ADAS3XX
FORTRAN

ABINEW

```
      FUNCTION ABINEW(OA,YA,FA,A,B,N)
C
      IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 FUNCTION: ABINEW ***********************
C
C-----------------------------------------------------------------------
C  FUNCTION TO EVALUATE INNER INTEGRALS FOR RATE COEFFICIENTS .ABINEW IS
C  CALLED BY QH & QHE.  THE PROCEDURES ALLOW FOR PROJECTILE AND TARGET
C  MASSES.
C  INPUT
C      OA=VECTOR OF CROSS-SECTIONS (CM2)
C      YA=VECTOR OF REDUCED RELATIVE SPEEDS. 1ST VALUE IS AT THRESHOLD
C      FA=VECTOR OF ALPHAS  (12TH VALUE IS FOR EXTRAPOLATION, PROVIDED
C         EXPLICITLY. EXTRAPOLATION BELOW YA(1) IS BASED ON FA(1))
C         N.B. OA(1) MUST BE NON-ZERO.
C             (OA,YA AND FA ARE OF FIXED LENGTH =24)
C
C      A=LOWER INTEGRAL LIMIT
C      B=UPPER INTEGRAL LIMIT
C      N=NUMBER OF CROSS-SECTIONS
C  OUTPUT
C      ABINEW=DEFINITE INTEGRAL.
C
C  ********** H.P. SUMMERS,JET            18 FEB 1987  ****************
C  **********                          COR. 31 JUL 1990  ****************
C  **********                               15 JUL 1991  REORDER EVAL AT
C                                                        LABEL 50
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
      DIMENSION OA(24),YA(24),FA(24)
```

BNQCTB

```
      SUBROUTINE BNQCTB(Z0,Z1,NMIN,NMAX,IMAX,NREP,NBEAM,BMENA,BMFRA,
     &                  CXMEMB,IBLOCK,QTHREP,ALPHA)
C
      IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: BNQCTB ********************
C
C -----------------------------------------------------------------------
C  SUBROUTINE TO CALCULATE THEORETICAL CHARGE EXCHANGE RATE COEFFICIENTS
C  FROM NEUTRAL HYDROGEN.
C
C  RATE DATA IS RETURNED TO REPRESENTATIVE N-SHELLS FOR USE BY BUNDLE-N
C  CODES.
C
C  INPUT FROM ARCHIVED DATASET IS ON UNIT 11.
C
C  THE NAME OF THE SELECTED DATASET IS CONTAINED IN: 'CXMEMB'
C
C  AND IS OPENED IN THE SUBROUTINE.
C
C  THIS VERSION USES   '1989 RESTRUCTURED DATA'   MEMBERS WITH THE
C  CHANGED L-FITTING PARAMETERS
C  THE NEW PARAMETERS ARE TRANSFERED IN   COMMON /LFIT89/
C
C  THE SUBROUTINE IS A DEVELOPMENT OF QCHEX, NEWCX2, NCHEX2 ETC.
C  ORIGINALLY WRITTEN BY J. SPENCE.  THIS VERSION ECONOMISES ON
C  SUBROUTINES.
C
C  INPUT
C      Z0=TARGET ION NUCLEAR CHARGE
C      Z1=RECOMBINING TARGET ION CHARGE
C      NMIN=LOWEST REPRESENTATIVE N-LEVEL OF TARGET
C      NMAX=HIGHEST REPRESENTATIVE N-LEVEL OF TARGET
C      IMAX=NUMBER OF REPRESENTATIVE LEVELS
C      NREP(I)=REPRESENTATIVE N-LEVELS
C      NBEAM=NUMBER OF ENERGY COMPONENTS IN NEUTRAL HYDROGEN BEAM
C      BMENA(J)=BEAM ENERGY COMPONENTS (EV/AMU)
C      BMFRA(J)=BEAM FRACTIONS IN ENERGY COMPONENTS
C      CXMEMB=DATA SET NAME OF CHARGE EXCHANGE DATA SET.
C      IBLOCK=1 SELECT UDW METHOD OR 1ST DATA BLOCK
C             =2 SELECT CCAO METHOD OR 2ND DATA BLOCK
C             =3 SELECT CTMC METHOD OR 3RD DATA BLOCK
C             =4 SELECT CCMO METHOD OR 4TH DATA BLOCK
```

```
C
C  OUTPUT
C      QTHREP(I)=MEAN RATE COEFFICIENTS FOR REPRESENTATIVE
C                N-LEVELS  (AVERAGED OVER BEAM FRACTIONS) (CM3 SEC-1)
C      ALPHA=SIZE OF 1/N**ALPHA TAIL FOR CH.EXCH X-SECT.
C
C  ********** H.P.SUMMERS, JET            13 DEC 1989  ***************
C ----------------------------------------------------------------------
C
C----------------------------------------------------------------------
C
C UPDATE:  19/01/94 - JONATHAN NASH - TESSELLA SUPPORT SERVICES PLC
C
C          THE FOLLOWING MODIFICATIONS HAVE BEEN MADE TO THE SUBROUTINE:
C
C          1) THE COMPLETE CHARGE EXCHANGE DATA SET NAME IS NOW PASSED
C             INTO THE ROUTINE RATHER THAN JUST THE MEMBER NAME.
C
C          2) THE ROUTINE HAS BEEN UPGRADED TO READ NEW ADF01 FORMAT.
C
C  NOTES:  NO ATTEMPT HAS BEEN MADE TO RESTRUCTURE THE ROUTINE. RATHER
C          THE MINIMUM AMOUNT OF WORK TO INTEGRATE THE ROUTINE INTO
C          ADAS310 HAS BEEN COMPLETED.
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 17-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - ADDED "STATUS='UNKNOWN'" TO OPEN STATEMENT
C
C VERSION: 1.3                          DATE: 22-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REPLACED CALLS TO NAG ROUTINE E02BBF WITH ADAS ROUTINE
C                 DXNBBF
C
C VERSION: 1.4                          DATE: 23-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REPLACED CALLS TO NAG ROUTINE E01BAF WITH ADAS ROUTINE
C                 DXNBAF
C
C VERSION: 1.5                          DATE: 23-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - RELABELLED LOOP COUNTERS FOR LOOPS 176 AND 177
C
C VERSION: 1.6                          DATE: 24-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - RENAMED NBENG TO NBENG2 TO AVOID CONFUSION WITH
C                 OTHER NBENG IN OTHER ROUTINES
C                 REMOVED SUPERFLUOUS VARIABLES
C
C VERSION: 1.7                          DATE: 14-10-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C               - CORRECTED SECOND CALL TO DXNBAF - IT WAS USING XSA AND
C                 YSA RATHER THAN XSA AND ZSA
C
C VERSION: 1.8                            DATE: 09-04-98
C MODIFIED: HARVEY ANDERSON ( UNIVERSITY OF STRATHCLYDE )
C               - CHANGED VARIBLE MXE FROM 24 TO 40.
C               - INCREASED SIZE OF ARRAYS ASSOCIATED WITH THE
C                 ROUTINES DXNBAF AND DXNBBF.
C               - REPLACED NUMERICAL VALUE WITH THE PARAMETER
C                 MXE IN THE IF STATEMENT WHICH TESTS TO ENSURE
C                 THAT THE NUMBER OF BEAM ENERGIES READ FROM
C                 INPUT FILE IS NOT GREATER THE ARRAY DIMMENSIONS
C                 OF THE RELEVANT ARRAYS.
C
C VERSION: 1.9                            DATE: 23-06-98
C MODIFIED: RICHARD MARTIN
C               -CORRECTED SCCS ERROR.
C
C----------------------------------------------------------------------
C
C          (I*4)  MXE       = MAXIMUM NO. OF ENERGIES.
C          (I*4)  MXN       = MAXIMUM NO. OF N SHELLS.
C          (I*4)  IZR       = ION CHARGE OF RECEIVER.
C          (I*4)  IZD       = ION CHARGE OF DONOR.
C          (I*4)  INDD      = DONOR STATE INDEX.
C          (I*4)  NBENG2    = NUMBER OF ENERGIES READ.
C          (I*4)  NMINF     = LOWEST N-SHELL FOR WHICH DATA READ.
C          (I*4)  NMAXF     = HIGHEST N-SHELL FOR WHICH DATA READ.
C
C          (L*4)  LPARMS    = FLAGS IF L-SPLITTING PARAMETERS PRESENT.
C                             .TRUE.  => L-SPLITTING PARAMETERS PRESENT.
C                             .FALSE  => L-SPLITTING PARAMETERS ABSENT.
C          (L*4)  LSETL     = FLAGS IF L-RESOLVED DATA PRESENT.
C                             .TRUE.  => L-RESOLVED DATA PRESENT.
C                             .FALSE  => L-RESOLVED DATA ABSENT.
C          (L*4)  LSETM     = FLAGS IF M-RESOLVED DATA PRESENT.
C                             .TRUE.  => M-RESOLVED DATA PRESENT.
C                             .FALSE  => M-RESOLVED DATA ABSENT.
C
C          (C*80) TITLE     = NOT SET - TITLE FOR DATA SOURCE.
C          (C*2)  SYMBR     = RECEIVER ION ELEMENT SYMBOL.
C          (C*2)  SYMBD     = DONOR ION ELMENT SYMBOL.
```

```
C
C          (I*4)  LFORMA()  = PARAMETERS FOR CALCULATING L-RES X-SEC.
C                             DIMENSION: MXE
C
C          (R*8)  BENGY()   = COLLISION ENERGIES.
C                             UNITS: EV/AMU (READ AS KEV/AMU)
C                             DIMENSION: MXE
C          (R*8)  ALPHAA()  = EXTRAPOLATION PARAMETER ALPHA.
C                             DIMENSION: MXE
C          (R*8)  XLCUTA()  = PARAMETERS FOR CALCULATING L-RES X-SEC.
C                             DIMENSION: MXE
C          (R*8)  PL2A()    = PARAMETERS FOR CALCULATING L-RES X-SEC.
C                             DIMENSION: MXE
C          (R*8)  PL3A()    = PARAMETERS FOR CALCULATING L-RES X-SEC.
C                             DIMENSION: MXE
C          (R*8)  XTOT()    = TOTAL CHARGE EXCHANGE CROSS-SECTION.
C                             UNITS: CM2
C                             DIMENSION: MXE
C
C          (R*8)  XSIGN(,)  = N-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS.
C                             UNITS: CM2
C                             1ST DIMENSION: MXE
C                             2ND DIMENSION: MXN
C          (R*8)  XSIGL(,)  = L-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS.
C                             UNITS: CM2
C                             1ST DIMENSION: MXE
C                             2ND DIMENSION: (MXN*(MXN+1))/2
C          (R*8)  XSIGM(,)  = M-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS.
C                             UNITS: CM2
C                             1ST DIMENSION: MXE
C                             2ND DIMENSION: (MXN*(MXN+1)*(MXN+2))/6
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    MXN       , MXE
      PARAMETER( MXN = 20  , MXE = 40 )
C-----------------------------------------------------------------------
      INTEGER    IZR     , IZD     , INDD     , NBENG2  , NMINF   ,
     &           NMAXF
C-----------------------------------------------------------------------
      LOGICAL    LPARMS  , LSETL   , LSETM
C-----------------------------------------------------------------------
      CHARACTER  TITLE*80  , SYMBR*2   , SYMBD*2
C-----------------------------------------------------------------------
      INTEGER    LFORMA(MXE)
C-----------------------------------------------------------------------
      REAL*8     BENGY(MXE)   , ALPHAA(MXE)  , XLCUTA(MXE)  ,
     &           PL2A(MXE)    , PL3A(MXE)    , XTOT(MXE)
C-----------------------------------------------------------------------
      REAL*8     XSIGN(MXE,MXN)                      ,
     &           XSIGL(MXE,(MXN*(MXN+1))/2)          ,
     &           XSIGM(MXE,(MXN*(MXN+1)*(MXN+2))/6)
C-----------------------------------------------------------------------
C
       CHARACTER CXMEMB*80
       DIMENSION ZDATA(30),BMENA(6),BMFRA(6)
       DIMENSION NDATA(2),IEDATA(2)
       DIMENSION QTHREP(31),RATE(6,31),NREP(31)
       DIMENSION XSA(MXE),YSA(MXE),ZSA(MXE)
       DIMENSION WTS(MXE),B(MXE),A(MXE+4,4),DIAG(MXE+4)
       DIMENSION XKA(MXE+4),C(MXE+4),ZKA(MXE+4),ZC(MXE+4)
CX     DIMENSION WRK(160)
       DATA LCK,LWRK/28,160/
       DATA ZDATA/1.00D+00,2.00D+00,0.00D+00,4.00D+00,5.00D+00,6.00D+00,
     &            0.00D+00,8.00D+00,0.00D+00,1.00D+01,0.00D+00,0.00D+00,
     &            0.00D+00,1.40D+01,0.00D+00,0.00D+00,0.00D+00,0.00D+00,
     &            0.00D+00,0.00D+00,0.00D+00,0.00D+00,0.00D+00,0.00D+00,
     &            0.00D+00,0.00D+00,0.00D+00,0.00D+00,0.00D+00,0.00D+00/
```

C1BSIG

```
      SUBROUTINE C1BSIG( NENRGY , NSHELL , NENER ,
     &                   INSEL  , ILSEL  , IMSEL ,
     &                   IEDATA , NDATA  ,
     &                   XTOT   , XSIGN  , XSIGL , XSIGM ,
     &                   ALPHAA ,
     &                   SIGA
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: C1BSIG *********************
C
C  PURPOSE:  TO EXTRACT VALID CROSS-SECTIONS FROM INPUT CHARGE-EXCHANGE
C            FILE FOR A GIVEN SUB-BLOCK.
C
C  CALLING PROGRAM: ADAS301
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  NENRGY   = NUMBER OF TABULATED INPUT ENERGIES.
C  INPUT : (I*4)  NSHELL   = NO. OF TABULATED PRINCIPAL QUANTUM N-SHELLS
```

```
C
C  INPUT : (I*4)  NENER    = NUMBER OF VALID ENERGIES/VEL. FOR SUB-BLOCK
C  INPUT : (I*4)  INSEL    = SELECTED INPUT PRINCIPAL QUANTUM N-SHELL
C                            ( 0 => TOTAL CROSS SECTION).
C  INPUT : (I*4)  ILSEL    = SELECTED INPUT DATA L QUANTUM SHELL
C                            ( -1   => TOTAL CROSS-SECTION FOR N SHELL)
C  INPUT : (I*4)  IMSEL    = SELECTED INPUT DATA M QUANTUM SHELL
C                            ( -1   => TOTAL CROSS-SECTION FOR NL SHELL)
C
C  INPUT : (I*4)  IEDATA() = INDEX RANGE FOR VALID QUANTUM NUMBERS IN
C                            'XSIGN(,)'.
C                             DIMENSION: 1 => LOWER INDEX BOUND
C                                        2 => UPPER INDEX BOUND
C  INPUT : (I*4)  NDATA()  = INDEX RANGE FOR VALID INPUT ENERGIES/VELS.
C                            IN 'XTOT()', 'XSIGN(,)','ALPHAA()'
C                             DIMENSION: 1 => LOWER INDEX BOUND
C                                        2 => UPPER INDEX BOUND
C
C  INPUT : (R*8)  XTOT()   = TOTAL CROSS SECTIONS (UNITS: cm**2)
C                            1st DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  XSIGN(,) = CROSS SECTIONS FOR EACH N-SHELL
C                                   (UNITS: cm**2)
C                            1st DIMENSION: ENERGY INDEX
C                            2nd DIMENSION: QUANTUM N-SHELL INDEX
C  INPUT : (R*8)  XSIGL(,,)=INPUT DATA FILE: L-RESOLVED CROSS-SECTIONS.
C                           1st DIMENSION: ENERGY INDEX
C                           2ND DIMENSION: INDEXED BY FUNCTION I4IDFL.
C                           3rd DIMENSION: DATA SUB-BLOCK INDEX
C  INPUT : (R*8)  XSIGM(,,)=INPUT DATA FILE: M-RESOLVED CROSS-SECTIONS.
C                           1st DIMENSION: ENERGY INDEX
C                           2ND DIMENSION: INDEXED BY FUNCTION I4IDFM.
C                           3rd DIMENSION: DATA SUB-BLOCK INDEX
C  INPUT : (R*8)  ALPHAA() =
C                            1st DIMENSION: ENERGY INDEX
C
C  OUTPUT: (R*8)  SIGA()   = VALID CROSS SECTIONS READ FROM INPUT FILE
C                            FOR PRINCIPAL QUATUM NUMBER 'INSEL' AND
C                            GIVEN SUB-BLOCK. (UNITS: cm**2)
C                            1st DIMENSION: ENERGY INDEX
C
C          (I*4)  IE       = ARRAY INDEX: ENERGY INDEX
C          (I*4)  I1ST     = ARRAY INDEX: FIRST VALID ENERGY INDEX - 1
C          (I*4)  IN       = 'NDATA(2)' - IF 'INSEL > NDATA(2)'
C
C          (R*8)  AVAL     = 'NDATA(2)/INSEL' -  IF 'INSEL > NDATA(2)'
C          (R*8)  ZERO     = PARAMETER = EFFECTIVE ZERO (1.0D-72)
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4IDFL     ADAS      PROVIDES UNIQUE INDEX GIVEN N AND L
C          I4IDFM     ADAS      PROVIDES UNIQUE INDEX GIVEN N, L AND M
C
C AUTHOR:  PAUL E. BRIDEN (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 4569
C
C DATE:    07/02/91
C
C UPDATE:  19/04/95  H P SUMMERS - EXTENSION TO INCLUDE L AND M
C                                  SUB-SHELL CROSS-SECTIONS
C
C-----------------------------------------------------------------------
      REAL*8    ZERO
C-----------------------------------------------------------------------
      PARAMETER ( ZERO = 1.0D-72 )
C-----------------------------------------------------------------------
      INTEGER   NENRGY              , NSHELL              ,
     &          NENER               , INSEL               ,
     &          ILSEL               , IMSEL
      INTEGER   IE                  , I1ST                , IN
      INTEGER   I4IDFL              , I4IDFM
C-----------------------------------------------------------------------
      REAL*8    AVAL
C-----------------------------------------------------------------------
      INTEGER   IEDATA(2)           , NDATA(2)
C-----------------------------------------------------------------------
      REAL*8    XTOT(NENRGY)        , ALPHAA(NENRGY)        ,
     &          SIGA(NENRGY)        , XSIGN(NENRGY,NSHELL)  ,
     &          XSIGL(NENRGY,(NSHELL*(NSHELL+1))/2)         ,
     &          XSIGM(NENRGY,(NSHELL*(NSHELL+1)*(NSHELL+2))/6)
C-----------------------------------------------------------------------
```

