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Appendix A

Partial of the Fortran® source code

```
        SUBROUTINE ALG871(INP,OUT,COF,DT)
C
C This subroutine is for calculating neutron flux in simplified model
C of Thai Research Reactor 1/M1 C (TRR 1/M1). This model was done in
C 1-D, 1-group homogenized core in longigudinal axis.Reactor is divided
C 28 regions ; 15 regions @1" in active cell region, 6 regions @1.14"
C in graphite + water reflector region and 8@ 10" in water reflector.
C The initial condions are flux at each end ( region 0 and 28 ) equalized
C to 0. It initially skip cladding effect.
C
C Input will be groups of diffusion coefficients, absorption macroscopic
C cross section and normalized source term. Output will be normalized flux
C in each zone.
C
C Written by Ake Sompong, Chulalongorn University, Thailand
C 19 May 1996
C
C Declaration
      DOUBLE PRECISION INP(*), OUT(*), COF(*), DT
      DOUBLE PRECISION A(27,3),D(27),DZ(27),B(26),ALPHA(27),FLUX(27)
      DOUBLE PRECISION SIGMAA(27),S(27),V,FAVG
      INTEGER*2 I,J
C
C A(27,3)      = matrix of coefficient for flux in each zone
C S(27)        = matrix of source term
C FLUX(27)     = matrix of neutron flux in each zone
C D(30)        = matrix of diffusion coefficient in each zone
C DZ(27)       = matrix of delta distance in each zone
C SIGMAA(27)   = matrix of absorbtion macroscopic cross section in each zone
C B(26)        = matrix of buffer parameter between caculation
C ALPHA(27)    = matrix of buffer parameter between caculation
C V            = neutron velocity at thermal energy 0.0253 ev

C Define input
      DO 22 I=1,27
       D(I)=INP(I)
       SIGMAA(I)=INP(I+27)
      S(I)=INP(I+54)*2.0D12
22    CONTINUE
       V=INP(82)

C Define delta z in each zone.
      DO 21 I=1,27
       IF (( I.LE.3 ).OR.( I.GE.25 )) THEN
      DZ(I)=25.0D0
       ELSE IF ( I.LE.6 ) THEN
      DZ(I)=2.9D0
       ELSE IF ( I.LE.21 ) THEN
      DZ(I)=2.54D0
       ELSE
      DZ(I)=2.9D0
       ENDIF
21    CONTINUE
C
C calculate value of matirx coefficient A(27,3)
      DO 10 I=1,27
       DO 11 J= 1,3
        IF (( J.EQ.2 ).AND.( I.EQ.1 )) THEN
```

```
          A(I,J) = 4.D0/DZ(I)*((D(I)*DZ(I)+D(I+1)*DZ(I+1))/(DZ(I)+
     &         DZ(I+1))**2)+1.D0/V/DT+SIGMAA(I)
        ELSE IF (( J.EQ.1 ).AND.( I.GE.2 )) THEN
          A(I,J) = -2.D0/DZ(I)*(D(I)*DZ(I)+D(I-1)*DZ(I-1))/(DZ(I)+
     &         DZ(I-1))**2
        ELSE IF (( J.EQ.2 ).AND.( I.LE.26 )) THEN
          A(I,J) = 2.D0/DZ(I)*((D(I)*DZ(I)+D(I+1)*DZ(I+1))/(DZ(I)+
     &         DZ(I+1))**2+(D(I)*DZ(I)+D(I-1)*DZ(I-1))/(
     &         DZ(I)+DZ(I-1))**2)+1.D0/V/DT+SIGMAA(I)
        ELSE IF (( J.EQ.2 ).AND.( I.EQ.27 )) THEN
          A(I,J) = 2.D0/DZ(I)*((D(I)*DZ(I)+D(I)*DZ(I))/(DZ(I)+
     &         DZ(I))**2+(D(I-1)*DZ(I-1)+D(I)*DZ(I))/(DZ(I)+
     &         DZ(I-1))**2)+SIGMAA(I)+1.D0/V/DT
        ELSE IF (( J.EQ.3 ).AND.( I.LE.26 )) THEN
          A(I,J) = -2.D0/DZ(I)*(D(I+1)*DZ(I+1)+D(I)*DZ(I))/(DZ(I)+
     &         DZ(I+1))**2
        ELSE
          A(I,J)=0.0D0
        ENDIF
 11     CONTINUE
 10   CONTINUE
C
C Calculate buffer parameter matrix B(26) and ALPHA(27)
        B(1)= A(1,3)/A(1,2)
        ALPHA(1)=S(1)/A(1,2)
        DO 15 I=2,27
          IF ( I.LE.26 ) THEN
            B(I)=A(I,3)/(A(I,2)-A(I,1)*B(I-1))
          ENDIF
          ALPHA(I)=(S(I)-A(I,1)*ALPHA(I-1))/(A(I,2)-A(I,1)*B(I-1))
 15   CONTINUE
C
C Back substitution for getting FLUX(27) value
      FAVG=0.0D0
        FLUX(27)=ALPHA(27)
        DO 18 I=26,1,-1
          FLUX(I)=ALPHA(I)-B(I)*FLUX(I+1)
          IF (( I.GE.7 ).AND.( I.LE.21 )) THEN
        FAVG=FAVG+FLUX(I)
      ENDIF
 18   CONTINUE
C
C Define output
        DO 19 I=1,27
        OUT(I)=FLUX(I)/1.0D13
 19     CONTINUE
        OUT(28)=FAVG/15.0D0/1.0D13

        RETURN
        END
```

```
      SUBROUTINE ALG872(INP,OUT,COF,DT)
C
C This programm is for calculate the temperature profile in the fuel,
C gap, clad and liquid. It divided fuel in small pieces of interesting 47
C zones which done in 1-D. radial axis.
C
C Fuel cross section in circular and devided in radius 10+25+1+10+1 regions.
C The first 10 regions is in central zirconium rod, 25 in fuel-moderator
C meat, 1 in gap, 10 in clad and the rest is in coolant. Each different
C material have differ delta space.
C
C Written by Ake Sompong, Chulalongorn University, Thailand
C Date 19 May 1996
C
C Expected inputs are inlet temp. of coolant and flux
C Expected coeffcients are dimension, density, thermal conductivity,
C Epected outputs are average fuel temperature, maximum temperature,
C coolant temperature, heat produced
C
C Declaration
      DOUBLE PRECISION INP(*),OUT(*),COF(*),DT
      DOUBLE PRECISION DRFUEL,RHO(48),RHOFUEL,CP(48),CPFUEL,DR(48)
      DOUBLE PRECISION R(48),RHOGAP,CPGAP,DRGAP,KGAP,RHOCLD,CPCLD
      DOUBLE PRECISION RHOZR,CPZR,KZR,DRZR,K(42),DRCLD,KCLD,B(47)
      DOUBLE PRECISION A(48,3),S(48),H,T(48),FLUX,ER,TCAVG
      DOUBLE PRECISION TFAVG,TCLD,MAFR,CPC,TCIN,TCOUT,HEAT,TFMAX
      DOUBLE PRECISION ALPHA(48),NEG,KFUEL,M,HTAREA
      INTEGER*2 I,J
C
C Define definition for each parameter
C RHO(42)=density of material in regions, gm/cc
C CP(42)=specific heat of material in regions, Joules/C.gm
C DR(44)=delta radius between regions, cm
C K(44)=thermal conductivity of material in regions, W/cm.C
C R(44)=radius of point speified in bracket, cm
C A(42,3)=matrix of coefficient of temperature equation
C S(42)=matrix of source term in left hand of temp. equation
C T(42)=matrix of temperature in regions, C
C B(41),ALPHA(42)=matrix of buffer parameter
C DRFUEL=delta radius in fuel, cm
C RHOFUEL=fuel density, gm/cc
C CPFUEL=specific heat of fuel at 0 C, joule/cc.C
C RHOGAP=gap density, gm/cc
C CPGAP=gap specific heat, joule/cc.C
C DRGAP=delta radius in gap, cm
C KGAP=gap thermal conductivity
C RHOCLD=clad density, gm/cc
C CPCLD=clad specific heat, joule/cc.C
C DRCLD=delta radius in clad region, C
C KCLD=thermal conductivity of clad, W/cm.C
C RHOZR=zirconium rod density, gm/cc
C CPZR=specific heat of central zirconium rod, joule/gm.C
C KZR=thermal conductivity of central zirconium rod, W/cm.C
C DRZR=delta redius in central rod, cm
C H=heat transfer coefficient, W/cm.cm.C
C FLUX=zone flux, neutron/cm.cm.s
C ER=energy released per fission, Mev/fission
C TCAVG=average coolant temperature
```

```
C TFAVG=average fuel temperature, C
C TCLD=clad temperature, C
C MAFR=coolant mass flow rate, kg/s
C CPC=coolant specific heat, joule/gm.C
C TCIN=coolant temperature inlet to zone, C
C TCOUT=coolant temperature outlet from zone, C
C HEAT=heat produced in region, W
C TFMAX=maximum temperature of fuel in regions, C
C NEG=temperature negative reactivity
C M=mass of water hold in flow channel

C Define input
      FLUX=INP(1)*1D13
         TCIN=INP(2)
         MAFR=INP(3)
         H=INP(4)
         ER=INP(5)
      NEG=INP(6)

C Define intitial value for output, getting data from Cassbase.
         TCOUT=OUT(1)
         TFAVG=OUT(2)
         TCAVG=OUT(3)
         TFMAX=OUT(4)
         HEAT=OUT(5)
      DO 46 I=1,48
         T(I)=OUT(I+5)
46    CONTINUE

C
C Define coefficient
         RHOFUEL=COF(1)
         CPFUEL=COF(2)
         KFUEL=COF(3)
         RHOGAP=COF(4)
         CPGAP=COF(5)
         DRGAP=COF(6)
         KGAP=COF(7)
         RHOCLD=COF(8)
         CPCLD=COF(9)
         KCLD=COF(10)
         DRCLD=COF(11)
         CPC=COF(12)
         RHOZR=COF(13)
         CPZR=COF(14)
         KZR=COF(15)
      M=COF(16)
C
C Define constant value
      HTAREA=29.78*100
      DRFUEL=.0599D0
      DRZR=0.03175D0
      DO 42 I=1,47
       IF ( I.LE.11 ) THEN
           RHO(I)=RHOZR
           CP(I)=CPZR
           DR(I)=DRZR
           K(I)=KZR
