,1
FCV17@2,FE17@159,1
VGL554A,OILCOOLS,1
FE17@146,TW17@146A,1
VGL557A,FE17@146,1
TW17@7@,VGL557A,1

OILCOOLU,SIP1AA,1
TW17@14 ,OILCOOLU,1
VGL558A,TW17@147B,1
FE17@159,VGL558A,1
TW17@147A,OILCOOLU,1
FE17@147,TW17@147A,1
VGL562A,FE17@147,1
VGA17@725A,VGL562A,1
TW17@7@,VGA17@725A,1
```

Adjacency input for the first crosstie network follows. This crosstie outputs to pump train 1AA through FCV17#3 and to pump train 1BB through FCV17#2. The inputs to the crosstie network are from 3 FCV's through which flow from each of the component cooling heat exchangers passes. The ouputs from CCHXR#, B, and C pass into the network via FCV7#8, FCV7#15, and FCV7#12, respectively.
The network has been modelled by considering it as three legs linked together. Leg 1 is the segment bounded by FCV7#195 and FCV7#196, Leg 2 is the segment bounded by FCV7#9 and FCV7#1E, and Leg 3 is the segment bounded by FCV7#194 and FCV7#197. Flow through each leg is bi-directional.

Input to FCV17#3

```
DUM3Y,FCV17#3,DUMAND1Y   DUM3Y is flow from left to right in Leg 1.
DUMAND1Y,FCV17#3,DUM3Y
FCV7#12,DUMAND1Y,DUM5Y   DUM5Y is flow from right to left in Leg 2.
DUM5Y,DUMAND1Y,FCV7#12
FCV7#9,DUM5Y,1
FCV7#1#,FCV7#9,1

FCV7#8,DUM5Y,DUM6Y       DUM6Y is flow from left to right in Leg 3.
DUM6Y,DUM5Y,FCV7#8
FCV7#197,DUM6Y,1
VB#7#515B,FCV7#197,1     VB- is a butterfly valve.
FDATA3,OPRA2Y,1
OPRA2Y,VB#7#515B,1       Local operators are needed to re-orient VB-'s.
VB#7#515A,VB#7#515B,1
FCV7#194,VB#7#515A,1
FDATA3,OPRA1Y,1
OPRA1Y,VB#7#515A,1
FCV7#15,DUM6Y,DUM2Y      DUM2Y is flow from left to right in Leg 2.
DUM2Y,DUM6Y,FCV7#15
FCV7#195,DUM2Y,1
FCV7#196,FCV7#195,1
FCV7#12,DUM2Y,DUM5Y
DUM5Y,DUM2Y,FCV7#12
```

```
FCV7@196,DUM3Y,1
FCV7@195,FCV7@196,1
FCV7@15,DUM3Y,DUM7Y      DUM7Y is flow from right to left in Leg 3.
DUM7Y,DUM3Y,FCV7@15
FCV7@194,DUM7Y,1
VB@7@515A,FCV7@194,1
VB@7@515B,VB@7@515A,1
FCV7@197,VB@7@515B,1
DUM1@Y,DUM7Y,1           DUM4Y is flow from right to left in Leg 2.
FCV7@8,DUM1@Y,DUM4Y
DUM4Y,DUM1@Y,FCV7@8
FCV7@1@,DUM4Y,1
FCV7@9,FCV7@1@,1
FCV7@12,DUM4Y,DUM3Y
DUM3Y,DUM4Y,FCV7@12

 Input to FCV17@2
DUM1@Y,FCV17@2,DUM6Y
DUM6Y,FCV17@2,DUM1@Y


TW7@162,FCV7@12,1
CCHXRC,TW7@162,1         CCHXRC is component cooling heat exchanger C.  All 3
VB@7@51@,CCHXRC,1        heat exchangers are modelled on the primary side only.
TW7@2@1,VB@7@51@,1
FE7@2@1,TW7@2@1,1

TW27@161,FCV7@15,1
CCHXRB,TW27@161,1        CCHXRB is component cooling heat exchanger B.
VB27@51@,CCHXRB,1
TW27@2@@,VB27@51@,1
```

```
FE27@2@@,TW27@2@@,1

TW17@161,FCV7@8,1
CCHXRA,TW17@161,1        CCHXRA is component cooling heat exchanger A.
VB17@51@,CCHXRA,1
TW17@199,VB17@51@,1
FE17@199,TW17@199,1
```

Adjacency input for the 2nd crosstie network follows. This crosstie outputs to the 3 component cooling heat exchanger trains. The connections to trains A, B, and C are FE17@199, 2@@, and 2@1, respectively. The inputs to the network are from the 5 component cooling water pump trains which connect to the network at VB17@5@5A, VB17@5@5, VB@7@5@5, VB27@5@5B, and VB27@5@5A.
The network is modelled by breaking it into 9 legs and these are depicted on the digraph. Each leg is bounded by dummy nodes for flow in each direction.

```
DUM11Y,FE17@199,DUM14Y          Input to HXR train A is from Leg 1 or Leg 2.
DUM14Y,FE17@199,DUM11Y
FCV7@25,DUM11Y,'
VB17@5@5A,DUM11Y,DUM25Y
DUM25Y,DUM11Y,VB17@5@5A
VB17@5@7,DUM25Y,1
DUM18Y,DUM25Y,VB17@5@5B
FCV7@26,DUM18Y,1
FCV7@27,FCV7@26,1
VB17@5@5B,DUM25Y,DUM18Y
VB@7@5@5,DUMAND2Y,DUM2@Y        These next 4 lines are a triple input AND-gate

DUM2@Y,DUMAND2Y,VB@7@5@5        to DUM18Y. The inputs are from VB@7@5@5,
DUMAND2Y,DUM18Y,DUM29Y          Leg 6, and Leg 9.
DUM29Y,DUM18Y,DUMAND2Y
FCV7@22,DUM29Y,1
DUM15Y,DUM29Y,DUM16Y
DUM11Y,DUM15Y,1
FCV7@13,DUM15Y,1
FCV7@23,FCV7@13,1
DUM16Y,DUM29Y,DUM15Y
FCV7@14,DUM16Y,1
FCV7@18,FCV7@14,1
DUM31Y,DUM16Y,1
FCV7@16,DUM31Y,1
VB27@5@5A,DUM31Y,DUM28Y
DUM28Y,DUM31Y,VB27@5@5A
VB27@5@7,DUM28Y,1
VB275@5B,DUM28Y,DUM21Y
DUM21Y,DUM28Y,VB275@5B
FCV7@29,DUM21Y,1
FCV7@28,FCV7@29,1
```

```
VB07@5@5,DUMAND4Y,DUM19Y
DUM19Y,DUMAND4Y,VB07@5@5
DUMAND4Y,DUM21Y,DUM29Y
DUM29Y,DUM21Y,DUMAND4Y
FCV7@27,DUM19Y,1
FCV7@26,FCV7@27,1
VB17@5@5B,DUM19Y,DUM26Y
DUM26Y,DUM19Y,VB17@5@5B
VB17@5@7,DUM26Y,1
VB17@5@5A,DUM26Y,DUM33Y
DUM33Y,DUM26Y,VB17@5@5A
FCV7@25,DUM33Y,1
DUM14Y,DUM33Y,1
FCV7@23,DUM14Y,1
FCV7@13,FCV7@23,1
DUM16Y,DUM14Y,DUM3@Y
DUM3@Y,DUM14Y,DUM16Y
FCV7@22,DUM3@Y,1
```

These next 4 lines are a triple input AND-gate to DUM21Y. The inputs are from VB07@5@5, Leg 7, and Leg 9.

```
VB07@5@5,DUMAND3Y,DUM2@Y
DUM2@Y,DUMAND3Y,VB07@5@5
DUMAND3Y,DUM3@Y,DUM19Y
DUM19Y,DUM3@Y,DUMAND3Y
FCV7@28,DUM2@Y,1
FCV7@29,FCV7@28,1
DUM27Y,DUM2@Y,VB27@5@5B
VB27@5@5B,DUM2@Y,DUM27Y
VB27@5@7,DUM27Y,1
VB27@5@5A,DUM27Y,DUM32Y
DUM32Y,DUM27Y,VB27@5@5A
FCV7@16,DUM32Y,1
DUM17Y,DUM32Y,1
FCV7@18,DUM17Y,1
FCV7@14,FCV7@18,1
DUM3@Y,DUM17Y,DUM15Y
DUM15Y,DUM17Y,DUM3@Y
DUM15Y,DUMAND5Y,DUM3@Y
DUM3@Y,DUMAND5Y,DUM15Y
DUMAND5Y,FE7@2@1,DUM16Y
DUM16Y,FE7@2@1,DUMAND5Y
```

These next 4 lines are a triple input AND-gate to DUM3@Y. The inputs are from VB07@5@5, Leg 6, and Leg 7.

Input to HXR train C is from Leg 2, Leg 9, or Leg 3.

```
DUM17Y,FE27#2##,DUM31Y          Input to HXR train B is from Leg 3 or Leg 4.
DUM31Y,FE27#2##,DUM17Y
```

Adjacency input for the five pump trains follows. Since the entire system pressure and suction is provided by these pumps, failure of a pump train propogates upstream to components dependent upon suction AND downstream to components dependent upon pressure. Hence, the pumps trains are "strong", i.e., in each train all nodes reach to each other and then to those nodes bounding upstream and downstream.

```
VC17#5#4A,VB17#5#5A,1
VB17#5#5A,VC17#5#4A,1
CCWP1AA,VC17#5#4A,1     CCWP- is component cooling water pump.
VC17#5#4A,CCWP1AA,1

                        STRAINR- is a strainer which should be installed only
CCWP1AA,STRAINR1AA,1    only during system cleanup.  Its failure represents
STRAINR1AA,VB17#5#3A,1  its presence during normal operation AND its blockage
                        of sufficient flow through the pump train.

VC17#5#4B,VB17#5#5B,1
VB17#5#5B,VC17#5#4B,1
CCWP1BB,VC17#5#4B,1
VC17#5#4B,CCWP1BB,1
CCWP1BB,STRAINR1BB,1
STRAINR1BB,VB17#5#3B,1

VC47#5#4,VB47#555,1
VB47#5#5,VC47#5#4,1
CCWPCS,VC47#5#4,1
VC47#5#4,CCWPCS,1
CCWPCS,STRAINRCS,1
STRAINRCS,VB47#5#3,1

VC27#5#4B,VB27#5#5B,1
VB27#5#5B,vC27#5#4B,1
CCWP2BB,VC27#5#4B,1
VC27#5#4B,CCWP2BB,1
CCWP2BB,STRAINR2BB,1
STRAINR2BB,VB27#5#3B,1

VC27#5#4A,VB27#5#5A,1
VB27#5#5A,VC27#5#4A,1
CCWP2AA,VC27#5#4A,1
VC27#5#4A,CCWP2AA,1
CCWP2AA,STRAINR2AA,1
STRAINR2AA,VB27#5#3A,1
```

Adjacency input for the third crosstie network follows. This network is of a component represents failure of suction generated by pumps to be propogated upstream of the component to the oil coolers.
Inputs to the network are the 5 pump trains and the outputs are the upstream oil cooler trains. The network is modelled as 3 legs.

```
VB17@5@3A,TW17@7@,DUM34Y        Flow from oil cooler train 1AA can be drawn
DUM34Y,TW17@7@,VB17@5@3A        through either CCWP train 1AA or Leg 1.
FCV7@34,DUM34Y,1
VB17@5@3B,DUM34Y,DUM36Y
DUM36Y,DUM34Y,VB17@5@3B
FCV7@64,DUM36Y,1
FCV7@74,FCV7@64,1
VB@7@5@3,DUM36Y,FCV7@76
FCV7@76,DUM36Y,VB@7@5@3
VB@7@5@3,DUMAND6Y,FCV7@76
FCV7@76,DUMAND6Y,VB@7@5@3
DUMAND6Y,FCV17@75,DUM37Y        Flow from oil cooler train 1BB can be drawn
DUM37Y,FCV17@75,DUMAND6Y        through either CCWP train CS, Leg 2, or Leg 3.
FCV7@78,FCV7@76,1
VB27@5@3@,FCV7@78,FCV7@39
FCV7@39,FCV7@78,VB27@5@3B
VB27@5@3A,FCV7@39,1
FCV7@74,DUM37Y,1
FCV7@64,FCV7@74,1
VB17@5@3B,DUM37Y,DUM35Y
DUM35Y,DUM37Y,VB17@5@3B
FCV7@34,DUM35Y,1
```

ADJACENCY IMPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve model open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DCIMST, which is action instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YA, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

```
      ** FCV7023 **
FDATA3,FCV7023,1
488MOV1A2A,FCV7023,OPRL7023
OPRL7023,FCV7023,488MOV1A2A
OPRR7023,FCV7023,OPRL7023
OPRL7023,FCV7023,OPRR7023        LINK1YA is connection from MOT1YA to FCV7023.  MOT1YA
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YB, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYB.

```
      ** FCV7013 **
FDATA3,FCV7013,1
OPRR7013,FCV7013,OPRL7013
OPRL7013,FCV7013,OPRR7013        LINK1YB is connection from MOT1YB to FCV7013.  MOT1YB
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YC, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYC.

```
      ** FCV7814 **
FDATA3,FCV7814,1
OPRR7814,FCV7814,OPRL7814
OPRL7814,FCV7814,OPRR7814        LINK1YC is connection from MOT1YC to FCV7814.  MOT1YC
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YD, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

```
      ** FCV7818 **
FDATA3,FCV7818,1
480MOV2A2A,FCV7818,OPRL7818
OPRL7818,FCV7818,480MOV2A2A
OPRR7818,FCV7818,OPRL7818
OPRL7818,FCV7818,OPRR7818        LINK1YD is connection from MOT1YD to FCV7818.  MOT1YD
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YE, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYE.

```
      ** FCV7026 **
FDATA3,FCV7026,1
OPRR7026,FCV7026,OPRL7026
OPRL7026,FCV7026,OPRR7026        LINK1YE is connection from MOT1YE to FCV7026.  MOT1YE
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YF, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYF.

```
      ** FCV7027 **
FDATA3,FCV7027,1
OPRR7027,FCV7027,OPRL7027
OPRL7027,FCV7027,OPRR7027        LINK1YF is connection from MOT1YF to FCV7027.  MOT1YF
^     Inputs to DUM11YF
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YG, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYG.

```
      ** FCV7028 **
FDATA3,FCV7028,1
OPRR7028,FCV7028,OPRL7028
OPRL7028,FCV7028,OPRR7028        LINK1YG is connection from MOT1YG to FCV7028.  MOT1YG
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YH, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYH.

```
      ** FCV7029 **
FDATA3,FCV7029,1
OPRR7029,FCV7029,OPRL7029
OPRL7029,FCV7029,OPRR7029        LINK1YH is connection from MOT1YH to FCV7029.  MOT1YH
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YI, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYI.

```
      ** FCV7064 **
FDATA3,FCV7064,1
OPRR7064,FCV7064,OPRL7064
OPRL7064,FCV7064,OPRR7064        LINK1YI is connection from MOT1YI to FCV7064.  MOT1YI
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YJ, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYJ.

```
      ** FCV7074 **
FDATA3,FCV7074,1
OPRR7074,FCV7074,OPRL7074
OPRL7074,FCV7074,OPRR7074        LINK1YJ is connection from MOT1YJ to FCV7074.  MOT1YJ
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YK, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYK.

```
      ** FCV7076 **
FDATA3,FCV7076,1
OPRR7076,FCV7076,OPRL7076
OPRL7076,FCV7076,OPRR7076        LINK1YK is connection from MOT1YK to FCV7076.  MOT1YK
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YL, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYL.

```
      ** FCV7078 **
FDATA3,FCV7078,1
OPRR7078,FCV7078,OPRL7078
OPRL7078,FCV7078,OPRR7078        LINK1YL is connection from MOT1YL to FCV7078.  MOT1YL
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YM, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

```
      ** FCV7#195 **
FDATA3,FCV7#195,1
480MOV2A2A,FCV7#195,OPRL7#195
OPRL7#195,FCV7#195,480MOV2A2A
OPRR7#195,FCV7#195,OPRL7#195
OPRL7#195,FCV7#195,OPRR7#195        LINK1YM is connection from MOT1YM to FCV7#195.  MOT1YM
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YM, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYM.

```
      ** FCV7#196 **
FDATA3,FCV7#196,1
OPRR7#196,FCV7#196,OPRL7#196        LINK1YM is connection from MOT1YM to FCV7#196.  MOT1YM
OPRL7#196,FCV7#196,OPRR7#196
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YO, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

Process power source unknown for this valve and labelled POWERYO.

```
      ** FCV709 **
FDATA3,FCV709,1
OPRL709,FCV709,OPRR709        LINK1YO is connection from MOT1YO to FCV709.  MOT1YO
OPRR709,FCV709,OPRL709 ^MOT1YO,FCV709,OPRA1YO   is the motor that moves valve plug FCV709.  OPRA1YO
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

This unit model is the same as the one used in the injection systems except that this valve needn't open upon receipt of the safety injection signal. Successful operation of the valve does not, therefore, require a connection to DSIINST, safety injection instrumentation. An operator knows whether to open the valve based upon component cooling system pressures and flow data. This required input to the operators is called FDATA3. This is not the same as FDATA1YP, the flow data in the immediate region of the valve which is used to indicate to the operator whether or not the valve is open or closed. Detailed modeling of the flow sensing network would probably have some overlap between the two FDATA's, tho.

```
      ** FCV7010 **
FDATA3,FCV7010,1
480MOV1A2A,FCV7010,OPRL7010
OPRL7010,FCV7010,480MOV1A2A
OPRL7010,FCV7010,OPRR7010
OPRR7010,FCV7010,OPRL7010        LINK1YP is connection from MOT1YP to FCV7010.  MOT1YP
```

ADJACENCY INPUT FOR SAFETY INJECTION OR CENTRIFUGAL CHARGING PUMP

DATA FROM TVA DWG's 45W760-62-1, 45W760-63-1

This pump is normally on. The unit model consists only of connections from the process power to the pump.

ASSUMPTION: It is assumed that the control logic and the design of the control circuitry is the same for the CCWP's as for the SIP's and CCP's, with the exception of the low header pressure input in the CCWP's. This assumption is based on the logic diagram in FSAR figure 9.2-23.

ASSUMPTION: It is assumed in this unit model that control power is not needed to keep the relay mechanism closed which allows the process power to flow to the pump motor. This is based upon interpretation of notes describing the mechanism 45W760-62-1.

```
      ** CCWP1AA **
MOT2YQ,CCWP1AA,1        MOT2YQ is driving motor and CCWP1AA is pump.
R2YQ,MOT2YQ,1           R2YQ is relay.
480VS1A1A,R2YQ,1        480VS1A1A is process electrical power.
```

ADJACENCY INPUT FOR SAFETY INJECTION OR CENTRIFUGAL CHARGING PUMP

DATA FROM TVA DWG's 45W760-62-1, 45W760-63-1

ASSUMPTION: It is assumed that the control logic and the design of the control circuitry is the same for the CCWP's as for the SIP's and CCP's, with the exception of the low header pressure input in the CCWP's. This assumption is based on the logic diagram in FSAR figure 9.2-23.