C1OUT0

```
      SUBROUTINE C1OUT0( IWRITE   , LSETL  , LSETM ,
     &                   LOSEL    , LFSEL  , TITLF ,
     &                   TITLE    , TITLX  , TITLM , DATE  ,
     &                   INSEL    , ILSEL  , IMSEL ,
     &                   IEVAL    , LERNG  , EOA   , SIGOA ,
     &                   KPLUS1   , COEF
     &                 )
      IMPLICIT NONE
```

```
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: C1OUT0 *********************
C
C  PURPOSE:  TO  PRINT DATA CONCERNING THE SELECTED CHEXDATA SUB-BLOCK
C            AND SELECTED PRINCIPAL QUANTUM NUMBER.
C
C  CALLING PROGRAM: ADAS301
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IWRITE  = OUTPUT UNIT FOR RESULTS
C  INPUT : (L*4)  LSETL() = .TRUE.  => L-RESOLVED DATA READ
C                           .FALSE. => NO L-RESOLVED DATA READ
C  INPUT : (L*4)  LSETM() = .TRUE.  => M-RESOLVED DATA READ
C                           .FALSE. => NO M-RESOLVED DATA READ
C  INPUT : (L*4)  LOSEL   = .TRUE.  => INTERPOLATED   VALUES  FOR   ISPF
C                                      PANEL INPUT VALUES CALCULATED
C                           .FALSE  => INTERPOLATED   VALUES  FOR   ISPF
C                                      PANEL INPUT VALUES NOT CALCULATED
C  INPUT : (L*4)  LFSEL   = .TRUE.  => MINIMAX POLYNOMIAL FITTED.
C                           .FALSE. => MINIMAX POLYNOMIAL NOT FITTED
C  INPUT : (C*80) TITLF   = INFORMATION STRING READ FROM CHEXDATA FILE
C                           FOR SELECTED SUB-BLOCK.
C
C  INPUT : (C*40) TITLE   = TITLE OF RUN (READ FROM ISPF PANEL)
C  INPUT : (C*80) TITLX   = INFORMATION STRING CONTAINING: INPUT DATA
C                           FILE-NAME, SELECTED SUB-BLOCK AND N-SHELL.
C  INPUT : (C*80) TITLM   = DIAGNOSTIC LINE INFORMATION FROM 'MINIMAX'
C  INPUT : (C*8)  DATE    = CURRENT DATE (AS 'DD/MM/YY')
C
C  INPUT : (I*4)  INSEL   = SELECTED PRINCIPAL QUANTUM NUMBER.
C                           (0 => TOTAL CROSS-SECTION).
C  INPUT : (I*4)  ILSEL   = SELECTED INPUT DATA L QUANTUM SHELL
C                           ( -1    => TOTAL CROSS-SECTION FOR N SHELL)
C  INPUT : (I*4)  IMSEL   = SELECTED INPUT DATA M QUANTUM SHELL
C                           ( -1    => TOTAL CROSS-SECTION FOR NL SHELL)
C
C  INPUT : (I*4)  IEVAL   = NUMBER OF ISPF ENTERED ENERGY VALUES.
C  INPUT : (L*4)  LERNG() = .TRUE.  => ENERGY 'EOA()' IN RANGE
C                           .FALSE. => ENERGY 'EOA()' OUT OF RANGE
C                           (RANGE = INPUT ENERGY RANGE FOR SUB-BLOCK)
C  INPUT : (R*8)  EOA()   = ISPF ENTERED ENERGIES (eV/amu)
C  INPUT : (R*8)  SIGOA() = SPLINE INTEROPLATED X-SEC VALUE AT 'EOA()'
C
C  INPUT : (I*4)  KPLUS1  = NUMBER OF MINIMAX COEFFICIENTS
C  INPUT : (R*8)  COEF()  = COEFFICIENTS OF FITTED MINIMAX POLYNOMIAL
C
C          (I*4)  L1      = PARAMETER = 1
C          (I*4)  L2      = PARAMETER = 2
C          (I*4)  L3      = PARAMETER = 3
C
C          (I*4)  I       = GENERAL ARRAY ELEMENT INDEX
C
C          (R*8)  R8ECON  = FUNCTION (SEE ROUTINE SECTION BELOW)
C          (R*8)  R8SCON  = FUNCTION (SEE ROUTINE SECTION BELOW)
C          (R*8)  VAUNIT  = VELOCITY (UNITS: at.units)
C          (R*8)  VCMS    = VELOCITY (UNITS: cm/sec  )
C          (R*8)  SIGAO2  = CROSS-SECTION (UNITS: pi*(a0**2) )
C          (R*8)  RCOEF   = RATE-COEFFICIENT (UNITS: cm**3/sec )
C
C          (C*80) CADAS   = ADAS HEADER: INCLUDES RELEASE, PROGRAM, TIME
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXADAS     ADAS      GATHERS ADAS HEADER INFORMATION
C          R8ECON     ADAS      REAL*8 FUNCTION: CONVERT ENGY/VEL. FORM
C          R8SCON     ADAS      REAL*8 FUNCTION: CONVERT X-SECTION FORM
C
C AUTHOR  : PAUL E. BRIDEN (TESSELLA SUPPORT SERVICES PLC)
C           K1/0/81
C           JET EXT. 4569
C
C DATE:    07/02/91
C
C UPDATE:  22/09/93 - J NASH    - ADAS91:
C          REMOVED PRINTING OF DATA SUB-BLOCK TITLE (COMMENTED OUT).
C
C UPDATE:  18/04/95   H P SUMMERS - ADDED L AND M RESOLUTION
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 24-04-95
C MODIFIED: TIM HAMMOND(TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 13-05-96
C MODIFIED: TIM HAMMOND
C               - REMOVED HOLLERITH CONSTANTS FROM OUTPUT AND TIDIED UP
C                 HEADER
C-----------------------------------------------------------------------
      INTEGER    L1           , L2           , L3
C-----------------------------------------------------------------------
      PARAMETER( L1 = 1       , L2 = 2       , L3 = 3     )
C-----------------------------------------------------------------------
      INTEGER    IWRITE       , INSEL        , ILSEL     , IMSEL     ,
     &           IEVAL        , KPLUS1
```

```
      INTEGER    I
C-----------------------------------------------------------------------
      REAL*8     R8ECON       , R8SCON
      REAL*8     VAUNIT       , VCMS         , SIGAO2     , RCOEF
C-----------------------------------------------------------------------
      LOGICAL    LSETL        , LSETM        , LOSEL      , LFSEL
C-----------------------------------------------------------------------
      CHARACTER  TITLF*(*)    , TITLE*(*)    , TITLX*(*)  , TITLM*(*) ,
     &           DATE*8
      CHARACTER  CADAS*80
C-----------------------------------------------------------------------
      REAL*8     EOA(IEVAL)   , SIGOA(IEVAL) ,
     &           COEF(KPLUS1)
C-----------------------------------------------------------------------
      LOGICAL    LERNG(IEVAL)
C-----------------------------------------------------------------------
      SAVE       CADAS
C-----------------------------------------------------------------------
      DATA       CADAS/' '/
C-----------------------------------------------------------------------
```

C1OUTG

```
       SUBROUTINE C1OUTG( LGHOST , TITLF  ,
     &                    TITLE  , TITLX  , TITLM , DATE ,
     &                    ENERA  , SIGA   , NENER ,
     &                    EOMA   , SIGOMA , NMX   ,
     &                    EOSA   , SIGOSA , NPSPL ,
     &                    LGRD1  , LDEF1  , LFSEL ,
     &                    XMIN   , XMAX   , YMIN  , YMAX
     &                  )
       IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C1OUTG *********************
C
C  PURPOSE:  GRAPHIC ROUTINE FOR SELECTED TRANSITION USING GHOST80.
C            (IDENTICAL TO: B1OUTG - EXCEPT SOME VARIABLES HAVE BEEN
C             RENAMED AS HAVE THE MAIN TITLE 'ISPEC(1:48)' AND AXES.
C             - ALSO ARGUMENT 'TITLF(C*80)' INTRODUCED.)
C
C            PROVIDES COMPARATIVE GRAPH OF:
C                                ORIGINAL CHEXDATA.DATA    (CROSSES    )
C                                SPLINE INTERPOLATED DATA  (FULL CURVE)
C                                MINIMAX FIT TO DATA       (DASH CURVE )
C
C            PLOT IS LOG10(X-SECT.(CM**2)) VERSUS LOG10(ENERGY(EV/AMU))
C
C  CALLING PROGRAM: ADAS301
C
C  SUBROUTINE:
C
C  INPUT : (L*4)  LGHOST  = .TRUE.  => GHOST80 INITIALISED
C                           .FALSE. => GHOST80 NOT INITIALISED
C  INPUT : (C*80) TITLF   = INFORMATION STRING READ FROM CHEXDATA FILE
C                           FOR SELECTED SUB-BLOCK.
C
C  INPUT : (C*40) TITLE   = TITLE OF RUN (READ FROM ISPF PANEL)
C  INPUT : (C*120)TITLX   = INFORMATION STRING CONTAINING: INPUT DATA
C                           FILE-NAME, SELECTED BLOCK and QUANTUM SHELL
C  INPUT : (C*80) TITLM   = DIAGNOSTIC LINE INFORMATION FROM 'MINIMAX'
C  INPUT : (C*8)  DATE    = CURRENT DATE (AS 'DD/MM/YY')
C
C  INPUT : (R*8)  ENERA() = INPUT DATA FILE: SELECTED SUB-BLOCK -
C                           VALID ENERGIES (eV/amu)
C  INPUT : (R*8)  SIGA()  = INPUT DATA FILE: SELECTED SUB-BLOCK/N-SHELL
C                           CROSS-SECTIONS (cm**2) AT 'ENERA()'
C  INPUT : (I*4)  NENER   = INPUT DATA FILE: NUMBER OF ENERGY/X-SECTION
C                           PAIRS FOR THE SELECTED SUB-BLOCK.
C
C  INPUT : (R*8)  EOMA()  = MINIMAX: SELECTED ENERGIES (eV/amu)
C  INPUT : (R*8)  SIGOMA()= N-SHELL CROSS-SECTIONS (cm**2) AT 'EOMA()'
C  INPUT : (I*4)  NMX     = NUMBER OF MINIMAX  GENERATED ENERGY/X-SECT.
C                           PAIRS FOR GRAPHICAL DISPLAY.
C
C  INPUT : (R*8)  EOSA()  = SPLINE: SELECTED ENERGIES (eV/amu)
C  INPUT : (R*8)  SIGOSA()= N-SHELL CROSS-SECTIONS (cm**2) AT 'EOSA()'
C  INPUT : (I*4)  NPSPL   = NUMBER  OF SPLINE INTERPOLATED ENGY/X-SECT.
C                           PAIRS FOR GRAPHICAL DISPLAY.
C
C  INPUT : (L*4)  LGRD1   = .TRUE.  => PUT GRAPH IN GRID FILE
C                           .FALSE. => DO NOT PUT GRAPH IN GRID FILE
C  INPUT : (L*4)  LDEF1   = .TRUE.  => USE DEFAULT GRAPH SCALING
C                           .FALSE. => DO NOT USE DEFAULT GRAPH SCALING
C  INPUT : (L*4)  LFSEL   = .TRUE.  => CARRY OUT MINIMAX POLYNOMIAL
C                                      FITTING
C                           .FALSE. => - DO NOT DO THE ABOVE -
C
C  INPUT : (R*8)  XMIN    = GRAPH: LOWER LIMIT FOR ENERGY (eV/amu)
C  INPUT : (R*8)  XMAX    = GRAPH: UPPER LIMIT FOR ENERGY (eV/amu)
C  INPUT : (R*8)  YMIN    = GRAPH: LOWER LIMIT FOR CROSS-SECTION (cm**2)
C  INPUT : (R*8)  YMAX    = GRAPH: UPPER LIMIT FOR CROSS-SECTION (cm**2)
C
```

```
C
C          (R*4)  GHZERO  = PARAMETER = VALUE BELOW WHICH GHOST80
C                           TAKES NUMBERS AS BEING ZERO = 1.0E-36
C          (R*4)  YDMIN   = PARAMETER = MINIMUM ALLOWED Y-VALUE FOR
C                           PLOTTING. (USED FOR DEFAULT GRAPH SCALING)
C                           (SET TO 'GHZERO'/ZERO TO REMOVE)
C
C          (I*4)  I4UNIT  = FUNCTION (SEE ROUTINE SECTION BELOW)
C          (I*4)  I       = GENERAL USE - ARRAY INDEX
C          (I*4)  IKEY    = NUMBER OF 'KEY()' VALUES TO BE OUTPUT
C          (I*4)  ICOUNT  = NUMBER OF POINTS PLOTTED FOR GRAPH CURVE
C
C          (R*4)  XHIGH   = UPPER X-AXIS LIMIT FOR USE WITH GHOST80
C          (R*4)  XLOW    = LOWER X-AXIS LIMIT FOR USE WITH GHOST80
C          (R*4)  YHIGH   = UPPER Y-AXIS LIMIT FOR USE WITH GHOST80
C          (R*4)  YLOW    = LOWER Y-AXIS LIMIT FOR USE WITH GHOST80
C          (R*4)  XA4()   = X-AXIS CO0ORDINATES FOR USE WITH GHOST80
C          (R*4)  YA4()   = Y-AXIS CO0ORDINATES FOR USE WITH GHOST80
C
C          (C*88) ISPEC   = GRAPH TITLE (INCORPORATES 'TITLE')
C          (C*80) CADAS   = ADAS HEADER: INCLUDES RELEASE, PROGRAM, TIME
C          (C*12) DNAME   = '      DATE: '
C          (C*23) XTIT    = X-AXIS UNITS/TITLE
C          (C*23) YTIT    = Y-AXIS UNITS/TITLE
C          (C*9)  KEY0    = '    KEY: '
C          (C*9)  MNMX0   = 'MINIMAX: '
C          (C*8)  CINFO   = 'TITLE  : '
C          (C*8)  ADAS0   = 'ADAS   :'
C          (C*22) KEY()   = DESCRIPTIVE KEY FOR GRAPH (3 TYPES)
C
C          (C*1)  GRID    = DUMMY NAME VARIABLE FOR USE WITH GHOST80
C          (C*1)  PIC     = DUMMY NAME VARIABLE FOR USE WITH GHOST80
C          (C*3)  C3BLNK  = BLANK 3 BYTE STRING
C          (C*7)  C7      =  7 BYTE STRING = 'TITLX(1:4)'//'C3BLNK'
C
C
C ROUTINES:
C          ROUTINE     SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXADAS      ADAS      GATHERS ADAS HEADER INFORMATION
C          XXLIM8      ADAS      SETTING UP OF DEFAULT GRAPH AXES
C          XXGSEL      ADAS      SELECTS POINTS WHICH WILL FIT ON GRAPH
C          I4UNIT      ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C                      GHOST80   NUMEROUS SUBROUTINES
C
C AUTHOR:  PAUL E. BRIDEN (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 4569
C
C DATE:    07/02/91
C
C UPDATE:  07/08/91 - PE BRIDEN: INTRODUCED SUBROUTINE 'XXGSEL'
C
C UPDATE:  25/11/91 - PE BRIDEN: MADE FILNAM/PICSAV ARGUMENT LIST
C                                COMPATIBLE WITH GHOST VERSION 8.
C
C UPDATE:  23/04/93 - PE BRIDEN - ADAS91: ADDED I4UNIT FUNCTION TO WRITE
C                                         STATEMENTS FOR SCREEN MESSAGES
C
C UPDATE:  24/05/93 - PE BRIDEN - ADAS91: CHANGED I4UNIT(0)-> I4UNIT(-1)
C
C UPDATE:  22/09/93 - J NASH    - ADAS91:
C          REMOVED PRINTING OF DATA SUB-BLOCK TITLE (COMMENTED OUT).
C
C UPDATE:  01/05/95 - Tim Hammond - IDL-ADAS:
C                     UNIX conversion
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      REAL*4     GHZERO           , YDMIN
C-----------------------------------------------------------------------
      PARAMETER( GHZERO = 1.0E-36 , YDMIN = 1.0E-20 )
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
      INTEGER    NENER           , NMX              , NPSPL
      INTEGER    I               , IKEY             , ICOUNT
      INTEGER    PIPEOU          , ONE              , ZERO
      PARAMETER (PIPEOU = 6      , ONE=1            , ZERO=0)
C-----------------------------------------------------------------------
      REAL*8     ENERA(NENER)    , SIGA(NENER)      ,
     &           EOMA(NMX)       , SIGOMA(NMX)      ,
     &           EOSA(NPSPL)     , SIGOSA(NPSPL)    ,
     &           XMIN            , XMAX             ,
     &           YMIN            , YMAX
C-----------------------------------------------------------------------
      REAL*4     XHIGH           , XLOW             ,
     &           YHIGH           , YLOW
      REAL*4     XA4(100)        , YA4(100)
C-----------------------------------------------------------------------
      CHARACTER  TITLE*40 , TITLF*80    , TITLX*120  , TITLM*80  ,
     &           DATE*8
      CHARACTER  CADAS*80 ,
     &           ISPEC*88 , DNAME*12    , XTIT*23    , YTIT*23   ,
     &           MNMX0*9     , KEY0*9   , ADAS0*8    , CINFO*8   ,
     &           KEY(3)*22
      CHARACTER  GRID*1   , PIC*1       , C3BLNK*3   , C7*7
C-----------------------------------------------------------------------
```

```
      LOGICAL    LGHOST   , LGRD1       , LDEF1     , LFSEL
C-----------------------------------------------------------------------
      SAVE       ISPEC    , CADAS
C-----------------------------------------------------------------------
      DATA ISPEC(1:48)
     & /'CHARGE-EXCHANGE  CROSS-SECTION  VERSUS  ENERGY: '/
      DATA DNAME/'      DATE: '/
      DATA XTIT/'    ENERGY (eV/amu)    '/
      DATA YTIT/' CROSS-SECTION (cm**2) '/
      DATA ADAS0/'ADAS   :'/
     &     CINFO/'TITLE  :'/,
     &     MNMX0/'MINIMAX: '/,
     &     KEY0 /'KEY    : '/,
     &     KEY(1)/'(CROSSES - INPUT DATA)'/,
     &     KEY(2)/' (FULL LINE - SPLINE) '/,
     &     KEY(3)/'(DASH LINE - MINIMAX) '/
      DATA GRID  /' '/   ,
     &     PIC   /' '/   ,
     &     C3BLNK/'   '/ ,
     &     CADAS /' '/
C-----------------------------------------------------------------------
```