```

```
      ELSE IF ( I.LE.36 ) THEN
           RHO(I)=RHOFUEL
        CP(I)=CPFUEL+4.17D-3*T(I)
           DR(I)=DRFUEL
           K(I)=KFUEL
      ELSE IF ( I.EQ.37 ) THEN
           RHO(I)=RHOGAP
           CP(I)=CPGAP
           DR(I)=DRGAP
           K(I)=KGAP
      ELSE
           RHO(I)=RHOCLD
           CP(I)=CPCLD
        DR(I)=DRCLD/10.D0
           K(I)=KCLD
         ENDIF
         IF ( I.EQ.1 ) THEN
       R(I)=0.D0
         ELSE
       R(I)=R(I-1)+DR(I)
         END IF
 42   CONTINUE

C Initialize matrix value to 0.
     DO 70 I=1,48
      DO 71 J=1,3
       A(I,J)=0.0D0
 71     CONTINUE
      S(I)=0.0D0
 70   CONTINUE

C Define matrix coefficinet A(48,3) and source term S(48)
     DO 40 I=1,48
         DO 41 J=1,3
      IF (( J.EQ.3 ).AND.( I.EQ.1 )) THEN
        A(I,J)=-4.D0*K(I)/DR(I)**2
      ELSE IF (( J.EQ.2 ).AND.( I.EQ.1 )) THEN
        A(I,J)=RHO(I)*CP(I)/DT+4.D0*K(I)/DR(I)**2
      ELSE IF (( J.EQ.1 ).AND.( I.LE.46 ).AND.( I.GE.2 )) THEN
        A(I,J)=-K(I)*(R(I)+R(I-1))/R(I)/(DR(I)+DR(I+1))/DR(I)
      ELSE IF (( J.EQ.2 ).AND.( I.LE.46 ).AND.( I.GE.2 )) THEN
        A(I,J)=1.D0/(DR(I)+DR(I+1))/R(I)*(K(I+1)*(R(I)+R(I+1))/
  &            DR(I+1)+K(I)*(R(I)+R(I-1))/DR(I))+RHO(I)*CP(I)/DT
      ELSE IF (( J.EQ.3 ).AND.( I.LE.46 ).AND.( I.GE.2 )) THEN
        A(I,J)=-K(I+1)*(R(I)+R(I+1))/R(I)/(DR(I)+DR(I+1))/DR(I+1)
      ELSE IF (( J.EQ.1 ).AND.( I.EQ.47 )) THEN
       A(I,J)=-K(I)/DR(I)
      ELSE IF (( J.EQ.2 ).AND.( I.EQ.47 )) THEN
       A(I,J)=K(I)/DR(I)+H+RHO(I)*CP(I)*DR(I)/2.D0/DT
      ELSE IF (( J.EQ.3 ).AND.( I.EQ.47 )) THEN
       A(I,J)=-H
      ELSE IF (( J.EQ.1 ).AND.( I.EQ.48 )) THEN
       A(I,J)=-H*HTAREA
      ELSE IF (( J.EQ.2 ).AND.( I.EQ.48 )) THEN
       A(I,J)=H*HTAREA+2.D0*MAFR*CPC+M*CPC/DT
      ELSE
       A(I,J)=0.D0
         END IF
```

```
 41     CONTINUE
        IF ( I.LE.10 ) THEN
         S(I)=RHO(I)*CP(I)/DT*T(I)
        ELSE IF ( I.EQ.11 ) THEN
         S(I)=RHO(I)*CP(I)/DT*T(I)+FLUX*ER*1.6D-13*0.05206D0
     &        /(0.34538D0+NEG*(T(I)-20.D0))/2.D0
        ELSE IF (( I.GE.12 ).AND.( I.LE.36 )) THEN
         S(I)=RHO(I)*CP(I)/DT*T(I)+FLUX*ER*1.6D-13*0.05206D0
     &        /(0.34538D0+NEG*(T(I)-20.D0))
        ELSE IF (( I.GE.37 ).AND.( I.LE.46 )) THEN
            S(I)=RHO(I)*CP(I)/DT*T(I)
        ELSE IF ( I.EQ.47 ) THEN
         S(I)=RHO(I)*CP(I)*DR(I)/DT*T(I)/2
        ELSE IF ( I.EQ.48 ) THEN
         S(I)=M*CPC/DT*T(I)+2.D0*MAFR*CPC*TCIN
           ENDIF
 40     CONTINUE

C Define buffer matrix B(47) and ALPHA(48)
          B(1)=A(1,3)/A(1,2)
          ALPHA(1)=S(1)/A(1,2)
      DO 43 I=2,48
        IF ( I.LE.47 ) THEN
            B(I)=A(I,3)/(A(I,2)-A(I,1)*B(I-1))
           ENDIF
          ALPHA(I)=(S(I)-A(I,1)*ALPHA(I-1))/(A(I,2)-A(I,1)*B(I-1))
 43     CONTINUE
C
C Back substitution for getting T(48),TFMAX and TFAVG
      T(48)=ALPHA(48)
      TFAVG=0.0D0
      DO 44 I=47,1,-1
          T(I)=ALPHA(I)-B(I)*T(I+1)
       IF (( I.GE.12 ).AND.( I.LE.35 )) THEN
        TFAVG=T(I)*22.0D0/7*((R(I)+DR(I)/2.0D0)**2.0D0-(R(I)-DR(I)
     &        /2.0D0)**2.0D0)+TFAVG
           ENDIF
 44     CONTINUE
      TFAVG=TFAVG/22.D0*7.D0/(R(35)**2-R(12)**2)
      TCLD=T(47)
      TFMAX=T(11)
C
C Calculate coolant temperature in region.
      TCOUT=2.D0*T(48)-TCIN
      TCAVG=T(48)
      HEAT=MAFR*CPC*(TCOUT-TCIN)/1.D6*.92D0

C Factor 0.92 in heat term is due to the delay in fission product decayed
C heat which will be computed in alg876.for later.

C Define output
          OUT(1)=TCOUT
          OUT(2)=TFAVG
          OUT(3)=TCAVG
          OUT(4)=TFMAX
          OUT(5)=HEAT
      DO 45 I=1,48
       OUT(I+5)=T(I)
```

```
45    CONTINUE
          RETURN
          END
```

```
      SUBROUTINE ALG873(INP,OUT,COF,DT)
C
C This programm is to calculate the fission product poisonning from
C Xenon-135 and Samarium-149. They both value will be added in macroscopic
C cross section of the system and act as "reactivity feedback from the
C operating ractor.
C
C Written by Ake Sompong, Chulalongorn University, Thailand
C Date 19 May 1996
C
C Declaration
      DOUBLE PRECISION INP(*), OUT(*), COF(*), DT
      DOUBLE PRECISION GAMMAI,SIGMAF,FLUX,LAMDAI,I,GAMMAX
      DOUBLE PRECISION SIGAX,GAMMAP,LAMDAP,P,SIGAS,S,X
      DOUBLE PRECISION LAMDAX

C X          = normalized Xenon concentration
C I          = normalized Iodine concentration
C P          = normalized Promethium concentration
C S          = noramalized Samarium concentration
C GAMMAI     = Iodine fission fragment yield
C GAMMAX     = Xenon fission fragment yield
C GAMMAP     = Promethium fission fragment yield
C LAMDAI     = Iodine decay constant in 1/sec
C LAMDAX     = Xenon decay constant in 1/sec
C LAMDAP     = Promethium decay constant in 1/sec
C FLUX       = neutron flux in neutron/cc/sec
C SIGAX      = absorbtion microscopic cross section of Xenon
C SIGAS      = absorbtion microscopic cross section of Samarium
C SIGMAF     = fission macroscopic cross section of fuel

C Input
      FLUX=INP(1)*1.0D13
      SIGMAF=INP(2)

C Coefficient
      GAMMAI=COF(1)
      GAMMAX=COF(2)
      GAMMAP=COF(3)
      LAMDAI=COF(4)
      LAMDAX=COF(5)
      LAMDAP=COF(6)
      SIGAX=COF(7)*1D-24
      SIGAS=COF(8)*1D-24

C Define initial conditon getting data from Cassbase
      I=OUT(1)*1.0D15
      X=OUT(2)*1.0D15
      P=OUT(3)*1.0D15
      S=OUT(4)*1.0D15

C Xenon and Samarium Calcualtion
      I=(GAMMAI*SIGMAF*FLUX-LAMDAI*I)*DT+I
      X=(GAMMAX*SIGMAF*FLUX+LAMDAI*I-LAMDAX*X-SIGAX*FLUX*X)*DT+X
      P=(GAMMAP*SIGMAF*FLUX-LAMDAP*P)*DT+P
      S=(LAMDAP*P-SIGAS*FLUX*S)*DT+S

C Output
```

```
OUT(1)=I/1D15
OUT(2)=X/1D15
OUT(3)=P/1D15
OUT(4)=S/1D15

  RETURN
  END
```

```
      SUBROUTINE ALG874(INP,OUT,COF,DT)
C
C This progrmm is written for calculate atom density, diffusion coeff.
C , absorbtion macro. cross sec. and fission macro. cross sec of element
C in Thai Research Reactor TRR1/M1. Fuel cells hexagonal shape and totally
C innitial installation 100 fuel pin with 2 shim rod, 1 regualting rod,
C 1 safety rod and 1 transient rod. The initial fuel pin had 8.5% of 20%
C enrichment in uranium. The rest is zirconium hydride-1.6.
C
C Inputs should be rod position X(5), average fuel zone temperature T(27)
C normalized concentration X-135 and Sm-149.
C Coefficinets should be microscopic cross section at thermal energy of
C each element.
C Outputs will be diffusion coefficient, absorbtion macroscopic cross
C section and fission cross section in each zone. Add with poison reactivity
C in core ( average value ) which is sum of Samarium and Xenon.
C
C Variable declaration
      DOUBLE PRECISION INP(*),OUT(*),COF(*),DT
      DOUBLE PRECISION T(27),X(5)
      DOUBLE PRECISION SAU28,SSU28,SAH2O,SSH2O,SAZR,SSZR,SAH
      DOUBLE PRECISION SSH,SAC,SSC,SAB,SSB,SGU25,SSU25,SFU25
      DOUBLE PRECISION SFU235,SAXE,SSXE,SASM,SSSM
      DOUBLE PRECISION D(27),SIGMAA(27),SIGMAF(27),NH2O(27)
      DOUBLE PRECISION NU25(27),NU28(27),NH(27),NC(27),NB(27),NGRA(27)
      DOUBLE PRECISION NZR(27),NXE(27),NSM(27),YUDUMMY,XWLRT2
      DOUBLE PRECISION XC(5),XRU(5),XCT,XCDUMMY,NWATER,NGRAPHITE,YUT
      DOUBLE PRECISION XLR(4),XLT,XLDUMMY,XWUR(5),XWURT(4),XWURD(4)
      DOUBLE PRECISION XWLRD1,XWLRD2,NEG,YU(5),XWLRT1,PREACT,SIGAFM
      INTEGER*2 P,I,J
C
C Define definition for each variable used in programm.
C T(1..27)=average fuel pin temperature (C) in each zone.
C X(1..5)=control rod position in cm. fully withdrawn=0.0 and fully
C       inserted=38.1 cm  No. 1..5 represent shim1,shim2,regulating,
C       safety and transient rods consequenly.
C SAU28=absorbtion micro. cross section U-238 in barns at thermal E., barns
C SSU28=scattering micro. cross section U-238 in barns at thermal E.