ASSUMPTION: It is assumed in this unit model that control power is not needed to keep the relay mechanism closed which allows the process power to flow to the pump motor. This is based upon interpretation of notes describing the mechanism in 45W760-62-1.

```
      ** CCWP1BB **
MOT2YR,CCWP1BB,1            MOT2YR is driving motor and CCWP1BB is pump.
R2YR,MOT2YR,1           R2YR is relay.
480VS1B1B,R2YR,1            480VS1B1BYR is process electrical power.
COIL2YR,R2YR,1          COIL2YR, when energized, closes R2YR.
```

```
      Multiple AND-gate for inputs of switches to COIL2YR
SWSI1YR,COIL2YR,DUMAND8YR       SWSI1YR switches on receipt of SIS.
DUMAND8YR,COIL2YR,SWSI1YR
SWA2YR,DUMAND8YR,DUMAND7YR      SWA2YR uses normal control power to energize COIL2YR.
DUMAND7YR,DUMAND8YR,SWA2YR
SWC2YR,DUMAND7YR,SWB2YR SWC2YR uses emergency control power to energize COIL2YR.
SWB2YR,DUMAND7YR,SWC2YR SWB2YR is local control and uses norm. or emerg. power.

OPRC2YR,SWB2YR,1                OPRC2YR is local operator.
FDATA3,OPRC2YR,1        FDATA3 is control room instrumentation monitoring
FDATA2YR,OPRC2YR,1        flow (heat removal) in CCS to determine need to turn
                        this pump on.

FUSE4YR,SWC2YR,1                FUSE4YR is fuse for emergency control power.
R3YR,FUSE4YR,R4YR
R4YR,FUSE4YR,R3YR
FUSE10IV,R3YR,1
FUSE10II,R4YR,1
SWX3YR,R4YR,1
OPRF7YR,SWX3YR,1
ANNIV,OPRF7YR,1  ANN- is annunciator to signal need to switch to alternate pwr.
SWX2YR,FUSE4YR,1                SWX2YR is switch from normal to emerg. control power.
OPRF4YR,SWX2YR,1                OPRF4YR operates SWX2YR.

      Multiple AND-gate for inputs of transmitters/indicators to OPRF4YR
FDATA2YR,OPRF4YR,DUMAND10YR
DUMAND10YR,OPRF4YR,FDATA2YR
LT8YR,DUMAND10YR,DUMAND9YR      LT8YR indicates SWA2YR status.
DUMAND9YR,DUMAND10YR,LT8YR
LT7YR,DUMAND9YR,DUMAND6YR       LT7YR indicates SWA3YR status.
DUMAND6YR,DUMAND9YR,LT7YR
LT6YR,DUMAND6YR,OPRC2YR LT6YR indicates control power status.
OPRC2YR,DUMAND6YR,LT6YR

OPRF6YR,SWC2YR,1                OPRF6YR operates auxillary control switch SWC2YR.
DUM35YR,OPRF6YR,1

FDATA2YR,DUM35YR,OPRC2YR
OPRC2YR,DUM35YR,FDATA2YR
FDATA3,DUM35YR,1

FUSE3YR,SWA2YR,1                FUSE3YR is fuse for normal control power.
FUSE3YR,LT7YR,1         Indicator lights LT7YR and LT8YR use norm. con. power.
FUSE3YR,LT8YR,1
FUSE3YR,SWB2YR,FUSE4YR
FUSE4YR,SWB2YR,FUSE3YR
R5YR,FUSE3YR,R6YR
R6YR,FUSE3YR,R5YR
FUSE10II,R5YR,1
```

```
FUSE10IV,R6YR,1
SWX4YR,R6YR,1
ANNII,OPRF8YR,1 ANN- is annunciator to signal need to switch to alternate pwr.
OPRF8YR,SWX4YR,1
FUSE3YR,SWA3YR,1              SWA3YR enables auto receipt of SIS.
DUM35YR,OPRF5YR,1
OPRF5YR,SWA2YR,1              OPRF5YR operates SWA2SYR, SWA3YR which are both part of same actuator.
SWA3YR,SWSI1YR,1
OPWF5YR,SWA3YR,1              OPWF5SYR fails by not enabling SISI6 receipt.
SISI6B,SWSI1YR,SWPRES1YR SISIGB is input from Safeguards Actuation Logic.
SWPRES1YR,SWSI1YR,SISIGB SWPRES1YR is actuation switch of low pressure header.
```

ADJACENCY INPUT FOR SAFETY INJECTION OR CENTRIFUGAL CHARGING PUMP

DATA FROM TVA DWG's 45W760-62-1, 45W760-63-1

ASSUMPTION: It is assumed that the control logic and the design of the control circuitry is the same for the CCWP's as for the SIP's and CCP's, with the exception of the low header pressure input in the CCWP's. This assumption is based on the logic diagram in FSAR figure 9.2-23.

ASSUMPTION: It is assumed in this unit model that control power is not needed to keep the relay mechanism closed which allows the process power to flow to the pump motor. This is based upon interpretation of notes describing the mechanism in 45W760-62-1.

The digraph model for CCWPCS consists of two redundant pump control digraphs AND-ed together with the output of the gate connecting to the motor. Each control system enables power from a different 480 volt shutdown bus, however, only one of the two shutdown busses (480VS2B2B) is normally enabled. To enable the other bus (480VS1A2A) requires an operator action.

```
      ** CCWPCS **
R2YS,MOT2Y,R2YV          R2YS and R2YV are outputs of the 2 control systems.
R2YV,MOT2Y,R2YS
MINRLKSWG1,R2YSWG1,1     MINRLKSWG1 is manual interlock enabling power to
MINRLKSWG1,R2YSWG2,1     the pump to be "swung" from either unit.
OPRF9Y,R2YSWG2,1         OPRF9Y must close R2YSWG2 to enable alternate power.
MOT2Y,CCWPCS,1

      Control system for normal feeder
480VS2B2B,R2YSWG1,1      480VS2B2B is process electrical power.
R2YSWG1,R2YS,1
```

```
COIL2YS,R2YS,1          COIL2YS, when energized, closes R2YS.

       Multiple AND-gate for inputs of switches to COIL2YS
SWSI1YS,COIL2YS,DUMAND8YS       SWSI1YS switches on receipt of SIS.
DUMAND8YS,COIL2YS,SWSI1YS
SWA2YS,DUMAND8YS,DUMAND7YS      SWA2YS uses normal control power to energize COIL2YS.
DUMAND7YS,DUMAND8YS,SWA2YS
SWC2YS,DUMAND7YS,SWB2YS SWC2YS uses emergency control power to energize COIL2YS.
SWB2YS,DUMAND7YS,SWC2YS SWB2YS is local control and uses norm. or emerg. power.

OPRC2YS,SWB2YS,1                OPRC2YS is local operator.
FDATA3,OPRC2YS,1        FDATA3 is control room instrumentation monitoring
FDATA2YS,OPRC2YS,1        flow (heat removal) in CCS to determine need to turn
                        this pump on.

FUSE4YS,SWC2YS,1                FUSE4YS is fuse for emergency control power.
R3YS,FUSE4YS,R4YS
R4YS,FUSE4YS,R3YS
FUSE2@II,R3YS,1
FUSE2@IV,R4YS,1
SWX3YS,R4YS,1
OPRF7YS,SWX3YS,1
ANNII,OPRF7YS,1 ANN- is annunciator to signal need to switch to alternate pwr.
SWX2YS,FUSE4YS,1                SWX2YS is switch from normal to emerg. control power.
OPRF4YS,SWX2YS,1                OPRF4YS operates SWX2YS.

       Multiple AND-gate for inputs of transmitters/indicators to OPRF4YS
FDATA2YS,OPRF4YS,DUMAND1@YS
DUMAND1@YS,OPRF4YS,FDATA2YS
LT8YS,DUMAND1@YS,DUMAND9YS      LT8YS indicates SWA2YS status.
DUMAND9YS,DUMAND1@YS,LT8YS
LT7YS,DUMAND9YS,DUMAND6YS       LT7YS indicates SWA3YS status.
DUMAND6YS,DUMAND9YS,LT7YS
LT6YS,DUMAND6YS,OPRC2YS LT6YS indicates control power status.
OPRC2YS,DUMAND6YS,LT6YS

OPRF6YS,SWC2YS,1                OPRF6YS operates auxillary control switch SWC2YS.
DUM35YS,OPRF6YS,1

FDATA2YS,DUM35YS,OPRC2YS
OPRC2YS,DUM35YS,FDATA2YS
FDATA3,DUM35YS,1

FUSE3YS,SWA2YS,1                FUSE3YS is fuse for normal control power.
FUSE3YS,LT7YS,1         Indicator lights LT7YS and LT8YS use norm. con. power.
FUSE3YS,LT8YS,1
FUSE3YS,SWB2YS,FUSE4YS
FUSE4YS,SWB2YS,FUSE3YS
R5YS,FUSE3YS,R6YS
```

```
R6YS,FUSE3YS,R5YS
FUSE2@IV,R5YS,1
FUSE2@II,R6YS,1
SWI4YS,R6YS,1
ANNIV,OPRF8YS,1 ANN- is annunciator to signal need to switch to alternate pwr.
OPRF8YS,SWI4YS,1
FUSE3YS,SWA3YS,1              SWA3YS enables auto receipt of SIS.
DUM35YS,OPRF5YS,1
OPRF5YS,SWA2YS,1              OPRF5YS operates SWA2YS, SWA3YS which are both part of same actuator.
SWA3YS,SWSI1YS,1
OPWF5YS,SWA3YS,1              OPWF5YS fails by not enabling SISI6 receipt.
SISI6B,SWSI1YS,1              SISI6B is input from Safeguards Actuation Logic.


      Control system for alternate feeder
480VS1A2A,R2YSWG2,1     480VS1A2A is process electrical power.
R2YSWG2,R2YV,1
COIL2YV,R2YV,1          COIL2YV, when energized, closes R2YV.

      Multiple AND-gate for inputs of switches to COIL2YV
SWSI1YV,COIL2YV,DUMAND8YV       SWSI1YV switches on receipt of SIS.
DUMAND8YV,COIL2YV,SWSI1YV
SWA2YV,DUMAND8YV,DUMAND7YV      SWA2YV uses normal control power to energize COIL2YV.
DUMAND7YV,DUMAND8YV,SWA2YV
SWC2YV,DUMAND7YV,SWB2YV SWC2YV uses emergency control power to energize COIL2YV.
SWB2YV,DUMAND7YV,SWC2YV SWB2YV is local control and uses norm. or emerg. power.

OPRC2YV,SWB2YV,1        OPRC2YV is local operator.
FDATA3,OPRC2YV,1        FDATA3 is control room instrumentation monitoring
FDATA2YV,OPRC2YV,1      flow (heat removal) in CCS to determine need to turn
                        this pump on.

FUSE4YV,SWC2YV,1        FUSE4YV is fuse for emergency control power.
R3YV,FUSE4YV,R4YV
R4YV,FUSE4YV,R3YV
FUSE1@III,R3YV,1
FUSE1@I,R4YV,1
SWI3YV,R4YV,1
OPRF7YV,SWI3YV,1
ANNIII,OPRF7YV,1 ANN- is annunciator to signal need to switch to alternate pwr.
SWI2YV,FUSE4YV,1              SWI2YV is switch from normal to emerg. control power.
OPRF4YV,SWI2YV,1              OPRF4YV operates SWI2YV.

      Multiple AND-gate for inputs of transmitters/indicators to OPRF4YV
FDATA2YV,OPRF4YV,DUMAND1@YV
DUMAND1@YV,OPRF4YV,FDATA2YV
LT8YV,DUMAND1@YV,DUMAND9YV      LT8YV indicates SWA2YV status.
DUMAND9YV,DUMAND1@YV,LT8YV
LT7YV,DUMAND9YV,DUMAND6YV       LT7YV indicates SWA3YV status.
```

```
DUMAND6YV,DUMAND9YV,LT7YV
LT6YV,DUMAND6YV,OPRC2YV LT6YV indicates control power status.
OPRC2YV,DUMAND6YV,LT6YV

OPRF6YV,SWC2YV,1                OPRF6YV operates auxillary control switch SWC2YV.
DUM35YV,OPRF6YV,1

FDATA2YV,DUM35YV,OPRC2YV
OPRC2YV,DUM35YV,FDATA2YV
FDATA3,DUM35YV,1

FUSE3YV,SWA2YV,1        FUSE3YV is fuse for normal control power.
FUSE3YV,LT7YV,1         Indicator lights LT7YV and LT8YV use norm. con. power.
FUSE3YV,LT8YV,1
FUSE3YV,SWB2YV,FUSE4YV
FUSE4YV,SWB2YV,FUSE3YV
R5YV,FUSE3YV,R6YV
R6YV,FUSE3YV,R5YV
FUSE1@I,R5YV,1
FUSE1@III,R6YV,1
SWI4YV,R6YV,1
ANNI,OPRF8YV,1 ANN- is annunciator to signal need to switch to alternate pwr.
OPRF8YV,SWI4YV,1
FUSE3YV,SWA3YV,1                SWA3YV enables auto receipt of SIS.
DUM35YV,OPRF5YV,1
OPRF5YV,SWA2YV,1                OPRF5YV operates SWA2SYV, SWA3YV which are both part of same actuator.
SWA3YV,SWSI1YV,1
OPWF5YV,SWA3YV,1                OPWF5SYV fails by not enabling SISI6 receipt.
SISI6A,SWSI1YV,1                SISI6A is input from Safeguards Actuation Logic.
```

ADJACENCY INPUT FOR SAFETY INJECTION OR CENTRIFUGAL CHARGING PUMP

DATA FROM TVA DWG's 45W760-62-1, 45W760-63-1

ASSUMPTION: It is assumed that the control logic and the design of the control circuitry is the same for the CCWP's as for the SIP's and CCP's, with the exception of the low header pressure input in the CCWP's. This assumption is based on the logic diagram in FSAR figure 9.2-23.

ASSUMPTION: It is assumed in this unit model that control power is not needed to keep the relay mechanism closed which allows the process power to flow to the pump motor. This is based upon interpretation of notes describing the mechanism in 45W760-62-1.

```
      ** CCWP2BB **
MOT2YT,CCWP2BB,1                MOT2YT is driving motor and CCWP2BB is pump.
```

```
R2YT,NOT2YT,1          R2YT is relay.
480VS2B1B,R2YT,1              480VS2B1BYT is process electrical power.
COIL2YT,R2YT,1         COIL2YT, when energized, closes R2YT.

       Multiple AND-gate for inputs of switches to COIL2YT
SWSI1YT,COIL2YT,DUMAND8YT      SWSI1YT switches on receipt of SIS.
DUMAND8YT,COIL2YT,SWSI1YT
SWA2YT,DUMAND8YT,DUMAND7YT     SWA2YT uses normal control power to energize COIL2YT.
DUMAND7YT,DUMAND8YT,SWA2YT
SWC2YT,DUMAND7YT,SWB2YT SWC2YT uses emergency control power to energize COIL2YT.
SWB2YT,DUMAND7YT,SWC2YT SWB2YT is local control and uses norm. or emerg. power.

OPRC2YT,SWB2YT,1       OPRC2YT is local operator.
FDATA3,OPRC2YT,1       FDATA3 is control room instrumentation monitoring
FDATA2YT,OPRC2YT,1     flow (heat removal) in CCS to determine need to turn
                       this pump on.

FUSE4YT,SWC2YT,1              FUSE4YT is fuse for emergency control power.
R3YT,FUSE4YT,R4YT
R4YT,FUSE4YT,R3YT
FUSE20II,R3YT,1
FUSE20IV,R4YT,1
SWX3YT,R4YT,1
OPRF7YT,SWX3YT,1
ANNII,OPRF7YT,1  ANN- is annunciator to signal need to switch to alternate pwr.
SWX2YT,FUSE4YT,1              SWX2YT is switch from normal to emerg. control power.
OPRF4YT,SWX2YT,1              OPRF4YT operates SWX2YT.

       Multiple AND-gate for inputs of transmitters/indicators to OPRF4YT
FDATA2YT,OPRF4YT,DUMAND10YT
DUMAND10YT,OPRF4YT,FDATA2YT
LT8YT,DUMAND10YT,DUMAND9YT     LT8YT indicates SWA2YT status.
DUMAND9YT,DUMAND10YT,LT8YT
LT7YT,DUMAND9YT,DUMAND6YT      LT7YT indicates SWA3YT status.
DUMAND6YT,DUMAND9YT,LT7YT
LT6YT,DUMAND6YT,OPRC2YT LT6YT indicates control power status.
OPRC2YT,DUMAND6YT,LT6YT

OPRF6YT,SWC2YT,1              OPRF6YT operates auxillary control switch SWC2YT.
DUM35YT,OPRF6YT,1

FDATA2YT,DUM35YT,OPRC2YT
OPRC2YT,DUM35YT,FDATA2YT
FDATA3,DUM35YT,1

FUSE3YT,SWA2YT,1              FUSE3YT is fuse for normal control power.
FUSE3YT,LT7YT,1        Indicator lights LT7YT and LT8YT use norm. con. power.
FUSE3YT,LT8YT,1
FUSE3YT,SWB2YT,FUSE4YT
```

```
FUSE4YT,SWB2YT,FUSE3YT
R5YT,FUSE3YT,R6YT
R6YT,FUSE3YT,R5YT
FUSE20IV,R5YT,1
FUSE20II,R6YT,1
SWI4YT,R6YT,1
ANNIV,OPRF8YT,1
OPRF8YT,SWI4YT,1
FUSE3YT,SWA3YT,1              SWA3YT enables auto receipt of SIS.
DUM35YT,OPRF5YT,1
OPRF5YT,SWA2YT,1              OPRF5YT operates SWA2SYT, SWA3YT which are both part of same actuator.
SWA3YT,SWSI1YT,1
OPWF5YT,SWA3YT,1              OPWF5SYT fails by not enabling SISI6 receipt.
SISI6B,SWSI1YT,SWPRES1YT SISI6B is input from Safeguards Actuation Logic.
SWPRES1YT,SWSI1YT,SISI6B SWPRES1YT is actuation switch of low pressure header.
```

ADJACENCY INPUT FOR SAFETY INJECTION OR CENTRIFUGAL CHARGING PUMP

DATA FROM TVA DWG's 45W760-62-1, 45W760-63-1

This pump is normally on. The unit model consists only of connections from the process power to the pump.

ASSUMPTION: It is assumed that the control logic and the design of the control circuitry is the same for the CCWP's as for the SIP's and CCP's, with the exception of the low header pressure input in the CCWP's. This assumption is based on the logic diagram in FSAR figure 9.2-23.