C1SPLN

```
      SUBROUTINE C1SPLN(         LOSEL ,
     &                  NENER , IEVAL , NPSPL  ,
     &                  ENERA , EOA   , EOSA   ,
     &                  SIGA  , SIGOA , SIGOSA ,
     &                  LERNG
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C1SPLN *********************
C
C  (IDENTICAL TO: B1SPLN (EXCEPT SOME VARIABLE NAMES ARE CHANGED))
C
C  PURPOSE:
C         1) PERFORMS CUBIC SPLINE ON LOG(ENERGY) VERSUS LOG(X-SECTION)
C            INPUT DATA, ('ENERA' VERSUS 'SIGA' , NENER DATA PAIRS),
C            FOR A GIVEN SUB-BLOCK.
C
C         2) INTERPOLATES 'IEVAL' X-SECT. VALUES USING  ABOVE  SPLINES
C            AT ENERGIES READ IN FROM ISPF PANELS FOR TABULAR  OUTPUT.
C            (ANY ENERGIES VALUES WHICH REQUIRED EXTRAPOLATION ARE SET
C             TO ZERO).
C                 - THIS STEP ONLY TAKES PLACE IF 'LOSEL=.TRUE.' -
C
C         3) INTERPOLATES 'NPSPL' X-SECT VALUES USING ABOVE SPLINES AT
C            ENERGIES EQUI-DISTANCE  ON RANGE OF LOG(ENERGIES)  STORED
C            IN INPUT 'ENERA' ARRAY.
C
C  CALLING PROGRAM: ADAS301
C
C
C  SUBROUTINE:
C
C  INPUT : (L*4)  LOSEL   = .TRUE.  => CALCULATE X-SECS FOR INPUT ENGYS.
C                                      READ FROM ISPF PANEL.
C                           .FALSE. => - DO NOT DO THE ABOVE -
C
C  INPUT : (I*4)  NENER   = INPUT DATA FILE: NO. OF VALID ENERGY/X-SECT.
C                           PAIRS READ FOR THE SUB-BLOCK BEING ASSESSED
C  INPUT : (I*4)  IEVAL   = NUMBER OF  ISPF  ENTERED  ENERGY  VALUES  AT
C                           WHICH INTERPOLATED X-SEC VALUES ARE REQUIRED
C                           FOR TABULAR OUTPUT.
C  INPUT : (I*4)  NPSPL   = NUMBER OF  SPLINE  INTERPOLATED  ENGY/X-SECT
C                           REQUIRED FOR GRAPHICAL DISPLAY.
C
C  INPUT : (I*4)  ENERA() = INPUT DATA FILE: ENERGIES (EV/AMU)
C  INPUT : (I*4)  EOA()   = ISPF PANEL ENTERED ENERGIES (EV/AMU)
C  OUTPUT: (I*4)  EOSA()  = 'NPSPL' ENERGIES FOR GRAPHICAL OUTPUT
C                           (EV/AMU).
C
C  INPUT : (R*8)  SIGA()  = INPUT DATA FILE: SELECTED SUB-BLOCK -
C                           X-SECTION VALUES AT 'ENERA()'. (CM**2)
C  OUTPUT: (I*4)  SIGOA() = SPLINE INTERPOLATED X-SEC VALUES AT 'EOA()'
C                           (EXTRAPOLATED VALUES = 0.0).
C  OUTPUT: (R*8)  SIGOSA()= SPLINE INTERPOLATED X-SEC VALUES AT 'EOSA()'
C
C  OUTPUT: (L*4)  LERNG() = .TRUE.  => OUTPUT   SPLINE    VALUE    WAS
C                                      INTERPOLATED FOR 'DLOG(EOA()'.
C                           .FALSE. => OUTPUT   SPLINE    VALUE    WAS
C                                      EXTRAPOLATED FOR 'DLOG(EOA()'.
C                                      (NOTE: 'YOUT()=0' AS 'IOPT < 0').
C
C          (I*4)  NIN     = PARAMETER = MAX. NO. OF  INPUT  ENGY/X-SEC
C                                       PAIRS MUST BE >= 'NENER'
C          (I*4)  NOUT    = PARAMETER = MAX. NO. OF 'OUTPUT ENGY/X-SEC
C                                       PAIRS MUST BE >= 'IEVAL' &'NPSPL'
C          (R*8)  ZERO    = PARAMETER = EFFECTIVE ZERO (1.0D-72)
C          (R*8)  ZEROL   = PARAMETER = LN(ZERO) APPROX.  = -165.7
C
```

```
C          (I*4)  IARR    = ARRAY SUBSCRIPT USED FOR ENGY/X-SEC PAIRS
C          (I*4)  IOPT    = DEFINES THE BOUNDARY DERIVATIVES FOR THE
C                           SPLINE ROUTINE 'XXSPLE', SEE 'XXSPLE'.
C                           (VALID VALUES = <0, 0, 1, 2, 3, 4)
C
C          (R*8)  ESTEP   = THE SIZE OF STEP BETWEEN 'XOUT()' VALUES FOR
C                           GRAPHICAL  OUTPUT  ENGY/X-SEC  PAIRS  TO  BE
C                           CALCULATED USING SPLINES.
C
C          (L*4)  LSETX   = .TRUE.  => SET UP SPLINE PARAMETERS RELATING
C                                      TO 'XIN' AXIS.
C                           .FALSE. => DO NOT SET UP SPLINE PARAMETERS
C                                      RELATING TO 'XIN' AXIS.
C                                      (I.E. THEY WERE SET IN A PREVIOUS
C                                            CALL )
C                           (VALUE SET TO .FALSE. BY 'XXSPLE')
C
C          (R*8)  XIN()   = LOG( 'ENERA()' )
C          (R*8)  YIN()   = LOG( 'SIGA()' )
C          (R*8)  XOUT()  = LOG(ENERGIES AT WHICH SPLINES REQUIRED)
C          (R*8)  YOUT()  = LOG(OUTPUT SPLINE INTERPOLATED X-SEC VALUES)
C          (R*8)  DF()    = SPLINE INTERPOLATED DERIVATIVES
C
C          (L*4)  LDUMP() = .TRUE.  => OUTPUT SPLINE VALUE INTRPOLATED
C                                      FOR 'YOUT()'.
C                           .FALSE. => OUTPUT SPLINE VALUE EXTRAPOLATED
C                                      FOR 'YOUT()'.
C                                      (NOTE: USED AS A DUMMY ARGUMENT.
C                                             ALL VALUES WILL BE TRUE.)
C
C NOTE:
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXSPLE     ADAS      SPLINE SUBROUTINE (EXTENDED DIAGNOSTICS)
C          R8FUN1     ADAS      REAL*8 FUNCTION: ( X -> X )
C
C AUTHOR:  PAUL E. BRIDEN (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 4569
C
C DATE:    07/02/91
C
C UPDATE:  30/11/93 - J NASH    - ADAS91:
C          INCREASED MAX NUMBER OF INPUT ENERGIES ('NIN') FROM 24 TO 30.
C
C UPDATE:  19/04/95   H P SUMMERS - ADDED TRAP FOR ZERO INPUTS
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    NIN          , NOUT
C-----------------------------------------------------------------------
      REAL*8     ZERO         , ZEROL
C-----------------------------------------------------------------------
      PARAMETER( NIN = 30     , NOUT = 100    )
      PARAMETER( ZERO = 1.0D-72  , ZEROL = -165.7D0 )
C-----------------------------------------------------------------------
      INTEGER    NENER        , IEVAL         , NPSPL
      INTEGER    IOPT         , IARR
C-----------------------------------------------------------------------
      REAL*8     R8FUN1       , ESTEP
C-----------------------------------------------------------------------
      LOGICAL    LOSEL        , LSETX
C-----------------------------------------------------------------------
      REAL*8     ENERA(NENER) , SIGA(NENER)   ,
     &           EOA(IEVAL)   , SIGOA(IEVAL)  ,
     &           EOSA(NPSPL)  , SIGOSA(NPSPL)
      REAL*8     XIN(NIN)     , YIN(NIN)      ,
     &           XOUT(NOUT)   , YOUT(NOUT)
      REAL*8     DF(NIN)
C-----------------------------------------------------------------------
      LOGICAL    LERNG(IEVAL) , LDUMP(NOUT)
C-----------------------------------------------------------------------
      EXTERNAL   R8FUN1
C-----------------------------------------------------------------------
```

C2CHKB

```
      SUBROUTINE C2CHKB( IUNIT  , NBSEL  , IBSEL  ,
     &                   IZ0IN  , IZ0    ,
     &                   LOPEN  , IRCODE
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C2CHKB *********************
C
C  PURPOSE: TO CHECK THE SELECTED BLOCK (IBSEL) OF DATA  EXISTS  IN  THE
C           INPUT DATA SET AND IF SO IT REPRESENTS THE ENTERED VALUES OF
C           'IZ0IN' (NUCLEAR CHARGE OF SELECTED IONISING ION ELEMENT).
C
```

```
C           IT ALSO CLOSES THE INPUT DATA SET ALLOCATION IF OPEN.
C
C  CALLING PROGRAM: SSIA
C
C  SUBROUTINE:
C
C  INPUT : (I*4)   IUNIT   = UNIT TO WHICH INPUT DATA SET IS ALLOCATED
C  INPUT : (I*4)   NBSEL   = TOTAL NUMBER OF DATA-BLOCKS READ FROM INPUT
C                            DATA SET.
C  INPUT : (I*4)   IBSEL   = INDEX OF DATA-BLOCK SELECTED FOR ANALYSIS
C
C  INPUT : (I*4)   IZ0IN   = REQUESTED: NUCLEAR CHARGE OF ELEMENT
C  INPUT : (I*4)   IZ0     = INPUT FILE: NUCLEAR CHARGE OF ELEMENT
C
C  I/O   : (L*4)   LOPEN   = INPUT : .TRUE.  => INPUT DATA SET OPEN.
C                                    .FALSE. => INPUT DATA SET CLOSED.
C                            OUTPUT: ALWAYS RETURNED AS .FALSE.
C  OUTPUT: (I*4)   IRCODE  = RETURN CODE FROM SUBROUTINE:
C                            0 => NO ERROR DETECTED.
C                            2 => DISCREPANCY BETWEEN REQUESTED ELEMENT
C                                 AND THAT IN INPUT DATA FILE.
C                            3 => SELECTED DATA-BLOCK  OUT OF RANGE  OR
C                                 DOES NOT EXIST.
C
C           (I*4)   I4UNIT  = FUNCTION (SEE ROUTINE SECTION BELOW)
C
C           (C*44)  DSNAME  = FULL MVS NAME OF DATA SET OPENED
C
C ROUTINES:
C           ROUTINE    SOURCE    BRIEF DESCRIPTION
C           ------------------------------------------------------------
C           E2FILE     ADAS      OPEN DATA SET FOR SELECTED ELEMENT
C           I4UNIT     ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C
C AUTHOR:  PAUL E. BRIDEN (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/37
C          JET EXT. 2520
C
C DATE:    06/06/91
C
C UPDATE:  23/04/93 - PE BRIDEN - ADAS91: ADDED I4UNIT FUNCTION TO WRITE
C                                         STATEMENTS FOR SCREEN MESSAGES
C
C UPDATE:  24/05/93 - PE BRIDEN - ADAS91: CHANGED I4UNIT(0)-> I4UNIT(-1)
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                            DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C           - PUT UNDER S.C.C.S. CONTROL
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER     I4UNIT
      INTEGER     IUNIT          , IRCODE           ,
     &            NBSEL          , IBSEL            ,
     &            IZ0IN          , IZ0
C-----------------------------------------------------------------------
      LOGICAL     LOPEN
C-----------------------------------------------------------------------
      CHARACTER   DSNAME*44
C-----------------------------------------------------------------------
```