C SAH2O=absorbtion micro. cross section water in barns at thermal E
C SSH2O=scattering micro. cross section water in barns at thermal E.
C SAZR =absorbtion micro. cross section zirconium in barns at thermal E
C SSZR =scattering micro. cross section zirconium in barns at thermal E.
C SAH  =absorbtion micro. cross section hydrogen in barns at thermal E
C SSH  =scattering micro. cross section hydrogen in barns at thermal E.
C SAC  =absorbtion micro. cross section carbon in barns at thermal E
C SSC  =scattering micro. cross section carbon in barns at thermal E.
C SAB  =absorbtion micro. cross section boron in barns at thermal E
C SSB  =scattering micro. cross section boron in barns at thermal E.
C SGU25=gamma reaction absorbtion micro. cross section U-235 in
C       barns at thermal E.
C SSU25=scattering micro. cross section U-235 in barns at thermal E.
C SFU25=fission micro. cross section U-235 in barns at thermal E
C SAXE==absorbtion micro. cross section Xe-135 in barns at thermal E
C SSXE=scattering micro. cross section Xe-135 in barns at thermal E.
C SASM==absorbtion micro. cross section Sm-149 in barns at thermal E
C SSSM=scattering micro. cross section Sm-149 in barns at thermal E.
C D(27)=diffusion coefficient in each zone
C SIGMAA(27)=total absorbtion cross section in each zone
```

```
C SIGMAF(27)=fission cross section in each zone
C NU25(27)=atomic density of U-235 in each region, atom/cc
C NU28(27)=atomic density of U-230 in each region
C NH(27)  =atomic density of hydrogen atom in each region
C NZR(27) =atomic density of zirconium in each region,
C NB(27)  =atomic density of natural boron in each region
C NC(27)  =atomic density of carbon atom in each region
C NGRA(27)=atomic density of carbon atom (graphite) in each region
C NH2O(27)=atomic density of water in each region
C NXE(27)=atomic density of Xenon-135 in each region
C NXM(27)=atomic density of Samarium-149 in each region

C Input declaration
        X(1)=INP(1)
        X(2)=INP(2)
        X(3)=INP(3)
        X(4)=INP(4)
        X(5)=INP(5)
        NEG=INP(6)
        DO 10 I=1,27
         IF (( I.GE.7 ).AND.( I.LE.26 )) THEN
          T(I)=INP(I)
       NXE(I)=INP(I+20)*1D15
       NSM(I)=INP(I+40)*1D15
         ELSE
       T(I)=0.0D0
       NXE(I)=0.0D0
       NSM(I)=0.0D0
         ENDIF
10      CONTINUE

C coefficient declaration
      SAU28=COF(1)*1.0D-24
      SSU28=COF(2)*1.0D-24
      SAH2O=COF(3)*1.0D-24
      SSH2O=COF(4)*1.0D-24
      SAZR=COF(5)*1.0D-24
      SSZR=COF(6)*1.0D-24
      SAH=COF(7)*1.0D-24
      SSH=COF(8)*1.0D-24
      SAC=COF(9)*1.0D-24
      SSC=COF(10)*1.0D-24
      SAB=COF(11)*1.0D-24
      SSB=COF(12)*1.0D-24
      SGU25=COF(13)*1.0D-24
      SSU25=COF(14)*1.0D-24
      SFU25=COF(15)*1.0D-24
      SAXE=COF(16)*1.0D-24
      SSXE=COF(17)*1.0D-24
      SASM=COF(18)*1.0D-24
      SSSM=COF(19)*1.0D-24

C Initialized number of  fuel pin in core ( excluded control rod )
        P = 100

C calculate atom density of element in core
        XC(1)=X(1)
        XC(2)=X(2)
```

```
      XC(3)=X(3)
      XC(4)=X(4)
      XC(5)=X(5)
    NWATER=1.1066D22+2.004D22/(P+5.D0)
      DO 99 I=7,21
     XCT=0.0D0
       DO 98 J=1,5
      IF ( XC(J).GT.2.54D0 ) THEN
              XCDUMMY=2.54
      ELSE IF ( XC(J).LT.0.0D0 ) THEN
       XCDUMMY=0.0D0
        ELSE
       XCDUMMY=XC(J)
        ENDIF
        IF ( J.LE.4 ) THEN
             XCT=XCT+XCDUMMY
        ENDIF
      XC(J)=XC(J)-2.54D0
98     CONTINUE
       NH2O(I)=NWATER
     NU25(I)=(1.6065D20*P+1.3439D20*(4.D0-XCT/2.54D0))/(P+5.D0)
     NU28(I)=(6.4261D20*P+5.3066D20*(4.D0-XCT/2.54D0))/(P+5.D0)
     NH(I)=(3.2240D22*P+2.697D22*(4.D0-XCT/2.54D0))/(P+5.D0)
     NZR(I)=(2.2732D22*P+1.9511D22*(4.D0-XCT/2.54D0))/(P+5D0)
     NB(I)=(XCT*5.6222D22+4.8400D22*XCDUMMY)/2.54D0/(P+5.D0)
     NC(I)=(XCT*1.4056D22+1.2101D22*XCDUMMY)/2.54D0/(P+5.D0)
     NGRA(I)=0.0D0
99   CONTINUE
C
C calculate atom density in graphite reflector, upper region
      XRU(1)=X(1)
      XRU(2)=X(2)
      XRU(3)=X(3)
      XRU(4)=X(4)
      XRU(5)=X(5)
    NGRAPHITE=5.131557D22*P/(P+5.0)
      DO 97 I=4,6
     YUT=0.0D0
      DO 96 J=1,5
     IF ( XRU(J).GT.29.4D0 ) THEN
      YU(J)=XRU(J)-29.4D0
       ELSE
      YU(J)=0.0D0
       ENDIF
     IF ( YU(J).GT.2.9D0 ) THEN
      YUDUMMY=2.9D0
       ELSE
            YUDUMMY=YU(J)
       ENDIF
       IF ( J.LE.4 ) THEN
            YUT=YUT+YUDUMMY
       ENDIF
     XRU(J)=XRU(J)-2.9D0
96    CONTINUE
     NB(I)=((11.6D0-YUT)*5.6222D22+(2.9D0-YUDUMMY)*4.8400D22)
   &      /(P+5.D0)/2.9D0
     NC(I)=((11.6D0-YUT)*1.4056D22+(2.9D0-YUDUMMY)*1.2101D22)
   &      /(P+5.0)/2.9D0
```

```
      NGRA(I)=NGRAPHITE
      NH2O(I)=NWATER
    NZR(I)=0.0D0
    NH(I)=0.0D0
    NU25(I)=0.0D0
    NU28(I)=0.0D0
 97   CONTINUE
C
C calculate atom density in graphite reflector, lower region
      XLR(1)=X(1)
      XLR(2)=X(2)
      XLR(3)=X(3)
      XLR(4)=X(4)
      DO 94 I=22,24
    XLT=0.0D0
      DO 95 J=1,4
     IF ( XLR(J).GE.2.9D0 ) THEN
       XLDUMMY=2.9D0
     ELSE IF ( XLR(J).LE.0.0D0 ) THEN
       XLDUMMY=0.0D0
        ELSE
             XLDUMMY=XLR(J)
        ENDIF
        XLT=XLT+XLDUMMY
     XLR(J)=XLR(J)-2.9D0
 95   CONTINUE
       NH2O(I)=NWATER
       NGRA(I)=NGRAPHITE
    NU25(I)=XLT*3.D0/8.7D0*1.3439D20/(P+5.D0)
    NU28(I)=XLT*3.D0/8.7D0*5.3066D20/(P+5.D0)
    NZR(I)=XLT*3.D0/8.7D0*1.9151D22/(P+5.D0)
    NH(I)=XLT*3.D0/8.7D0*2.697D22/(P+5.D0)
    NB(I)=0.0D0
    NC(I)=0.0D0
 94   CONTINUE

C Calculate atom density in water reflector, upper region
      XWUR(1)=X(1)
      XWUR(2)=X(2)
      XWUR(3)=X(3)
      XWUR(4)=X(4)
      XWUR(5)=X(5)
    XWURT(2)=0.0D0
    XWURT(3)=0.0D0
      DO 93 J=1,5
    IF (( XWUR(J).LE.4.4D0 ).AND.( XWUR(J).GE.0.0D0 )) THEN
      XWURD(2)=4.4D0-XWUR(J)
      XWURD(3)=25.0D0
    ELSE IF (( XWUR(J).LE.29.4D0 ).AND.( XWUR(J).GT.4.4D0 )) THEN
        XWURD(2)=0.0D0
        XWURD(3)=29.4D0-XWUR(J)
      ELSE
      XWURD(2)=0.0D0
      XWURD(3)=0.0D0
       ENDIF
    IF ( J.LE.4.0 ) THEN
        XWURT(2)=XWURT(2)+XWURD(2)
        XWURT(3)=XWURT(3)+XWURD(3)
```

```
        ENDIF
 93   CONTINUE
        DO 92 I=1,3
          IF ( I.GE.2 ) THEN
      NB(I)=(XWURT(I)*5.6222D22+4.84D22*XWURD(I))/(P+5.D0)/25.D0
      NC(I)=(XWURT(I)*1.4056D22+1.2101D22*XWURD(I))/(P+5.D0)/25.D0
        ELSE
      NB(I)=0.0D0
      NC(I)=0.0D0
        ENDIF
     NH2O(I)=0.0335D24
     NU25(I)=0.0D0
     NU28(I)=0.0D0
     NGRA(I)=0.0D0
     NZR(I)=0.0D0
     NC(I)=0.0D0
 92   CONTINUE

C Calculate atom density in water reflector, lower region
     XWLRT1=0.0D0
     XWLRT2=0.0D0
        DO 90 I=1,4
      IF (( X(I).GE.8.7D0 ).AND.( X(I).LE.33.7D0 )) THEN
        XWLRD1=X(I)-8.7D0
        XWLRD2=0.0D0
      ELSE IF (( X(I).GT.33.7D0 ).AND.( X(I).LE.38.1D0 )) THEN
        XWLRD1=25.0D0
        XWLRD2=X(I)-33.7D0
          ELSE
        XWLRD1=0.0D0
        XWLRD2=0.0D0
          ENDIF
          XWLRT1=XWLRT1+XWLRD1
          XWLRT2=XWLRT2+XWLRD2
 90   CONTINUE
        DO 89 I=25,27
     NU25(I)=0.0D0
     NU28(I)=0.0D0
     NZR(I)=0.0D0
     NC(I)=0.0D0
     NGRA(I)=0.0D0
     NH(I)=0.0D0
     NB(I)=0.0D0
     NH2O(I)=0.0335D24
 89   CONTINUE
     NU25(25)=XWLRT1*1.3439D20/(P+5.D0)/25.D0
     NU28(25)=XWLRT1*5.3066D20/(P+5.D0)/25.D0
     NH(25)=XWLRT1*2.697D22/(P+5.D0)/25.D0
     NZR(25)=XWLRT1*1.9151D22/(P+5.D0)/25.D0
     NU25(26)=XWLRT2*1.3439D20/(P+5.D0)/25.D0
     NU28(26)=XWLRT2*5.3066D20/(P+5.D0)/25.D0
     NH(26)=XWLRT2*2.697D22/(P+5.D0)/25.D0
     NZR(26)=XWLRT2*1.9151D22/(P+5.D0)/25.D0
C
C Calculate total microscopic cross section, diffusion coefficient and
C fission microscopic cross section changing due to temperature change in
C fuel pin in each zone.
     PREACT=0.0D0
```