ASSUMPTION: It is assumed in this unit model that control power is not needed to keep the relay mechanism closed which allows the process power to flow to the pump motor. This is based upon interpretation of notes describing the mechanism in 45W760-62-1.

```
** CCWP2AA **
MOT2YU,CCWP2AA,1        MOT2YU is driving motor and CCWP2AA is pump.
R2YU,MOT2YU,1           R2YU is relay.
480VS2A1A,R2YU,1        480VS2A1A is process electrical power.
```

The following is a 3/4 coincidence gate to model the fact that at least 3 of the 4 PS's must fail for SISI6- to fail.

```
DUM103,DSIINST,1
OPWF20,DUM103,1 OPWF20 can kill safety injection.
DUM103,SISI6A,1
```

```
DUM1Ø3,SISI6B,1
DUMAND1Ø1,DUM1Ø3,PSIV
PSIV,DUM1Ø3,DUMAND1Ø1
DUMAND1ØØ,DUMAND1Ø1,PSIII
PSIII,DUMAND1Ø1,DUMAND1ØØ
PSI,DUMAND1ØØ,PSII
PSII,DUMAND1ØØ,PSI
DUMAND1Ø1,DUM1Ø3,1
PSIV,DUM1Ø3,DUMAND1ØØ
DUMAND1ØØ,DUM1Ø3,PSIV
PSI,DUM1Ø3,DUMAND1Ø2
DUMAND1Ø2,DUM1Ø3,PSI
PSIV,DUMAND1Ø2,PSIII
PSIII,DUMAND1Ø2,PSIV
DUMAND!Ø2,DUM1Ø3,PSII
PSII,DUM1Ø3,DUMAND1Ø2
```

ADJACENCY INPUT FOR PROTECTION SET UNIT MODEL

DATA FROM TVA DWG 45N7ØØ-1

```
      ** PSI **
R13I,PSI,1              R13 is a pair of relays interlocked for switching
SWX5I,R13I,R12I         (using SWX5 and OPRF9) between normal and auxillary
OPRF9I,SWX5I,1          instrument power.
R16I,SWX5I,1            R16 is a relay in the 12ØVAC Instr. Power Dist. Panel.
TR1A,R16I,1             TR1A is a transformer which feeds into 12ØVAC IPDP.
FUSE9I,TR1A,1
SW4I,FUSE9I,1           SW4 can cut power to 12ØVAC IPDP.
OPWF1ØI,SW4I,1          OPWF1Ø operates SW4.
DUM7I,SW4I,1
R3I,DUM7I,1             R3 is a pair of relays interlocked for switching
SWX3I,R3I,48ØVS1A1A     (using SWX3 and OPRF6) between normal and alternate
OPRF6I,SWX3I,1          feeder 48ØVAC shutdown boards 1A1A and 1B1B,
48ØVS1B1B,SWX3I,1       respectively.
48ØVS1A1A,R3I,SWX3I


R12I,R13I,SWX5I         R12 is relay connecting inverter to instr. power bd.
STATINVI,R12I,1         STATINVI is static inverter which needs synch signal
R15I,STATINVI,1         from 12ØVAC IPDP.
TR1A,R15I,1             R15 is relay in 12ØVAC IPDP.
TR1I,STATINVI,R11I      TR1I is transformer within the 12ØVAC vital inverter.
R1ØI,TR1I,1             R1Ø is a relay which connects the 12ØVAC vital
DUM7I,R1ØI,1            inverter to the 48ØVAC shutdown feeders.
```

```
R11I,STATINVI,TR1I      R11 connects to alternate path to static inverter.
R9I,R11I,1              R9 is relay in 125 VDC vital battery board.
FUSE8I,R9I,1
125VVBI,FUSE8I,1

       Connections from 125VVBI for solenoid valve power
125VVBI,FUSEA12,1
125VVBI,FUSEB12,1
125VVBI,FUSEA1,1
125VVBI,FUSEB1,1
125VVBI,FUSEB5,1
125VVBI,FUSEA5,1
125VVBI,FUSE10I,1       FUSE10 connects to 6.9kv shutdown board control power, unit 1.
125VVBI,FUSE20I,1 FUSE20 connects to 6.9kv shutdown board control power, unit 2.

       Expanded AND-gate input to 125VVB
R8I,125VVBI,DUMAND11I   R8 connects 125VVB to battery BAT1.
DUMAND11I,125VVBI,R8I
FUSE6I,DUMAND11I,FUSE5I FUSE6 connects 125VVB to auxillary 480VAC boards.
FUSE5I,DUMAND11I,FUSE6I FUSE5 connects 125VVB to normal 480VAC boards.

R4I,FUSE5I,1
CH6RI,R4I,1             CH6RI is battery charger which is connected to normal
DUM7I,CH6RI,1           480VAC boards (i.e.,normal inverter feeder boards).
R5I,FUSE6I,1
R7I,R5I,1               R7 is normally open and is closed by operator OPRF8
SWX6I,R7I,1             actuating switch SWI6.
OPRF8I,SWX6I,1
CH6RIS,SWX6I,1          CH6RIS is spare battery charger.
R6I,CH6RIS,1            R6 is a pair of relays interlocked for switching
SWX4I,R6I,480VAV1A1A    (using SWX4 and OPRF7) between the 2 aux. 480VAC bds.
OPRF7I,SWX4I,1
480VAV1B1B,SWX4I,1
480VAV1A1A,R6I,SWX4I
FUSE7I,R8I,1
BAT1,FUSE7I,1           BAT1 is battery.

       ** PSII **
R13II,PSII,1            R13 is a pair of relays interlocked for switching
SWX5II,R13II,R12II      (using SWX5 and OPRF9) between normal and auxillary
OPRF9II,SWX5II,1        instrument power.
R16II,SWX5II,1          R16 is a relay in the 120VAC Instr. Power Dist. Panel.
TR1B,R16II,1            TR1A is a transformer which feeds into 120VAC IPDP.
FUSE9II,TR1B,1
SW4II,FUSE9II,1         SW4 can cut power to 120VAC IPDP.
OPWF10II,SW4II,1        OPWF10 operates SW4.
DUM7II,SW4II,1
R3II,DUM7II,1           R3 is a pair of relays interlocked for switching
SWX3II,R3II,480VS1B2B   (using SWI3 and OPRF6) between normal and alternate
```

```
OPRF6II,SWX3II,1          feeder 480VAC shutdown boards 1A1A and 1B1B,
480VS1A2A,SWX3II,1        respectively.
480VS1B2B,R3II,SWX3II


R12II,R13II,SWX5II        R12 is relay connecting inverter to instr. power bd.
STATINVII,R12II,1         STATINVI is static inverter which needs synch signal
R15II,STATINVII,1         from 120VAC IPDP.
TR1B,R15II,1              R15 is relay in 120VAC IPDP.
TR1II,STATINVII,R1III     TR1I is transformer within the 120VAC vital inverter.
R10II,TR1II,1             R10 is a relay which connects the 120VAC vital
DUM7II,R10II,1            inverter to the 480VAC shutdown feeders.
R11II,STATINVII,TR1II     R11 connects to alternate path to static inverter.
R9II,R11II,1              R9 is relay in 125 VDC vital battery board.

       Expanded AND-gate input to 125VVB
FUSE8II,R9II,1
125VVBII,FUSE8II,1

       Connections from 125VVBII for solenoid valve power
125VVBII,FUSEA7,1
125VVBII,FUSEB7,1
125VVBII,FUSEA6,1
125VVBII,FUSEB6,1

125VVBII,FUSE10II,1 FUSE10 connects to 6.9kv shutdown board control power, unit 1.
125VVBII,FUSE20II,1 FUSE20 connects to 6.9kv shutdown board control power, unit 2.
R8II,125VVBII,DUMAND1III        R8 connects 125VVB to battery BAT1.
DUMAND1III,125VVBII,R8II
FUSE6II,DUMAND1III,FUSE5II FUSE6 connects 125VVB to auxillary 480VAC boards.
FUSE5II,DUMAND1III,FUSE6II FUSE5 connects 125VVB to normal 480VAC boards.

R4II,FUSE5II,1
CH6RII,R4II,1             CH6RI is battery charger which is connected to normal
DUM7II,CH6RII,1           480VAC boards (i.e.,normal inverter feeder boards).
R5II,FUSE6II,1
R7I,R5II,1                R7 is normally open and is closed by operator OPRF8
SWX6I,R7I,1               actuating switch SWI6.
OPRF8I,SWX6I,1
CH6RIS,SWX6I,1            CH6RIS is spare battery charger.
R6I,CH6RIS,1              R6 is a pair of relays interlocked for switching
SWX4I,R6I,480VAV1A1A      (using SWX4 and OPRF7) between the 2 aux. 480VAC bds.
OPRF7I,SWX4I,1
480VAV1B1B,SWX4I,1
480VAV1A1A,R6I,SWX4I
FUSE7II,R8II,1
BAT1I,FUSE7II,1           BAT1 is battery.

      ** PSIII **
```

```
R13III,PSIII,1          R13 is a pair of relays interlocked for switching
SWX5III,R13III,R12III   (using SWX5 and OPRF9) between normal and auxillary
OPRF9III,SWX5III,1      instrument power.
R16III,SWX5III,1        R16 is a relay in the 120VAC Instr. Power Dist. Panel.
TR2A,R16III,1           TR1A is a transformer which feeds into 120VAC IPDP.
FUSE9III,TR2A,1
SW4III,FUSE9III,1       SW4 can cut power to 120VAC IPDP.
OPWF10III,SW4III,1      OPWF10 operates SW4.
DUM7III,SW4III,1
R3III,DUM7III,1         R3 is a pair of relays interlocked for switching
SWX3III,R3III,480VS2A1A (using SWX3 and OPRF6) between normal and alternate
OPRF6III,SWX3III,1      feeder 480VAC shutdown boards 1A1A and 1B1B,
480VS2B1B,SWX3III,1     respectively.
480VS2A1A,R3III,SWX3III


R12III,R13III,SWX5III   R12 is relay connecting inverter to instr. power bd.
STATINVIII,R12III,1     STATINVI is static inverter which needs synch signal
R15III,STATINVIII,1     from 120VAC IPDP.
TR2A,R15III,1           R15 is relay in 120VAC IPDP.
TR1III,STATINVIII,R1IIII TR1I is transformer within the 120VAC vital inverter.
R10III,TR1III,1         R10 is a relay which connects the 120VAC vital
DUM7III,R10III,1        inverter to the 480VAC shutdown feeders.
R11III,STATINVIII,TR1III R11 connects to alternate path to static inverter.
R9III,R1IIII,1          R9 is relay in 125 VDC vital battery board.

       Expanded AND-gate input to 125VVB
FUSE8III,R9III,1
125VVBIII,FUSE8III,1
125VVBIII,FUSE10III,1 FUSE10 connects to 6.9kv shutdown board control power, unit 1.
125VVBIII,FUSE20III,1 FUSE20 connects to 6.9kv shutdown board control power, unit 2.
R8III,125VVBIII,DUMAD1IIII R8 connects 125VVB to battery BAT1.
DUMAD1IIII,125VVBIII,R8III
FUSE6III,DUMAD1IIII,FUSE5III FUSE6 connects 125VVB to auxillary 480VAC boards.
FUSE5III,DUMAD1IIII,FUSE6III FUSE5 connects 125VVB to normal 480VAC boards.

R4III,FUSE5III,1
CH6RIII,R4III,1         CH6RI is battery charger which is connected to normal
DUM7III,CH6RIII,1       480VAC boards (i.e.,normal inverter feeder boards).
R5III,FUSE6III,1
R7II,R5III,1            R7 is normally open and is closed by operator OPRF8
SWI6II,R7II,1           actuating switch SWI6.
OPRF8II,SWI6II,1
CH6RIIS,SWI6II,1        CH6RIS is spare battery charger.
R6II,CH6RIIS,1          R6 is a pair of relays interlocked for switching
SWX4II,R6II,480VAV2A1A  (using SWI4 and OPRF7) between the 2 aux. 480VAC bds.
OPRF7II,SWX4II,1
480VAV2B1B,SWI4II,1
480VAV2A1A,R6II,SWI4II
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```
FUSE7III,R0??I,1
BATIII,FUSE7III,1       BATI is battery.

       ** PSIV **
R13IV,PSIV,1            R13 is a pair of relays interlocked for switching
SWX5IV,R13IV,R12IV      (using SWX5 and OPRF9) between normal and auxillary
OPRF9IV,SWX5IV,1        instrument power.
R16IV,SWX5IV,1          R16 is a relay in the 120VAC Instr. Power Dist. Panel.
TR2B,R16IV,1            TR1A is a transformer which feeds into 120VAC IPDP.
FUSE9IV,TR2B,1
SW4IV,FUSE9IV,1         SW4 can cut power to 120VAC IPDP.
OPWF10IV,SW4IV,1        OPWF10 operates SW4.
DUM7IV,SW4IV,1
R3IV,DUM7IV,1           R3 is a pair of relays interlocked for switching
SWX3IV,R3IV,480VS2B2B   (using SWX3 and OPRF6) between normal and alternate
OPRF6IV,SWX3IV,1        feeder 480VAC shutdown boards 1A1A and 1B1B,
480VS2A2A,SWX3IV,1      respectively.
480VS2B2B,R3IV,SWX3IV


R12IV,R13IV,SWX5IV      R12 is relay connecting inverter to instr. power bd.
STATINVIV,R12IV,1       STATINVI is static inverter which needs synch signal
R15IV,STATINVIV,1       from 120VAC IPDP.
TR2B,R15IV,1            R15 is relay in 120VAC IPDP.
TR1IV,STATINVIV,R11IV   TR1I is transformer within the 120VAC vital inverter.
R10IV,TR1IV,1           R10 is a relay which connects the 120VAC vital
DUM7IV,R10IV,1          inverter to the 480VAC shutdown feeders.
R11IV,STATINVIV,TR1IV   R11 connects to alternate path to static inverter.
R9IV,R11IV,1            R9 is relay in 125 VDC vital battery board.

       Expanded AND-gate input to 125VVB
FUSE8IV,R9IV,1
125VVBIV,FUSE8IV,1
125VVBIV,FUSE10IV,1 FUSE10 connects to 6.9kv shutdown board control power, unit 1.
125VVBIV,FUSE20IV,1 FUSE20 connects to 6.9kv shutdown board control power, unit 2.
R8IV,125VVBIV,DUMAND11IV        R8 connects 125VVB to battery BATI.
DUMAND11IV,125VVBIV,R8IV
FUSE6IV,DUMAND1?IV,FUSE5IV FUSE6 connects 125VVB to auxillary 480VAC boards.
FUSE5IV,DUMAND?1IV,FUSE6IV FUSE5 connects 125VVB to normal 480VAC boards.

R4IV,FUSE5IV,1
CH6RIV,R4IV,1           CH6RI is battery charger which is connected to normal
DUM7IV,CH6RIV,1         480VAC boards (i.e.,normal inverter feeder boards).
R5IV,FUSE6IV,1
R7II,R5IV,1             R7 is normally open and is closed by operator OPRF8
SWX6II,R7II,1           actuating switch SWI6.
OPRF8II,SWX6II,1
CH6RIIS,SWX6II,1        CH6RIS is spare battery charger.
R6II,CH6RIIS,1          R6 is a pair of relays interlocked for switching
```

```
SWX4II,R6II,480VAV2A1A  (using SWX4 and OPRF7) between the 2 aux. 480VAC bds.
OPRF7II,SWX4II,1
480VAV2B1B,SWX4II,1
480VAV2A1A,R6II,SWX4II
.USE7IV,R8IV,1
BATIV,FUSE7IV,1         BATI is battery.
```

ADJACENCY INPUT FOR ELECTRICAL POWER SUPPORT

DATA FROM TVA DWG. 15N500 AND FSAR PP. 8.2-7,8,9

Adjacency input for the electrical power system
and its subsystems are input as follows:

1) Electrical Power System
   a. Unit 1
   b. Unit 2
2) Relay interlock connections (*INRLK0)
3) 250 volt battery boards (250VBATBD-)
4) 480 volt auxillary building common board (480VABC-)

Input for each subsystem contains comments on data sources.

** UNIT 1 POWER **
Connections back to 6.9KV shutdown board 1BB (6900VS1BB).

```
R25,480MOV1B2B,R56      All R-'s are relays.  480MOV1B2B is MOV board 1B2B.
R24,R25,1
X1,R24,1                X- is a component of unknown type.
480VS1B2B,X1,R28        480VS1B2B is 480V shutdown board 1B2B.
R19,480VS1B2B,1
TR1B2B,R19,1            TR- is a transformer.
R18,TR1B2B,1
6900VS1BB,R18,1         6900VS1BB is 6.9KV shutdown board 1BB.
R56,480MOV1B2B,R25
OPRE42,MXFR20,1         OPRE42 operates R56 by actuation of MXFR20.
MXFR20,R56,1            MXFR- is man. transfer controller for closing relays.
R32,R56,1
X2,R32,1
R28,X1,480VS1B2B
OPRE37,R28,1
TR1BB,R28,1
R27,TR1BB,1
MXFR14,R27,1
OPRE36,MXFR14,1
6900VS1BB,R27,1
R26,480MOV1B1B,R33      480MOV1B1B is MOV board 1B1B.
OPRE39,MXFR17,1
MXFR17,R26,1
```

```
R24,R26,1
R33,480MOV1B1B,R26
R32,R33,1
R23,480VAV1B1B,R35      480VAV1B1B is cont. and aux. bldg. vent bd. 1B1B.
MXFR18,R23,1
OPRE40,MXFR18,1
R22,R23,1
I1,R22,1
R35,480VAV1B1B,R23
R34,R35,1
I2,R34,1
R37,480VAV1B2B,R21
MXFR19,R37,1
OPRE41,MXFR19,1
R36,R37,1
I2,R36,1
R21,480VAV1B2B,R37
R20,R21,1
I1,R20,1
OPRE38,R29,1
R29,I2,480VS1B1B
TR1BB,R29,1
480VS1B1B,I2,R29
R31,480VS1B1B,1
TR1B1B,R31,1
R30,TR1B1B,1
6900VS1BB,R30,1
```

Connections back to 6.9KV shutdown board 1AA (6900VS1AA).

```
R44,480MOV1A2A,R52      480MOV1A2A is MOV board 1A2A.
R43,R44,1
I3,R43,1
480VS1A2A,I3,R47        480VS1A2A is 480V shutdown board 1A2A.
R38,480VS1A2A,1
TR1A2A,R38,1
R58,TR1A2A,1
6900VS1AA,R58,1         6900VS1AA is 6.9KV shutdown board 1AA.
R52,480MOV1A2A,R44
MXFR26,R52,1
OPRE48,MXFR26,1
R51,R52,1
R47,I3,480VS1A2A
TR1AA,R47,1
OPRE47,R47,1
R46,TR1AA,1
MXFR21,R46,1
OPRE43,MXFR21,1
6900VS1AA,R46,1
R45,480MOV1A1A,R53      480MOV1A1A is MOV board 1A1A.
```

```
MXFR24,R45,1
OPRE45,  FR24,1
R43,R45,1
R53,480MOV1A1A,R45
R51,R53,1
I4,R51,1
R42,480VAV1A1A,R55      480VAV1A1A is 480V cont. and aux. bldg. vent bd. 1A1A.
MXFR25,R42,1
OPRE46,MXFR25,1
R41,R42,1
I3,R41,1
R55,480VAV1A1A,R42
R54,R55,1
I4,R54,1
R40,480VAV1A2A,R57      480VAV1A2A is 480V cont. and aux. bldg. vent bd. 1A2A.
R39,R40,1
I3,R39,1
R57,480VAV1A2A,R40
MXFR27,R57,1
OPRE49,MXFR27,1
R55,R57,1
I4,R55,1
R48,I4,480VS1A1A        480VS1A1A is 480V shutdown board 1A1A.
OPRE44,R48,1
TR1AA,R48,1
480VS1A1A,I4,R48
R50,480VS1A1A,1
TR1A1A,R50,1
R49,TR1A1A,1
6900VS1AA,R49,1
```

Connections from offsite and onsite power supplies to 6900VS1BB.

Expanded AND-gate for connections to 6900VS1BB.

```
R1728,DUMAND28,R1934
R1934,DUMAND28,R1728
DUMAND28,DUMAND27,R1914
R1914,DUMAND27,DUMAND28
DUMAND27,6900VS1BB,R1726
R1726,6900VS1BB,DUMAND27

MXFR1,R1728,AXFR3       AXFR3 is automatic switch to alternate feeder
AXFR3,R1728,MXFR1
OPRE22,MXFR1,1
R1724,R1728,6900VSUB3   6900VSUB- is 6.9KV utility bus (FSAR p. 8.3-5)
R1728,6900VSUB3,1       Power is bi-directional to/from utility buses.  This
6900VSUB3,R1728,R1724   permits interconnection of 6.9KV shutdown buses.
R2814,6900VSUB3,1
OPRB50,6900VSUB3,1      Access to 6900VSUB-'s requires 2 op.'s (e.g.,050,022).
```

```
CSSTDX,R2814,1          CSSTDX is common sta. serv. trans. D, wind. X.
161KVBAY4,CSSTDX,1
R1124,6900VUB1D,R1624   6900VUB- is 6900 volt unit board.
USST1BY,R1124,1         USST1BY= unit sta. serv. transformer 1B, winding Y.
500KVBAY8,USST1BY,1     500KVBAY8 is 1 500KV power line/conn. to plant,
500KV,500KVBAY8,1       500KV is 500KV source.
OPRE54,500KVBAY8,AXFR7  Offsite power is enabled only after switching (FSAR
AXFR7,500KVBAY8,OPRE54  p. 8.3-1)
R1624,6900VUB1D,R1124
6900VUB1D,R1724,1
OPRE23,MXFR2,1
MXFR2,R1624,AXFR96
AXFR96,R1624,MXFR2
6900VSBB,R1624,1        6900VSBB is 6.9KV start bus B.
DUM21,6900VSBB,1
R1612,DUM21,R1514
CSSTBY,R1612,1          CSSTBY is common sta. serv. transformer B, wind. Y.
161KVBAY13,CSSTBY,1     161KVBAY13 is 1 161KV power line/conn. to plant.
161KV,161KVBAY13,1      161KV is 161KV source.
OPRE55,161KVBAY13,AXFR8 Offsite power is enabled only by switching.
AXFR8,161KVBAY13,OPRE55
R1514,DUM21,R1612
CSSTAY,R1514,1
AXFR1,R1514,MXFR4       AXFR- is automatic transfer (auto relay close on UV).
MXFR4,R1514,AXFR1
OPRE24,MXFR4,1
161KVBAY4,CSSTAY,1      161KVBAY4 is 1 161KV power line/conn. to plant.
OPRE56,161KVBAY4,AXFR9  Offsite power enabled only by switching.
AXFR9,161KVBAY4,OPRE56
161KV,161KVBAY4,1
MXFR5,R1934,1
OPRE25,MXFR5,1
6900VSUB1,R1934,1
OPRB51,R1934,1
R1934,6900VSUB1,1
R2714,6900VSUB1,1
CSSTCX,R2714,1          LSSTCX is com. sta. serv. trans. C, wind. X.
161KVBAY13,CSSTCX,1
MXFR6,R1914,AXFR4
AXFR4,R1914,MXFR6
OPRE26,MXFR6,1
GENDSL1BB,R1914,1       GENDSL1BB is diesel generator 1BB.
SISI6A,DUM10,SISI6B     Either SISI6 automatically turns on all GENDSL's.
SISI6B,DUM10,SISI6A
OPRE27,GENDSL1BB,DUM10
DUM10,GENDSL1BB,OPRE27
DUM10,AXFR4,1           AXFR4 is automatic actuator dependent upon SILOGIC.
R1722,R1726,1
R1524,6900VUB1C,R1122   6900VUB- is 6900 volt unit board.
```

```
6900VUB1C,R1722,1
OPRE28,MXFR7,1
MXFR7,R1524,AXFR97
AXFR97,R.524,MXFR7
6900VSBA,R1524,1        6900VSBA is 6.9KV start bus A.
DUM22,6900VSBA,1
R1512,DUM22,R1614
CSSTAY,R1512,1
R1614,DUM22,R1512
CSSTBY,R1614,1
AXFR2,R1614,MXFR8
MXFR8,R1614,AXFR2
OPRE29,MXFR8,1
R1122,6900VUB1C,R1524
USST1BY,R1122,1
```

Connections from offsite and onsite power supplies to 6900VS1AA.