C2DATA

```
       SUBROUTINE C2DATA( IUNIT  , DSNAME ,
     &                    NSTORE , NEDIM  ,
     &                    NBSEL  , ISELA  ,
     &                    CPRIMY , CSECDY , CTYPE,
     &                    AMPA   , AMSA   , ALPHA  , ETHRA  ,
     &                    IEA    ,
     &                    TEEA   , SIA
     &                  )
       IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: C2DATA *********************
C
C  PURPOSE:  TO  FETCH  DATA  FROM  INPUT ION/ATOM CROSS-SECTION
C            FILES OF TYPE ADF02.
C
C  CALLING PROGRAM: ADAS302/SSIA
C
C  DATA:
C
C           UP TO 'NSTORE' SETS (DATA-BLOCKS) OF DATA MAY BE  READ FROM
C           THE FILE - EACH BLOCK FORMING A COMPLETE SET OF  CROSS-
C           SECTION VALUES FOR GIVEN COLLISION ENERGIES.
C           EACH DATA-BLOCK  IS  ANALYSED INDEPENDENTLY OF ANY  OTHER
C           DATA-BLOCK.
C
```

```
C           THE UNITS USED IN THE DATA FILE ARE TAKEN AS FOLLOWS:
C
C           COLLISION ENERGIES  : EV/AMU
C           CROSS-SECTION       : CM**2
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IUNIT    = UNIT TO WHICH INPUT FILE IS ALLOCATED.
C  INPUT : (C*80) DSNAME   = MVS DATA SET NAME OF DATA SET BEING READ
C
C  INPUT : (I*4)  NSTORE   = MAXIMUM NUMBER  OF  INPUT DATA-BLOCKS  THAT
C                            CAN BE STORED.
C  INPUT : (I*4)  NEDIM    = MAX NUMBER OF COLLISION ENERGIES ALLOWED
C
C  OUTPUT: (I*4)  NBSEL    = NUMBER OF DATA-BLOCKS ACCEPTED & READ IN.
C  OUTPUT: (I*4)  ISELA()  = READ - DATA-SET DATA-BLOCK ENTRY INDICES
C                            DIMENSION: DATA-BLOCK INDEX
C
C  OUTPUT: (C*5)  CPRIMY() = READ - PRIMARY SPECIES IDENTIFICATION
C                            DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (C*5)  CSECDY() = READ - SECONDARY SPECIES IDENTIFICATION
C                            DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (C*3)  CTYPE()  = READ - CROSS-SECTION TYPE
C                            DIMENSION: DATA-BLOCK INDEX
C
C  OUTPUT: (R*8)  AMPA()   = READ - PRIMARY SPECIES ATOMIC MASS NUMBER
C                            DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (R*8)  AMSA()   = READ - SECONDARY SPECIES ATOMIC MASS NUMBER
C                            DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (R*8)  ALPHA()  = READ - HIGH ENERGY EXTRAPOLATION PARM.
C                            DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (R*8)  ETHRA()  = READ - ENERGY THRESHOLD (EV)
C                            DIMENSION: DATA-BLOCK INDEX
C
C  OUTPUT: (I*4)  IEA()    = READ - NUMBER OF COLLISION ENERGIES
C                            DIMENSION: DATA-BLOCK INDEX
C
C  OUTPUT: (R*8)  TEEA(,)  = READ - COLLISION ENERGIES (UNITS: eV/AMU)
C                            1st DIMENSION: COLLISION ENERGY INDEX
C                            2nd DIMENSION: DATA-BLOCK INDEX
C
C  OUTPUT: (R*8)  SIA(,)   =READ - FULL SET OF COLLISION CROSS-
C                                  SECTION VALUES (cm**2)
C                            1st DIMENSION: COLLISION ENERGY INDEX
C                            2nd DIMENSION: DATA-BLOCK INDEX
C
C          (I*4)  I4EIZ0   = FUNCTION - (SEE ROUTINES SECTION BELOW)
C          (I*4)  I4FCTN   = FUNCTION - (SEE ROUTINES SECTION BELOW)
C          (I*4)  I4UNIT   = FUNCTION - (SEE ROUTINE SECTION BELOW)
C          (I*4)  IBLK     = ARRAY INDEX: DATA-BLOCK INDEX
C          (I*4)  ITT      = ARRAY INDEX: COLLISION ENERGY INDEX
C          (I*4)  NENUM    = NUMBER OF COLLISION ENERGIES FOR CURRENT
C                            DATA-BLOCK
C          (I*4)  IABT     = RETURN CODE FROM 'I4FCTN'
C          (I*4)  IPOS2    = GENERAL USE STRING INDEX VARIABLE
C
C          (R*8)  R8FCTN   = FUNCTION - (SEE ROUTINES SECTION BELOW)
C
C          (L*4)  LBEND    = IDENTIFIES WHETHER THE LAST OF THE  INPUT
C                            DATA SUB-BLOCKS HAS BEEN LOCATED.
C                            (.TRUE. => END OF SUB-BLOCKS REACHED)
C
C          (C*1)  CSLASH   = '/' - DELIMITER FOR 'XXHKEY'
C          (C*2)  C2       = GENERAL USE TWO BYTE CHARACTER STRING
C          (C*1)  CKEY1    = 'P'      - INPUT BLOCK HEADER KEY
C          (C*1)  CKEY2    = 'S'      - INPUT BLOCK HEADER KEY
C          (C*1)  CKEY3    = 'A'      - INPUT BLOCK HEADER KEY
C          (C*1)  CKEY4    = 'E'      - INPUT BLOCK HEADER KEY
C          (C*4)  CKEY5    = 'T'      - INPUT BLOCK HEADER KEY
C          (C*4)  CKEY6    = 'ISEL'   - INPUT BLOCK HEADER KEY
C          (C*3)  C3       = GENERAL USE THREE BYTE CHARACTER STRING
C          (C*9)  C10      = GENERAL USE NINE BYTE CHARACTER STRING
C          (C*80) C80      = GENERAL USE 80 BYTE  CHARACTER  STRING  FOR
C                            THE INPUT OF DATA-SET RECORDS.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXHKEY     ADAS      OBTAIN KEY/RESPONSE STRINGS FROM TEXT
C          I4FCTN     ADAS      INTEGER*4 FUNCTION    -
C                               CONVERT CHARACTER STRING TO INTEGER
C          I4UNIT     ADAS      INTEGER*4 FUNCTION    -
C                               FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C          R8FCTN     ADAS      REAL*8 FUNCTION       -
C                               CONVERT CHARACTER STRING TO REAL*8
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL. 0141-553-4196
C
C DATE:    12/11/96
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C           - PUT UNDER S.C.C.S. CONTROL
C
```

```
C VERSION: 1.2                              DATE: 14-02-97
C MODIFIED: RICHARD MARTIN
C                - CHANGED INITIALISATION 'CKEY2 /'S  '/' TO 'CKEY2 /'S'/ '
C
C
C-----------------------------------------------------------------------
      INTEGER    I4FCTN               , I4UNIT
      INTEGER    IUNIT                , NSTORE             ,
     &           NEDIM                , NBSEL
      INTEGER    IBLK                 , ITT                ,
     &           NENUM                , IABT               ,
     &           IPOS2
C-----------------------------------------------------------------------
      REAL*8     R8FCTN
C-----------------------------------------------------------------------
      LOGICAL    LBEND
C-----------------------------------------------------------------------
      CHARACTER  DSNAME*80
      CHARACTER  CSLASH*1             , C2*2               ,
     &           CKEY1*1              , CKEY2*1            ,
     &           CKEY3*1              , CKEY4*1            ,
     &           CKEY5*3              , CKEY6*4            ,
     &           C3*3                 , C9*9               , C80*80
C-----------------------------------------------------------------------
      INTEGER    ISELA(NSTORE)        , IEA(NSTORE)
C-----------------------------------------------------------------------
      CHARACTER  CPRIMY(NSTORE)*5     , CSECDY(NSTORE)*5   ,
     &           CTYPE(NSTORE)*3
C-----------------------------------------------------------------------
      REAL*8     AMPA(NSTORE)         , AMSA(NSTORE)
      REAL*8     ALPHA(NSTORE)        , ETHRA(NSTORE)
      REAL*8     TEEA(NEDIM,NSTORE)   , SIA(NEDIM,NSTORE)
C-----------------------------------------------------------------------
      SAVE       CSLASH               ,
     &           CKEY1                , CKEY2               ,
     &           CKEY3                , CKEY4               ,
     &           CKEY5
C
C-----------------------------------------------------------------------
C
      DATA       CSLASH / '/' /
      DATA       CKEY1  / 'P'      /   , CKEY2  / 'S'      /  ,
     &           CKEY3  / 'A'      /   , CKEY4  / 'E'      /  ,
     &           CKEY5  / 'T'      /   , CKEY6  / 'ISEL'   /
C
C **********************************************************************
```

C2ECON

```
      SUBROUTINE C2ECON( INTYP, OUTTYP, AMD,AMR,IEVAL, EIN, EOUT )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C2ECON *********************
C
C  PURPOSE: TO CONVERT AN ARRAY OF COLLISION  ENERGIES INTO A  SPECIFIED
C           FORM.
C
C  CALLING PROGRAM: GENERAL USE
C
C  SUBROUTINE:
C
C  INPUT :    (I*4)  INTYP   = 1 => 'EIN(ARRAY)' UNITS: DONOR   EV
C                              = 2 => 'EIN(ARRAY)' UNITS: RECVR   EV
C                              = 3 => 'EIN(ARRAY)' UNITS: ENERGY  EV/AMU
C  INPUT :    (I*4)  OUTTYP  = 1 => 'EOUT(ARRAY)' UNITS: DONOR  EV
C                              = 2 => 'EOUT(ARRAY)' UNITS: RECVR  EV
C                              = 3 => 'EOUT(ARRAY)' UNITS: ENERGY EV/AMU
C  INPUT :    (R*8)  AMD     = DONOR MASS NUMBER
C  INPUT :    (R*8)  AMR     = RECEIVER MASS NUMBER
C  INPUT :    (I*4)  IEVAL   = NO. OF ENERGIES IN EIN(ARRAY)
C  INPUT :    (R*8)  EIN()   = INPUT  ENERGIES (STATED UNITS)
C  OUTPUT:    (R*8)  EOUT()  = OUTPUT ENERGIES (STATED UNITS)
C
C
C             (I*4)  I       = GENERAL USE
C
C             (R*8)  ECONV() = ENERGY/VELOCITY CONVERSION PARAMETERS
C
C ROUTINES:  NONE
C
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL.  0141-553-4196
C
C DATE:    17/11/95
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                              DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C            - PUT UNDER S.C.C.S. CONTROL
```

```
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    INTYP                , OUTTYP                ,
     &           IEVAL
      INTEGER    I
C-----------------------------------------------------------------------
      REAL*8     AMD                  , AMR
      REAL*8     EIN(IEVAL)           , EOUT(IEVAL)
      REAL*8     ECONV(3)
C-----------------------------------------------------------------------
```

C2OUT0

```
      SUBROUTINE C2OUT0( IWRITE   , LFSEL  ,
     &                   TITLE    , TITLX  , TITLM ,
     &                   DATE     , CADAS  ,
     &                   IBSEL    , IEVAL  ,
     &                   ESYM     , IZ0    , IZ    , IZ1    ,
     &                   CPRIMY   , CSECDY ,
     &                   CTYPE  ,
     &                   LERNG    ,
     &                   VCMS     , VATU   , EEVA  ,
     &                   SIAA     ,
     &                   KPLUS1   , COEF
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C2OUT0 *********************
C
C  PURPOSE:  TO  PRINT DATA CONCERNING THE SELECTED CROSS-SECTION
C            DATA BLOCK UNDER ANALYSIS.
C
C  CALLING PROGRAM: ADAS302
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IWRITE  = OUTPUT UNIT FOR RESULTS
C  INPUT : (L*4)  LFSEL   = .TRUE.  => MINIMAX POLYNOMIAL FITTED.
C                           .FALSE. => MINIMAX POLYNOMIAL NOT FITTED
C
C  INPUT : (C*40) TITLE   = TITLE OF RUN (READ FROM ISPF PANEL)
C  INPUT : (C*120)TITLX   = INFORMATION STRING CONTAINING INPUT DATA-
C                           SET NAME IN BYTES 1->35.
C  INPUT : (C*80) TITLM   = DIAGNOSTIC LINE INFORMATION FROM 'MINIMAX'
C  INPUT : (C*8)  DATE    = CURRENT DATE (AS 'DD/MM/YY')
C  INPUT : (C*80) CADAS   = ADAS HEADER
C
C  INPUT : (I*4)  IBSEL   = DATA-BLOCK INDEX SELECTED FROM INPUT DATASET
C                           FOR ANALYSIS.
C  INPUT : (I*4)  IEVAL   = NUMBER OF USER ENTERED COLLISION ENERGIES
C
C  INPUT : (C*2)  ESYM    = INPUT FILE: SECONDARY - ELEMENT SYMBOL
C  INPUT : (I*4)  IZ0     = INPUT FILE: SECONDARY - NUCLEAR CHARGE
C  INPUT : (I*4)  IZ      = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                           SECONDARY SPECIES CHARGE
C  INPUT : (I*4)  IZ1     = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                           SECONDARY SPECEIS EFFECTIVE CHARGE
C
C  INPUT : (C*9)  CPRIMY  = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                           PRIMARY SPECIES INDENTIFICATION
C  INPUT : (C*9)  CSECDY  = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                           SECONDARY SPECIES IDENTIFICATION
C  INPUT : (C*2)  CTYPE   = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                           CROSS-SECTION TYPE
C
C  INPUT : (L*4)  LERNG()=  .TRUE.  => OUTPUT 'SIAA()' VALUE WAS INTER-
C                                      POLATED  FOR  THE  USER  ENTERED
C                                      COLLISION ENERGIES 'EEVA()'.
C                           .FALSE. => OUTPUT 'SIAA()' VALUE WAS EXTRA-
C                                      POLATED  FOR  THE  USER  ENTERED
C                                      COLLISION ENERGIES 'EEVA()'.
C                           DIMENSION: COLLISION ENERGY INDEX
C
C  INPUT : (R*8)  VCMS()  = USER ENTERED: COLLISION VELOCITY (cm s-1)
C                           DIMENSION: COLLISION ENERGY INDEX
C  INPUT : (R*8)  VATU()  = USER ENTERED: COLLISION VELOCITY (At. Un.)
C                           DIMENSION: COLLISION ENERGY INDEX
C  INPUT : (R*8)  EEVA()  = USER ENTERED: COLLISION ENERGY (EV/AMU)
C                           DIMENSION: COLLSION ENERGY INDEX
C
C  INPUT : (R*8)  SIAA()  = SPLINE INTERPOLATED OR  EXTRAPOLATED CX
C                           COLLSION CROSS-SECTIONS FOR
C                           THE USER ENTERED COLLISION ENERGIES.
C                           DIMENSION: COLLISION ENERGY INDEX
C
C  INPUT : (I*4)  KPLUS1  = NUMBER OF MINIMAX COEFFICIENTS
C  INPUT : (R*8)  COEF()  = COEFFICIENTS OF FITTED MINIMAX POLYNOMIAL
C
C          (I*4)  I       = GENERAL USE - ARRAY ELEMENT INDEX
C
```

```
C          (C*1)  C1E     = '*' IF RATE-COEFFICIENT WAS EXTRAPOLATED FOR
C                           THE CURRENT COLLISION ENERGY. (IT EQUALS
C                           ' ' IF IT WAS INTERPOLATED.)
C          (C*12) XFELEM  = FUNCTION - (SEE ROUTINES SECTION BELOW)
C          (C*12) CELEM   = RECEIVER ION  ELEMENT NAME
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XFELEM     ADAS      CHARACTER*12 FUNCTION -
C                               RETURNS ELEMENT NAME   FOR GIVEN Z0
C
C AUTHOR  : H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C           JA8.08
C           TEL. 0141-553-4196
C
C DATE:    12/11/96
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C            - PUT UNDER S.C.C.S. CONTROL
C
C-----------------------------------------------------------------------
      INTEGER    IWRITE        , IBSEL         , IEVAL      ,
     &           IZ0           , IZ            , IZ1        , KPLUS1
      INTEGER    I
C-----------------------------------------------------------------------
      LOGICAL    LFSEL
C-----------------------------------------------------------------------
      CHARACTER  TITLE*(*)     , TITLX*(*)     , TITLM*(*)  , ESYM*2  ,
     &           CPRIMY*5      , CSECDY*5      ,
     &           CTYPE*3       , DATE*8
      CHARACTER  XFELEM*12     ,
     &           C1E*1         ,
     &           CELEM*12      , CADAS*80
C-----------------------------------------------------------------------
      REAL*8     VCMS(IEVAL)   , EEVA(IEVAL)   , VATU(IEVAL) ,
     &           SIAA(IEVAL)   ,
     &           COEF(KPLUS1)
C-----------------------------------------------------------------------
      LOGICAL    LERNG(IEVAL)
C-----------------------------------------------------------------------
```

