

Solution to Problem VIa.5.1:

```

c                                     (Using Average Temperature)
c This program calculates the surface area of a steam generator.
c outside diameters must also be specified. Other notes:
c   1. Tube diameter is primarily determined from pumping power and
c      other considerations such as containment pressure limit.
c   2. Tube wall thickness is determined from ASME boiler code.
c   3. Number of tubes is primarily determined by cost optimization
c   4. A total fouling factor must be specified. This accounts not
c      only for actual fouling but also for calculational uncertainty.
c Data are in BU.
c The Dittus-Boelter correlation DB is used for the tube-side and the
c Rohsenow pool boiling correlation for the shell-side (secondary).
C P: is used for primary-side (tube) and s: for secondary-side (shell)
  implicit real*8 (a-h,o-z)
  data Cws,pi/0.0136,3.1415927/
  data dip,dop,aN/0.654,0.75,8485./
  data Qdot,Tp1,Tp2,Ts,akw/61.E6,604.,550.,525.24,10.80/
  data fi,fo,hfg/0.0,0.0002437,850.00,679.50/
  di=dip/12.00
  do=dop/12.00
  areai=pi*di*di*aN/4.00
  Tavp=0.5*(Tp1+Tp2)
  DTP=(Tp1-Tp2)
  Tw=0.5*(Tavp+Ts)
c Subroutine intrpl gets temperature and returns physical properties
  call intrpl(Tavp,cpp,cpg,amufp,amug,akfp,akg,prp,prg,sigf,
1      betaf,rof,rog,anuf,anug,vf,vfg,vg)
  call intrpl(Ts,cps,cpg,amufs,amug,akfs,akg,prs,prg,sigfs,
1      betaf,rofs,rogs,anuf,anug,vf,vfg,vg)
  Wp=Qdot/(cpp*(Tp1 - Tp2))
  effec=(Tp1-Tp2)/(Tp1-Ts)
  aLMTD=(Tp1-Tp2)/alog((Tp1-Ts)/(Tp2-Ts))
  Cmin=Wp*Cpp
  Y1=1./(Cmin*alog(1.-effec))
  Rep=4.*Wp/(pi*amufp*di*aN)
  hi=0.023*akfp*(Rep**0.8)*(Prp**0.3333333)/di
  termb=sqrt(sigfs/(rofs-rogs))
  terma=(termb/(amufs*hfg))**0.333333
  Z1=Cws*hfg*(Prs**1.7)*terma/Cps
  Y3=Z1/(Qdot**0.66666)
  terma=do/(di*hi)
  termb=do*alog(do/di)/(2.*akw)
  Y2=terma+termb+(do*fi/di)+fo
  z=Y2/Y1
  i=0
  x=10000.00
1  continue
  i=i+1
  fofx=Y1*x+(Y3*(x**0.666666))+Y2
  fpox=Y1+(0.6666666*Y3*(x**(-0.3333333)))
  xn=x-(fofx/fpox)
  diff=abs((xn-x)/xn)
  if(diff.le.1.E-6) go to 2
  if(i.gt.60) go to 3
  x=xn
  go to 1
2  continue
  aNTU=-alog(1.-effec)
  Rp=terma
  Rfp=fi+fo
  Rw=do*alog(do/di)/(2.*akw)
  Rs=Y3*(x**0.66666)
  sigR=Rp+Rfp+Rw+Rs
  U=1./sigR
  area=x
  aL=x/(pi*do*aN)
  fric=0.184/(Rep**0.2)
  dpi=fric*(aL/di)*(Wp*Wp/(2.*rof*32.20*areai*areai*144.00*12.96e6))

```

```

hs=1./Rs
Ws=Qdot/hfg
open(11,file='SG.OUT')
write(11,6) Wp,Tp1,Tp2,Pp,Ps,Ts,aN,dip,dop,aL,area,Rp,Rs,Rw,Rfp,U,Ws,aLMTD,
1      effec,hi,hs,Rep,dpi
write(11,8) Tfilm,cpp,amufp,akfp,Prp,akw,Ts,Cps,amufs,akfs,Prs,
1      sigfs,rofs,rogs,Cws
c  Format statements not shown
go to 9
3  continue
write(*,4)
4  format(' Did not converge in 30 iterations')
9  continue
stop
end

```