Expanded AND-gate for inputs to 6900VS1AA.

```
R1718,DUMAND30,R1932
R1932,DUMAND30,R1718
DUMAND30,DUMAND29,R1912
R1912,DUMAND29,DUMAND30
DUMAND29,6900VS1AA,R1716
R1716,6900VS1AA,DUMAND29
R1714,R1718,1
R1114,6900VUB1B,R1622   6900VUB- is 6900 volt unit board.
USST1AY,R1114,1         USST1AY is unit sta. serv. trans. 1A, wind. Y.
500KVBAY8,USST1AY,1
R1622,6900VUB1B,R1114
6900VUB1B,R1714,1
OPRE30,MXFR9,1
MXFR9,R1622,AXFR98
AXFR98,R1622,MXFR9
6900VSBB,R1622,1
MXFR10,R1932,1
OPRE31,MXFR10,1
6900VSUB2,R1932,1
OPRB52,R1932,1
R1932,6900VSUB2,1
R3812,6900VSUB2,1
CSSTDY,R3812,1          CSSTDY is com. sta. serv. trans. D, wind. Y.
161KVBAY4,CSSTDY,1
MXFR11,R1912,AXFR5
AXFR5,R1912,MXFR11
OPRE32,MXFR11,1
GENDSL1AA,R1912,1       GENDSL1AA is diesel generator 1AA.
OPRE33,GENDSL1AA,DUM10
DUM10,GENDSL1AA,OPRE33
```

```
DUM1@,AIFR5,1
MIFR12,R1716,AIFR6
AIFR6,R1716,MIFR12
OPRE34,MIFR12,1
R1712,R1716,6900VSUB4
R1716,6900VSUB4,1
6900VSUB4,R1716,R1712
R3712,6900VSUB4,1
OPRB53,6900VSUB4,1
CSSTCY,R3712,1          CSSTCY is com. sta. serv. trans. C, wind. Y.
161KVBAY13,CSSTCY,1
R1112,6900VUB1A,R1522   6900VUB- is 6900 volt unit board.
USST1AY,R1112,1
R1522,6900VUB1A,R1112
6900VUB1A,R1712,1
OPRE35,MIFR13,1
MIFR13,R1522,AIFR99
AIFR99,R1522,MIFR13
6900VSBA,R1522,1
```

** UNIT 2 POWER **
All comments (except headers) are Unit 1 nomeclature.

Connections back to 6.9KV shutdown board 2BB (6900VS2BB).

```
R25B,480MOV2B2B,R56B    All R-'s are relays.  480MOV1B2B is MOV board 1B2B.
R24B,R25B,1
I1B,R24B,1              I- is a component of unknown type.
480VS2B2B,I1B,R28B      480VS1B2B is 480V shutdown board 1B2B.
R19B,480VS2B2B,1
TR2B2B,R19B,1           TR- is a transformer.
R18B,TR2B2B,1
6900VS2BB,R18B,1        6900VS1BB is 6.9KV shutdown board 1BB.
R56B,480MOV2B2B,R25B
OPRE42B,MIFR20B,1       OPRE42 operates R56 by actuation of MIFR20.
MIFR20B,R56B,1          MIFR- is man. transfer controller for closing relays.
R32B,R56B,1
I2B,R32B,1
R28B,I1B,480VS2B2B
MIFR15B,R28B,1
OPRE37B,MIFR15B,1
TR2BB,R28B,1
R27B,TR2BB,1
MIFR14B,R27B,1
OPRE36B,MIFR14B,1
6900VS2BB,R27B,1
R26B,480MOV2B1B,R33B    480MOV1B1B is MOV board 1B1B.
OPRE39B,MIFR17B,1
```

```
MXFR17B,R26B,1
R24B,R26B,1
R33B,480MOV2B1B,R26B
R32B,R33B,1
R23B,480VAV2B1B,R35B     480VAV1B1B is cont. and aux. bldg. vent bd. 1B1B.
MXFR18B,R23B,1
OPRE40B,MXFR18B,1
R22B,R23B,1
I1B,R22B,1
R35B,480VAV2B1B,R23B
R34B,R35B,1
I2B,R34B,1
R37B,480VAV2B2B,R21B
MXFR19B,R37B,1
OPRE41B,MXFR19B,1
R36B,R37B,1
I2B,R36B,1
R21B,480VAV2B2B,R37B
R203,R21B,1
I1B,R20B,1
R29B,I2B,480VS2B1B
MXFR16B,R29B,1
OPRE38B,MXFR16B,1
TR2BB,R29B,1
480VS2B1B,I2B,R29B
R31B,480VS2B1B,1
TR2B1B,R31B,1
R30B,TR2B1B,1
6900VS2BB,R30B,1

        Connections back to 6.9KV shutdown board 2AA (6900VS2AA).
R44B,480MOV2A2A,R52B     480MOV1A2A is MOV board 1A2A.
R43B,R44B,1
I3B,R43B,1
480VS2A2A,I3B,R47B       480VS1A2A is 480V shutdown board 1A2A.
R38B,480VS2A2A,1
TR2A2A,R38B,1
R58B,TR2A2A,1
6900VS2AA,R58B,1         6900VS1AA is 6.9KV shutdown board 1AA.
R52B,480MOV2A2A,R44B
MXFR26B,R52B,1
OPRE48B,MXFR26B,1
R51B,R52B,1
R47B,I3B,480VS2A2A
MXFR22B,R47B,1
OPRE47B,MXFR22B,1
TR2AA,R47B,1
R46B,TR2AA,1
MXFR21B,R46B,1
```

```
OPRE43B,MXFR21B,1
6900VS2AA,R46B,1
R45B,4800MOV2A1A,R53B     4800MOV1A1A is MOV board 1A1A.
MXFR24B,R45B,1
OPRE45B,MXFR24B,1
R43B,R45B,1
R53B,4800MOV2A1A,R45B
R51B,R53B,1
I4B,R51B,1
R42B,4800VAV2A1A,R55B     4800VAV1A1A is 4800V cont. and aux. bldg. vent bd. 1A1A.
MXFR25B,R42B,1
OPRE46B,MXFR25B,1
R41B,R42B,1
I3B,R41B,1
R55B,4800VAV2A1A,R42B
R54B,R55B,1
I4B,R54B,1
R40B,4800VAV2A2A,R57B     4800VAV1A2A is 4800V cont. and aux. bldg. vent bd. 1A2A.
R39B,R40B,1
I3B,R39B,1
R57B,4800VAV2A2A,R40B
MXFR27B,R57B,1
OPRE49B,MXFR27B,1
R55B,R57B,1
I4B,R55B,1
R48B,I4B,4800VS2A1A       4800VS1A1A is 4800V shutdown board 1A1A.
MXFR23B,R48B,1
OPRE44B,MXFR23B,1
TR2AA,R48B,1
4800VS2A1A,I4B,R48B
R50B,4800VS2A1A,1
TR2A1A,R50B,1
R49B,TR2A1A,1
6900VS2AA,R49B,1
```

Connections from offsite and onsite power supplies to 6900VS2BB.

Expanded AND-gate for connections to 6900VS2BB.

```
R1828,DUMAND22B,R1938
R1938,DUMAND22B,R1828
DUMAND22B,DUMAND21B,R1924
R1924,DUMAND21B,DUMAND22B
DUMAND21B,6900VS2BB,R1826
R1826,6900VS2BB,DUMAND21B

MXFR1B,R1828,AIFR3B       AIFR3B is automatic switch to alternate feeder
AIFR3B,R1828,MXFR1B
OPRE22B,MXFR1B,1
R1824,R1828,6900VSUB3
```

```
6900VSUB3,R1828,R1824
R1828,6900VSUB3,1
R2814,6900VSUB3,1
OPRB50B,6900VSUB3,1
R1224,6900VUB2D,R1634   6900VUB- is 6900 volt unit board.
USST2BY,R1224,1         USST1BY= unit sta. serv. transformer 1B, winding Y.
MNGEN2,USST2BY,500KVBAY4  Unit 2 nuc. gen. modelled as enabled.
500KVBAY4,USST2BY,MNGEN2  500KVBAY8 is 1 500KV power line/conn. to plant,
500KV,500KVBAY4,1       500KV is 500KV source.
OPRE54B,500KVBAY4,AIFR7B Transfer to offsite requires switching.
AIFR7B,500KVBAY4,OPRE54B
R1634,6900VUB2D,R1224
6900VUB2D,R1824,1
OPRE23B,MIFR2B,1
MIFR2B,R1634,AIFR96B
AIFR96B,R1634,MIFR2B
6900VSBB,R1634,1        6900VSBB is 6.9KV start bus B.
MIFR5B,R1938,1
OPRE25B,MIFR5B,1
6900VSUB1,R1938,1
OPRB51B,R1938,1
R1938,6900VSUB1,1
MIFR6B,R1924,AIFR4B
AIFR4B,R1924,MIFR6B
OPRE26B,MIFR6B,1
GENDSL2BB,R1924,1       GENDSL1BB is diesel generator 1BB.
OPRE27B,GENDSL2BB,DUM10
DUM10,GENDSL2BB,OPRE27B
DUM10,AIFR4B,1
R1822,R1826,1
R1534,6900VUB2C,R1222   6900VUB- is 6900 volt unit board.
OPRE28B,MIFR7B,1
MIFR7B,R1534,AIFR97B
AIFR97B,R1534,MIFR7B
6900VSBA,R1534,1        6900VSBA is 6.9KV start bus A.
R1222,6900VUB2C,R1534
6900VUB2C,R1822,1
USST2BY,R1222,1
```

Connections from offsite and onsite power supplies to 6900VS2AA.

Expanded AND-gate for inputs to 6900VS2AA.

```
R1818,DUMAND42B,R1936
R1936,DUMAND42B,R1818
DUMAND42B,DUMAND32B,R1922
R1922,DUMAND32B,DUMAND42B
DUMAND32B,6900VS2AA,R1816
R1816,6900VS2AA,DUMAND32B
R1814,R1818,1
```

```
R1214,6900VUB2B,R1632   6900VUB- is 6900 volt unit board.
USST2AY,R1214,1         USST1AY is unit sta. serv. trans. 1A, wind. Y.
500KVBAY4,USST2AY,MNGEN2
MNGEN2,USST2AY,500KVBAY4
R1632,6900VUB2B,R1214
6900VUB2B,R1814,1
OPRE30B,MXFR9B,1
MXFR9B,R1632,AXFR98B
AXFR98B,R1632,MXFR9B
6900VSBB,R1632,1
MXFR10B,R1936,1
OPRE31B,MXFR10B,1
6900VSUB2,R1936,1
OPRB52B,R1936,1
R1936,6900VSUB2,1
MXFR11B,R1922,AXFR5B
AXFR5B,R1922,MXFR11B
OPRE32B,MXFR11B,1
GENDSL2AA,R1922,1       GENDSL1AA is diesel generator 1AA.
OPRE33B,GENDSL2AA,DUM10
DUM10,GENDSL2AA,OPRE33B
DUM10,AXFR5B,1
MXFR12B,R1816,AXFR6B
AXFR6B,R1816,MXFR12B
OPRE34B,MXFR12B,1
R1812,R1816,6900VSUB4
R1816,6900VSUB4,1
6900VSUB4,R1816,R1812
OPRB53B,6900VSUB4,1
R1212,6900VUB2A,R1532   6900VUB- is 6900 volt unit board.
USST2AY,R1212,1
R1532,6900VUB2A,R1212
6900VUB2A,R1812,1
OPRE35B,MXFR13B,1
MXFR13B,R1532,AXFR99B
AXFR99B,R1532,MXFR13B
6900VSBA,R1532,1
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

Only controls of relays in Unit 1 were modelled.

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.
This particular relay does not have a backup supply to the normal control power.

** R28 **

```
COIL1Z1,R28,1   COIL1Z1, when energized with control power, effects closure
EINRLK19,COIL1Z1,1       of R28. EINRLK19 is an interlock between this relay
       and R19.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z1,COIL1Z1,MXFR1Z1 AXFR1Z1 is hardware used to automatically actuate COIL1Z1.
IAXFR1Z1,AXFR1Z1,1      AXFR1Z1 is supported by monitoring instrumentation IAXFR1Z1.
OPWF1Z1,AXFR1Z1,1              OPWF1Z1 is operator who fails by not enabling AXFR1Z1.
DUM4YS,AXFR1Z1,1        DUM4YS is normal control power.  This is the normal
       control power source for hardware supported by this bus (480VS1928).
MXFR1Z1,COIL1Z1,AXFR1Z1 MXFR1Z1 is hardware needed to manually actuate COIL1Z1.
OPRF1Z1,MXFR1Z1,1              OPRF1Z1 is remote OP who uses MXFR1Z1.
IMXFR1Z1,OPRF1Z1,1      OP uses IMXFRZ1 instrumentation to determine need to
DUM4YS,MXFR1Z1,1        actuate.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.
This particular relay does not have a backup supply to the normal control power.

** R29 **

```
COIL1Z2,R29,1   COIL1Z2, when energized with control power, effects closure
EINRLK31,COIL1Z2,1       of R29. EINRLK31 is an interlock between this relay
       and R31.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z2,COIL1Z2,MXFR1Z2 AXFR1Z2 is hardware used to automatically actuate COIL1Z2.
IAXFR1Z2,AXFR1Z2,1      AXFR1Z2 is supported by monitoring instrumentation IAXFR1Z2.
```

```
OPWF1Z2,AXFR1Z2,1              OPWF1Z2 is operator who fails by not enabling AXFR1Z2.
DUM4YR,AXFR1Z2,1        DUM4YR is normal control power.  This is the normal
       control power source for hardware supported by this bus (480VS1B1B).
MXFR1[illegible],COIL1Z2,AXFR1Z2 MXFR1Z2 is hardware needed to manually actuate COIL1Z2.
OPRF1[illegible]  MXFR1[illegible],1              OPRF1Z2 is remote OP who uses MXFR1Z2.
IMXFR[illegible]  [illegible]RF1Z2,1      OP uses IMXFRZ2 instrumentation to determine need to
DUM4YR,[illegible]XFR1Z2,1        actuate.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.
This particular relay does not have a backup supply to the normal control power.

** R47 **

```
COIL1Z4,R47,1   COIL1Z4, when energized with control power, effects closure
EINRLK38,COIL1Z4,1       of R47.  EINRLK38 is an interlock between this relay
       and R38.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z4,COIL1Z4,MXFR1Z4 AXFR1Z4 is hardware used to automatically actuate COIL1Z4.
IAXFR1Z4,AXFR1Z4,1      AXFR1Z4 is supported by monitoring instrumentation IAXFR1Z4.
OPWF1Z4,AXFR1Z4,1              OPWF1Z4 is operator who fails by not enabling AXFR1Z4.
DUM4YV,AXFR1Z4,1        DUM4YV is normal control power.  This is the normal
       control power source for hardware supported by this bus (480VS1A2A).
MXFR1Z4,COIL1Z4,AXFR1Z4 MXFR1Z4 is hardware needed to manually actuate COIL1Z4.
OPRF1Z4,MXFR1Z4,1              OPRF1Z4 is remote OP who uses MXFR1Z4.
IMXFR1Z4,OPRF1Z4,1      OP uses IMXFRZ4 instrumentation to determine need to
DUM4YV,MXFR1Z4,1        actuate.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.
This particular relay does not have a backup supply to the normal control power.

```
        ** R48 **
COIL1Z4,R48,1   COIL1Z4, when energized with control power, effects closure
EINRLK5@,COIL1Z4,1       of R48.  EINRLK5@ is an interlock between this relay
        and R5@.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z4,COIL1Z4,MXFR1Z4 AXFR1Z4 is hardware used to automatically actuate COIL1Z4.
IAXFR1Z4,AXFR1Z4,1      AXFR1Z4 is supported by monitoring instrumentation IAXFR1Z4.
OPWF1Z4,AXFR1Z4,1               OPWF1Z4 is operator who fails by not enabling AXFR1Z4.

        Normal control power connection to battery boards
DUMPWRZ4,AXFR1Z4,1      DUMPWRZ4 is normal control power.  This is the normal
        control power source for hardware supported by this bus (480VS1A1A).
R5Z4,DUMPWRZ4,R6Z4      R5Z4 and R6Z4 are relays in batt. bd.'s I and III.
FUSE1@III,R5Z4,1
R6Z4,DUMPWRZ4,R5Z4
FUSE1@I,R6Z4,1
SWX4Z4,R6Z4,1
OPRF8Z4,SWX4Z4,1        OPRF8Z4 enables alt. feeder for normal control power.
NCONPWR1Z4,OPRF8Z4,1    NCONPWR1Z4 is instr. that OP- needs to know to switch
                        to alternate feeder to normal control power.

MXFR1Z4,COIL1Z4,AXFR1Z4 MXFR1Z4 is hardware needed to manually actuate COIL1Z4.
OPRF1Z4,MXFR1Z4,1               OPRF1Z4 is remote OP who uses MXFR1Z4.
IMXFR1Z4,OPRF1Z4,1      OP uses IMXFRZ4 instrumentation to determine need to
DUMPWR24,MXFR1Z4,1      actuate.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.
This particular relay does not have a backup supply to the normal control power nor is it interlocked with another relay.

** R27 **

COIL1Z5,R27,1 COIL1Z5, when energized with control power, effects closure
AXFR1Z5,COIL1Z5,MXFR1Z5 AXFR1Z5 is hardware used to automatically actuate COIL1Z5.
IAXFR1Z5,AXFR1Z5,1 AXFR1Z5 is supported by monitoring instrumentation IAXFR1Z5.
OPWF1Z5,AXFR1Z5,1 OPWF1Z5 is operator who fails by not enabling AXFR1Z5.
DUM4T,AXFR1Z5,1 DUM4T is normal control power. This is the normal control power source for hardware supported by this bus (6900VS1BB).
MXFR1Z5,COIL1Z5,AXFR1Z5 MXFR1Z5 is hardware needed to manually actuate COIL1Z5.
OPRF1Z5,MXFR1Z5,1 OPRF1Z5 is remote OP who uses MXFR1Z5.
IMXFR1Z5,OPRF1Z5,1 OP uses IMXFRZ5 instrumentation to determine need to
DUM4T,MXFR1Z5,1 actuate.

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.
This particular relay does not have a backup supply to the normal control power nor is it interlocked with another relay.

** R46 **

COIL1Z6,R46,1 COIL1Z6, when energized with control power, effects closure
AXFR1Z6,COIL1Z6,MXFR1Z6 AXFR1Z6 is hardware used to automatically actuate COIL1Z6.
IAXFR1Z6,AXFR1Z6,1 AXFR1Z6 is supported by monitoring instrumentation IAXFR1Z6.
OPWF1Z6,AXFR1Z6,1 OPWF1Z6 is operator who fails by not enabling AXFR1Z6.
DUM4S,AXFR1Z6,1 DUM4S is normal control power. This is the normal control power source for hardware supported by this bus (bus).
MXFR1Z6,COIL1Z6,AXFR1Z6 MXFR1Z6 is hardware needed to manually actuate COIL1Z6.
OPRF1Z6,MXFR1Z6,1 OPRF1Z6 is remote OP who uses MXFR1Z6.
IMXFR1Z6,OPRF1Z6,1 OP uses IMXFRZ6 instrumentation to determine need to
DUM4S,MXFR1Z6,1 actuate.

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