C2OUTG

```
      SUBROUTINE C2OUTG( LGHOST ,
     &                   TITLE  , TITLX  , TITLM , DATE  ,
     &                   ESYM   , IZ0    , IZ    ,
     &                   CPRIMY , CSECDY ,
     &                   CTYPE  ,
     &                   EEVA   , SIAA   , IEVAL ,
     &                   EFITM  , SIAM   , NMX   ,
     &                   LGRD1  , LDEF1  , LFSEL ,
     &                   XMIN   , XMAX   , YMIN  , YMAX
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C2OUTG *********************
C
C  PURPOSE:  PIPE COMMUNICATION WITH IDL TO PLOT GRAPH
C
C            PROVIDES COMPARATIVE GRAPH OF:
C                              SPLINE INTERPOLATED POINTS : CROSSES
C                              CURVE THROUGH SPLINE POINTS: FULL CURVE
C                              MINIMAX FIT TO SPLINE DATA : DASH CURVE
C
C            PLOT IS LOG10(CROSS-SECTION  (cm**2))
C                                 VERSUS
C                    LOG10(COLLISION ENERGY (eV/AMU))
C
C  CALLING PROGRAM: ADAS302
C
C  SUBROUTINE:
C
C  INPUT : (L*4)  LGHOST  = .TRUE.  => GHOST80 INITIALISED
C                           .FALSE. => GHOST80 NOT INITIALISED
C
C  INPUT : (C*40) TITLE   = TITLE OF RUN (READ FROM ISPF PANEL)
C  INPUT : (C*120)TITLX   = INFORMATION STRING CONTAINING: INPUT DATA
C                           FILE-NAME, SELECTED BLOCK, ION INFORMATION
C  INPUT : (C*80) TITLM   = DIAGNOSTIC LINE INFORMATION FROM 'MINIMAX'
C  INPUT : (C*8)  DATE    = CURRENT DATE (AS 'DD/MM/YY')
C
C  INPUT : (C*2)  ESYM    = INPUT FILE: SECONDARY - ELEMENT SYMBOL
C  INPUT : (I*4)  IZ0     = INPUT FILE: SECONDARY - NUCLEAR CHARGE
C  INPUT : (I*4)  IZ      = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                           SECONDARY SPECIES  CHARGE
C
C  INPUT : (C*5)  CPRIMY  = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                           PRIMARY SPECIES IDENTIFICATION
```

```
C  INPUT : (C*5)  CSECDY  = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                          SECONDARY SPECIES IDENTIFICATION
C  INPUT : (C*3)  CTYPE   = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                          CROSS-SECTION TYPE
C
C  INPUT : (R*8)  EEVA()  = USER ENTERED: COLLISION ENERGIES (eV/AMU)
C                          DIMENSION: COLLISION ENERGY INDEX
C  INPUT : (R*8)  SIAA()  = SPLINE INTERPOLATED OR  EXTRAPOLATED
C                          I/A CROSS-SECTIONS FOR
C                          THE USER ENTERED COLLISION ENERGIES.
C                          DIMENSION: COLLISION ENERGY INDEX
C  INPUT : (I*4)  IEVAL   = NUMBER OF USER ENTERED ENERGY VALUES
C
C  INPUT : (R*8)  EFITM() = MINIMAX: SELECTED ENERGIES (eV/AMU)
C  INPUT : (R*8)  SIAM()  = CROSS-SECTIONS AT 'EFITM()'
C  INPUT : (I*4)  NMX     = NUMBER OF MINIMAX GENERATED CX CROSS-
C                          SECTION VALUES FOR GRAPHICAL DISPLAY
C
C  INPUT : (L*4)  LGRD1   = .TRUE.  => PUT GRAPH IN GRID FILE
C                          .FALSE. => DO NOT PUT GRAPH IN GRID FILE
C  INPUT : (L*4)  LDEF1   = .TRUE.  => USE DEFAULT GRAPH SCALING
C                          .FALSE. => DO NOT USE DEFAULT GRAPH SCALING
C  INPUT : (L*4)  LFSEL   = .TRUE.  => CARRY OUT MINIMAX POLYNOMIAL
C                                      FITTING
C                          .FALSE. => - DO NOT DO THE ABOVE -
C
C  INPUT : (R*8)  XMIN    = GRAPH: LOWER LIMIT FOR ENERGY
C  INPUT : (R*8)  XMAX    = GRAPH: UPPER LIMIT FOR ENERGY
C  INPUT : (R*8)  YMIN    = GRAPH: LOWER LIMIT FOR CROSS-SECTION.
C  INPUT : (R*8)  YMAX    = GRAPH: UPPER LIMIT FOR CROSS-SECTION.
C
C
C          (I*4)  I       = GENERAL USE - ARRAY INDEX
C
C          (C*28) STRG1   =  DESCRIPTIVE STRING FOR ELEMENT SYMBOL
C          (C*28) STRG2   =  DESCRIPTIVE STRING FOR NUCLEAR CHARGE
C          (C*28) STRG4   =  DESCRIPTIVE STRING FOR STATE ION
C          (C*28) STRG5   =  DESCRIPTIVE STRING FOR STATE ION CHARGE
C          (C*28) STRG6   =  DESCRIPTIVE STRING FOR STATE META. INDEX
C          (C*32) HEAD1   =  HEADING FOR IONISING ION INFORMATION
C          (C*16) HEAD2   =  HEADING FOR INITIAL STATE INFORMATION
C          (C*16) HEAD3   =  HEADING FOR FINAL   STATE INFORMATION
C
C ROUTINES:
C          ROUTINE     SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXADAS      ADAS      GATHERS ADAS HEADER INFORMATION
C           XXFLSH      IDL-ADAS  CALLS FLUSH COMMAND TO CLEAR PIPE.
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL.  0141-553-4196
C
C DATE:    12/11/96
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C           - PUT UNDER S.C.C.S. CONTROL
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      REAL*4     GHZERO           , YDMIN
C-----------------------------------------------------------------------
      PARAMETER( GHZERO = 1.0E-36 , YDMIN = 1.0E-20 )
C-----------------------------------------------------------------------
      INTEGER    IZ0              , IZ              ,
     &           IEVAL            , NMX
      INTEGER    I
C-----------------------------------------------------------------------
      REAL*8     XMIN             , XMAX            ,
     &           YMIN             , YMAX
C-----------------------------------------------------------------------
      LOGICAL    LGHOST           ,
     &           LGRD1            , LDEF1           , LFSEL
C-----------------------------------------------------------------------
      CHARACTER  TITLE*40        , TITLX*120        , TITLM*80  ,
     &           DATE*8          , ESYM*2           ,
     &           CPRIMY*5        , CSECDY*5         ,
     &           CTYPE*3
      CHARACTER  STRG1*28        , STRG2*28         ,
     &           STRG3*28        , STRG4*28         ,
     &           STRG5*28        , STRG6*28         ,
     &           HEAD1*32        , HEAD2*16         , HEAD3*16
C-----------------------------------------------------------------------
      REAL*8     EEVA(IEVAL)     , SIAA(IEVAL)      ,
     &           EFITM(NMX)      , SIAM(NMX)
C-----------------------------------------------------------------------
      DATA HEAD1 /'----- REACTION INFORMATION -----'/ ,
     &     HEAD2 /' PRIMARY :      '/                 ,
     &     HEAD3 /' SECONDARY:     '/
      DATA STRG1 /' SECONDARY ELEMENT SYMBOL = '/ ,
     &     STRG2 /' SECONDARY NUCLEAR CHARGE = '/ ,
     &     STRG4 /' SECONDARY CHARGE         = '/ ,
     &     STRG5 /' TRANSITION TYPE          = '/ ,
     &     STRG6 /'                          = '/
```

```
C-----------------------------------------------------------------------
      INTEGER    PIPEIN    , PIPEOU , ONE      , ZERO
      PARAMETER( PIPEIN=5  , PIPEOU=6 , ONE=1    , ZERO=0 )
C-----------------------------------------------------------------------
```

C2SPLN

```
      SUBROUTINE C2SPLN( NEDIM  ,
     &                   IEA    , IEVAL   ,
     &                   TEEA   , EEVA    ,
     &                   SCX    , SCXA    ,
     &                   LERNG
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C2SPLN *********************
C
C  PURPOSE:
C          PERFORMS CUBIC SPLINE ON LOG(ENERGY <EV/AMU> ) VERSUS
C          LOG(CX CROSS-SECTION <CM2>).
C          INPUT DATA FOR A GIVEN DONOR/RECEIVER COMBINATION DATA-BLOCK.
C
C          USING  ONE-WAY SPLINES  IT  CALCULATES  THE  CROSS-SECTIONS
C          FOR  'IEVAL'  COLLISION ENERGIES VALUES  FROM
C          THE LIST OF COLLISION ENERGIES READ IN FROM THE INPUT FILE
C
C          IF A  VALUE  CANNOT  BE  INTERPOLATED  USING  SPLINES  IT  IS
C          EXTRAPOLATED VIA 'XXSPLE'. (SEE NOTES BELOW).
C
C  CALLING PROGRAM: ADAS302/SSIA
C
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IEA     = INPUT DATA FILE: NUMBER OF COLLISION ENER-
C                           GIES READ FOR THE DATA-BLOCK BEING ASSESSED
C  INPUT : (I*4)  IEVAL   = NUMBER OF ISPF ENTERED COLLISION ENERGIES
C                           VALUES FOR  WHICH  CX CROSS-SECTIONS
C                           ARE REQUIRED FOR TABULAR/GRAPHICAL OUTPUT.
C
C  INPUT : (R*8)  TEEA()  = INPUT DATA FILE: COLLISION ENERGIES (EV/AMU)
C                           FOR THE DATA-BLOCK BEING ASSESSED.
C                           DIMENSION: COLLISION ENERGY INDEX
C  INPUT : (R*8)  EEVA()  = USER ENTERED: COLLISION ENERGIES (EV/AMU)
C                           DIMENSION: COLLISION ENERGY INDEX
C
C  INPUT : (R*8)  SCX()    =INPUT DATA FILE: FULL SET OF CX CROSS-
C                           SECTIONS FOR THE DATA-BLOCK BEING ANALYSED
C                           1ST DIMENSION: COLLISION ENERGY INDEX
C  OUTPUT: (R*8)  SCXA()  = SPLINE INTERPOLATED OR  EXTRAPOLATED
C                           CX CROSS-SECTIONS FOR
C                           THE USER ENTERED COLLISION ENERGIES.
C                           DIMENSION: COLLISION ENERGIES INDEX
C
C  OUTPUT: (L*4)  LERNG()=  .TRUE.  => OUTPUT 'SCXA()' VALUE WAS INTER-
C                                      POLATED  FOR  THE  USER  ENTERED
C                                      COLLISION ENERGY 'EEVA()'.
C                           .FALSE. => OUTPUT 'SCXA()' VALUE WAS EXTRA-
C                                      POLATED  FOR  THE  USER  ENTERED
C                                      COLLISION ENERGY 'EEVA()'.
C                           DIMENSION: COLLISION ENERGY INDEX
C
C          (I*4)  NIN     = PARAMETER = MAX. NO. OF INPUT  ENERGY
C                                       VALUES. MUST BE >= 'IEA'
C          (I*4)  NOUT    = PARAMETER = MAX. NO. OF OUTPUT ENERGY
C                                       VALUES.  MUST BE >= 'IEVAL'
C          (I*4)  L1      = PARAMETER = 1
C
C
C          (I*4)  IET     = ARRAY SUBSCRIPT USED INPUT  FILE  COLLISION
C                           ENERGIES.
C          (I*4)  IT      = ARRAY  SUBSCRIPT  USED  FOR  USER  ENTERED
C                           COLLISION ENERGIES.
C          (I*4)  IOPT    = DEFINES THE BOUNDARY DERIVATIVES FOR THE
C                           SPLINE ROUTINE 'XXSPLE', SEE 'XXSPLE'.
C                           (VALID VALUES = <0, 0, 1, 2, 3, 4)
C
C          (L*4)  LSETX   = .TRUE.  => SET UP SPLINE PARAMETERS RELATING
C                                      TO 'XIN' AXIS.
C                           .FALSE. => DO NOT SET UP SPLINE PARAMETERS
C                                      RELATING TO 'XIN' AXIS.
C                                      (I.E. THEY WERE SET IN A PREVIOUS
C                                            CALL )
C                           (VALUE SET TO .FALSE. BY 'XXSPLE')
C
C          (R*8)  R8FUN1  = FUNCTION - (SEE ROUTINES SECTION BELOW)
C
C          (R*8)  XIN()   = LOG( DATA FILE COLLISION ENERGIES )
C          (R*8)  YIN()   = LOG( DATA FILE CX CROSS-SECTIONS)
C          (R*8)  XOUT()  = LOG( USER ENTERED COLLISION ENERGIES.)
C          (R*8)  YOUT()  = LOG( OUTPUT GENERATED CX CROSS-SECTIONS)
C          (R*8)  DF()    = SPLINE INTERPOLATED DERIVATIVES
```

```
C
C
C NOTE:
C
C          ONE-DIMENSIONAL SPLINE CARRIED OUT BY THIS SUBROUTINE:
C
C           LOG( SCX )  vs. LOG( E )
C
C           E      = COLLISION ENERGY (units: eV/AMU)
C           SCX    = CX CROSS-SECTION (units: cm**2)
C
C           Extrapolation criteria:
C
C           Low  E: zero gradient  extrapolation (i.e. DY(1)  = 0.0)
C           High E: zero curvature extrapolation (i.e. DDY(N) = 0.0)
C
C           (These criteria are met by calling XXSPLE with IOPT=4)
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXSPLE     ADAS      SPLINE SUBROUTINE (EXTENDED DIAGNOSTICS)
C          R8FUN1     ADAS      REAL*8 FUNCTION: ( X -> X )
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL. 0141-553-4196
C
C DATE:    16/11/95
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C           - PUT UNDER S.C.C.S. CONTROL
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    NIN                  , NOUT            , L1
C-----------------------------------------------------------------------
      REAL*8     ZERO
C-----------------------------------------------------------------------
      PARAMETER( NIN    = 24          , NOUT = 24       , L1 = 1     )
      PARAMETER( ZERO   = 1.0D-30 )
C-----------------------------------------------------------------------
      INTEGER    NEDIM                , IEA             , IEVAL
      INTEGER    IET                  , IT              , IOPT
C-----------------------------------------------------------------------
      REAL*8     R8FUN1
C-----------------------------------------------------------------------
      LOGICAL    LSETX
C-----------------------------------------------------------------------
      REAL*8     TEEA(NEDIM)          , EEVA(IEVAL)     ,
     &           SCX(NEDIM)           , SCXA(IEVAL)
      REAL*8     DF(NIN)              ,
     &           XIN(NIN)             , YIN(NIN)        ,
     &           XOUT(NOUT)           , YOUT(NOUT)
C-----------------------------------------------------------------------
      LOGICAL    LERNG(IEVAL)
C-----------------------------------------------------------------------
      EXTERNAL   R8FUN1
C-----------------------------------------------------------------------
```