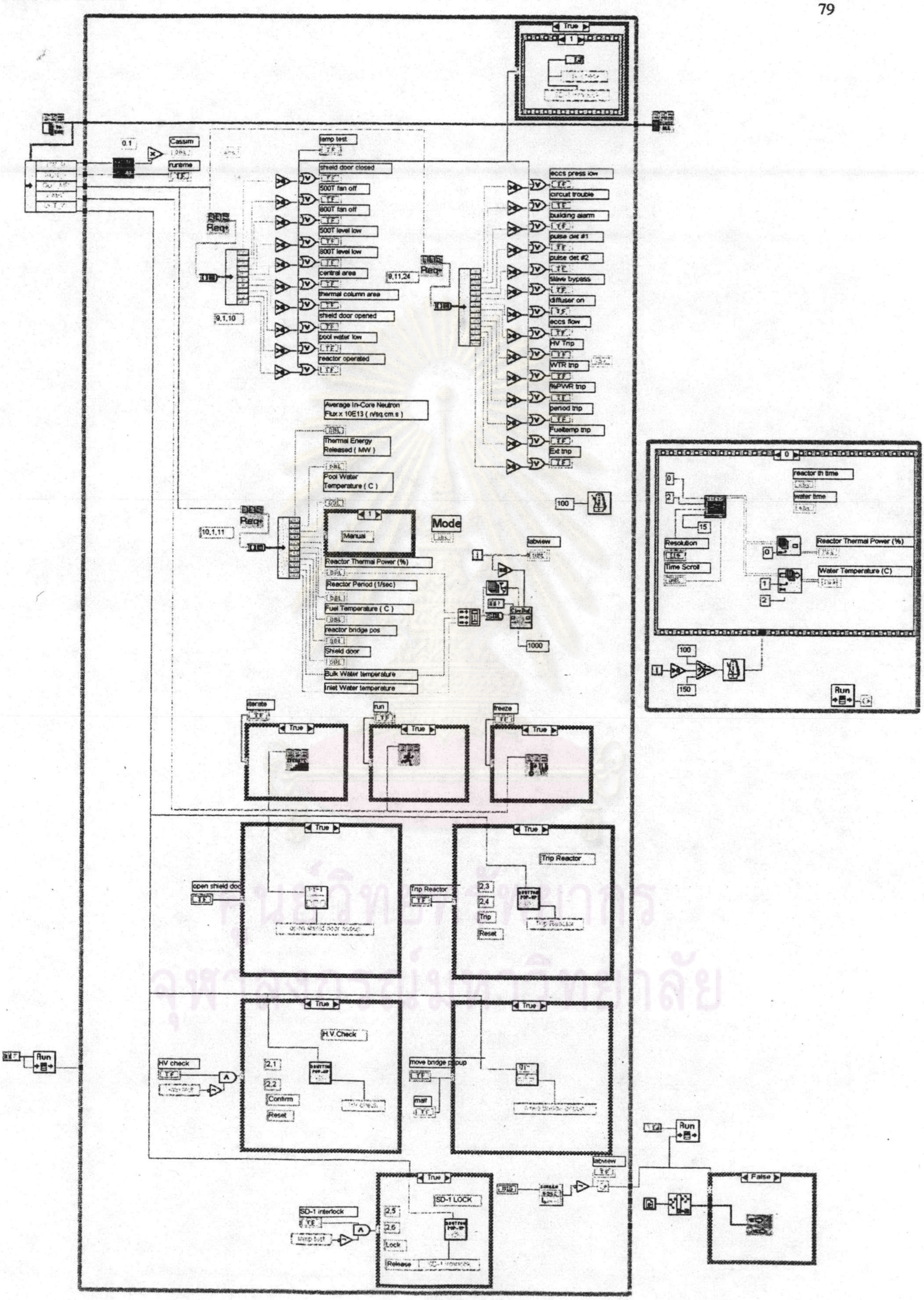
```
   SIGAFM=0.0D0
      DO 88 I=1,27
    SFU235=1.992842D-22/(0.34538+NEG*(T(I)-20.D0))
       SIGMAA(I)=0
    SIGMAA(I)=NU25(I)*(SFU235+SGU25)+NU28(I)*SAU28+NH(I)
  &          *SAH+NZR(I)*SAZR+NH2O(I)*SAH2O+NB(I)*SAB
  &          +(NC(I)+NGRA(I))*SAC+NXE(I)*SAXE+NSM(I)*SASM
  &          +0.008778
    D(I)=1.0D0/3.0D0/(NU25(I)*(SGU25+SFU235+0.9972D0*SSU25)+
  &       NU28(I)*(SAU28+0.9972D0*SSU28)+NH(I)*(SAH+0.3386D0*SSH)+
  &       NZR(I)*(SAZR+0.9927D0*SSZR)+NH2O(I)*(SAH2O+0.676D0*
  &       SSH2O)+NB(I)*(SAB+0.9394D0*SSB)+(NGRA(I)+NC(I))*
  &       (SAC+0.9444D0*SSC)+NXE(I)*(SAXE+0.9951D0*SSXE)+
  &       NSM(I)*(SASM+0.9955D0*SSSM)+0.039076)
    SIGMAF(I)=NU25(I)*SFU235
    IF (( I.GE.7 ).AND.( I.LE.21 )) THEN
     PREACT=PREACT+NSM(I)*SASM+NXE(I)*SAXE
     SIGAFM=SIGAFM+SIGMAA(I)
    ENDIF
 88 CONTINUE

C SFU235 value getting constant from worksheet. For more infomation,
C read in papers for explantion.

C Define output
      DO 87 I=1,27
       OUT(I)=D(I)
       OUT(I+27)=SIGMAA(I)
       OUT(I+54)=SIGMAF(I)
 87   CONTINUE
    OUT(82)=-PREACT/(SIGAFM-PREACT)

      RETURN
      END
```

```
                SUBROUTINE ALG875(INP,OUT,COF,DT)
C
C This subroutine is for calculate neutron source term which will support
C matrix equation in ALG871 neutron flux calculation.
C
C Written By Ake Sompong, Chulalongorn University, Bangkok, Thailand
C Date 13 June 1996
C
C Declaration
        DOUBLE PRECISION INP(*),OUT(*),COF(*),DT
        DOUBLE PRECISION FLUX,SIGMAF,NEW,V,LAMDA(6),C(6),BETAT,LAMC
        DOUBLE PRECISION S,BETA(6)
        INTEGER*2 I
C
C Parameter definition
C FLUX  = normalized neutron flux
C SIGMAF= macroscopic fission cross section, 1/cm
C NEW   = emitted fission neutron per neutron absorbed
C V     = neutron velocity at thermal energy, cm/s
C LAMDA(1..6)  = delayed neutron precursor decay constant, 1/s
C BETA(1..6)   = delayed neutron precursor fraction
C C(1..6)      = normalized delayed neutron precursor concentration
C
C Define input
     FLUX=INP(1)*1D13
        SIGMAF=INP(2)
        NEW=INP(3)
        V=INP(4)

C Define coefficient
        DO 63 I=1,6
         LAMDA(I)=COF(I)
         BETA(I)=COF(I+6)
 63     CONTINUE

C Define output, getting initial value from CASSBASE.
        DO 64 I=1,6
       C(I)=OUT(I+1)*3D10
 64     CONTINUE

     S=0.0D0
     BETAT=0.0D0
     LAMC=0.0D0
        DO 61 I=1,6
      LAMC=LAMC+LAMDA(I)*C(I)
      C(I)=(BETA(I)*NEW*SIGMAF*FLUX*DT+C(I))/(1.D0+LAMDA(I)*DT)
         BETAT=BETAT+BETA(I)
 61     CONTINUE
     S=(1.D0-BETAT)*NEW*SIGMAF*FLUX+LAMC+1.D0/V/DT*FLUX

C Define output
     OUT(1)=S/2D12
        DO 62 I=1,6
      OUT(I+1)=C(I)/3D10
 62     CONTINUE

        RETURN
        END
```