```
        ** R1728 **
COIL1Z7,R1728,1 COIL1Z7, when energized with control power, effects closure
EINRLK1726,COIL1Z7,1       of R1728.  EINRL1726 is an interlock between this relay
        and R1726.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z7,COIL1Z7,MXFR1Z7 AXFR1Z7 is hardware used to automatically actuate COIL1Z7.
IAXFR1Z7,AXFR1Z7,1      AXFR1Z7 is supported by monitoring instrumentation IAXFR1Z7.
OPWF1Z7,AXFR1Z7,1               OPWF1Z7 is operator who fails by not enabling AXFR1Z7.
DUM3T,AXFR1Z7,1 DUM3T is normal control power.  This is the normal
        control power source for hardware supported by this bus (6900VS1BB).
MXFR1Z7,COIL1Z7,AXFR1Z7 MXFR1Z7 is hardware needed to manually actuate COIL1Z7.
OPRF1Z7,MXFR1Z7,1               OPRF1Z7 is remote OP who uses MXFR1Z7.
IMXFR1Z7,OPRF1Z7,1      OP uses IMXFRZ7 instrumentation to determine need to
DUM3T,MXFR1Z7,SWX1Z7    actuate.  SWX1Z7 enables emergency (backup) power.
DUM4T,SWX1Z7,1  DUM4T is emergency (backup) power.  This is the
        emerg. con. power source for hardware supported by this bus (6900VS1BB).
SWX1Z7,MXFR1Z7,DUM3T    Manual transfer can use normal or emergency power.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

```
        ** R1934 **
COIL1Z8,R1934,1 COIL1Z8, when energized with control power, effects closure
EINRLK1726,COIL1Z8,1       of R1934.  EINRLK1726 is an interlock between this relay
        and R1726.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z8,COIL1Z8,MXFR1Z8 AXFR1Z8 is hardware used to automatically actuate COIL1Z8.
IAXFR1Z8,AXFR1Z8,1      AXFR1Z8 is supported by monitoring instrumentation IAXFR1Z8.
OPWF1Z8,AXFR1Z8,1               OPWF1Z8 is operator who fails by not enabling AXFR1Z8.
DUM3T,AXFR1Z8,1 DUM3T is normal control power.  This is the normal
        control power source for hardware supported by this bus (6900VS1BB).
```

```
MXFR1Z8,COIL1Z8,AXFR1Z8 MXFR1Z8 is hardware needed to manually actuate COIL1Z8.
OPRF1Z8,MXFR1Z8,1              OPRF1Z8 is remote OP who uses MXFR1Z8.
IMXFR1Z8,OPRF1Z8,1      OP uses IMXFRZ8 instrumentation to determine need to
DUM3T,MXFR1Z8,SWX1Z8    actuate.  SWX1Z8 enables emergency (backup) power.
DUM4T,SWX1Z8,1  DUM4T is emergency (backup) power.  This is the
       emerg. con. power source for hardware supported by this bus (6900VS1BB).
SWX1Z8,MXFR1Z8,DUM3T    Manual transfer can use normal or emergency power.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

```
       ** R1914 **
COIL1Z9,R1914,1 COIL1Z9, when energized with control power, effects closure
EINRLK1726,COIL1Z9,1       of R1914.  EINRLK1726 is an interlock between this relay
       and R1726.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z9,COIL1Z9,MXFR1Z9 AXFR1Z9 is hardware used to automatically actuate COIL1Z9.
IAXFR1Z9,AXFR1Z9,1      AXFR1Z9 is supported by monitoring instrumentation IAXFR1Z9.
OPWF1Z9,AXFR1Z9,1              OPWF1Z9 is operator who fails by not enabling AXFR1Z9.
DUM3T,AXFR1Z9,1 DUM3T is normal control power.  This is the normal
       control power source for hardware supported by this bus (6900VS1BB).
MXFR1Z9,COIL1Z9,AXFR1Z9 MXFR1Z9 is hardware needed to manually actuate COIL1Z9.
OPRF1Z9,MXFR1Z9,1              OPRF1Z9 is remote OP who uses MXFR1Z9.
IMXFR1Z9,OPRF1Z9,1      OP uses IMXFRZ9 instrumentation to determine need to
DUalT,MXFR1Z9,SWX1Z9    actuate.  SWX1Z9 enables emergency (backup) power.
DUM4T,SWX1Z9,1  DUM4T is emergency (backup) power.  This is the
       emerg. con. power source for hardware supported by this bus (6900VS1BB).
SWX1Z9,MXFR1Z9,DUM3T    Manual transfer can use normal or emergency power.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

```
       ** R1932 **
COIL1Z10,R1932,1        COIL1Z10, when energized with control power, effects closure
EINRLK1718,COIL1Z10,1       of R1932.  EINRLK1718 is an interlock between this relay
       and R1718.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z10,COIL1Z10,MXFR1Z10      AXFR1Z10 is hardware used to automatically actuate COIL1Z10.
IAXFR1Z10,AXFR1Z10,1    AXFR1Z10 is supported by monitoring instrumentation IAXFR1Z10.
OPWF1Z10,AXFR1Z10,1             OPWF1Z10 is operator who fails by not enabling AXFR1Z10.
DUM3S,AXFR1Z10,1        DUM3S is normal control power.  This is the normal
       control power source for hardware supported by this bus (6900VS1AA).
MXFR1Z10,COIL1Z10,AXFR1Z10      MXFR1Z10 is hardware needed to manually actuate COIL1Z10.
OPRF1Z10,MXFR1Z10,1             OPRF1Z10 is remote OP who uses MXFR1Z10.
IMXFR1Z10,OPRF1Z10,1    OP uses IMXFRZ10 instrumentation to determine need to
DUM3S,MXFR1Z10,SWX1Z10  actuate.  SWX1Z10 enables emergency (backup) power.
DUM4S,SWX1Z10,1 DUM4S is emergency (backup) power.  This is the
       emerg. con. power source for hardware supported by this bus (6900VS1AA).
SWX1Z10,MXFR1Z10,DUM3S  Manual transfer can use normal or emergency power.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

```
       ** R1912 **
COIL1Z11,R1912,1        COIL1Z11, when energized with control power, effects closure
EINRLK1718,COIL1Z11,1       of R1912.  EINRLK1718 is an interlock between this relay
       and R1718.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z11,COIL1Z11,MXFR1Z11      AXFR1Z11 is hardware used to automatically actuate COIL1Z11.
IAXFR1Z11,AXFR1Z11,1    AXFR1Z11 is supported by monitoring instrumentation IAXFR1Z11.
OPWF1Z11,AXFR1Z11,1             OPWF1Z11 is operator who fails by not enabling AXFR1Z11.
DUM3S,AXFR1Z11,1        DUM3S is normal control power.  This is the normal
       control power source for hardware supported by this bus (6900VS1AA).
MXFR1Z11,COIL1Z11,AXFR1Z11      MXFR1Z11 is hardware needed to manually actuate COIL1Z11.
```

```
OPRF1Z11,MXFR1Z11,1            OPRF1Z11 is remote OP who uses MXFR1Z11.
IMXFR1Z11,OPRF1Z11,1    OP uses IMXFRZ11 instrumentation to determine need to
DUM3S,MXFR1Z11,SWX1Z11  actuate.  SWX1Z11 enables emergency (backup) power.
DUM4S,SWX1Z11,1 DUM4S is emergency (backup) power.  This is the
      emerg. con. power source for hardware supported by this bus (6900VS1AA).
SWX1Z11,MXFR1Z11,DUM3S  Manual transfer can use normal or emergency power.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

```
      ** R1716 **
COIL1Z12,R1716,1        COIL1Z12, when energized with control power, effects closure
EINRLK1718,COIL1Z12,1       of R1716.  EINRLK1718 is an interlock between this relay
      and R1718.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z12,COIL1Z12,MXFR1Z12      AXFR1Z12 is hardware used to automatically actuate COIL1Z12.
IAXFR1Z12,AXFR1Z12,1    AXFR1Z12 is supported by monitoring instrumentation IAXFR1Z12.
OPWF1Z12,AXFR1Z12,1            OPWF1Z12 is operator who fails by not enabling AXFR1Z12.
DUM3S,AXFR1Z12,1        DUM3S is normal control power.  This is the normal
      control power source for hardware supported by this bus (6900VS1AA).
MXFR1Z12,COIL1Z12,AXFR1Z12      MXFR1Z12 is hardware needed to manually actuate COIL1Z12.
OPRF1Z12,MXFR1Z12,1            OPRF1Z12 is remote OP who uses MXFR1Z12.
IMXFR1Z12,OPRF1Z12,1    OP uses IMXFRZ12 instrumentation to determine need to
DUM3S,MXFR1Z12,SWX1Z12  actuate.  SWX1Z12 enables emergency (backup) power.
DUM4S,SWX1Z12,1 DUM4S is emergency (backup) power.  This is the
      emerg. con. power source for hardware supported by this bus (6900VS1AA).
SWX1Z12,MXFR1Z12,DUM3S  Manual transfer can use normal or emergency power.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

```
      ** R1624 **
COIL1Z13,R1624,1        COIL1Z13, when energized with control power, effects closure
EINRLK1124,COIL1Z13,1       of R1624.  EINRLK1124 is an interlock between this relay
```

and R1124. Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z13,COIL1Z13,MXFR1Z13 AXFR1Z13 is hardware used to automatically actuate COIL1Z13.
IAXFR1Z13,AXFR1Z13,1 AXFR1Z13 is supported by monitoring instrumentation IAXFR1Z13.
OPWF1Z13,AXFR1Z13,1 OPWF1Z13 is operator who fails by not enabling AXFR1Z13.
250VTBD1,AXFR1Z13,1 250VTBD1 is 250v d.c. turbine bldg. dist. board 1. This connection couldn't be found in available material. It is assumed based upon symmetry with R1622.
MXFR1Z13,COIL1Z13,AXFR1Z13 MXFR1Z13 is hardware needed to manually actuate COIL1Z13.
OPRF1Z13,MXFR1Z13,1 OPRF1Z13 is remote OP who uses MXFR1Z13.
IMXFR1Z13,OPRF1Z13,1 OP uses IMXFRZ13 instrumentation to determine need to
250VTBD1,MXFR1Z13,SWX1Z13 actuate. SWX1Z13 enables emergency (backup) power.
250VTBD2,SWX1Z13,1 250VTBD2 is 250v d.c. turbine bldg. dist. board 2. This connection couldn't be found in available material. It is assumed based upon symmetry with R1622.
SWX1Z13,MXFR1Z13,250VTBD1 Manual transfer can use normal or emergency power.

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

** R1524 **
COIL1Z14,R1524,1 COIL1Z14, when energized with control power, effects closure
EINRLK1122,COIL1Z14,1 of R1524. EINRLK1122 is an interlock between this relay and R1122. Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z14,COIL1Z14,MXFR1Z14 AXFR1Z14 is hardware used to automatically actuate COIL1Z14.
IAXFR1Z14,AXFR1Z14,1 AXFR1Z14 is supported by monitoring instrumentation IAXFR1Z14.
OPWF1Z14,AXFR1Z14,1 OPWF1Z14 is operator who fails by not enabling AXFR1Z14.
250VTBD2,AXFR1Z14,1 250VTBD2 is 250v d.c. turbine bldg. dist. board 2. This connection couldn't be found in available material. It is assumed based upon symmetry with R1522.
MXFR1Z14,COIL1Z14,AXFR1Z14 MXFR1Z14 is hardware needed to manually actuate COIL1Z14.
OPRF1Z14,MXFR1Z14,1 OPRF1Z14 is remote OP who uses MXFR1Z14.
IMXFR1Z14,OPRF1Z14,1 OP uses IMXFRZ14 instrumentation to determine need to
250VTBD2,MXFR1Z14,SWX1Z14 actuate. SWX1Z14 enables emergency (backup) power.
250VTBD1,SWX1Z14,1 250VTBD1 is 250v d.c. turbine bldg. dist. board 1. This connection couldn't be found in available material. It is assumed based upon symmetry with R1522.
SWX1Z14,MXFR1Z14,250VTBD2 Manual transfer can use normal or emergency power.

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

** R1622 **

```
COIL1Z15,R1622,1        COIL1Z15, when energized with control power, effects closure
EINRLK1114,COIL1Z15,1       of R1622.  EINRLK1114 is an interlock between this relay
      and R1114.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z15,COIL1Z15,MXFR1Z15      AXFR1Z15 is hardware used to automatically actuate COIL1Z15.
IAXFR1Z15,AXFR1Z15,1    AXFR1Z15 is supported by monitoring instrumentation IAXFR1Z15.
OPWF1Z15,AXFR1Z15,1             OPWF1Z15 is operator who fails by not enabling AXFR1Z15.
250VTBD2,AXFR1Z15,1     250VTBD2 is 250v d.c. turbine bldg. dist. board 2.
MXFR1Z15,COIL1Z15,AXFR1Z15      MXFR1Z15 is hardware needed to manually actuate COIL1Z15.
OPRF1Z15,MXFR1Z15,1             OPRF1Z15 is remote OP who uses MXFR1Z15.
IMXFR1Z15,OPRF1Z15,1    OP uses IMXFRZ15 instrumentation to determine need to
250VTBD2,MXFR1Z15,SWX1Z15       actuate.  SWX1Z15 enables emergency (backup) power.
250VTBD1,SWX1Z15,1      250VTBD1 is 250v d.c. turbine bldg. dist. board 1.
SWX1Z15,MXFR1Z15,250VTBD2       Manual transfer can use normal or emergency power.
```

ADJACENCY INPUT DATA FOR RELAYS

DATA FROM TVA 45- SERIES

This model is based upon interpretation of schematics of relay control hardware that appear on numerous wiring diagrams in the 45- series of TVA drawings. The model represents a relay which is normally open and is given either an automatic or manually generated signal to close.

** R1522 **

```
COIL1Z16,R1522,1        COIL1Z16, when energized with control power, effects closure
EINRLK1112,COIL1Z16,1       of R1522.  EINRLK1112 is an interlock between this relay
      and R1112.  Type of interlock = E (E = electrical, M = mechanical).
AXFR1Z16,COIL1Z16,MXFR1Z16      AXFR1Z16 is hardware used to automatically actuate COIL1Z16.
IAXFR1Z16,AXFR1Z16,1    AXFR1Z16 is supported by monitoring instrumentation IAXFR1Z16.
OPWF1Z16,AXFR1Z16,1             OPWF1Z16 is operator who fails by not enabling AXFR1Z16.
250VTBD1,AXFR1Z16,1     250VTBD1 is 250v d.c. turbine bldg. dist. board 1.
MXFR1Z16,COIL1Z16,AXFR1Z16      MXFR1Z16 is hardware needed to manually actuate COIL1Z16.
OPRF1Z16,MXFR1Z16,1             OPRF1Z16 is remote OP who uses MXFR1Z16.
IMXFR1Z16,OPRF1Z16,1    OP uses IMXFRZ16 instrumentation to determine need to
```

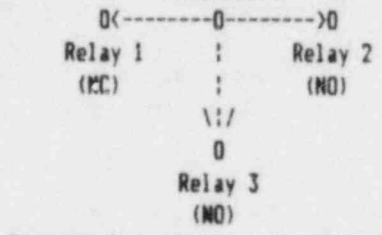
```
250VTBD1,MXFR1Z16,SWX1Z16       actuate.  SWX1Z16 enables emergency (backup) power.
250VTBD2,SWX1Z16,1      250VTBD2 is 250v d.c. turbine bldg. dist. board 2.
SWX1Z16,MXFR1Z16,250VTBD1       Manual transfer can use normal or emergency power.
```

d ADJACENCY OF INTERLOCKS TO RELAYS

The following is a list of the interlock connections between redundant relays. Each interlock is of the form *INRLK#, where * is the type of control signal/power (E=electrical, M=mechanical) and # is an identifier. The identifier was chosen as the number of the 1 normally closed relay that is connected to the interlock. The modelling of the interlocks reflects the possibility that certain failures of the interlock may cause those breakers connected to it to fail to perform the task they are designed for. The picture below illustrates this direct causality.

The input is broken into two groups. The first corresponds to the interlocks complementing those in the above unit models. The second group are the pairs associated with breakers not unit modelled.

```
EINRLK19,R19,1
EINRLK31,R31,1
EINRLK38,R38,1
EINRLK50,R50,1
EINRLK1726,R1726,1
EINRLK1718,R1718,1
EINRLK1124,R1124,1
EINRLK1122,R1122,1
EINRLK1114,R1114,1
EINRLK1112,R1112,1
```



Digraph of connection of interlock to three interlocked relays

```
MINRLK35,R23,1
MINRLK35,R35,1
MINRLK33,R26,1
MINRLK33,R33,1
MINRLK21,R37,1
MINRLK21,R21,1
MINRLK55,R42,1
MINRLK55,R55,1
MINRLK53,R45,1
MINRLK53,R53,1
MINRLK44,R52,1
MINRLK44,R44,1
MINRLK25,R56,1
MINRLK25,R25,1
MINRLK46,R57,1
MINRLK40,R40,1
```

ADJACENCY INPUT FOR 250 VOLT D.C. BATTERY BOARD UNIT MODEL

DATA FROM FSAR FIG. 8.2-12,13

This battery board supplies DC power to the 250v turbine building distribution boards.

Connections to the turbine boards

```
R14ZA,250VTBD1,R16ZA    250VTBD1 is 250 volt turbine bldg. dist. board 1.
R16ZA,250VTBD1,R14ZA R14ZA is normal path and R16ZA is alternate path to 250VTBD1.
FUSE203ZA1,R14ZA,1
FUSE203ZA2,R16ZA,1
MXFR4ZA,R16ZA,1 MXFR- is manual transfer hardware which OPRF4ZA uses to
OPRF4ZA,MXFR4ZA,1       enable the alternate path to the 250VTBD1.

R15ZA,250VTBD2,R17ZA 250VTBD2 is 250 volt turbine bldg. dist. board 2.
R17ZA,250VTBD2,R15ZA R15ZA is normal path and R17ZA is alternate path to 250VTBD2.
FUSE204ZA2,R15ZA,1
FUSE204ZA1,R17ZA,1
MXFR5ZA,R17ZA,1
OPRF5ZA,MXFR5ZA,1
```

** 250VBATBD1 **

Connection from panel 2 main bus to the trains leading to 250VTBD's.

```
CON1ZA1,FUSE203ZA1,1    CON- is an electrical contact.
R203ZA1,CON1ZA1,1
250VBBZA1,R203ZA1,1     250VBBZA1 is the bus in panel 2 which feeds the fuses.