C2TITL

```
      SUBROUTINE C2TITL( IBSEL  , DSFULL ,
     &                   CPRIMY , CSECDY ,
     &                   CTYPE ,
     &                   TITLX
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C2TITL *********************
C
C  PURPOSE:  TO CREATE THE DESCRIPTIVE TITLE FOR SELECTED DATA-BLOCK.
C
C  CALLING PROGRAM: ADAS302/SSIA
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IBSEL    = SELECTED DATA-BLOCK: INDEX
C  INPUT : (C*80) DSFULL   = FULL MVS INPUT DATA SET NAME
C
C  INPUT : (C*5)  CPRIMY   = SELECTED DATA-BLOCK: PRIMARY SPECIES
C                                                 IDENTIFICATION.
C  INPUT : (C*5)  CSECDY   = SELECTED DATA-BLOCK: SECONDARY SPECIES
C                                                 IDENTIFICATION.
C
C  INPUT : (C*3)  CTYPE    = SELECTED DATA-BLOCK: CROSS. SECT. TYPE
C
```

```
C  OUTPUT: (C*120) TITLX    = SELECTED DATA-BLOCK: DESCRIPTIVE TITLE
C
C          (C*2)  C2       = GENERAL USE 2 BYTE  CHARACTER  STRING
C           (I*4)  POS_NOW  = CURRENT POSITION IN TITLE STRING
C           (I*4)  LEN_NAME = LENGTH OF FILENAME
C          (I*4)  IFIRST   = POSITION OF FIRST CHARACTER IN FILENAME
C          (I*4)  ILAST    = POSITION OF LAST CHARACTER IN FILENAME
C
C ROUTINES:
C          XXSLEN          = UTILITY ROUTINE WHICH FINDS FIRST AND LAST
C                            NON-BLANK CHARACTERS IN A STRING.
C
C AUTHOR:  H. P. SUMMERS
C          JA8.08
C          TEL. 0141-553-4196
C
C DATE:    12/11/96
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                              DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C           - PUT UNDER S.C.C.S. CONTROL
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER    IBSEL
      INTEGER    POS_NOW         , LEN_NAME
      INTEGER    IFIRST          , ILAST
C-----------------------------------------------------------------------
      CHARACTER  DSFULL*80       ,
     &           CPRIMY*5        , CSECDY*5       ,
     &           CTYPE*3        , TITLX*120
      CHARACTER  C2*2
C-----------------------------------------------------------------------
```

C2VRDC

```
      SUBROUTINE C2VRDC( ICIND  ,
     &                   NBSEL  ,
     &                   CDONOR , CRECVR, CFSTAT , CTYPE ,
     &                   SCI    ,
     &                   SDONOR , SRECVR, SFSTAT , STYPE
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C2VRDC *********************
C
C  PURPOSE: TO SETUP DONOR/RECVR CHARACTER STRINGS FOR USE WITH SETTING
C           ISPF VARIABLES WHEN  SELECTED CROSS-SECTIONS ARE DISPLAYED.
C
C  CALLING PROGRAM: C2PAN2
C
C  SUBROUTINE:
C
C  INPUT : (I*4)   ICIND    = SELECTED/REQUESTED CROSS-SECTION DATA-BLOCK
C                             INDEX.
C
C  INPUT : (I*4)   NBSEL    = NUMBER OF DATA-BLOCK CROSS-SECTIONS.
C
C  INPUT : (C*9)   CDONOR() = INPUT DATA FILE: DONOR ION IDENTIFICATION
C                             DIMENSION: DATA-BLOCK INDEX
C  INPUT : (C*9)   CRECVR() = INPUT DATA FILE: RECEIVER ION IDENTIFICATION
C                             DIMENSION: DATA-BLOCK INDEX
C  INPUT : (C*10)  CFSTAT() = INPUT DATA FILE: FINAL STATE SPECIFICATION
C                             DIMENSION: DATA-BLOCK INDEX
C  INPUT : (C*2)   CTYPE()  = INPUT DATA FILE: CROSS-SECTION TYPE
C                             DIMENSION: DATA-BLOCK INDEX
C                             DIMENSION: DATA-BLOCK INDEX
C
C  OUTPUT: (C*3)   SCI      = ISPF PANEL VARIABLE: DATA-BLOCK INDEX
C
C  OUTPUT: (C*9)   SDONOR   = ISPF PANEL VARIABLE: DONOR ION IDENTIFICATION
C  OUTPUT: (C*9)   SRECVR   = ISPF PANEL VARIABLE: RECEIVER ION IDENTIFICATION
C  OUTPUT: (C*10)  SFSTAT   = ISPF PANEL VARIABLE: FINAL STATE SPECIFICATION
C  OUTPUT: (C*2)   STYPE    = ISPF PANEL VARIABLE: CROSS-SECTION TYPE
C
C
C ROUTINES: NONE
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL.  0141-553-4196
C
C DATE:    15/11/95
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                              DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C           - PUT UNDER S.C.C.S. CONTROL
C
```

```
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    ICIND           , NBSEL
C-----------------------------------------------------------------------
      CHARACTER  SCI*3           , STYPE*2          , SRECVR*9       ,
     &           SFSTAT*10       , SDONOR*9
      CHARACTER  CTYPE(NBSEL)*2  , CRECVR(NBSEL)*9  , CFSTAT(NBSEL)*10,
     &           CDONOR(NBSEL)*9
C-----------------------------------------------------------------------
```

C2WR11

```
      SUBROUTINE C2WR11( IUNIT    , UID    , DATE   ,
     &                   NSTORE   , NTDIM  ,
     &                   NBSEL    , ISELA  ,
     &                   CPRMYA   , CSCDYA ,
     &                   CTYPEA ,
     &                   DSFLLA   ,
     &                   AMDA     , AMRA   ,
     &                   ITA      ,
     &                   TPA      ,
     &                   QFTEQA   , QFTIAA
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C2WR11 *********************
C
C  PURPOSE:  TO  WRITE  DATA  TO THERMAL ION/ATOM
C            RATE COEFFICIENT PASSING FILE FOR GIVEN PRIMARY SPECIES.
C
C  CALLING PROGRAM: ADAS302
C
C  DATA:
C
C           UP TO 'NSTORE' SETS (DATA-BLOCKS) OF DATA MAY BE WRITTEN TO
C           THE FILE - EACH  BLOCK  FORMING  A  COMPLETE  SET OF  RATE-
C           COEFFICIENTS FOR THE  PRIMARY SPECEIS.
C
C           THE UNITS USED IN THE DATA FILE ARE TAKEN AS FOLLOWS:
C
C           TEMPERATURES        : EV
C           RATE COEFFICIENTS   : CM**3 SEC-1
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IUNIT    = UNIT TO WHICH INPUT FILE IS ALLOCATED.
C  INPUT : (C*6)  UID      = USER IDENTIFIER OF PRODUCER
C  INPUT : (C*8)  DATE     = DATE
C  INPUT : (I*4)  NSTORE   = MAXIMUM NUMBER  OF DATA-BLOCKS THAT CAN
C                            BE WRITTEN.
C  INPUT : (I*4)  NTDIM    = MAX NUMBER OF RECEIVER & DONOR TEMPERATURES
C                            ALLOWED
C
C  INPUT : (I*4)  NBSEL    = NUMBER OF DATA-BLOCKS WRITTEN
C  INPUT : (I*4)  ISELA()  = WRITE - DATA-SET DATA-BLOCK ENTRY INDICES
C                            DIMENSION: DATA-BLOCK INDEX
C  INPUT : (C*5)  CPRMYA() = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                            PRIMARY SPECEIS INDENTIFICATION
C                            DIMENSION: DATA-BLOCK INDEX
C  INPUT : (C*5)  CSCDYA() = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                            SECONDARY SPECIES IDENTIFICATION
C                            DIMENSION: DATA-BLOCK INDEX
C  INPUT : (C*3)  CTYPEA() = INPUT DATA FILE - SELECTED DATA-BLOCK:
C                            CROSS-SECTION TYPE
C                            DIMENSION: DATA-BLOCK INDEX
C  INPUT : (R*8)  AMRA     = READ - SECONDARY SPECIES ATOMIC MASS
C                            DIMENSION: DATA-BLOCK INDEX
C  INPUT : (R*8)  AMDA     = READ - PRIMARY SPECIES  ATOMIC MASS
C                            DIMENSION: DATA-BLOCK INDEX
C  INPUT : (C*44) DSFLLA() = MVS DATA SET NAME OF SOURCE DATA SET
C                            DIMENSION: DATA-BLOCK INDEX
C
C
C  INPUT : (I*4)  ITA()    = READ - NUMBER OF TEMPERATURES
C                            DIMENSION: DATA-BLOCK INDEX
C
C  INPUT : (R*8)  TPA(,)   = READ - TEMPERATURES (UNITS: EV)
C                            1ST DIMENSION: TEMPERATURE INDEX
C                            2nd DIMENSION: DATA-BLOCK INDEX
C
C  INPUT : (R*8)  QFTEQA(,)= READ - EQUAL TEMPERATURE RATE-COEFFICIENTS
C                                   (UNITS: cm**3 sec-1)
C                            1st DIMENSION: SECONDARY TEMPERATURE INDEX
C                            2nd DIMENSION: DATA-BLOCK INDEX
C  INPUT : (R*8)  QFTIAA(,,)=READ - FULL SET OF RATE-COEFFICIENTS
C                                   (UNITS: cm**3 sec-1)
C                            1st DIMENSION: PRIMARY   TEMPERATURE INDEX
C                            2nd DIMENSION: SECONDARY TEMPERATURE INDEX
C                            3rd DIMENSION: DATA-BLOCK INDEX
C
```

```
C          (C*2)  CEQUAL   = PARAMETER = 'EQ'
C
C          (I*4)  I4EIZ0   = FUNCTION - (SEE ROUTINES SECTION BELOW)
C          (I*4)  I4FCTN   = FUNCTION - (SEE ROUTINES SECTION BELOW)
C          (I*4)  I4UNIT   = FUNCTION - (SEE ROUTINE SECTION BELOW)
C          (I*4)  IBLK     = ARRAY INDEX: DATA-BLOCK INDEX
C          (I*4)  ITR      = ARRAY INDEX: SECONDARY TEMPERATURE INDEX
C          (I*4)  ITD      = ARRAY INDEX: PRIMARY   TEMPERATURE INDEX
C          (I*4)  NTRNUM   = NUMBER OF SECONDARY TEMPERATURES FOR CURRENT
C                            DATA-BLOCK
C          (I*4)  NTDNUM   = NUMBER OF PRIMARY   TEMPERATURES FOR CURRENT
C                            DATA-BLOCK
C          (I*4)  IABT     = RETURN CODE FROM 'I4FCTN'
C
C
C          (C*10) IONNAM   = READ - PRIMARY SPECIES DESIGNATION STRING
C          (C*80) C80      = GENERAL USE 80 BYTE  CHARACTER  STRING  FOR
C                            THE INPUT OF DATA-SET RECORDS.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      INTEGER*4 FUNCTION    -
C                               FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL. 0141-553-4196
C
C DATE:    18/11/96
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 19-11-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C           - PUT UNDER S.C.C.S. CONTROL
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
      INTEGER    IUNIT                , NSTORE             ,
     &           NTDIM                , NBSEL
      INTEGER    IBLK                 , IT                 ,
     &           ITR                  , ITD
C-----------------------------------------------------------------------
      CHARACTER  UID*6                , DATE*8
      CHARACTER  CEQUAL*10
C-----------------------------------------------------------------------
      INTEGER    ISELA(NSTORE)        ,
     &           ITA(NSTORE)
C-----------------------------------------------------------------------
      REAL*8     AMRA(NSTORE)        , AMDA(NSTORE)
      REAL*8     TPA(NTDIM,NSTORE)    ,
     &           QFTEQA(NTDIM,NSTORE)
      REAL*8     QFTIAA(NTDIM,NTDIM,NSTORE)
C-----------------------------------------------------------------------
      CHARACTER  DSFLLA(NSTORE)*80
      CHARACTER  CPRMYA(NSTORE)*5     , CSCDYA(NSTORE)*5    ,
     &           CTYPEA(NSTORE)*3
C-----------------------------------------------------------------------
      DATA       CEQUAL/' *EQUAL**'/
C -----------------------------------------------------------------------
```

C3ALRS

```
      SUBROUTINE C3ALRS( IORD , EM1  , EM2  ,
     &                   EPRO , TTAR , ETHR ,
     &                   YA   , N    , NS   ,
     &                   OA   , SQEF
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ********************** FORTRAN77 SUBROUTINE : C3ALRS ***************
C
C  PURPOSE:  COMPUTES ALPHAS AND REDUCED SPEEDS.  RETURNS AN EFFECTIVE
C            CHARGE-EXCHANGE RATE COEFFICIENT
C
C  CALLING PROGRAM: SQEF
C
C  SUBROUTINE:
C
C  INPUT : (I*4)   IORD  = 1 FOR 1ST PARTICLE INCIDENT AND MONOENERGETIC
C                        = 2 FOR 2ND PARTICLE INCIDENT AND MONOENERGETIC
C  INPUT : (I*4)   ISEL  = SELECTOR FOR PARTICULAR RATE COEFFT.
C                          CHOSEN FROM TABLE
C  INPUT : (R*8)   EM1   = ATOMIC MASS NUMBER FOR 1ST PARTICLE
C  INPUT : (R*8)   EM2   = ATOMIC MASS NUMBER FOR 2ND PARTICLE
C  INPUT : (R*8)   EPRO  = INCIDENT PARTICLE ENERGY (EV/AMU)
C  INPUT : (R*8)   TTAR  = MAXWELL TEMPERATURE OF TARGET PARTICLES (EV)
C  INPUT : (R*8)   ETHR  = THRESHOLD ENERGY
C  INPUT : (R*8)   ZSEL  = NUCLEAR CHARGE (REQUIRED ONLY
C                          FOR PARTICULAR ISEL)
C  INPUT : (I*4)   NSEL  = PRINC. QUANTUM NO. (REQUIRED ONLY
```

```
C                          FOR PARTICULAR ISEL
C                          NB. NSEL SHOULD BE ZERO ON ENTRY OTHERWISE)
C  INPUT : (I*4)   N     = NUMBER OF SOURCE DATA VALUES
C
C  OUTPUT: (R*8)   SQEF  = RATE COEFFICIENT (CM3 SEC-1)
C  OUTPUT: (R*8)   OA()  = RATE COEFFTS.(CM**3 SEC-1) FOR SELECTED
C                          SOURCE DATA
C  OUTPUT: (R*8)   EA()  = SET OF ENERGIES (EV/AMU) FOR
C                          SELECTED SOURCE DATA
C  I/O   : (R*8)   YA()  = ENERGIES ON INPUT, SPEEDS ON OUTPUT
C
C          (I*4)   ISWIT = ENERGY RANGE SWITCHING INDEX
C          (I*4)   I     = GENERAL INDEX
C          (I*4)   K     = GENERAL INDEX
C
C          (R*8)   ABI   = FUNCTION - SEE BELOW
C          (R*8)   EMT   = SELECTED MASS
C          (R*8)   F     = GENERAL VARIABLE
C          (R*8)   SUM   = GENERAL VARIABLE
C          (R*8)   SXI   = GENERAL VARIABLE
C          (R*8)   SXXI  = GENERAL VARIABLE
C          (R*8)   U     = GENERAL VARIABLE
C          (R*8)   V     = GENERAL VARIABLE
C          (R*8)   VTHR  = THRESHOLD SPEED
C          (R*8)   X     = GENERAL VARIABLE
C          (R*8)   XI    = GENERAL VARIABLE
C          (R*8)   XRMIN = GENERAL VARIABLE
C          (R*8)   XXI   = GENERAL VARIABLE
C          (R*8)   XA()  = GAUSS-LAGUERRE NODES   (9-POINT)
C          (R*8)   WXA() = GAUSS-LAGUERRE WEIGHTS (9-POINT)
C
C
C  ROUTINES:
C           ROUTINE    SOURCE    BRIEF DESCRIPTION
C           ------------------------------------------------------------
C           ABI        ADAS      COMPUTES INTEGRAL FOR RATE COEFFICIENT
C
C  AUTHOR:  C J. WHITEHEAD, PAP, UNIVERSITY OF STRATHCLYDE
C           EXT 4205
C
C  DATE:    14/11/94
C
C  UPDATE:  09/12/94 - HP SUMMERS: ADJUST FORMATTING
C
C  UPDATE:  03/05/95 - PE BRIDEN : ADD DATA DECLARATION FOR F AND EMT.
C                                  (STOPS COMPILATION WARNING OF
C                                   UNINITIALISED VARIABLES.)
C
C  UPDATE:  15/05/95 - TIM HAMMOND: UNIX PORT - PUT INTO SCCS
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER IORD   , N     , ISWIT , K     , NS    , I
C-----------------------------------------------------------------------
      REAL*8  EM1    , EM2   , EPRO  , TTAR  , ETHR  ,
     &        EMT    , U     , V     , VTHR  , ABI
      REAL*8  XI     , X     , XRMIN , SUM   , SXI   , F     , XXI   ,
     &        SQEF   , SXXI
C-----------------------------------------------------------------------
      REAL*8  XA(9)     , WXA(9)
      REAL*8  YA(24)    , FA(24)   , OA(24)
C-----------------------------------------------------------------------
C     GAUSS-LAGUERRE DATA (9PT)
C-----------------------------------------------------------------------
      DATA F  / 0.0 / ,
     &     EMT/ 0.0 /
      DATA XA / 0.1523222277D0   , 0.8072200227D0   , 2.0051351556D0   ,
     &          3.7834739733D0   , 6.2049567778D0   , 9.3729852516D0   ,
     &          13.4662369110D0  , 18.8335977889D0  , 26.3740718909D0  /
      DATA WXA/ 3.36126421798D-1 , 4.11213980424D-1 , 1.99287525371D-1 ,
     &          4.74605627657D-2 , 5.59962661079D-3 , 3.05249767093D-4 ,
     &          6.59212302608D-6 , 4.11076933035D-8 , 3.29087403035D-11/
C-----------------------------------------------------------------------
```