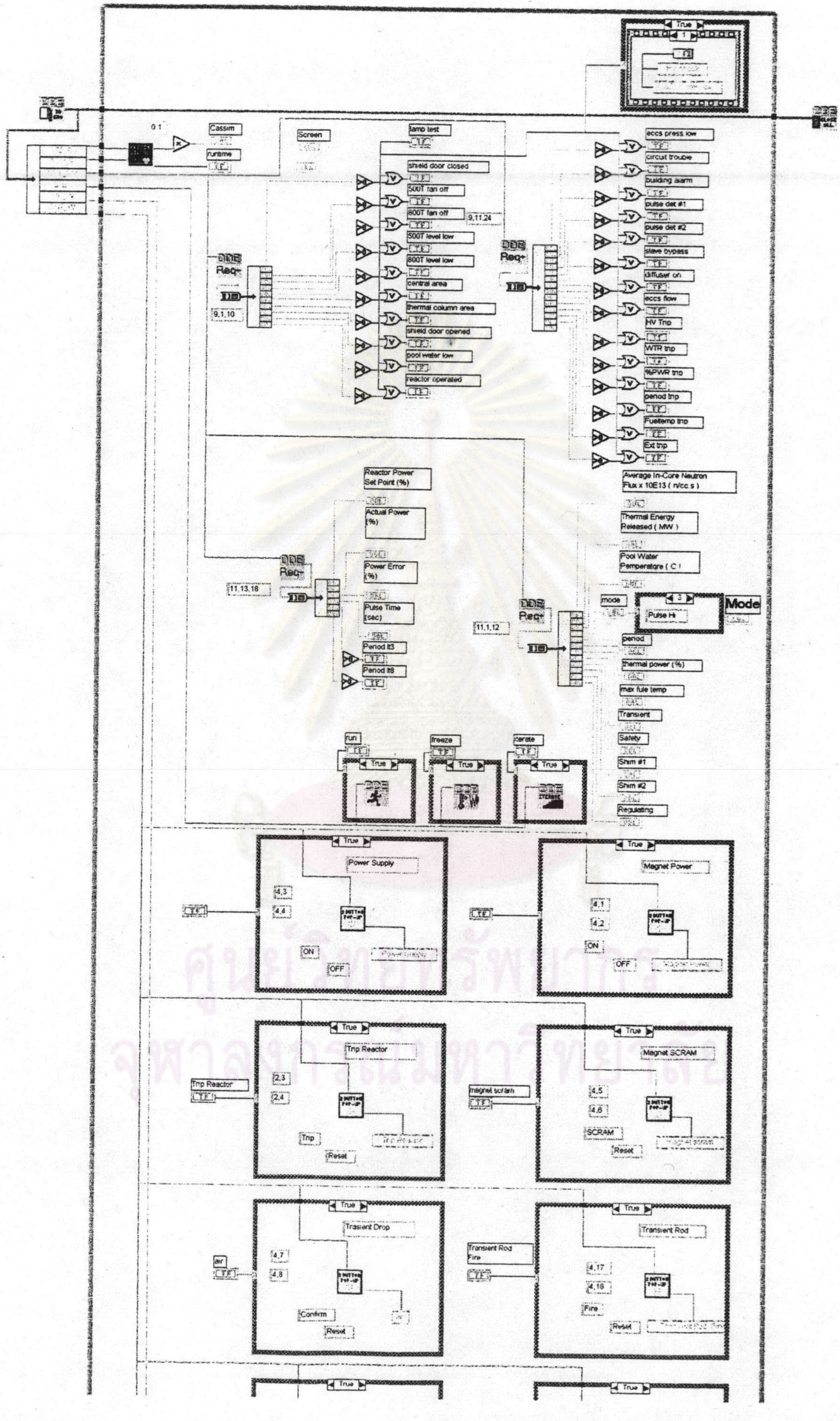
Appendix B

Wiring Diagram of the front end

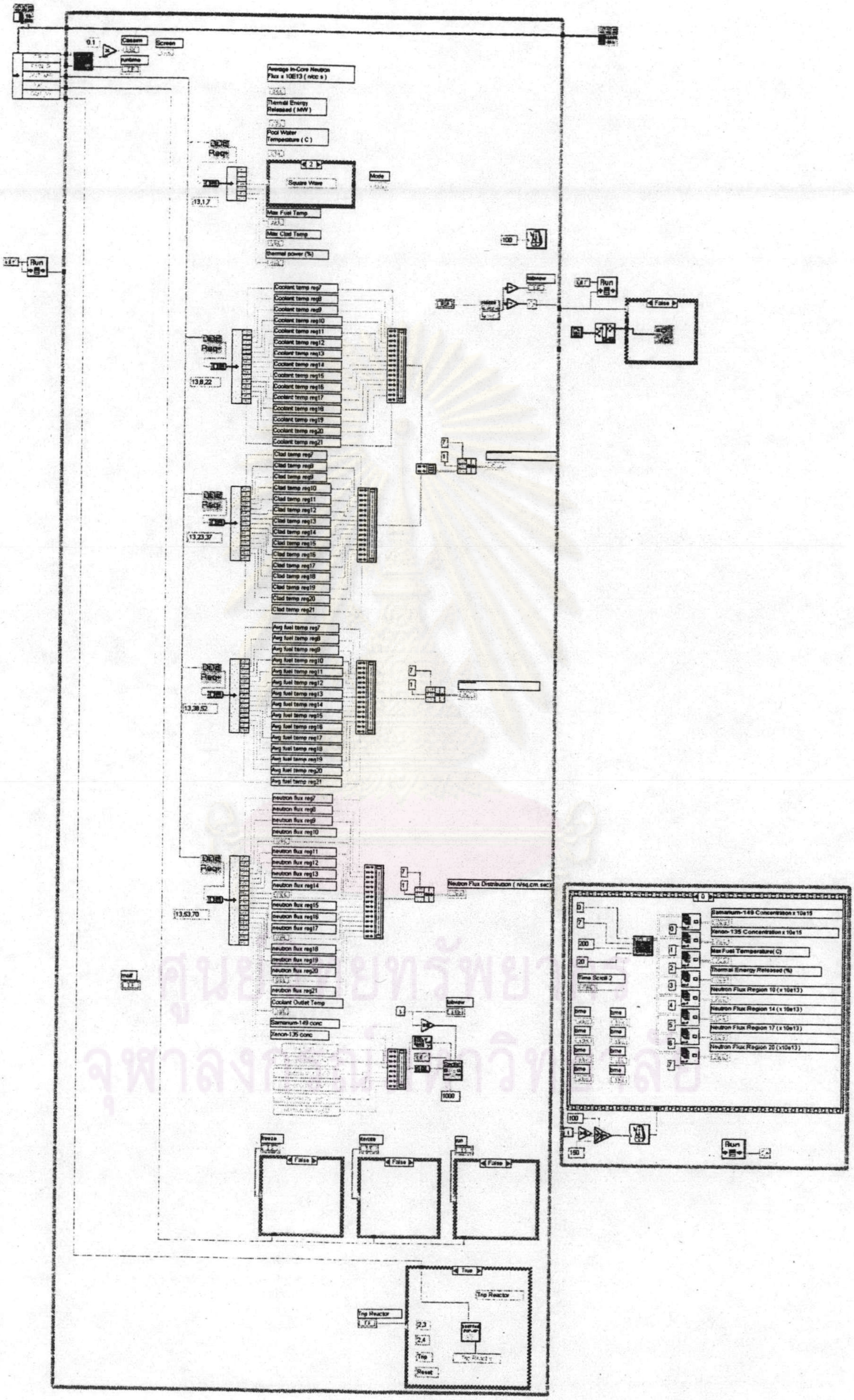
Reactor Preview
05/14/97 09:29 PM



Control Rod Panel
05/14/97 09:39 PM



Reactor Cooling System
05/14/97 09:49 PM


Average In-Core Neutron Flux x 10E13 (n/cc s)
Thermal Energy Released (MW)
Pool Water Temperature (C)
Square Wave
Mode
Max Fuel Temp
Max Clad Temp
Thermal power (%)
Run
Coolant temp reg7
Coolant temp reg8
Coolant temp reg9
Coolant temp reg10
Coolant temp reg11
Coolant temp reg12
Coolant temp reg13
Coolant temp reg14
Coolant temp reg15
Coolant temp reg16
Coolant temp reg17
Coolant temp reg18
Coolant temp reg19
Coolant temp reg20
Coolant temp reg21
Clad temp reg7
Clad temp reg8
Clad temp reg9
Clad temp reg10
Clad temp reg11
Clad temp reg12
Clad temp reg13
Clad temp reg14
Clad temp reg15
Clad temp reg16
Clad temp reg17
Clad temp reg18
Clad temp reg19
Clad temp reg20
Clad temp reg21
Avg fuel temp reg7
Avg fuel temp reg8
Avg fuel temp reg9
Avg fuel temp reg10
Avg fuel temp reg11
Avg fuel temp reg12
Avg fuel temp reg13
Avg fuel temp reg14
Avg fuel temp reg15
Avg fuel temp reg16
Avg fuel temp reg17
Avg fuel temp reg18
Avg fuel temp reg19
Avg fuel temp reg20
Avg fuel temp reg21
neutron flux reg7
neutron flux reg8
neutron flux reg9
neutron flux reg10
neutron flux reg11
neutron flux reg12
neutron flux reg13
neutron flux reg14
neutron flux reg15
neutron flux reg16
neutron flux reg17
neutron flux reg18
neutron flux reg19
neutron flux reg20
neutron flux reg21
Coolant Outlet Temp
Samarium-149 conc
Xenon-135 conc
Neutron Flux Distribution (n/sq.cm. sec)
Samarium-149 Concentration x 10e15
Xenon-135 Concentration x 10e15
Max Fuel Temperature(C)
Thermal Energy Released (%)
Neutron Flux Region 10 (x10e13)
Neutron Flux Region 14 (x10e13)
Neutron Flux Region 17 (x10e13)
Neutron Flux Region 20 (x10e13)
Time Scroll 2
False
True
Trip Reactor
Reset