CON2ZA1,FUSE204ZA1,1
R204ZA1,CON2ZA1,1
250VBBZA1,R204ZA1,1

DUMAND1ZA1,250VBBZA1,R205ZA1
TMOT2ZA1,DUMAND1ZA1,R206ZA1     TMOT- is a thermal magnetic overcurrent trip.
```

Inputs to 250VBBZA1 follow. There are three inputs: a 250v battery and a battery charger, both of which each board has, and a shared battery charger. Since the shared charger is not part of the unit model, it is placed at the end of this adjacency input.

Battery input

```
R104ZA1,TMOT2ZA1,1
SHNT1ZA1,R104ZA1,1      SHNT1ZA1 is a 1000 amp shunt.
FUSE101ZA1,SHNT1ZA1,1
250VBATZA1,FUSE101ZA1,1 250VBATZA1 is 250 volt battery.
```

Charger (not shared)

```
R206ZA1,DUMAND1ZA1,TMOT2ZA1
TMOT3ZA1,R206ZA1,1
FUSE206ZA1,TMOT3ZA1,1
TMOT1ZA1,FUSE206ZA1,1
R2ZA1,TMOT1ZA1,1
CHRGR1ZA1,R2ZA1,1       CHRGR1ZA1 is 250v batt. charger; not safety related (15E500-2).
TMOT7ZA1,CHRGR1ZA1,1
R3ZA1,TMOT7ZA1,1
R4ZA1,R3ZA1,R5ZA1       R4ZA1 and R5ZA1 are relays to redundant power supplies to CHRGR1ZA1.
MINRLK2ZA1,R4ZA1,1      MINRLK2ZA1 is the mechanical interlock between R4ZA1 and R5ZA1.
R10ZA1,R4ZA1,1
480VABCA,R10ZA1,1       480VABCA is normal power to CHRGR1ZA1.
R5ZA1,R3ZA1,R4ZA1
MINRLK2ZA1,R5ZA1,1
MXFR2ZA1,R5ZA1,1
OPRF2ZA1,MXFR2ZA1,1
R11ZA1,R5ZA1,1
480VS1A1A,R11ZA1,1      480VS1A1A is alternate power to CHRGR1ZA1.

        ** 250VBATBD2 **
        Connection from panel 2 main bus to the trains leading to 250VTBD's.
CON1ZA2,FUSE203ZA2,1    CON- is an electrical contact.
R203ZA2,CON1ZA2,1
250VBBZA2,R203ZA2,1     250VBBZA2 is the bus in panel 2 which feeds the fuses.

CON2ZA2,FUSE204ZA2,1
R204ZA2,CON2ZA2,1
250VBBZA2,R204ZA2,1

DUMAND1ZA2,250VBBZA2,R205ZA2
TMOT2ZA2,DUMAND1ZA2,R206ZA2     TMOT- is a thermal magnetic overcurrent trip.

        Inputs to 250VBBZA2 follow. There are three inputs: a 250v battery
        and a battery charger, both of which each board has, and a shared
        battery charger.  Since the shared charger is not part of the
        unit model, it is placed at the end of this adjacency input.

        Battery input
R104ZA2,TMOT2ZA2,1
SHNT1ZA2,R104ZA2,1      SHNT1ZA2 is a 1000 amp shunt.
FUSE101ZA2,SHNT1ZA2,1
250VBATZA2,FUSE101ZA2,1 250VBATZA2 is 250 volt battery.

        Charger (not shared)
R206ZA2,DUMAND1ZA2,TMOT2ZA2
TMOT3ZA2,R206ZA2,1
FUSE206ZA2,TMOT3ZA2,1
TMOT1ZA2,FUSE206ZA2,1
R2ZA2,TMOT1ZA2,1
```

```
CHRGR1ZA2,R2ZA2,1       CHRGR1ZA2 is 250v batt. charger; not safety related (15E500-2).
TMOT7ZA2,CHRGR1ZA2,1
R3ZA2,TMOT7ZA2,1
R4ZA2,R3ZA2,R5ZA2       R4ZA2 and R5ZA2 are relays to redundant power supplies to CHRGR1ZA2.
MINRLK2ZA2,R4ZA2,1      MINRLK2ZA2 is the mechanical interlock between R4ZA2 and R5ZA2.
R10ZA2,R4ZA2,1
480VABCB,R10ZA2,1       480VABCB is normal power to CHRGR1ZA2.
R5ZA2,R3ZA2,R4ZA2
MINRLK2ZA2,R5ZA2,1
MXFR2ZA2,R5ZA2,1
OPRF2ZA2,MXFR2ZA2,1
R11ZA2,R5ZA2,1
480VS2A1A,R11ZA2,1      480VS2A1A is alternate power to CHRGR1ZA2.

      Connection from shared charger's output relays to both bat. bd.'s.
R205ZA2,250VBBZA2,DUMAND1ZA2
TMOT4ZA2,R205ZA2,1
FUSE205ZA2,TMOT4ZA2,1
R1ZA2,FUSE205ZA2,1      R1ZA2 is a relay which enables power to flow to 250VBATZA2 from
                        the shared charger.  The charger is normally not connected to
                        either of the battery boards.
MINRLK1ZA,R1ZA2,1       These three lines are the connection between the shared and
TMOT5ZA,R1ZA2,1 unique components.  Shared components end in -ZA, unique in -ZA2.
MXFR1ZA,R1ZA2,1

      Connection from shared charger's output relays to both bat. bd.'s.
R205ZA1,250VBBZA1,DUMAND1ZA1
TMOT4ZA1,R205ZA1,1
FUSE205ZA1,TMOT4ZA1,1
R1ZA1,FUSE205ZA1,1      R1ZA1 is a relay which enables power to flow to 250VBATZA1 from
                        the shared charger.  The charger is normally not connected to
                        either of the battery boards.
MINRLK1ZA,R1ZA1,1       These three lines are the connection between the shared and
TMOT5ZA,R1ZA1,1 unique components.  Shared components end in -ZA, unique in -ZA1.
MXFR1ZA,R1ZA1,1

      Charger (shared)
OPRF1ZA,MXFR1ZA,1
R6ZA,TMOT5ZA,1
CHRGRSZA,R6ZA,1 CHRGRSZA is the shared charger.  It is modelled as being able
TMOT6ZA,CHRGRSZA,1 to support both battery boards simultaeously by itself.
R7ZA,TMOT6ZA,1
R8ZA,R7ZA,R9ZA  R8ZA and R9ZA are relays that enable the redundant power supplies
MINRLK3ZA,R8ZA,1        to the shared charger.  They are interlocked by MINRLK3ZA.
R12ZA,R8ZA,1
480VABCB,R12ZA,1        480VABCB is the 480v aux. bldg. comm. board, bus B.
R9ZA,R7ZA,R8ZA
MINRLK3ZA,R9ZA,1
MXFR3ZA,R9ZA,1
```

```
OPRF3ZA,MXFR3ZA,1
R13ZA,R9ZA,1
480VS1B2B,R13ZA,1       480VS1B2B is 480v shutdown board 1B2B.


       Input to 480 volt auxillary bldg. common board (TVA DWG. 15E500-1)
       The board is comprised of two busses.
MXFR31,R3,1     R3 (NO) connects Bus A to Bus B when closed.
OPRE2,MXFR31,1  OP- is operator who uses man. xfr 31 hardware to close R3.
480VABCB,R3,1   480VABCB is 480 volt aux. bld. comm. board bus B.
R1,R3,1         To connect ultimate sources to sinks.
R1,480VABCB,R3  R1 is relay in path from 6.9kv comm. bd. B.
TRBABC,R1,1     TRBABC is transformer.
R2,TRBABC,1
6900VCBB,R2,1   6900VCBB is 6900 volt common board B.
R1626,6900VCBB,R1216
6900VSBB,R1626,1        6900VSBB is 6900 volt start board B.
R1216,6900VCBB,R1626
AXFR9,R1216,MXFR30      AXFR- is automatic breaker closing hardware.
MXFR30,R1216,AXFR9      MXFR- is manual breaker closing hardware.
OPRE1,MXFR30,1          OPRE1 is operator who actuates with MXFR30.
USST2AY,R1216,1 USST2AY is unit station service transformer 2A, winding Y.
R3,480VABCB,R1

480VABCA,R3,1   480VABCA is 480 volt aux. bld. comm. board bus A.
R4,R3,1         To connect ultimate sources to sinks.
R4,480VABCA,R3
TRAABC,R4,1     TRAABC is transformer.
R5,TRAABC,1
6900VCBA,R5,1   6900VCBA is 6900 volt common board A.
R1526,6900VCBA,R1126
6900VSBA,R1526,1        6900VSBA is 6900 volt start board A.
R1126,6900VCBA,R1526
USST1BY,R1126,1 USST1BY is unit station service transformer 1B, winding Y.
AXFR10,R1126,MXFR32     AXFR- is automatic breaker closing hardware.
MXFR32,R1126,AXFR10     MXFR- is manual breaker closing hardware.
OPRE3,MXFR32,1          OPRE3 is operator who actuates with MXFR32.

R3,480VABCA,R4
```

```
ONSITE,GENDSL1BB,1
ONSITE,GENDSL1AA,1
ONSITE,GENDSL2BB,1
ONSITE,GENDSL2AA,1
```

```
ONSITE,MNGEN2,1

OFFSITE,161KV,1
OFFSITE,500KV,1


OPRREMOTE,OPRE42,1
OPRREMOTE,OPRE37,1
OPRREMOTE,OPRE36,1
OPRREMOTE,OPRE39,1
OPRREMOTE,OPRE40,1
OPRREMOTE,OPRE41,1
OPRREMOTE,OPRE38,1
OPRREMOTE,OPRE48,1
OPRREMOTE,OPRE47,1
OPRREMOTE,OPRE43,1
OPRREMOTE,OPRE45,1
OPRREMOTE,OPRE46,1
OPRREMOTE,OPRE49,1
OPRREMOTE,OPRE44,1
OPRREMOTE,OPRE22,1
OPRREMOTE,OPRE54,1
OPRREMOTE,OPRE23,1
OPRREMOTE,OPRE55,1
OPRREMOTE,OPRE24,1
OPRREMOTE,OPRE56,1
OPRREMOTE,OPRE25,1
OPRREMOTE,OPRE26,1
OPRREMOTE,OPRE27,1
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OPRREMOTE,OPRE30,1
OPRREMOTE,OPRE31,1
OPRREMOTE,OPRE32,1
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OPRREMOTE,OPRE34,1
OPRREMOTE,OPRE35,1
OPRREMOTE,OPRE42B,1
OPRREMOTE,OPRE37B,1
OPRREMOTE,OPRE36B,1
OPRREMOTE,OPRE39B,1
OPRREMOTE,OPRE40B,1
OPRREMOTE,OPRE41B,1
OPRREMOTE,OPRE38B,1
OPRREMOTE,OPRE48B,1
OPRREMOTE,OPRE47B,1
OPRREMOTE,OPRE43B,1
OPRREMOTE,OPRE45B,1
OPRREMOTE,OPRE46B,1
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OPRREMOTE,OPRE49B,1
OPRREMOTE,OPRE44B,1
OPRREMOTE,OPRE22B,1
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OPRREMOTE,OPRF6T,1
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OPRREMOTE,OPRF4U,1
OPRREMOTE,OPRF6U,1
OPRREMOTE,OPRF5U,1
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OPRREMOTE,OPRF6YV,1
OPRREMOTE,OPRF8YV,1
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OPRREMOTE,OPRF1RC,1
OPRREMOTE,OPRF1RD,1

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OPRLOCAL,OPRB53B,1
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OPRLOCAL,OPRC2YT,1
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OPRLOCAL,OPRL70196,1
OPRLOCAL,OPRL709,1
OPRLOCAL,OPRL7010,1
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OPRLOCAL,OPRA1RB,1
OPRLOCAL,OPRA1RC,1
OPRLOCAL,OPRA1RD,1

OPRMASTER,OPRREMOTE,1
OPRMASTER,OPRLOCAL,1
0,0,0
```

ADJACENCY INPUT FOR MOTOR OPERATED FLOW CONTROL VALVE UNIT MODEL

DATA FROM TVA DWG 45W760-63-8

```
;     To create a unique valve, change (VALVE) to valve number, POWER1
;     to motive power source, SILOGIC1 to logic train, and $ to component
;     index. If valve connects to SILOGIC, remove tabs in '*Connections...'.
;     This model is for a valve which must be opened.  If specific valve
;     is of same type, search for all 'closed$' and 'open$' and delete '$'.
;     If specific valve is of the opposite type, search out the words,
;     delete '$', and replace the words with their complements.
;
;     D E L E T E   A L L   L I N E S   B E G I N N I N G   W I T H   ";"

      ** FCV(VALVE) **
LINK1$,FCV(VALVE),1       LINK1$ is connection from MOT1$ to FCV(VALVE).  MOT1$
MOT1$,FCV(VALVE),OPRA1$ is the motor that moves valve plug FCV(VALVE).  OPRA1$
OPRA1$,FCV(VALVE),MOT1$ determines whether FCV(VALVE) is open or closed from
DUM13$,OPRA1$,1         flow data, valve position indicating lights, and
                        direction of resistance to cranking of LINK1$.
                        LINP1$ is the connection from the operator's hand
                        to the valve plug.  These valve status parameters
                        for local OP's are AND-ed inputs to DUM13$.
CON1$,MOT1$,1           CON1$ is wire connection.
SW51$,CON1$,1           SW51$, when closed, allows power to flow to MOT1$.
VMOT1$,SW51$,1          VMOT1$ is Variable Magnetic Overcurrent Trip.
R1$,VMOT1$,1            R1$ is a relay.
POWER1,R1$,1    POWER1 is process electrical power.
VHTR1$,MOT1$,1          VHTR1$ is valve heater.
DUM12$,VHTR1$,1
FUSE2$,DUM12$,FUSE1$    FUSE2$ is normal control power positive voltage fuse.
XFMR1$,FUSE2$,1         XFMR1$ is potential transformer.
XFMR1$,FUSE3$,1
FUSE4$,FUSE2$,1         FUSE4$ is normal control power negative voltage fuse.
XFMR1$,FUSE4$,1
FUSE3$,FUSE1$,1         FUSE3$ is auxillary control power neg. voltage fuse.
VMOT1$,XFMR1$,1
FUSE1$,DUM12$,FUSE2$    FUSE1$ is auxillary control power pos. voltage fuse.
XFMR1$,FUSE1$,1
SWX1$,FUSE1$,1          OPRF3$ monitors with LT5$ the power out of the control
OPRF3$,SWX1$,1          power fuse and can use SWX1$ to switch to the
LT5$,OPRF3$,DUM11$      auxillary fuse.  OPRF3$ also uses remote valve position
DUM11$,OPRF3$,LT5$      data DUM11$ to ascertain if valve can be actuated.
COIL1$,SW51$,1          COIL1$, when energized, closes SW51$.

SW54$,COIL1$,SW55$      COIL1$ can be energized iff valve is not fully open$
SW55$,COIL1$,SW54$      as determined by sense switch SW56$.
LINK1$,SW54$,1
LINK1$,SW55$,1
SW56$,SW55$,1           SW55$ is pos'n sense switch (closed iff valve closed$).
SW56$,SW54$,1           SW54$ is torque limit switch (open iff valve open$).
LINX1$,SW56$,1
SWB1$,SW56$,DUMAND51$   SWB1$ is local switch which electrically energizes
DUMAND51$,SW56$,SWB1$   COIL1$.
```

```
        *Connections for hardware connected to SILOGIC*
   Indented 1 tab since not used in SIPIS.  If used, remove tabs and
   indent the 2 lines of code above this insert.
       SWSI2$,SW56$,DUMAND56$  SWSI2$ closes upon receipt of SILOGIC signal.
       DUMAND56$,SW56$,SWSI2$  When SWSI2$ is closed, normal control power
       FUSE2$,SWSI2$,1         flows to SW56$ which closes SW51$.
       OPWF1$,SWA4$,1          OPWF1$ switches SWA4$ so that SWSI2$ is enabled
       SWA4$,SWSI2$,1          to close upon receipt of SILOGIC.
       SILOGIC1,SWSI2$,1
       SWB1$,DUMAND56$,DUMAND51$
       DUMAND51$,DUMAND56$,SWB1$

SWC1$,DUMAND51$,SWA1$   SWC1$ is auxillary remote control switch.
SWA1$,DUMAND51$,SWC1$   SWA1$ is normal remote control switch.
DSIINST,OPRF1$,1        DSIINST is safety injection indication instrumentation.
DSIINST,OPRA1$,1        All valve actuating operators need this input to
DSIINST,OPRF2$,1        know that injection is necessary.
DSIINST,OPRC1$,1

OPRC1$,SWB1$,1          OPRC1$ is local operator who ascertains valve position
DUM13$,OPRC1$,1         by inputs to DUM13$ (see comment in 3rd line).
DUM12$,SWB1$,1          SWB1$ is actuator for both normal and emerg. power.

       Inputs to DUM13$
LINK1$,DUMAND58$,DUMAND52$
DUMAND52$,DUMAND58$,LINK1$
DUMAND53$,DUM13$,DUM11$
DUM11$,DUM13$,DUMAND53$
FDATA1$,DUMAND53$,DUMAND58$
DUMAND58$,DUMAND53$,FDATA1$
LT4$,DUMAND52$,LT3$     LT3$ and LT4$ are valve position sensing lights located
LT3$,DUMAND52$,LT4$     next to the valve.

DUM12$,SW53$,1          SW53$ uses normal or auxillary control power.
SW53$,LT3$,1            SW53$ is valve pos'n sense switch (open iff valve not closed$).
LINK1$,SW53$,1          LINK1$ is connection of valve plug to SW52$ - SW56$
DUM12$,SW52$,1          SW52$ uses normal or auxillary control power.
SW52$,LT4$,1            SW52$ is valve pos'n sense switch (closed iff valve closed$).
LINK1$,SW52$,1

OPRF2$,SWC1$,1
FUSE1$,SWC1$,1          SWC1$ is actuator for emergency control power.
DUM11$,OPRF2$,1
OPRF1$,SWA1$,1
FUSE2$,SWA1$,1          SWA1$ is actuator for normal control power.
DUM11$,OPRF1$,1
```

```
      Inputs to DUM11$
LT1$,DUMAND54$,LT2$     LT1$, LT2$ are red and green valve plug position
SW53$,LT1$,1            indicator lights located in unit main control room.
LT2$,DUMAND54$,LT1$
SW52$,LT2$,1
DUMAND54$,DUMAND57$,OPRC1$
OPRC1$,DUMAND57$,DUMAND54$
DUMAND57$,DUMAND55$,OPRA1$
OPRA1$,DUMAND55$,DUMAND57$
DUMAND55$,DUM11$,FDATA1$
FDATA1$,DUM11$,DUMAND55$
0,0,0
```

ADJACENCY INPUT FOR SAFETY INJECTION LOGIC

DATA FROM TVA DWG. 47W611-63-1, FSAR FIG. 7.2-1, WESTINGHOUSE DWG. 108D408
Page numbers (e.g. PAGE 1) refer to digraph page number
Only header comments are consistent with two trains. Comments
on side are in Train A nomenclature only.