C3CORR

```
      SUBROUTINE C3CORR( NVALS   , IBSEL  ,
     &                   QATOM   , ATOM   ,
     &                   QEFREF  , ATMREF ,
     &                   NSTORE  , NA     ,
     &                   RION    , SCALED
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C3CORR *******************
C
C  PURPOSE: APPLY A CORRECTION TO REFERENCE RATE COEFFICIENT TO ALLOW
C           FOR VARIATION OF PLASMA PARAMETERS ALONG ONE-DIMENSIONAL
C           SCANS
C
C  CALLING PROGRAM: SQEF
C
```

```
C  SUBROUTINE:
C
C  INPUT : (I*4)   NVALS()    = NUMBER OF VALUES IN SELECTED DATA BLOCK
C                               1ST. DIM: NSTORE
C  INPUT : (I*4)   IBSEL     = SELECTED BLOCK INDEX
C  INPUT : (R*8)   QATOM(,) = EFFECT. RATE COEFFT. TO SCALE WITH PARAM.
C                               1ST. DIM: NA
C                               2ND. DIM: NSTORE
C  INPUT : (R*8)   ATOM(,)  = PLASMA PARAM. VALUES TO BASE SCALING ON
C                               1ST. DIM: NA
C                               2ND. DIM: NSTORE
C  INPUT : (R*8)   QEFREF() = RATE COEFFICIENT REFERENCE VALUES
C                               1ST. DIM: NSTORE
C  INPUT : (R*8)   ATMREF() = REFERENCE VALUES FOR PLASMA PARAM.
C                               1ST. DIM: NSTORE
C  INPUT : (R*8)   RION      = SPECIFIED PARM. VALUE FOR COEFFT. OUTPUT
C  INPUT : (I*4)   NSTORE    = NUMBER OF DATA BLOCKS IN DATASET.
C  INPUT : (I*4)   NA        = MAX. NO. OF PARAM. VALUES IN BLOCK
C
C  OUTPUT: (R*8)   SCALED    = SCALED PLASMA PARAMETER
C
C  PARAM : (I*4)   MXIN      = MAX. NO. OF INPUT DATA SET VALUES
C
C          (I*4)   MAXVAL    = NUMBER OF DATA VALUES IN SELECTED SET
C          (I*4)   IOPT      = DEFINES THE BOUNDARY DERIVATIVES FOR THE
C                              SPLINE ROUTINE 'XXSPLE'. SEE 'XXSPLE'.
C                              ( VALID VALUES = <0, 0, 1, 2, 3, 4)
C          (I*4)   J         = LOOP INDEX.
C
C          (L*4)   LSETX     = FLAGS TO SPLINE ROUTINE 'XXSPLN' IF
C                              SPLINE PARAMETERS SHOULD BE SET UP.
C                              .TRUE.  => SET UP SPLINE PARAMS.
C                              .FALSE. => DO NOT SET UP SPLINE PARAMS.
C
C          (L*4)   LINTRP    = FLAGS TO IDENTIFY IF SCALED VALUE INTER-
C                              POLATED. (OUTPUT FROM XXSPLE).
C                              .TRUE.  => SCALED VALUE INTERPOLATED
C                              .FALSE. => SCALED VALUE EXTRAPOLATED.
C
C          (R*8)   VL()      = LN(INPUT VALUE/REF. VALUE) FOR PARAM.
C                              DIMENSION: 1
C          (R*8)   QVL()     = LN(INPUT TABLE RATE COEF.) FOR PARAM.
C                              DIMENSION: 1
C          (R*8)   VECL()    = LN(TABLE VALUE/REF. VALUE) FOR PARAM.
C                              DIMENSION: MXIN
C          (R*8)   QVECL()   = LN(TABLE RATE COEF./REF. RATE COEF.)
C                              DIMENSION: MXIN
C          (R*8)   DY()      = DERIVATIVES AT INPUT KNOTS TO XXSPLN.
C                              DIMENSION: MXIN
C
C  ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          XXSPLE     ADAS      SPLINE SUBROUTINE (EXTENDED DIAGNOSTICS)
C          R8FUN1     ADAS      PERFORMS TRANSFORMATION ( X -> X )
C
C  NOTES:  THE QUANTITIES WHICH ARE SCALED BY THIS ROUTINE ARE :  ION
C          DENSITY, ION TEMPERATURE, EFFECTIVE Z AND MAGNETIC
C          FIELD THIS CODE IS TAKEN FROM THE OLDER ADAS CODE
C          'QEFFH.FOR' BY H.P.  SUMMERS
C
C  AUTHOR:  C.J. WHITEHEAD, PAP, UNIVERSITY OF STRATHCLYDE
C           EXT 4205
C
C  DATE:    24/11/94
C
C  UPDATE:  19/12/94 - HP SUMMERS: ADJUST FORMATTING
C
C  UPDATE:  21/04/95 - HP SUMMERS: REORDER TWO-DIMENSIONAL ARRAY INDICES
C
C  UPDATE:  03/05/95 - PE BRIDEN : 1) REPLACED CALLS TO SPLINE NAG
C                                     ROUTINES E01BAF/E02BBF WITH A
C                                     CALL TO XXSPLE. (REQUIRED SOME
C                                     RECODING). + CHECK FOR ATTEMPTED
C                                     EXTRAPOLATION.
C                                  2) MADE CHANGES TO CODE TO MAKE IT
C                                     ANSI STANDARD FORTRAN 77.
C                                  3) TIDIED UP CODE + ADDED CHECK TO
C                                     MAKE SURE INTERNAL ARRAYS ARE
C                                     LARGE ENOUGH.
C                                  4) GENERAL CHANGES TO FORMAT ETC.
C
C  UPDATE:  15/05/95 - Tim Hammond: UNIX PORT
C                      Put under SCCS control
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER    MXIN
      REAL*8     R8FUN1
C
      PARAMETER( MXIN = 24 )
      EXTERNAL   R8FUN1
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
      INTEGER    IBSEL           , NSTORE          , NA
```

```
C-----------------------------------------------------------------------
      REAL*8     RION             , SCALED
C-----------------------------------------------------------------------
      INTEGER    NVALS(NSTORE)
C-----------------------------------------------------------------------
      REAL*8     QEFREF(NSTORE)   , ATMREF(NSTORE)  ,
     &           QATOM(NA,NSTORE) , ATOM(NA,NSTORE)
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    MAXVAL           , IOPT            , J
C-----------------------------------------------------------------------
      LOGICAL    LSETX            , LINTRP(1)
C-----------------------------------------------------------------------
      REAL*8     VL(1)            , QVL(1)          ,
     &           VECL(MXIN)       , QVECL(MXIN)     ,
     &           DY(MXIN)
C-----------------------------------------------------------------------
```

C3DATA

```
      SUBROUTINE C3DATA( IUNIT  , DSNAME ,
     &                   NSTORE ,
     &                   NBSEL  , ISELA  ,
     &                   CWAVEL , CDONOR , CRECVR ,
     &                   CFILE  , CPCODE , CINDM  ,
     &                   QEFREF ,
     &                   ENREF  , TEREF  , DEREF  , ZEREF   , BMREF  ,
     &                   NENERA , NTEMPA , NDENSA , NZEFFA  , NBMAGA ,
     &                   ENERA  , TEMPA  , DENSA  , ZEFFA   , BMAGA  ,
     &                   QENERA , QTEMPA , QDENSA , QZEFFA  , QBMAGA
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C3DATA *********************
C
C  PURPOSE : TO FETCH DATA FROM INPUT QEF DATA SET.
C
C  CALLING PROGRAM: ADAS303, SQEF
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IUNIT     = UNIT NUMBER TO READ FROM
C  INPUT : (C*80) DSNAME    = MVS DATA SET NAME OF DATA SET BEING READ
C  INPUT : (I*4)  NSTORE    = MAXIMUM NUMBER OF DATA BLOCKS ALLOWED
C
C  OUTPUT: (I*4)  NBSEL     = NUMBER OF BLOCKS PRESENT
C  OUTPUT: (I*4)  ISELA()   = INDEX NUMBER OF DATA BLOCK
C
C  OUTPUT: (C*5)  CWAVEL()= INPUT DATA FILE: TRANSITION
C                           DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (C*8)  CDONOR()= INPUT DATA FILE: DONOR NEUTRAL ATOM
C                           DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (C*5)  CRECVR()= INPUT DATA FILE: RECEIVER NUCLEUS
C                           DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (C*8)  CFILE() = INPUT DATA FILE: SPECIFIC ION FILE SOURCE
C                           DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (C*8)  CPCODE()= INPUT DATA FILE: PROCESSING CODE
C                           DIMENSION: DATA-BLOCK INDEX
C  OUTPUT: (C*6)  CINDM() = FILE DATA FILE: EMISSION TYPE
C                           DIMENSION: DATA-BLOCK INDEX
C
C  OUTPUT: (R*8)  QEFREF()  = REFERENCE VALUE OF RATE COEFFICIENT
C  OUTPUT: (R*8)  ENREF()   =     "       "   "  ENERGY
C  OUTPUT: (R*8)  TEREF()   =     "       "   "  TEMPERATURE
C  OUTPUT: (R*8)  DEREF()   =     "       "   "  DENSITY
C  OUTPUT: (R*8)  ZEREF()   =     "       "   "  EFFECTIVE Z
C  OUTPUT: (R*8)  BMREF()   =     "       "   "  MAGNETIC FIELD
C  OUTPUT: (I*4)  NENERA()  = NUMBER OF ENERGIES
C  OUTPUT: (I*4)  NTEMPA()  = NUMBER OF TEMPERATURES
C  OUTPUT: (I*4)  NDENSA()  = NUMBER OF DENSITIES
C  OUTPUT: (I*4)  NZEFFA()  = NUMBER OF EFFECTIVE Z'S
C  OUTPUT: (I*4)  NBMAGA()  = NUMBER OF MAGNETIC FIELD VALUES
C                             1ST. DIM: NSTORE
C                             (FOR ABOVE ARRAYS)
C
C  OUTPUT: (R*8)  ENERA(,)  = ENERGIES
C  OUTPUT: (R*8)  QENERA(,) = RATE COEFFICIENTS FOR ENERGY VALUE
C  OUTPUT: (R*8)  TEMPA(,)  = TEMPERATURES
C  OUTPUT: (R*8)  QTEMPA(,) = RATE COEFFICIENTS FOR TEMPERATURES
C  OUTPUT: (R*8)  DENSA(,)  = DENSITIES
C  OUTPUT: (R*8)  QDENSA(,) = RATE COEFFICIENTS FOR DESNITIES
C  OUTPUT: (R*8)  ZEFFA(,)  = EFFECTIVE Z
C  OUTPUT: (R*8)  QZEFFA(,) = RATE COEFFICIENTS FOR EFFECTIVE Z
C  OUTPUT: (R*8)  BMAGA(,)  = MAGNETIC FIELD
C  OUTPUT: (R*8)  QBMAGA(,) = RATE COEFFICIENTS FOR MAGNETIC FIELDS
C                             1ST DIM: 12 OR 24  DEPENDING ON PARAMETER
C                             2ND DIM: NSTORE
C
C  ROUTINES:
C           ROUTINE    SOURCE    BRIEF DESCRIPTION
C           ------------------------------------------------------------
```

```
C           I4UNIT     ADAS      FETCHES FILE HANDLE FOR ERROR MESSAGE
C
C  AUTHOR:  H P SUMMERS, UNIVERSITY OF STRATHCLDYE
C           JA 8.08
C           TEL.  0141-553-4196
C
C  DATE:    19/04/95
C
C  UPDATE:  04/05/95 TIM HAMMOND - UNIX PORT
C                                  Increased DSNAME from 44 -> 80
C
C  UPDATE:  15/05/95 TIM HAMMOND - UNIX PORT
C                                  Changed delimiter character from
C                                    '\' to '!' as otherwise will not
C                                    compile.
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER IUNIT  , ISTORE , NSTORE  , NBSEL  , J
      INTEGER I4UNIT
C-----------------------------------------------------------------------
      CHARACTER DSNAME*80                  , STRING*80
      CHARACTER CINDM(NSTORE)*6            , CFILE(NSTORE)*8         ,
     &          CPCODE(NSTORE)*8           , CWAVEL(NSTORE)*5        ,
     &          CDONOR(NSTORE)*8           , CRECVR(NSTORE)*5
C-----------------------------------------------------------------------
      INTEGER ISELA(NSTORE)
      INTEGER NENERA(NSTORE), NTEMPA(NSTORE), NDENSA(NSTORE)
      INTEGER NZEFFA(NSTORE), NBMAGA(NSTORE)
C-----------------------------------------------------------------------
      REAL*8 QEFREF(NSTORE)
      REAL*8 ENREF(NSTORE) , TEREF(NSTORE)
      REAL*8 DEREF(NSTORE) , ZEREF(NSTORE)
      REAL*8 BMREF(NSTORE)
      REAL*8 ENERA(24,NSTORE), QENERA(24,NSTORE)
      REAL*8 TEMPA(12,NSTORE), QTEMPA(12,NSTORE)
      REAL*8 DENSA(24,NSTORE), QDENSA(24,NSTORE)
      REAL*8 ZEFFA(12,NSTORE), QZEFFA(12,NSTORE)
      REAL*8 BMAGA(12,NSTORE), QBMAGA(12,NSTORE)
C-----------------------------------------------------------------------
      EXTERNAL I4UNIT
C-----------------------------------------------------------------------
```