Appendix C

Block oriented in Cassbase®

BLKNUM	SEQNUM	BLKNAME/BLKDESC	
1	1	AAA_BEGIN	BEGIN BLOCK
2	2	AAA_SRS_COM	S/W INTERFACE BLOCK COMMON S/W
3	3	AAA_SRS_11	SELF RESET S/W SCREEN 1/1
4	4	AAA_SRS_21	SELF RESET S/W SCREEN 2/1
5	5	AAA_SRS_31	SELF RESET S/W SCREEN 3/1
6	6	AAA_SRS_41	SELF RESET S/W SCREEN 4/1
7	7	AAA_INP_SC2	STEADY SIGNAL FROM SCREEN#2
8	8	AAA_INPUT1	INPUT BLOCK 1
9	9	AAA_ALARMBAR	NON-MOVABLE BLOCK ALARM BAR
10	10	AAA_DISPLAY1	NON-MOVABLE BLOCK ALARM BAR
11	11	AAA_DISPLAY2	NON-MOVABLE BLOCK SCREEN 2
12	12	AAA_DISPALY3	NON-MOVABLE BLOCK ALARM BAR
13	13	AAA_DISPLAY4	DISPLAY SCREEN 4
14	14	AAA_DISPLAY5	DISPLAY 5
15	15	AAA_S1	SOURCE TERM REGION 1
16	16	AAA_S2	SOURCE TERM REGION 2
17	17	AAA_S3	SOURCE TERM REGION 3
18	18	AAA_S4	SOURCE TERM REGION 4
19	19	AAA_S5	SOURCE TERM REGION 5
20	20	AAA_S6	SOURCE TERM REGION 6
21	21	AAA_S7	SOURCE TERM REGION 7
22	22	AAA_S8	SOURCE TERM REGION 8
23	23	AAA_S9	SOURCE TERM REGION 9
24	24	AAA_S10	SOURCE TERM REGION 10
25	25	AAA_S11	SOURCE TERM REGION 11
26	26	AAA_S12	SOURCE TERM REGION 12
27	27	AAA_S13	SOURCE TERM REGION 13
28	28	AAA_S14	SOURCE TERM REGION 14
29	29	AAA_S15	SOURCE TERM REGION 15
30	30	AAA_S16	SOURCE TERM REGION 16
31	31	AAA_S17	SOURCE TERM REGION 17
32	32	AAA_S18	SOURCE TERM REGION 18
33	33	AAA_S19	SOURCE TERM REGION 19
34	34	AAA_S20	SOURCE TERM REGION 20
35	35	AAA_S21	SOURCE TERM REGION 21
36	36	AAA_S22	SOURCE TERM REGION 22
37	37	AAA_S23	SOURCE TERM REGION 23
38	38	AAA_S24	SOURCE TERM REGION 24
39	39	AAA_S25	SOURCE TERM REGION 25
40	40	AAA_S26	SOURCE TERM REGION 26
41	41	AAA_S27	SOURCE TERM REGION 27
42	42	AAA_T26	TEMPERATURE CALCULATION REG26
43	43	AAA_T25	TEMPERATURE CALCULATION REG25
44	44	AAA_T24	TEMPERATURE CALCULATION REG24
45	45	AAA_T23	TEMPERATURE CALCULATION REG23
46	46	AAA_T22	TEMPERATURE CALCULATION REG22
47	47	AAA_T21	TEMPERATURE CALCULATION REG21
48	48	AAA_T20	TEMPERATURE CALCULATION REG20
49	49	AAA_T19	TEMPERATURE CALCULATION REG19
50	50	AAA_T18	TEMPERATURE CALCULATION REG18
51	51	AAA_T17	TEMPERATURE CALCULATION REG17
52	52	AAA_T16	TEMPERATURE CALCULATION REG16
53	53	AAA_T15	TEMPERATURE CALCULATION REG15
54	54	AAA_T14	TEMPERATURE CALCULATION REG14

55	55	AAA_T13	TEMPERATURE CALCULATION REG13
56	56	AAA_T12	TEMPERATURE CALCULATION REG12
57	57	AAA_T11	TEMPERATURE CALCULATION REG11
58	58	AAA_T10	TEMPERATURE CALCULATION REG10
59	59	AAA_T9	TEMPERATURE CALCULATION REG9
60	60	AAA_T8	TEMPERATURE CALCULATION REG8
61	61	AAA_T7	TEMPERATURE CALCULATION REG7
62	62	AAA_T_HEAT1	SUM OF PROMPT HEAT REG12-21
63	63	AAA_T_HEAT2	SUM PROMPT HEAT REG7-11
64	64	AAA_T_HTOT	TOTAL PROMPT HEAT IN CORE
65	65	AAA_P7	POISON REACTIVITY REG 7
66	66	AAA_P8	POISON REACTIVITY REG 8
67	67	AAA_P9	POISON REACTIVITY REG 9
68	68	AAA_P10	POISON REACTIVITY REG 10
69	69	AAA_P11	POISON REACTIVITY REG 11
70	70	AAA_P12	POISON REACTIVITY REG 12
71	71	AAA_P13	POISON REACTIVITY REG 13
72	72	AAA_P14	POISON REACTIVITY REG 14
73	73	AAA_P15	POISON REACTIVITY REG 15
74	74	AAA_P16	POISON REACTIVITY REG 16
75	75	AAA_P17	POISON REACTIVITY REG 17
76	76	AAA_P18	POISON REACTIVITY REG 18
77	77	AAA_P19	POISON REACTIVITY REG 19
78	78	AAA_P20	POISON REACTIVITY REG 20
79	79	AAA_P21	POISON REACTIVITY REG 21
80	80	AAA_P22	POISON REACTIVITY REG 22
81	81	AAA_P23	POISON REACTIVITY REG 23
82	82	AAA_P24	POISON REACTIVITY REG 24
83	83	AAA_P25	POISON REACTIVITY REG 25
84	84	AAA_P26	POISON REACTIVITY REG 26
85	85	AAA_D	ATOM DENSITY REG 1-27
86	86	AAA_N	NEUTRON FLUX CALCULATION
87	87	AAA_PERIOD	REACTOR PERIOD CALCULATION
88	88	AAA_H1	DECAY HEAT STARTING AT BLOCK1
89	89	AAA_H2	DECAY HEAT STARTING AT BLOCK96
90	90	AAA_H3	DECAY HEAT STARTING AT BLOC191
91	91	AAA_H4	DECAY HEAT STARTING AT BLOC286
92	92	AAA_H5	DECAY HEAT STARTING AT BLOC381
93	93	AAA_H6	DECAY HEAT STARTING AT BLOC476
94	94	AAA_H7	DECAY HEAT STARTING AT BLOC571
95	95	AAA_H8	DECAY HEAT STARTING AT BLOC666
96	96	AAA_H9	DECAY HEAT STARTING AT BLOC761
97	97	AAA_H10	DECAY HEAT STARTING AT 856
98	98	AAA_H_SUM	SUM OF DECAY HEAT GENERATED
99	99	AAA_HEAT_TOT	SUM OF DECAY AND PROMPT HEAT
100	100	AAA_H_PERCEN	HEAT RELEASED IN %
101	101	AAA_BRID_POS	BRIDGE POSITION CALCULATION
102	102	AAA_DOOR_POS	SHIELD DOOR POSITION
103	103	AAA_FAULT	FAULT GENERATOR
104	104	AAA_PP_FSEL	PRIMARY PUMP FLOW SECLECTION
105	105	AAA_SP_FSEL	SECONDARY PUMP FLOW SELECTION
106	106	AAA_SPCT800T	ON SEC PUMP,CT800T FAN,NOTLVL8
107	107	AAA_CT800OUT	COOLING TOW. 800T OUT TEMP SEL
108	108	AAA_SPCT500T	AND ON SEC PUMP, CT500T FAN
109	109	AAA_CT500OUT	COOLING TW 500T OUT TEMP SELEC
110	110	AAA_HXSEINTE	HX SECONDARY LOOP INLET TEMP
111	111	AAA_HX_500T	HEAT EXCHANGER 500T
112	112	AAA_HX_800T	HEAT EXCHANGER 800T

113	113	AAA_HXPRIOUT HX PRIMARY LOOP OUTLET TEMP
114	114	AAA_HXSECOUT HX SECONDARY LOOP OUTLET TEMP
115	115	AAA_POOL_TEM POOL TEMPERATURE CALCULATION
116	116	DUMMY
117	117	AAA_HLAVGTF1 AVERAGE FUEL TEMP IN CORE 1
118	118	AAA_HLAVGF2 AVERAGE FUEL TEMP IN CORE 2
119	119	AAA_HLCLADT1 MAXIMUM CLAD TEMPERATURE 1
120	120	AAA_HLCLADT2 MAXIMUM CLAD TEMPERATURE 2
121	121	AAA_PWGT115 POWER GENERATED GT 110%
122	122	AAA_FTEGT600 AVG FUEL TE GT 600 C
123	123	AAA_PWSTPTCN POWER SETPOINT CONVERSION
124	124	AAA_PWERRPEC POWER ERROR FROM STPT IN %
125	125	AAA_P_SMAVG SAMARIUM CONC REGION 7-21
126	126	AAA_P_XWAVG XENON 135 AVERAGE CONC
127	127	AAA_P_AVG POISONING AVERAGE IN CORE
128	128	AAA_END
129	129	CAA-BEGIN CAA START BLOCK
130	130	CAA_EQPC_BEG EQUIPMENT CONTROL COMMON BLOCK
131	131	CAA_RSFF_HV H.V CHECK FLIP FLOP RESET S/W
132	132	CAA_RSFF_TRP FLIP FLOP S/W TRIP REACTOR
133	133	CAA_RSFF_SD1 DOOR LOCK CONTROL BLOCK
134	134	CAA_EQPC_END EQUIPMENT CONTROL END BLOCK
135	135	CAA_EQP1_BEG EQUIPMENT COTROL SCREEN1 BEGIN
136	136	CAA_RST_THER OR SIGNAL TO RESET MOVE THERMA
137	137	CAA_RST_CENT OR SIGNAL RESET MOVE TO CENTEL
138	138	CAA_BR_THER BLOCK MOVE BRIDE TO THERMAL
139	139	CAA_BR_CENTE BLOCK MOVE BRIDGE TO CENTRAL
140	140	DUMMY DUMMY
141	141	CAA_AND_OPDO AND BLOCK FOR OPEN SHIELD DOOR
142	142	CAA_RSFF_OPD OPEN DOOR COMMAND BLOCK
143	143	CAA_RSFF_CLD CLOSE DOOR COMMAND BLOCK
144	144	CAA_EQP1_END EQUIPMENT CONTROL SCREEN1 END
145	145	CAA_EQP2_BEG EQUIPMENT CONTROL SCREEN2 BEGI
146	146	CAA_RSFF_MGP FLIP FLOP S/W MAGNET POWER
147	147	CAA_RSFF_POW FLIP FLOP S/W POWER SUPPLY
148	148	CAA_RSFF_SCA FLIP FLOP S/W SCRAM MAGNET
149	149	CAA_RSFF_AIR FLIP FLOP S/W TRANSIENT ROD
150	150	CAA_RSFF_SH1 FLIP FLOP S/W SHIM1
151	151	CAA_RSFF_SH2 FLIP FLOP S/W SHIM2
152	152	CAA_RSFF_SAF FLIP FLOP S/W SAFETY ROD
153	153	CAA_RSFF_REG FLIP FLOP S/W REGULATING ROD
154	154	CAA_RSFF_FIR FLIP FLOP S/W FIRE TRANSIENT
155	155	CAA_EQP2_END EQUIPMENT CONTROL SCREEN2 END
156	156	CAA_EQP3_BEG EQUIPMENT CONTROL SCREEN3 BEGI
157	157	CAA_RSFF_PP PRIMARY PUMP CONTROL BLOCK
158	158	CAA_RSFF_SP SECONDARY PUMP CONTROL BLOCK
159	159	CAA_RSFF_CF8 COOLING TOWER 800T FAN CONTROL
160	160	CAA_RSFF_CF5 COOLING TOWER 500T FAN CONTROL
161	161	CAA_RSFF_DP DIFFUSOR PUMP CONTROL BLOCK
162	162	CAA_RSFF_MUV MAKEUP WATER VALVE CONTROL
163	163	CAA_RSFF_ECS ECCS VALVE CONTROL BLOCK
164	164	CAA_RSFF_CHO COOLING TOWER SELECTION
165	165	CAA_EQP3_END EQUIPMENT CONTROL SCREEN3 END
166	166	CAA_EQP4_BEG EQUIPMENT CONTROL SCREEN4 BEGI
167	167	CAA_EQP4_END EQUIPMENT CONTROL SCREEN4 END
168	168	CAA_RST_PWRT RESET GROUP OF %PWR TRIP
169	169	CAA_RSF_PWRT RSFF OF %PWR TRIP
170	170	CAA_RST_HVT RESET GROUP OF HV CHECK