```
      ** PAGE 1 **
      SAFETY INJECTION SIGNAL (SIS) CENTRAL LOGIC

      Inputs to DSIINST follow. DSIINST is the control room intrumentation
      the operators monitor to determine if safety injection is needed.
      DSIINST is an input to all hardware which can be used to manually
      enable safety injection.
      The model is based upon a conversation with a TVA operator and upon
      Westinghouse dwg. 108D408. Four parameters are monitored: Press-
      urizer level, steam generator pressure, containment pressure,
      and pressurizer pressure. The first 3 parameters are displayed on
      PAM recorders, whereas pressurizer pressure is not (based on the dwg).
      Inputs to the model are 23 transducers and the model consists of
      one expanded 23 input AND-gate, since no data was available as to
      any prioritizing of the data being monitored.
DPLPAMS,DSIINST,DUMAND40        DPLPAMS is pressurizer level PAM's.
DUMAND40,DSIINST,DPLPAMS
DLCPPAMS,DUMAND40,DUMAND41      DLCPPAMS is lower containment pressure PAM's.
DUMAND41,DUMAND40,DLCPPAMS
DSGPPAMS,DUMAND41,DPPINST       DSGPPAMS is steam gen. pressure PAM's.
DPPINST,DUMAND41,DSGPPAMS       DPPINST is pressurizer press. instrumentation.
```

```
DUMAND42,DPPINST,PI458
DUMAND43,DUMAND42,PI457
PI455A,DUMAND43,PI456
PY455A,PI455A,1
PS455,PY455A,1
PI456,DUMAND43,PI455A
PY456A,PI456,1
PS456,PY456A,1
PI457,DUMAND42,DUMAND43
PY457A,PI457,1
PS457,PY457A,1
PI458,DPPINST,DUMAND42
PY458A,PI458,1
PS458,PY458A,1
        Inputs to DSGPPAMS
DUMAND44,DSGPPAMS,PI536A
DUMAND45,DUMAND44,PI526A
DUMAND46,DUMAND45,PI546A
DUMAND47,DUMAND46,PI516A
DUMAND48,DUMAND47,PI545A
DUMAND49,DUMAND48,PI525A
DUMAND50,DUMAND49,PI535A
DUMAND51,DUMAND50,PI515A
DUMAND52,DUMAND51,PI544A
DUMAND53,DUMAND52,PI534A
PI514A,DUMAND53,PI524A
PY514A,PI514A,1
PS514,PY514A,1
PI524A,DUMAND53,PI514A
PY524A,PI524A,1
PS524,PY524A,1
PI534A,DUMAND52,DUMAND53
PY534A,PI534A,1
PS534,PY534A,1
PI544A,DUMAND51,DUMAND52
PY544A,PI544A,1
PS544,PY544A,1
PI515A,DUMAND50,DUMAND51
PY515A,PI515A,1
PS515,PY515A,1
PI535A,DUMAND49,DUMAND50
PY535A,PI535A,1
PS535,PY535A,1
PI525A,DUMAND48,DUMAND49
PY525A,PI525A,1
PS525,PY525A,1
PI545A,DUMAND47,DUMAND48
PY545A,PI545A,1
```

```
PS545,PY545A,1
PI516A,DUMAND46,DUMAND47
PY516C,PI516A,1
PS516,PY516C,1
PI546A,DUMAND45,DUMAND46
PY546C,PI546A,1
PS546,PY546C,1
PI526A,DUMAND44,DUMAND45
PY526C,PI526A,1
PS526,PY526C,1
PI536A,DSGPPAMS,DUMAND44
PY536C,PI536A,1
PS536,PY536C,1
        Inputs to DLCPPAMS
DUMAND54,DLCPPAMS,PI937
DUMAND55,DUMAND54,PI936
PI934,DUMAND55,PI935
PY934A,PI934,1
PS934,PY934A,1
PI935,DUMAND55,PI934
PY935A,PI935,1
PS935,PY935A,1
PI936,DUMAND54,DUMAND55
PY936A,PI936,1
PS936,PY936A,1
PI937,DLCPPAMS,DUMAND54
PY937A,PI937,1
PS937,PY937A,1
        Inputs to DPLPAMS
DUMAND56,DPLPAMS,LI461
LI459A,DUMAND56,LI460A
LY459C,LI459A,1
LS459,LY459C,1
LT459,LS459,1
PSI,LT459,1             PS- is protection set power supply.
LI460A,DUMAND56,LI459A
LY460C,LI460A,1
LS460,LY460C,1
LT460,LS460,1
PSII,LT460,1
LI461,DPLPAMS,DUMAND56
LY461C,LI461,1
LS461,LY461C,1
LT461,LS461,1
PSIII,LT461,1
```

```
        Train A central logic.
SW1A,SISI6A,1           SW1A is SIS actuation switch.  SISI6A is train A SIS.
AND7A,SW1A,1
SW4A,AND7A,1            SW4A, operated by OPWF2Ø,resets SW1A after time delay.
DSIINST,OPWF2Ø,1        OPWF2Ø resets SW1A (i.e., turns off SISI6A) on the
OPWF2Ø,SW4A,1           basis of DSIINST.
SW1A,TIMDEL1A,1         TIMDEL1A is a 1-2 minute signal delay.
TIMDEL1A,AND7A,1
AND7A,OR11A,AND8A
AND8A,OR11A,AND7A
OR11A,AND8A,1
RCTRP1A,AND8A,1         RCTRP1A is train A reactor trip signal.
AND8A,NOT6A,1
NOT6A,AND1A,1

        Manual safety injection signal actuation logic and connections
        of the instrumentation and bistable networks to SW1A.
        Networks monitor pressurizer pressure, main steam lines,
        steam line differential pressure, and hi containment pressure.
OR1A,SW1A,1
OR1,OR1A,AND1A          OR1 comes from manual SIS actuation logic.
AND1A,OR1A,OR1
SW5,OR1,SW6             Either SW5 or SW6 can actuate SIS.
DSIINST,OPRF11,1        OPRF11 knows to manually actaute from DSIINST.
OPRF11,SW5,1            OPRF11 operates SW5, OPRF12 operates SW6.
SW6,OR1,SW5
DSIINST,OPRF12,1        OPRF12 knows to manually actuate from DSIINST.
OPRF12,SW6,1
OR2A,AND1A,1            OR2A is junction of all network inputs.
      Expanded AND-gate of all inputs to OR2A
AND2A,OR2A,DUMAND1A     AND2A is junction of all pressurizer pressure inputs.
DUMAND1A,OR2A,AND2A
AND5A,DUMAND1A,DUMAND2A AND5A is junction of all main steam line inputs.
DUMAND2A,DUMAND1A,AND5A
OR1ØA,DUMAND2A,2OF3C7A  2OF3C7A is hi containment pressure.
2OF3C7A,DUMAND2A,OR1ØA
      Connections of steam line networks to AND5A
NOT4A,AND5A,1
AND4A,AND5A,1
OR8A,AND4A,1
2OF4C2A,OR8A,2OF4C3A    2OF4C2A is low steam line pressure.
2OF4C3A,OR8A,2OF4C2A    2OF4C3A is steam line lo lo average temperature.
2OF4C1A,AND4A,1         2OF4C1A is hi steam line flow.
```

```
       Train B central logic.
SW1B,SISI6B,1          SW1A is SIS actuation switch.  SISI6A is train A SIS.
AND7B,SW1B,1
SW4B,AND7B,1           SW4A, operated by OPWF2Ø, resets SW1A after time delay.
OPWF2Ø,SW4B,1
SW1B,TIMDEL1B,1        TIMDEL1A is a 1-2 minute signal delay.
TIMDEL1B,AND7B,1
AND7B,OR11B,AND8B
AND8B,OR11B,AND7B
OR11B,AND8B,1
RCTRP1B,AND8B,1        RCTRP1A is train A reactor trip signal.
AND8B,NOT6B,1
NOT6B,AND1B,1
OR1B,SW1B,1
OR1,OR1B,AWD1B         OR1 comes from manual SIS actuation logic.
AND1B,OR1B,OR1

OR2B,AND1B,1           OR2A is junction of all network inputs.
       Expanded AND-gate of all inputs to OR2A
AND2B,OR2B,DUMAND1B    AND2A is junction of all pressurizer pressure inputs.
DUMAND1B,OR2B,AND2B
AND5B,DUMAND1B,DUMAND2B AND5A is junction of all main steam line inputs.
DUMAND2B,DUMAND1B,AND5B
OR1ØB,DUMAND2B,2OF3C7B  2OF3C7A is hi containment pressure.
2OF3C7B,DUMAND2B,OR1ØB
       Connections of steam line networks to AND5A
NOT4B,AND5B,1
AND4B,AND5B,1
OR8B,AND4B,1
2OF4C2B,OR8B,2OF4C3B   2OF4C2A is low steam line pressure.
2OF4C3B,OR8B,2OF4C2B   2OF4C3A is steam line lo lo average temperature.
2OF4C1B,AND4B,1        2OF4C1A is hi steam line flow.

       ** PAGE 2 **
       PRESSURIZER PRESSURE INSTRUMENTATION AND BISTABLE LOGIC NETWORKS

       Train A logic.
NOT1A,AND2A,1          Inputs to AND2A are lo press. pressure and hi
AND3A,NOT1A,1          press. pressure (which has a manual block/reset).
NOT2A,AND3A,1          AND3A is connected to block/reset.
SW2A,NOT2A,1           SW2A is block/reset switch.
OPWF13,SW2A,1          OPWF13 operates SW2A.
SW2A,OR3A,AND3A
AND3A,OR3A,SW2A
OR3A,AND3A,1
NOT3A,AND3A,1          Input '   NT3A is hi pressurizer pressure.
2OF3C2A,NOT3A,1
```

```
        Train B logic.
NOT1B,AND2B,1           Inputs to AND2A are lo press. pressure and hi
AND3B,NOT1B,1           press. pressure (which has a manual block/reset).
NOT2B,AND3B,1           AND3A is connected to block/reset.
SW2B,NOT2B,1            SW2A is block/reset switch.
OPWF13,SW2B,1           OPWF13 operates SW2A.
SW2B,OR3B,AND3B
AND3B,OR3B,SW2B
OR3B,AND3B,1
NOT3B,AND3B,1           Input to NOT3A is hi pressurizer pressure.
2OF3C2B,NOT3B,1

        Note on component nomenclature:
        Components are coded with the 6 character label (A1)(A2)(NNN)(A3)
        of which the first two characters are the useful descriptors. A1
        is the parameter being monitored with P=Pressure, F=Flow, L=Level, and
        T=Temperature.  A2 is the type of component with B=Bistable,
        L=Light, S=Switch, and T=Transducer.

        Expanded 2/3 coincidence gates 2OF3C2A and 2OF3C2B
PS455B,2OF3C2A,PS456B
PS455B,2OF3C2B,PS456B
PB455B,PS455B,1         Each bistable can be disabled if OPW- switches it to
OPRF455B,PS455B,OPWF14  test mode AND if OPR- fails to re-enable or if the
OPWF14,PS455B,OPRF455B  test mode light fails to indicate that bistable is in
PL455B,OPRF455B,1       test mode.
PS455,PB455B,1
PT455,PS455,1
PSI,PT455,1
PS456B,2OF3C2A,PS455B
PS456B,2OF3C2B,PS455B
PB456B,PS456B,1
OPRF456B,PS456B,OPWF14
OPWF14,PS456B,OPRF456B
PL456B,OPRF456B,1
PS456,PB456B,1
PT456,PS456,1
PSII,PT456,1
PS455B,2OF3C2A,PS457B
PS455B,2OF3C2B,PS457B
PB457B,PS457B,1
OPRF457B,PS457B,OPWF14
OPWF14,PS457B,OPRF457B
PL457B,OPRF457B,1
PS457,PB457B,1
PT457,PS457,1
PSIII,PT457,1
PS457B,2OF3C2A,PS455B
PS457B,2OF3C2B,PS455B
```

```
PS456B,2OF3C2A,PS457B
PS456B,2OF3C2B,PS457B
PS457B,2OF3C2A,PS456B
PS457B,2OF3C2B,PS456B

2OF3C1A,AND2A,1          Input to 2OF3C1A is lo pressurizer pressure.
2OF3C1B,AND2B,1
        Expanded 2/3 coincidence gate 2OF3C1A,B
PS457D,2OF3C1A,PS455D
PS457D,2OF3C1B,PS455D
PB457D,PS457D,1
OPRF457D,PS457D,OPWF15
OPWF15,PS457D,OPRF457D
PL457D,OPRF457D,1
PS457,PB457D,1
PS455D,2OF3C1A,PS457D
PS455D,2OF3C1B,PS457D
PB455D,PS455D,1
OPRF455D,PS455D,OPWF15
OPWF15,PS455D,OPRF455D
PL455D,OPRF455D,1
PS455,PB455D,1
PS457D,2OF3C1A,PS456D
PS457D,2OF3C1B,PS456D
PB456D,PS456D,1
OPRF456D,PS456D,OPWF15
OPWF15,PS456D,OPRF456D
PL456D,OPRF456D,1
PS456,PB456D,1
PS456D,2OF3C1A,PS457D
PS456D,2OF3C1B,PS457D
PS455D,2OF3C1A,PS456D
PS455D,2OF3C1B,PS456D
PS456D,2OF3C1A,PS455D
PS456D,2OF3C1B,PS455D

        ;; PAGE 3 **
        HI MAIN STEAM LINE FLOW INSTRUMENTATION AND BISTABLE LOGIC
        Expanded 2/4 coincidence gate 2OF4C1A,B.  Failure orientation is
        based upon failure of any three inputs.
OR4A,DUMAND3A,OR5A
OR5A,DUMAND3A,OR4A
DUMAND3A,2OF4C1A,OR6A
OR6A,2OF4C1A,DUMAND3A
OR4A,DUMAND4A,OR5A
OR5A,DUMAND4A,OR4A
DUMAND4A,2OF4C1A,OR7A
OR7A,2OF4C1A,DUMAND4A
OR4A,2OF4C1A,DUMAND5A
```

```
DUMAND5A,2OF4C1A,OR4A
OR6A,DUMAND5A,OR7A
OR7A,DUMAND5A,OR6A
OR5A,2OF4C1A,DUMAND6A
DUMAND6A,2OF4C1A,OR5A
OR6A,DUMAND6A,OR7A
OR7A,DUMAND6A,OR6A

OR4B,DUMAND3B,OR5B
OR5B,DUMAND3B,OR4B
DUMAND3B,2OF4C1B,OR6B
OR6B,2OF4C1B,DUMAND3B
OR4B,DUMAND4B,OR5B
OR5B,DUMAND4B,OR4B
DUMAND4B,2OF4C1B,OR7B
OR7B,2OF4C1B,DUMAND4B
OR4B,2OF4C1B,DUMAND5B
DUMAND5B,2OF4C1B,OR4B
OR6B,DUMAND5B,OR7B
OR7B,DUMAND5B,OR6B
OR5B,2OF4C1B,DUMAND6B
DUMAND6B,2OF4C1B,OR5B
OR6B,DUMAND6B,OR7B
OR7B,DUMAND6B,OR6B

FS522B,OR4A,FS523B
FS522B,OR4B,FS523B
FB522B,FS522B,1
OPRF522B,FS522B,OPWF15
OPWF15,FS522B,OPRF522B
FL522B,OPRF522B,1
FS522,FB522B,1
FS522,FT522,1
PSI,FT522,1
FS523B,OR4A,FS522B
FS523B,OR4B,FS522B
FB523B,FS523B,1
OPRF523B,FS523B,OPWF15
OPWF15,FS523B,OPRF523B
FL523B,OPRF523B,1
FS523,FB523B,1
FS523,FT523,1
PSII,FT523,1
```

```
FS512B,OR5A,FS513B
FS512B,OR5B,FS513B
FB512B,FS512B,1
OPRF512B,FS512B,OPWF15
OPWF15,FS512B,OPRF512B
FL512B,OPRF512B,1
FS512,FB512B,1
FS512,FT512,1
PSI,FT512,1
FS513B,OR5A,FS512B
FS513B,OR5B,FS512B
FB513B,FS513B,1
OPRF513B,FS513B,OPWF15
OPWF15,FS513B,OPRF513B
FL513B,OPRF513B,1
FS513,FB513B,1
FS513,FT513,1
PSII,FT513,1

FS532B,OR6A,FS533B
FS532B,OR6B,FS533B
FB532B,FS532B,1
OPRF532B,FS532B,OPWF15
OPWF15,FS532B,OPRF532B
FL532B,OPRF532B,1
FS532,FB532B,1
FS532,FT532,1
PSI,FT532,1
FS533B,OR6A,FS532B
FS533B,OR6B,FS532B
FB533B,FS533B,1
OPRF533B,FS533B,OPWF15
OPWF15,FS533B,OPRF533B
FL533B,OPRF533B,1
FS533,FB533B,1
FS533,FT533,1
PSII,FT533,1

FS542B,OR7A,FS543B
FS542B,OR7B,FS543B
FB542B,FS542B,1
OPRF542B,FS542B,OPWF15
OPWF15,FS542B,OPRF542B
FL542B,OPRF542B,1
FS542,FB542B,1
FS542,FT542,1
PSI,FT542,1
FS543B,OR7A,FS542B
FS543B,OR7B,FS542B
```

```
FB543B,FS543B,1
OPRF543B,FS543B,OPWF15
OPWF15,FS543B,OPRF543B
FL543B,OPRF543B,1
FS543,FB543B,1
FS543,FT543,1
PSII,FT543,1
```

** PAGE 4 **

LO MAIN STEAM LINE PRESSURE INSTRUMENTATION AND BISTABLE LOGIC

Expanded 2/4 coincidence gate 2OF4C2A. Failure orientation is based upon failure of any three inputs.

```
PS516A,DUMAND7A,PS526A
PS526A,DUMAND7A,PS516A
DUMAND7A,2OF4C2A,PS536A
PS536A,2OF4C2A,DUMAND7A
PS516A,DUMAND8A,PS526A
PS526A,DUMAND8A,PS516A
DUMAND8A,2OF4C2A,PS546A
PS546A,2OF4C2A,DUMAND8A
PS516A,DUMAND9A,PS536A
PS536A,DUMAND9A,PS516A
DUMAND9A,2OF4C2A,PS546A
PS546A,2OF4C2A,DUMAND9A
PS526A,DUMAND10A,PS536A
PS536A,DUMAND10A,PS526A
DUMAND10A,2OF4C2A,PS546A
PS546A,2OF4C2A,DUMAND10A
PS516A,DUMAND7B,PS526A
PS526A,DUMAND7B,PS516A
DUMAND7B,2OF4C2B,PS536A
PS536A,2OF4C2B,DUMAND7B
PS516A,DUMAND8B,PS526A
PS526A,DUMAND8B,PS516A
DUMAND8B,2OF4C2B,PS546A
PS546A,2OF4C2B,DUMAND8B
PS516A,DUMAND9B,PS536A
PS536A,DUMAND9B,PS516A
DUMAND9B,2OF4C2B,PS546A
PS546A,2OF4C2B,DUMAND9B
PS526A,DUMAND10B,PS536A
PS536A,DUMAND10B,PS526A
DUMAND10B,2OF4C2B,PS546A
PS546A,2OF4C2B,DUMAND10B

PB516A,PS516A,1
OPRF516A,PS516A,OPWF16
OPWF16,PS516A,OPRF516A
```

```
PL516A,OPRF516A,1
PS516,PB516A,1
PT516,PS516,1
PSIV,PT516,1

PB526A,PS526A,1
OPRF526A,PS526A,OPWF16
OPWF16,PS526A,OPRF526A
PL526A,OPRF526A,1
PS526,PB526A,1
PT526,PS526,1
PSIII,PT526,1

PB536A,PS536A,1
OPRF536A,PS536A,OPWF16
OPWF16,PS536A,OPRF536A
PL536A,OPRF536A,1
PS536,PB536A,1
PT536,PS536,1
PSIII,PT536,1

PB546A,PS546A,1
OPWF16,PS546A,OPRF546A
OPRF546A,PS546A,OPWF16
PL546A,OPRF546A,1
PS546,PB546A,1
PT546,PS546,1
PSIV,PT546,1

        ** PAGE 5 **
        LO LO MAIN STEAM LINE Tavg AND MANUAL BLOCK/RESET LOGIC
AND6A,NOT4A,1           Inputs to AND6A are from lo lo Tavg and blk/reset.
NOT5A,AND6A,1
SW3A,NOT5A,1
OPWF18,SW3A,1           OPWF18 operates blk/reset switch SW3A.
SW3A,OR9A,AND6A
AND6A,OR9A,SW3A
OR9A,AND6A,1
2OF4C3A,AND6A,1         Input to 2OF4C3A is lo lo Tavg.