171 171 CAA_RSF_HVT RSFF OF HV TRIP DISPLAY
172 172 CAA_RST_WTRT RESET GROUP OF WTR TRIP DISPLA
173 173 CAA_RSF_WTRT RSFF OF WTR TRIP
174 174 CAA_RST_FTT RESET GROUP OF FUEL TEMP TRIP
175 175 CAA_RSF_FTT RSFF OF FUEL TEMP TRIP DISPALA
176 176 CAA_EXTTRIP GROUP OF EXTERNAL TRIP DISPLAA
177 177 CAA_RSF_EXTT RSFF OF EXTERNAL GROUP DISPLAY
178 178 DUMMY
179 179 CAA_MODE MODE CONVERSION
180 180 CAA_TRIP_RST TRIP RESET SIGNAL
181 181 CAA_TRIP_CMD REACTOR TRIP SIGNAL
182 182 CAA_TRIP_RSF NOT OF SIGNAL REACTOR TRIP
183 183 CAA_END CAA END BLOCK
184 184 RE_BEGIN REGULATING BLOCK START
185 185 RE_NOT_MIN REGUALTING NOT IN MINIMUM POS
186 186 RE_NOT_MAX REGUALTING NOT IN MAX POSITION
187 187 RE_MMI REGUALTING MAN-MACHINE INTERFA
188 188 RE_MA_UP REGUALTING MANUAL UP
189 189 RE_MA_UPRST REGULATING MANUAL UP RESET
190 190 RE_MA_UP_RSF REGUALTING MANUAL UP RSFF
191 191 RE_MA_DO REGUALTING MANUAL DOWN
192 192 RE_MA_DOWRST REGUALTING MANUAL DOWN RESET
193 193 RE_MA_DORSFF REGULATING MANUAL DOWN RSFF
194 194 RE_PW_LTSTPT POWER LESS THAN SET POINT
195 195 RE_AU_UP REGUALTING AUTO UP
196 196 RE_AU_UPRST REGUALATING AUTO UP RST
197 197 RE_AU_UPRSFF REGUALTING AUTO UP RSFF
198 198 RE_PW_GTSTPT POWER PRODUCED GT SETPOINT
199 199 RE_AU_DOW1 REGUALTING AUTO DOWN1
200 200 RE_AUDOW1RST REGULATING AUTO DOWN1 RESET
201 201 RE_AUDOW1RSF REGUALTING AUTO DOWN1 RSFF
202 202 RE_AU_DOW2 REGUALTING AUTO DOWN2
203 203 RE_AUDOW2RST REGUALTING AUTO DOWN2 RST
204 204 RE_AU_DO2RSF REGULATING AUTO DOWN2 RSF
205 205 RE_PEGE16 PERIOD GT 16 SECOND
206 206 RE_PWRERLT20 POWER ERROR GE -20%
207 207 RE_AUPWRPER AUTOMODE PWR GE-20%&PERI GT 16
208 208 RE_PWERRGE5 POWER ERROR GE 5%
209 209 RE_AU_DOW3 REGUALTING AUTO DOWN3
210 210 RE_AU_DO3RST REGULATING AUTO DOWN3 RESET
211 211 RE_AU_DO3RSF REGUALTING AUTO DOWN3 RSFF
212 212 RE_AU_DOW4 REGUALTING AUTO DOWN4
213 213 RE_AU_DO4RST REGULATING AUTO DOWN1 RESET
214 214 RE_AU_DO4RSF REGUALTING AUTO DOWN1 RSFF
215 215 RE_SQ_UP REGUALTING SQUARE UP
216 216 RE_SQ_UPRST REGULATING SQUARE UP RESET
217 217 RE_SQ_UPRSFF REGUALTING SQUARE UP RSFF
218 218 RE_SQ_DOW REGULATING SQUARE DOWN
219 219 RE_SQ_DOWRST REGUALATING SQUARE DOWN RST
220 220 RE_SQ_DOWRSF REGULATING SQUARE DOWN RSFF
221 221 RE_POS_GT387 REGULATING POS GT 38.75%
222 222 RE_POS_LT375 REGULATING ROD POS LT 37.5%
223 223 RE_PH_UPFAST REGULATING POS OK PULSE HI UP
224 224 RE_PH_DOW REGULATING PULSE HI DOWN
225 225 RE_PH_DOWRST REGULATING PULSE HI DOWN RST
226 226 RE_PH_DOWRSF REGULATING PULSE HI DOWN RSFF
227 227 RE_PH_UP REGUALTING PULSE HI UP
228 228 RE_PH_UPRST REGUALTING PULSE HI UP RESET

229 229 RE_PH_UPRSF REGUALATING PULSE HI RSFF
230 230 RE_POS_GT45 REGUALATING POS GT 45%
231 231 RE_POS_LT437 REGULATING ROD POS LT .4375
232 232 RE_PL_UP REGUALTING PULSE LO UP
233 233 RE_PL_UPRST REGUALATING PULSE LO UP RST
234 234 RE_PL_UPRSFF REGULATING PULSE LO UP RSFF
235 235 RE_PL_DOW REGUALTING PULSE LO DOWN
236 236 RE_PL_DOWRST REGUALTING PULSE LO DOWN RST
237 237 RE_PL_DOWRSF REGUALTING PULSE LO DOWN RSFF
238 238 RE_UP REGULATING UP SUM
239 239 RE_DOWN REGULATING DOWN
240 240 RE_V_VARY11 REGUALTING SPEED CALC 1
241 241 RE_V_VARY12 REG ROD SPEED SLOWER THAN 2
242 242 RE_V_VARY21 ROD SPEED DOWN VARY FASTER TH1
243 243 RE_V_VARY1 REGULATING V VARY AS ERROR
244 244 RE_V_VARY2 REG ROD VARY 2 (SLOWER THAN 1)
245 245 RE_V_NORMV REGUALTING NORMAL SPEED TRAVEL
246 246 RE_V_FASTV REGUALTING FAST SPEED
247 247 RE_V_FIXSLOW REG ROD AUTO DOWN SLOW
248 248 RE_V_SELECT ROD SPEED SELECTION
249 249 RE_ROD_POS REGUALTING ROD POSITION
250 250 RE_POSCONVET REGULATING POS CONVERSION
251 251 RE_END REGULATING END BLOCK
252 252 DUMMY
253 253 S1_BEGIN SHIM #1BEGIN BLOCK
254 254 S1_NOT_MIN SHIM#1 NOT IN MINIMUM POS
255 255 S1_NOT_MAX SHIM#1 NOT IN MAX POSITION
256 256 S1_MMI SHIM#1 MAN-MACHINE INTERFA
257 257 S1_MA_UP SHIM#1 MANUAL UP
258 258 S1_MA_UPRST SHIM#1 MANUAL UP RESET
259 259 S1_MA_UP_RSF SHIM#1 MANUAL UP RSFF
260 260 S1_MA_DO SHIM#1 MANUAL DOWN
261 261 S1_MA_DOWRST SHIM#1 MANUAL DOWN RESET
262 262 S1_MA_DORSFF SHIM#1 MANUAL DOWN RSFF
263 263 S1_S1GTRE SHIM 1 POS GT REG ROD POS
264 264 S1_AUTOUPCMD S1 UP CMD
265 265 S1_AUTODOCMD S1 AUTO DOWN COMMAND
266 266 S1_REPOSLT20 REGULATING POS LT 20%
267 267 S1_AU_UP SHIM#1 AUTO UP
268 268 S1_AU_UPRST SHIM#1 AUTO UP RST
269 269 S1_AU_UPRSFF SHIM#1 AUTO UP RSFF
270 270 S1_REPOSGT80 SHIM#1 POS GT.80%
271 271 S1_AU_DOW1 SHIM#1 AUTO DOWN1
272 272 S1_AUDOW1RST SHIM#1 AUTO DOWN1 RESET
273 273 S1_AUDOW1RSF SHIM#1 AUTO DOWN1 RSFF
274 274 S1_AU_DOW2 SHIM#1 AUTO DOWN2
275 275 S1_AUDOW2RST SHIM#1 AUTO DOWN2 RST
276 276 S1_AU_DO2RSF SHIM#1 AUTO DOWN2 RSF
277 277 S1_AU_DOW3 S1 AUTO DOWN3
278 278 S1_AU_DO3RST S1 AUTO DOWN3 RESET
279 279 S1_AU_DO3RSF S1 AUTO DOWN3 RSFF
280 280 S1_AU_DOW4 S1 AUTO DOWN4
281 281 S1_AU_DO4RST S1 AUTO DOWN1 RESET
282 282 S1_AU_DO4RSF S1 AUTO DOWN1 RSFF
283 283 S1_SQ_UP REGUALTING SQUARE UP
284 284 S1_SQ_UPRST REGULATING SQUARE UP RESET
285 285 S1_SQ_UPRSFF REGUALTING SQUARE UP RSFF
286 286 S1_SQ_DOW REGULATING SQUARE DOWN

287	287	S1_SQ_DOWRST	REGUALATING SQUARE DOWN RST
288	288	S1_SQ_DOWRSF	REGULATING SQUARE DOWN RSFF
289	289	S1_POS_GT387	SHIM #1 POS GT 38.75%
290	290	S1_POS_LT375	SHIM #1 ROD POS LT 37.5%
291	291	S1_PH_UPFAST	SHIM #1 OK FOR PULSE HI UP FAS
292	292	S1_PH_DOW	SHIM #1 PULSE HI DOWN
293	293	S1_PH_DOWRST	SHIM #1 PULSE HI DOWN RST
294	294	S1_PH_DOWRSF	SHIM #1 PULSE HI DOWN RSFF
295	295	S1_PH_UP	SHIM #1 PULSE HI UP
296	296	S1_PH_UPRST	SHIM #1 PULSE HI UP RESET
297	297	S1_PH_UPRSF	SHIM #1 PULSE HI UP RSFF
298	298	S1_POS_GT45	REGUALATING POS GT 45%
299	299	S1_POS_LT437	REGULATING ROD POS LT 43.75%
300	300	S1_PL_UP	REGUALTING PULSE LO UP
301	301	S1_PL_UPRST	REGUALATING PULSE LO UP RST
302	302	S1_PL_UPRSFF	REGULATING PULSE LO UP RSFF
303	303	S1_PL_DOW	REGUALTING PULSE LO DOWN
304	304	S1_PL_DOWRST	REGUALTING PULSE LO DOWN RST
305	305	S1_PL_DOWRSF	REGUALTING PULSE LO DOWN RSFF
306	306	S1_UP	REGULATING UP SUM
307	307	S1_DOWN	REGULATING DOWN
308	308	S1_V_VARY1	SHIM#1 SPEED VARY 1
309	309	S1_V_VARY2	S1 SPEED VARY 2
310	310	S1_V_FIXSLOW	S1 SPEED FIX SLOW
311	311	S1_VNORMV	SHIM#1 NORMAL SPEED GROUP
312	312	S1_VFASTV	SHIM#1 FAST SPEED GROUP
313	313	S1_V_SELECT	ROD SPEED SELECTION
314	314	S1_ROD_POS	SHIM#1 ROD POSITION
315	315	S1_RODCONVET	SHIM#1 ROS POS CONVERSION
316	316	S1_END	SHIM #1 END BLOCK
317	317	DUMMY	
318	318	S2_BEGIN	SHIM #2 BEGIN BLOCK
319	319	S2_V_SELECT	ROD SPEED SELECTION
320	320	S2_ROD_POS	SHIM#2 ROD POSITION
321	321	S2_RODCONVET	SHIM#2 ROD POS CONVERSION
322	322	S2_NOT_MIN	SHIM#2 NOT IN MINIMUM POS
323	323	S2_NOT_MAX	SHIM#2 NOT IN MAX POSITION
324	324	S2_MMI	SHIM#2 MAN-MACHINE INTERFA
325	325	S2_MA_UP	SHIM#2 MANUAL UP
326	326	S2_MA_UPRST	SHIM#2 MANUAL UP RESET
327	327	S2_MA_UP_RSF	SHIM#2 MANUAL UP RSFF
328	328	S2_MA_DO	SHIM#2 MANUAL DOWN
329	329	S2_MA_DOWRST	SHIM#2 MANUAL DOWN RESET
330	330	S2_MA_DORSFF	SHIM#2 MANUAL DOWN RSFF
331	331	S2_POS_GT387	SHIM #2 POS GT 38.75%
332	332	S2_POS_LT375	SHIM#2 ROD POS LT 37.5%
333	333	S2_PH_UPFAST	SHIM #2 OK FOR PULSE HI UP FAS
334	334	S2_PH_DOW	SHIM #2 PULSE HI DOWN
335	335	S2_PH_DOWRST	SHIM #2 PULSE HI DOWN RST
336	336	S2_PH_DOWRSF	SHIM #2 PULSE HI DOWN RSFF
337	337	S2_PH_UP	SHIM #2 PULSE HI UP
338	338	S2_PH_UPRST	SHIM #2 PULSE HI UP RESET
339	339	S2_PH_UPRSF	SHIM #2 PULSE HI UP RSFF
340	340	S2_POS_GT45	SHIM#2 POS GT 45%
341	341	S2_POS_LT437	SHIM#2 ROD POS LT 43.75%
342	342	S2_PL_UP	SHIM#2 PULSE LO UP
343	343	S2_PL_UPRST	REGUALATING PULSE LO UP RST
344	344	S2_PL_UPRSFF	REGULATING PULSE LO UP RSFF

345 345 S2_PL_DOW SHIM#2 PULSE LO DOWN
346 346 S2_PL_DOWRST REGUALTING PULSE LO DOWN RST
347 347 S2_PL_DOWRSF REGUALTING PULSE LO DOWN RSFF
348 348 S2_UP SHIM#2 UP SUM
349 349 S2_DOWN_NORV SHIM#2 DOWN IN NORMAL SPEED
350 350 S2_DOWN SHIM#2 DOWN COMMAND
351 351 S2_END SHIM #2 END BLOCK
352 352 SA_BEGIN SAFETY BEGIN BLOCK
353 353 SA_V_SELECT ROD SPEED SELECTION
354 354 SA_ROD_POS SAFETY ROD POSITION
355 355 SA_RODCONVET SAFETY ROD POS CONVERSION
356 356 SA_NOT_MIN SAFETY NOT IN MINIMUM POS
357 357 SA_NOT_MAX SAFETY NOT IN MAX POSITION
358 358 SA_MMI SAFETY MAN-MACHINE INTERFA
359 359 SA_MA_UP SAFETY MANUAL UP
360 360 SA_MA_UPRST SAFETY MANUAL UP RESET
361 361 SA_MA_UP_RSF SAFETY MANUAL UP RSFF
362 362 SA_MA_DO SAFETY MANUAL DOWN
363 363 SA_MA_DOWRST SAFETY MANUAL DOWN RESET
364 364 SA_MA_DORSFF SAFETY MANUAL DOWN RSFF
365 365 SA_POS_GT387 SAFETY POS GT 38.75%
366 366 SA_POS_LT375 SAFETY ROD POS LT 37.5%
367 367 SA_PH_UPFAST SHI#2 OK FO PH UP FAST
368 368 SA_PH_DOW SAFETY PULSE HI DOWN
369 369 SA_PH_DOWRST SAFETY PULSE HI DOWN RST
370 370 SA_PH_DOWRSF SAFETY PULSE HI DOWN RSFF
371 371 SA_PH_UP SAFETY PULSE HI UP
372 372 SA_PH_UPRST SAFETY PULSE HI RESET
373 373 SA_PH_UPRSF SAFETY PULSE HI RSFF
374 374 SA_POS_GT45 SAFETY POS GT 45%
375 375 SA_POS_LT437 SAFETY ROD POS LT 43.75%
376 376 SA_PL_UP SAFETY PULSE LO UP
377 377 SA_PL_UPRST SAFETY PULSE LO UP RST
378 378 SA_PL_UPRSFF SAFETY PULSE LO UP RSFF
379 379 SA_PL_DOW SAFETY PULSE LO DOWN
380 380 SA_PL_DOWRST SAFETY PULSE LO DOWN RST
381 381 SA_PL_DOWRSF SAFETY PULSE LO DOWN RSFF
382 382 SA_UP SAFETY UP SUM
383 383 SA_DOWN_NORV SAFETY DOWN IN NORMAL SPEED
384 384 SA_DOWN SAFETY DOWN COMMAND
385 385 SA_END SAFETY END BLOCK
386 386 TR_BEGIN TRANSIENT BEGIN BLOCK
387 387 TR_V_SELECT ROD SPEED SELECTION
388 388 TR_ROD_POS TRANS ROD POSITION
389 389 TR_RODCONVET TRANSIENT ROD POS CONVERSION
390 390 TR_NOT_MIN TRANS NOT IN MINIMUM POS
391 391 TR_NOT_MAX TRANS NOT IN MAX POSITION
392 392 TR_MMI TRANS MAN-MACHINE INTERFA
393 393 TR_MA_UP TRANS MANUAL UP
394 394 TR_MA_UPRST TRANS MANUAL UP RESET
395 395 TR_MA_UP_RSF TRANS MANUAL UP RSFF
396 396 TR_MA_DO TRANS MANUAL DOWN
397 397 TR_MA_DOWRST TRANS MANUAL DOWN RESET
398 398 TR_MA_DORSFF TRANS MANUAL DOWN RSFF
399 399 TR_POSLT5587 TRANSIENT POS LT 0.55875
400 400 TR_PHDOW1NOR TRANS PULS HI DOWN NORMAL
401 401 TR_PHDOW1RST TRANS PULS HI DOWN NORM RST
402 402 TR_PHDOW1RSF TRANS PULS HI DOWN NORM RSFF

403 403 TR_PHUPFAST TRANS PULS HI UP FAST
404 404 TR_PHTIMER TRANS PULS HI TIMER
405 405 TR_PHUPFARST TRANS PULS HI UP FAST RST
406 406 TR_PHUPFARSF TRANS PULS HI UP FAST RSFF
407 407 TR_PHDOW2FAS TRANS PULS HI DOWN FAST
408 408 TR_PHDOW2RST TRANS PULS HI DOW FAST RST
409 409 TR_PHDOW2RSF TRANS PULS HI DOW FAST RSFF
410 410 TR_PLDOW1NOR TRANS PULS LO DOWN NORMAL
411 411 TR_PLDOW1RST TRANS PULS LO DOWN NORM RST
412 412 TR_PLDOW1RSF TRANS PULS LO DOWN NORM RSFF
413 413 TR_REPOS4345 REGUALTING POS BETW 43.75-45%
414 414 TR_S1POS4345 SHIM#1 POS BETWEEN 43.750-45%
415 415 TR_S2POS4345 SHIM#1 POS BETWEEN 43.750-45%
416 416 TR_SAPOS4345 SAFETY POS BETWEEN 43.75-45%
417 417 TR_PLUPFAST TRANS PULS LO UP FAST
418 418 TR_PLUPFARST TRANS PULS LO UP FAST RST
419 419 TR_PLUPFARSF TRANS PULS LO UP FAST RSFF
420 420 TR_PLDOW2FAS TRANS PULS LO DOWN 2 FAST
421 421 TR_PLDOW2RST TRANS PULS LO DOWN FAST RST
422 422 TR_PLDOW2RSF TRANS PULS LO DOW FAST RSFF
423 423 TR_UP TRANS UP CMD
424 424 TR_DOWN_MODE TRANS DOWN NORMAL
425 425 TR_DOWN TRANSIENT ROD DOWN
426 426 TR_RODFAST SPEED SELECT FAST UP/DOWN
427 427 TR_RODNORM TRANS ROD SPEED NORMAL
428 428 TR_END TRANSIENT END BLOCK

About Author

Mr.Ake Sompong was born on 3 September 1969 in Lampang province. He got bechelor degree in Mechanical Engineering from Chiengmai University in 1990.

Then he worked for The Siam Navaloha Company as production engineer for 3 years before left to further his course in master degree in Department of Nuclear Technology, Faculty of Engineering, Chulalongorn University.