        Expanded 2/3 coincidence gate 2OF4C3A
TS412D,DUMAND11A,TS422D
TS422D,DUMAND11A,TS412D
DUMAND11A,2OF4C3A,TS432D
TS432D,2OF4C3A,DUMAND11A
TS412D,DUMAND12A,TS422D
TS422D,DUMAND12A,TS412D
DUMAND12A,2OF4C3A,TS442D
TS442D,2OF4C3A,DUMAND12A
```

```
TS412D,DUMAND13A,TS432D
TS432D,DUMAND13A,TS412D
DUMAND13A,2OF4C3A,TS442D
TS442D,2OF4C3A,DUMAND13A
TS422D,DUMAND14A,TS432D
TS432D,DUMAND14A,TS422D
DUMAND14A,2OF4C3A,TS442D
TS442D,2OF4C3A,DUMAND14A

AND6B,NOT4B,1          Inputs to AND6A are from lo lo Tavg and blk/reset.
NOT5B,AND6B,1
SW3B,NOT5B,1
OPWF18,SW3B,1          OPWF18 operates blk/reset switch SW3A.
SW3B,OR9B,AND6B
AND6B,OR9B,SW3B
OR9B,AND6B,1
2OF4C3B,AND6B,1        Input to 2OF4C3A is lo lo Tavg.

      Expanded 2/3 coincidence gate 2OF4C3B
TS412D,DUMAND11B,TS422D
TS422D,DUMAND11B,TS412D
DUMAND11B,2OF4C3B,TS432D
TS432D,2OF4C3B,DUMAND11B
TS412D,DUMAND12B,TS422D
TS422D,DUMAND12B,TS412D
DUMAND12B,2OF4C3B,TS442D
TS442D,2OF4C3B,DUMAND12B
TS412D,DUMAND13B,TS432D
TS432D,DUMAND13B,TS412D
DUMAND13B,2OF4C3B,TS442D
TS442D,2OF4C3B,DUMAND13B
TS422D,DUMAND14B,TS432D
TS432D,DUMAND14B,TS422D
DUMAND14B,2OF4C3B,TS442D
TS442D,2OF4C3B,DUMAND14B

TB412D,TS412D,1
OPWF17,TS412D,OPRF412D
OPRF412D,TS412D,OPWF17
TL412D,OPRF412D,1
TS411A,SI61,1
SI61,TB412D,1
TE411A,TS411A,1
TS411B,SI61,1
SI61,TB412D,1
TE411B,TS411B,1
PSI,TE411A,1
PSI,TE411B,1
```

```
TB422D,TS422D,1
OPWF17,TS422D,OPRF422D
OPRF422D,TS422D,OPWF17
TL422D,OPRF422D,1
TS421A,SI62,1
SI62,TB422D,1
TE421A,TS421A,1
TS421B,SI62,1
SI62,TB422D,1
TE421B,TS421B,1
PSII,TE421A,1
PSII,TE421B,1

TB432D,TS432D,1
OPWF17,TS432D,OPRF432D
OPRF432D,TS432D,OPWF17
TL432D,OPRF432D,1
TS431A,SI63,1
SI63,TB432D,1
TE431A,TS431A,1
TS431B,SI63,1
SI63,TB432D,1
TE431B,TS431B,1
PSIII,TE431A,1
PSIII,TE431B,1

TB442D,TS442D,1
OPWF17,TS442D,OPRF442D
OPRF442D,TS442D,OPWF17
TL442D,OPRF442D,1
TS441A,SI64,1
SI64,TB442D,1
TE441A,TS441A,1
TS441B,SI64,1
SI64,TB442D,1
TE441B,TS441B,1
PSIV,TE441A,1
PSIV,TE441B,1
```

STEAM LINE DIFFERENTIAL PRESSURE INSTRUMENTATION AND BISTABLE LOGIC

Expanded AND-gate for OR1@A. Inputs are four 2/3 coincidence gates.

```
2OF3C3A,DUMAND15A,2OF3C5A
2OF3C5A,DUMAND15A,2OF3C3A
DUMAND15A,DUMAND16A,2OF3C6A
2OF3C6A,DUMAND16A,DUMAND15A
DUMAND16A,OR1@A,2OF3C4A
2OF3C4A,OR1@A,DUMAND16A
2OF3C3B,DUMAND15B,2OF3C5B
2OF3C5B,DUMAND15B,2OF3C3B
DUMAND15B,DUMAND16B,2OF3C6B
2OF3C6B,DUMAND16B,DUMAND15B
DUMAND16B,OR1@B,2OF3C4B
2OF3C4B,OR1@B,DUMAND16B
```

Expanded 2/3 coincidence gate 2OF3C3A,B

```
PS514A,2OF3C3A,PS515A
PS514A,2OF3C3B,PS515A
PB514A,PS514A,1
OPWF18,PS514A,OPRF514A
OPRF514A,PS514A,OPWF18
PL514A,OPRF514A,1
PS514,PB514A,1
PT514,PS514,1
PT524,PS524,1
PS524,PB514A,1
PSI,PT514,1
PSI,PT524,1
PS515A,2OF3C3A,PS514A
PS515A,2OF3C3B,PS514A
PB515A,PS515A,1
OPWF18,PS515A,OPRF515A
OPRF515A,PS515A,OPWF18
PL515A,OPRF515A,1
PS515,PB515A,1
PT515,PS515,1
PT535,PS535,1
PS535,PB515A,1
PSII,PT515,1
PSII,PT535,1
PS514A,2OF3C3A,PS516C
PS514A,2OF3C3B,PS516C
PS516C,2OF3C3A,PS514A
PS516C,2OF3C3B,PS514A
PB516C,PS516C,1
OPWF18,PS516C,OPRF516C
OPRF516C,PS516C,OPWF18
PL516C,OPRF516C,1
```

```
PS516,PB516C,1
PT516,PS516,1
PT546,PS546,1
PS546,PB516C,1
PSIV,PT516,1
PSIV,PT546,1
PS515A,2OF3C3A,PS516C
PS515A,2OF3C3B,PS516C
PS516C,2OF3C3A,PS515A
PS516C,2OF3C3B,PS515A
```

Expanded 2/3 coincidence gate 2OF3C5A,B

```
PS534A,2OF3C5A,PS515B
PS534A,2OF3C5B,PS515B
PB534A,PS534A,1
OPWF18,PS534A,OPRF534A
OPRF534A,PS534A,OPWF18
PL534A,OPRF534A,1
PS534,PB534A,1
PT534,PS534,1
PT544,PS544,1
PS544,PB534A,1
PSI,PT534,1
PSI,PT544,1
PS515B,2OF3C5A,PS534A
PS515B,2OF3C5B,PS534A
PB515B,PS515B,1
OPWF18,PS515B,OPRF515B
OPRF515B,PS515B,OPWF18
PL515B,OPRF515B,1
PS515,PB515B,1
PT515,PS515,1
PT535,PS535,1
PS535,PB515B,1
PSII,PT515,1
PSII,PT535,1
PS534A,2OF3C5A,PS526D
PS534A,2OF3C5B,PS526D
PB526D,PS526D,1
OPWF18,PS526D,OPRF526D
OPRF526D,PS526D,OPWF18
PL526D,OPRF526D,1
PS526,PB526D,1
PT526,PS526,1
PT536,PS536,1
PS536,PB526D,1
PSIII,PT526,1
PSIII,PT536,1
PS526D,2OF3C5A,PS534A
```

```
PS526D,2OF3C5B,PS534A
PS515B,2OF3C5A,PS526D
PS515B,2OF3C5B,PS526D
PS526D,2OF3C5A,PS515B
PS526D,2OF3C5B,PS515P

        Expanded 2/3 coincidence gate 2OF3C6A,B
PS534B,2OF3C6A,PS525B
PS534B,2OF3C6B,PS525B
PB534B,PS534B,1
OPWF18,PS534B,OPRF534B
OPRF534B,PS534B,OPWF18
PL534B,OPRF534B,1
PS534,PB534B,1
PT534,PS534,1
PT544,PS544,1
PS544,PB534B,1
PSI,PT534,1
PSI,PT544,1
PS525B,2OF3C6A,PS534B
PS525B,2OF3C6B,PS534B
PB525B,PS525B,1
OPWF18,PS525B,OPRF525B
OPRF525B,PS525B,OPWF18
PL525B,OPRF525B,1
PS525,PB525B,1
PT525,PS525,1
PT545,PS545,1
PS545,PB525B,1
PSII,PT525,1
PSII,PT545,1
PS534B,2OF3C6A,PS516D
PS534B,2OF3C6B,PS516D
PB516D,PS516D,1
OPWF18,PS516D,OPRF516D
OPRF516D,PS516D,OPWF18
PL516D,OPRF516D,1
PS516,PB516D,1
PT516,PS516,1
PT546,PS546,1
PS546,PB516D,1
PSIV,PT516,1
PSIV,PT546,1
PS516D,2OF3C6A,PS534B
PS516D,2OF3C6B,PS534B
PS525B,2OF3C6A,PS516D
PS525B,2OF3C6B,PS516D
PS516D,2OF3C6A,PS525B
PS516D,2OF3C6B,PS525B
```

Expanded 2/3 coincidence gate 2OF3C4A,B

```
PS514B,2OF3C4A,PS525A
PS514B,2OF3C4B,PS525A
PB514B,PS514B,1
OPWF18,PS514B,OPRF514B
OPRF514B,PS514B,OPWF18
PL514B,OPRF514B,1
PS514,PB514B,1
PT514,PS514,1
PT524,PS524,1
PS324,PB514B,1
PSI,PT514,1
PSI,PT524,1
PS525A,2OF3C4A,PS514B
PS525A,2OF3C4B,PS514B
PB525A,PS525A,1
OPWF18,PS525A,OPRF525A
OPRF525A,PS525A,OPWF18
PL525A,OPRF525A,1
PS545,PB525A,1
PT545,PS545,1
PT525,PS525,1
PS525,PB525A,1
PSII,PT545,1
PSII,PT525,1
PS514B,2OF3C4A,PS526C
PS514B,2OF3C4B,PS526C
PB526C,PS526C,1
OPWF18,PS526C,OPRF526C
OPRF526C,PS526C,OPWF18
PL526C,OPRF526C,1
PS526,PB526C,1
PT526,PS526,1
PT536,PS536,1
PS536,PB526C,1
PSIII,PT526,1
PSIII,PT536,1
PS526C,2OF3C4A,PS514B
PS526C,2OF3C4B,PS514B
PS525A,2OF3C4A,PS526C
PS525A,2OF3C4B,PS526C
PS526C,2OF3C4A,PS525A
PS526C,2OF3C4B,PS525A
```

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        ** PAGE 7 **
        HI CONTAINMENT PRESSURE INSTRUMENTATION AND BISTABLE LOGIC
        Expanded 2/3 coincidence gate 2OF3C7A,B
PS936B,2OF3C7A,PS935B
PS936B,2OF3C7B,PS935B
PB936B,PS936B,1
OPWF19,PS936B,OPRF936B
OPRF936B,PS936B,OPWF19
PL936B,OPRF936B,1
PS936,PB936B,1
PT936,PS936,1
PSII,PT936,1
PS935B,2OF3C7A,PS936B
PS935B,2OF3C7B,PS936B
PB935B,PS935B,1
OPWF19,PS935B,OPRF935B
OPRF935B,PS935B,OPWF19
PL935B,OPRF935B,1
PS935,PB935B,1
PT935,PS935,1
PSIII,PT935,1
PS936B,2OF3C7A,PS934B
PS936B,2OF3C7B,PS934B
PB934B,PS934B,1
OPWF19,PS934B,OPRF934B
OPRF934B,PS934B,OPWF19
PL934B,OPRF934B,1
PS934,PB934B,1
PT934,PS934,1
PSIV,PT934,1
PS934B,2OF3C7A,PS936B
PS934B,2OF3C7B,PS936B
PS935B,2OF3C7A,PS934B
PS935B,2OF3C7B,PS934B
PS934B,2OF3C7A,PS935B
PS934B,2OF3C7B,PS935B
0,0,0
```

APPENDIX D

PROBABILITY DATA BASE

COMPONENT	GENERIC TYPE	# OF FAILURE MODES	PROBABILITY OF EACH FAILURE MODE			
CCP1AA	PUMPA	4	0.50E-03	0.10E-04	0.10E-02	0.80E-02
VGA62509	VNO	3	0.14E-07	0.10E-02	0.80E-02	
OILCOOLS	OILCL	1	0.10E-03			
VGL553A	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VGL552A	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VGL554A	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VGL557A	VNO	3	0.14E-07	0.10E-02	0.80E-02	
CCP1BB	PUMPA	4	0.50E-03	0.10E-04	0.10E-02	0.80E-02
VGA62510	VNO	3	0.14E-07	0.10E-02	0.80E-02	
OILCOOLT	OILCL	1	0.10E-03			
VGL553B	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VGL552B	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VGL554B	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VGL557B	VNO	3	0.14E-07	0.10E-02	0.80E-02	
480MOV1B1B	BUS	1	0.32E-09			
SISIGA	SIMRLY	2	0.49E-06	0.10E-02		
480MOV1A1A	BUS	1	0.32E-09			
OPWF5S	OPW	1	0.10E-02			
FUSE10I	FUSE	1	0.11E-08			
6900VS1BB	BUS	1	0.32E-09			
OPWF5T	OPW	1	0.10E-02			
FUSE10IV	FUSE	1	0.11E-08			
FUSE10II	FUSE	1	0.11E-08			
OPWF5U	OPW	1	0.10E-02			
OPWF5V	OPW	1	0.10E-02			
CCWPCS	PUMPA	4	0.50E-03	0.10E-04	0.10E-02	0.80E-02
CCWP1AA	PUMPNO	3	0.10E-04	0.10E-02	0.80E-02	
FCV7012	VNO	3	0.14E-07	0.10E-02	0.80E-02	
CCHXRC	HXR	1	0.23E-05			
VB070510	VNO	3	0.14E-07	0.10E-02	0.80E-02	
FCV708	VNO	3	0.14E-07	0.10E-02	0.80E-02	
CCHXRA	HXR	1	0.23E-05			
VB170510	VNO	3	0.14E-07	0.10E-02	0.80E-02	
FCV7025	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VB170505A	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VB070505	VNO	3	0.14E-07	0.10E-02	0.80E-02	
FCV7022	VNO	3	0.14E-07	0.10E-02	0.80E-02	
STRAINR1AA	STRANR	1	0.80E-02			
VB170503A	VNO	3	0.14E-07	0.10E-02	0.80E-02	
VC070504	VCAO	1	0.10E-03			
STRAINRCS	STRANR	1	0.80E-02			
VB070503	VNO	3	0.14E-07	0.10E-02	0.80E-02	
480VS1A1A	BUS	1	0.32E-09			
R50	BKRNC	2	0.15E-08	0.10E-02		
TR1A1A	XFRMR	1	0.72E-07			
R49	BKRNC	2	0.15E-08	0.10E-02		
480VS1B1B	BUS	1	0.32E-09			

NOTE: See Page 107 of Volume I for detailed explanation.

R31	BKRNC	2	0.15E-08	0.10E-02			
TR1B1B	XFRMR	1	0.72E-07				
R30	BKRNC	2	0.15E-08	0.10E-02			
R2YSWG1	BKRNC	2	0.15E-08	0.10E-02			
480VS2B2B	BUS	1	0.32E-09				
R19B	BKRNC	2	0.15E-08	0.10E-02			
TR2B2B	XFRMR	1	0.72E-07				
R18B	BKRNC	2	0.15E-08	0.10E-02			
OPWF5YS	OPW	1	0.10E-02				
R32	BKRNC	2	0.15E-08	0.10E-02			
R33	BKRNC	2	0.15E-08	0.10E-02			
R51	BKRNC	2	0.15E-08	0.10E-02			
R53	BKRNC	2	0.15E-08	0.10E-02			
6900VS2BB	BUS	1	0.32E-09				
EINRLK31	AXFRA	1	0.50E-06				
EINRLK50	AXFRA	1	0.50E-06				
EINRLK1726	AXFRA	1	0.50E-06				
EINRLK1718	AXFRA	1	0.50E-06				
SIP1AA	PUMPA	4	0.50E-03	0.10E-04	0.10E-02	0.80E-02	
OILCOOLU	OILCL	1	0.10E-03				
VGL558A	VNO	3	0.14E-07	0.10E-02	0.80E-02		
VGL562A	VNO	3	0.14E-07	0.10E-02	0.80E-02		
VGA170725A	VNO	3	0.14E-07	0.10E-02	0.80E-02		
SIP1BB	PUMPA	4	0.50E-03	0.10E-04	0.10E-02	0.80E-02	
OILCOOLV	OILCL	1	0.10E-03				
VGL558B	VNO	3	0.14E-07	0.10E-02	0.80E-02		
VGL562B	VNO	3	0.14E-07	0.10E-02	0.80E-02		
VGA170725B	VNO	3	0.14E-07	0.10E-02	0.80E-02		
VGA63527	VNO	3	0.14E-07	0.10E-02	0.80E-02		
VC63526	VCAO	1	0.10E-03				
VGA63525	VNO	3	0.14E-07	0.10E-02	0.80E-02		
VC63524	VCAO	1	0.10E-03				
6900VS1AA	BUS	1	0.32E-09				
6900VS1BB	BUS	1	0.32E-09				
FCV1703	VNO	3	0.14E-07	0.10E-02	0.80E-02		
FCV17075	VNO	3	0.14E-07	0.10E-02	0.80E-02		
FCV1702	VNO	3	0.14E-07	0.10E-02	0.80E-02		
EINRLK1726	AXFRA	1	0.50E-06				
EINRLK1718	AXFRA	1	0.50E-06				
FCV63153	VNO	3	0.14E-07	0.10E-02	0.80E-02		
FCV63152	VNO	3	0.14E-07	0.10E-02	0.80E-02		
VC63581	VCAO	1	0.10E-03				
FCV6325	VMOAO	6	0.40E-02	0.28E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02
FCV6326	VMOAO	6	0.40E-02	0.28E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02
VGA63573	VNC	5	0.10E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02	
FCV6342	VMOAC	6	0.40E-02	0.50E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02

FUSEA12	FUSE	1	0.11E-08					
FCV6341	VMOAC	6	0.40E-02	0.50E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02
FUSEA7	FUSE	1	0.11E-08					
VC63570	VCNC	1	0.25E-06					
FCV6339	VMOAO	6	0.40E-02	0.28E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02
FCV6340	VMOAO	6	0.40E-02	0.28E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02
HDR8	PIPE	1	0.15E-07					
LCV62136	VMOAO	6	0.40E-02	0.28E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02
LCV62135	VMOAO	6	0.40E-02	0.28E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02
SISIGB	SIMRLY	2	0.49E-06	0.10E-02				
VC63510	VCAO	1	0.10E-03					
FCV6322	VNO	3	0.14E-07	0.10E-02	0.80E-02			
FCV635	VNO	3	0.14E-07	0.10E-02	0.80E-02			
FUSE20IV	FUSE	1	0.11E-08					
HDR6	PIPE	1	0.15E-07					
VC63504	VCAO	1	0.10E-03					
HDR7	PIPE	1	0.15E-07					
HDR5	PIPE	1	0.15E-07					
HDR4	PIPE	1	0.15E-07					
FCV6347	VNO	3	0.14E-07	0.10E-02	0.80E-02			
VGA62533	VNC	5	0.10E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02	
VGA62527	VNC	5	0.10E-07	0.10E-02	0.10E-03	0.70E-03	0.80E-02	
VC62532	VCAO	1	0.10E-03					
VC62525	VCAO	1	0.10E-03					
FCV6348	VNO	3	0.14E-07	0.10E-02	0.80E-02			

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The report describes the demonstration of the Digraph-Matrix Analysis on a Nuclear Power Plant's High Pressure Safety Injection System. The demonstration work was beyond the scope of both the methods and the criteria used by the NRC to license nuclear power plants. The analysis discovered components whose failure could jeopardize the High Pressure Injection System given the postulated accident. All these components had been previously considered both in the safety analysis and in the licensing review. The results demonstrate the capability of Digraph-Matrix Analysis to model an accident sequence (including front-line systems, support systems, and operator actions) as a continuously integrated model to discover functional systems interactions. Also, the method is scrutable and can be used on a complex system which contains both a large number of components and dependent loops. Volume 1 is the main report and the description of the method. Volume 2 contains the digraphs, adjacency listings, and data base.

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JULY 1984