C3DATAO

```
      SUBROUTINE C3DATAO( IUNIT  , IBSEL  ,
     &                    NBSEL  , NSTORE ,
     &                    IPASS  ,
     &                    IONNAM , QEFREF ,
     &                    TEREF  , DEREF  ,
     &                    ZEREF  , ENREF  ,
     &                    BMREF  , NENERA ,
     &                    NDENSA , NZEFFA ,
     &                    NBMAGA , NTEMPA ,
     &                    ENERA  , QENERA ,
     &                    TEMPA  , QTEMPA ,
     &                    DENSA  , QDENSA ,
     &                    ZEFFA  , QZEFFA ,
     &                    BMAGA  , QBMAGA )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C3DATAO ********************
C
C ***********************************************************************
C * WARNING - WARNING - WARNING - WARNING - WARNING - WARNING - WARNING*
C *---------------------------------------------------------------------*
C * OLD VERSION OF C3DATA - ONLY USED BY SQEF (UNTIL SQEF UPDATED)     *
C ***********************************************************************
C
C  PURPOSE : READ IN VALUES FROM AN 'IONATOM' DATA SET OPENED BY
C            C3FILE
C
C  CALLING PROGRAM: SQEF
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IUNIT     = UNIT NUMBER TO READ FROM
C                             (OPENED BY C3FILE)
C  INPUT : (I*4)  NSTORE    = ARRAY DIMENSION
C  INPUT : (I*4)  ISEL      = INDEX NUMBER OF SELECTED BLOCK
C                             FROM IONATOM FILE
C  INPUT : (I*4)  IPASS     = 0 IF DATA FILE TO BE READ IN AFRESH
C                           = 1 IF DATA FILE IS NOT TO BE READ IN AGAIN
C                             (IPASS IS SET TO 0 WHEN
C                              ISEL IS NOT A VALID INDEX)
C  OUTPUT: (I*4)  NBSEL     = NUMBER OF BLOCKS PRESENT
C  OUTPUT: (C*80) IONNAM    = NAME OF ION
C
C  OUTPUT: (R*8)  QEFREF()  = REFERENCE VALUE OF RATE COEFFICIENT
C  OUTPUT: (R*8)  ENREF()   =     "       "   "  ENERGY
C  OUTPUT: (R*8)  TEREF()   =     "       "   "  TEMPERATURE
C  OUTPUT: (R*8)  DEREF()   =     "       "   "  DENSITY
```

```
C  OUTPUT: (R*8)  ZEREF()   =     "       "   "  EFFECTIVE Z
C  OUTPUT: (R*8)  BMREF()   =     "       "   "  MAGNETIC FIELD
C  OUTPUT: (I*4)  NENERA()  = NUMBER OF ENERGIES
C  OUTPUT: (I*4)  NTEMPA()  = NUMBER OF TEMPERATURES
C  OUTPUT: (I*4)  NDENSA()  = NUMBER OF DENSITIES
C  OUTPUT: (I*4)  NZEFFA()  = NUMBER OF EFFECTIVE Z'S
C  OUTPUT: (I*4)  NBMAGA()  = NUMBER OF MAGNETIC FIELD VALUES
C                             1ST. DIM: NSTORE
C                             (FOR ABOVE ARRAYS)
C  OUTPUT: (R*8)  ENERA(,)  = ENERGIES
C  OUTPUT: (R*8)  QENERA(,) = RATE COEFFICIENTS FOR ENERGY VALUE
C  OUTPUT: (R*8)  TEMPA(,)  = TEMPERATURES
C  OUTPUT: (R*8)  QTEMPA(,) = RATE COEFFICIENTS FOR TEMPERATURES
C  OUTPUT: (R*8)  DENSA(,)  = DENSITIES
C  OUTPUT: (R*8)  QDENSA(,) = RATE COEFFICIENTS FOR DESNITIES
C  OUTPUT: (R*8)  ZEFFA(,)  = EFFECTIVE Z
C  OUTPUT: (R*8)  QZEFFA(,) = RATE COEFFICIENTS FOR EFFECTIVE Z
C  OUTPUT: (R*8)  BMAGA(,)  = MAGNETIC FIELD
C  OUTPUT: (R*8)  QBMAGA(,) = RATE COEFFICIENTS FOR MAGNETIC FIELDS
C                             1ST DIM: NSTORE
C                             2ND DIM: 12 OR 24  DEPENDING ON PARAMETER
C
C  ROUTINES:
C           ROUTINE    SOURCE    BRIEF DESCRIPTION
C           ------------------------------------------------------------
C           I4UNIT     ADAS      FETCHES FILE HANDLE FOR ERROR MESSAGE
C
C UPDATE: 15/05/95        -        Tim Hammond      UNIX PORT
C                                  Put under SCCS control
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER IUNIT  , ISTORE , NBSEL  , J     ,
     &        IBSEL  , NSTORE , IPASS
      INTEGER I4UNIT
C-----------------------------------------------------------------------
      CHARACTER STRING*80
      CHARACTER IONNAM*80(80)
C-----------------------------------------------------------------------
      INTEGER NENERA(NSTORE), NTEMPA(NSTORE), NDENSA(NSTORE)
      INTEGER NZEFFA(NSTORE), NBMAGA(NSTORE)
C-----------------------------------------------------------------------
      REAL*8 QEFREF(NSTORE)
      REAL*8 ENREF(NSTORE) , TEREF(NSTORE)
      REAL*8 DEREF(NSTORE) , ZEREF(NSTORE)
      REAL*8 BMREF(NSTORE)
      REAL*8 ENERA(NSTORE,24), QENERA(NSTORE,24)
      REAL*8 TEMPA(NSTORE,12), QTEMPA(NSTORE,12)
      REAL*8 DENSA(NSTORE,24), QDENSA(NSTORE,24)
      REAL*8 ZEFFA(NSTORE,12), QZEFFA(NSTORE,12)
      REAL*8 BMAGA(NSTORE,12), QBMAGA(NSTORE,12)
C-----------------------------------------------------------------------
      EXTERNAL I4UNIT
C-----------------------------------------------------------------------
```

C3FILE

```
      SUBROUTINE C3FILE(IUNIT, ATNAME, IRCODE, DSNAME)
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C3FILE *********************
C
C  PURPOSE: TO OPEN AN 'IONATOM' DATA SET FOR ATOM 'ATNAME'
C           CURRENTLY AVAILABLE ATOMS ARE : H, HE, LI
C
C
C
C  DATA SET OPENED: 'JETUID.<GROUP>.<TYPE>
C                           (<EXTENSION>#<ATOM SYMBOL>)'
C
C  CALLING PROGRAM: SQEF
C
C  SUBROUTINE:
C
C  INPUT : (I*4)   IUNIT   = UNIT TO WHICH DATA SET WILL BE CONNECTED
C          (C*2)   ATNAME  = NAME OF ATOM
C
C  OUTPUT: (I*4)   IRCODE  = RETURN CODE FROM SUBROUTINE:
C                            0 => DATA SET SUCCESSFULLY CONNECTED
C                            1 => REQUESTED DATA  SET  MEMBER  DOES  NOT
C                                 EXISTS - DATA SET NOT CONNECTED.
C                            9 => REQUESTED DATA  SET  EXISTS BUT CANNOT
C                                 BE OPENED.
C  OUTPUT: (C*44)  DSNAME  = FULL MVS NAME OF OPENED DATA SET
C
C          (I*4)   LENF1   = FIRST NON-BLANK CHR OF 'DSNAME' GROUP PART
C          (I*4)   LENF2   = LAST  NON-BLANK CHR OF 'DSNAME' GROUP PART
C          (I*4)   LENF3   = FIRST NON-BLANK CHR OF 'DSNAME' TYPE PART
C          (I*4)   LENF4   = LAST  NON-BLANK CHR OF 'DSNAME' TYPE PART
C          (I*4)   LENF5   = FIRST NON-BLANK CHR OF 'DSNAME' EXT PART
C          (I*4)   LENF6   = LAST  NON-BLANK CHR OF 'DSNAME' EXT PART
C          (I*4)   LENF7   = FIRST NON-BLANK CHR OF 'ATNAME'
C          (I*4)   LENF8   = LAST  NON-BLANK CHR OF 'ATNAME'
```

```
C
C          (C*6)   USERID  = ADAS SOURCE DATA USER ID
C          (C*8)   USRGRP  = ADAS SOURCE DATA GROUPNAME
C          (C*5)   USRTYP  = ADAS SOURCE DATA TYPENAME
C          (C*4)   USREXT  = ADAS SOURCE DATA EXTENSION
C
C          (L*4)   LEXIST  = .TRUE.  => REQUESTED  DATA  SET  EXISTS.
C                            .FALSE. => REQUESTED  DATA  SET  DOES  NOT
C                                       EXIST.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXUID      ADAS      FETCHES/SETS ADAS SOURCE DATA USER ID
C          XXSQEF     ADAS      FETCHES/SETS ADAS SOURCE DATA FILENAME
C          XXSLEN     ADAS      OBTAINS FIRST AND LAST NON-BLANK
C                               CHARACTERS IN A STRING
C
C AUTHOR:  C.J. WHITEHEAD, STRATHCLYDE
C          EXT 4205
C          BASED ON CODE IN F1FILE.F
C
C
C DATE:    24/11/94
C
C UPDATE:  15/05/95 - Tim Hammond - UNIX PORT
C                                   Added SCCS Header
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER     IUNIT         , IRCODE         ,
     &            LENF1         , LENF2          , LENF3      ,
     &            LENF4         , LENF5          , LENF6      ,
     &            LENF7         , LENF8
C-----------------------------------------------------------------------
      CHARACTER   USERID*6      , DSNAME*44      , ATNAME*2   ,
     &            USRGRP*8      , USRTYP*5       , USREXT*4
C-----------------------------------------------------------------------
      LOGICAL     LEXIST
C-----------------------------------------------------------------------
```

C3OUT0

```
      SUBROUTINE C3OUT0( IWRITE   , LFSEL  ,
     &                   TITLE    , TITLX  , TITLM , DATE   ,
     &                   IBSEL    , IEVAL  ,
     &                   DIVAL    , DEREF  ,
     &                   TIVAL    , TEREF  ,
     &                   ZFVAL    , ZEREF  ,
     &                   BMVAL    , BMREF  ,
     &                   CWAVEL   , CDONOR ,
     &                   CRECVR   , CFILE  ,
     &                   CPCODE   , CINDM  ,
     &                   LERNG    ,
     &                   EAMU     , EATM   , ECMS  ,
     &                   QEFA     ,
     &                   KPLUS1   , COEF
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: C3OUT0 *********************
C
C  PURPOSE:  TO  PRINT DATA CONCERNING THE SELECTED TRANSITION DATA-
C            BLOCK UNDER ANALYSIS.
C
C  CALLING PROGRAM: ADAS303
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IWRITE  = OUTPUT UNIT FOR RESULTS
C  INPUT : (L*4)  LFSEL   = .TRUE.  => MINIMAX POLYNOMIAL FITTED.
C                           .FALSE. => MINIMAX POLYNOMIAL NOT FITTED
C
C  INPUT : (C*40) TITLE   = TITLE OF RUN (READ FROM ISPF PANEL)
CX INPUT : (C*120)TITLX   = INFORMATION STRING CONTAINING INPUT DATA-
C                           SET NAME IN BYTES 1->35.
C  INPUT : (C*80) TITLM   = DIAGNOSTIC LINE INFORMATION FROM 'MINIMAX'
C  INPUT : (C*8)  DATE    = CURRENT DATE (AS 'DD/MM/YY')
C
C  INPUT : (R*8)  DIVAL     = SELECTED OUTPUT VALUE: ION DENSITY (CM-3)
C  INPUT : (R*8)  DEREF     = REFERENCE VALUE      : ION DENSITY (CM-3)
C
C  INPUT : (R*8)  TIVAL     = SELECTED OUTPUT VALUE: ION TEMPERATURE(EV)
C  INPUT : (R*8)  TEREF     = REFERENCE VALUE      : ION TEMPERATURE(EV)
C
C  INPUT : (R*8)  ZFVAL     = SELECTED OUTPUT VALUE: Z-EFFECTIVE
C  INPUT : (R*8)  ZEREF     = REFERENCE VALUE      : Z-EFFECTIVE
C
C  INPUT : (R*8)  BMVAL     = SELECTED OUTPUT VALUE: MAGNETIC FIELD (T)
C  INPUT : (R*8)  BMREF     = REFERENCE VALUE      : MAGNETIC FIELD (T)
```

```
C
C  INPUT : (I*4)  IBSEL   = DATA-BLOCK INDEX SELECTED FROM INPUT DATASET
C                           FOR ANALYSIS.
C  INPUT : (I*4)  IEVAL   = NUMBER OF USER ENTERED BEAM ENERGY VALUES
C
C  INPUT : (C*5)  CWAVEL  = INPUT DATA FILE: TRANSITION
C  INPUT : (C*8)  CDONOR  = INPUT DATA FILE: DONOR NEUTRAL ATOM
C  INPUT : (C*5)  CRECVR  = INPUT DATA FILE: RECEIVER NUCLEUS
C  INPUT : (C*8)  CFILE   = INPUT DATA FILE: SPECIFIC ION FILE SOURCE
C  INPUT : (C*8)  CPCODE  = INPUT DATA FILE: PROCESSING CODE
C  INPUT : (C*6)  CINDM   = FILE DATA FILE: EMISSION TYPE
C
C  INPUT : (L*4)  LERNG()=  .TRUE.  => OUTPUT 'QEFA()' VALUE WAS INTER-
C                                      POLATED  FOR  THE  USER  ENTERED
C                                      BEAM ENERGY 'EAMU()'.
C                           .FALSE. => OUTPUT 'QEFA()' VALUE WAS EXTRA-
C                                      POLATED  FOR  THE  USER  ENTERED
C                                      BEAM ENERGY 'EAMU()'.
C                           DIMENSION: BEAM ENERGY INDEX
C
C  INPUT : (R*8)  EAMU()  = USER ENTERED: BEAM ENERGY (EV/AMU)
C                           DIMENSION: BEAM ENERGY INDEX
C  INPUT : (R*8)  EATM()  = USER ENTERED: BEAM ENERGY (AT. UNITS)
C                           DIMENSION: BEAM ENERGY INDEX
C  INPUT : (R*8)  ECMS()  = USER ENTERED: BEAM ENERGY (CM/SEC)
C                           DIMENSION: BEAM ENERGY INDEX
C
C  INPUT : (R*8)  QEFA()  = SPLINE INTERPOLATED OR  EXTRAPOLATED  EFF.
C                           EMIS. COEFFTS. FOR THE USER ENTERED BEAM
C                           ENERGIES.
C                           DIMENSION: BEAM ENERGY INDEX
C
C  INPUT : (I*4)  KPLUS1  = NUMBER OF MINIMAX COEFFICIENTS
C  INPUT : (R*8)  COEF()  = COEFFICIENTS OF FITTED MINIMAX POLYNOMIAL
C
C          (I*4)  I       = GENERAL USE - ARRAY ELEMENT INDEX
C
C          (C*1)  C1E     = '*' IF RATE-COEFFICIENT WAS EXTRAPOLATED FOR
C                           THE CURRENT BEAM ENERGY. (IT EQUALS
C                           ' ' IF IT WAS INTERPOLATED.)
C          (C*80) CADAS   = ADAS HEADER: INCLUDES RELEASE, PROGRAM, TIME
C          (C*80) CSTRNG  = MARKER TO USED TO FIND TITLE IN TITLX
C          (I*4)  IFIRST  = FIRST POSITION OF MARKER CSTRNG IN TITLX
C          (I*4)  ILAST   = LAST POSITION OF MARKER CSTRNG IN TITLX
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXADAS     ADAS      GATHERS ADAS HEADER INFORMATION
C
C AUTHOR  : H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C           JA8.08
C           TEL. 0141-553-4196
C
C DATE:    23/04/95
C
C UPDATE:  03/05/95 PE BRIDEN - ADDED 1-D SCAN POSITIONS TABLE.
C                             - ADDED BEAM ENERGY COLUMN FOR CM/SEC.
C                               (REQD. UPDATE OF ARGUMENT LIST)
C                             + OTHER MINOR MODS.
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 15-05-95
C MODIFIED: TIM HAMMOND(TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 13-05-96
C MODIFIED: TIM HAMMOND
C               - REMOVED HOLLERITH CONSTANTS FROM OUTPUT AND TIDIED UP
C                 HEADER
C-----------------------------------------------------------------------
      INTEGER    IWRITE        , IBSEL         , IEVAL     ,
     &           IZ0           , IZ            , KPLUS1
      INTEGER    I             , IFIRST        , ILAST
C-----------------------------------------------------------------------
      LOGICAL    LFSEL
C-----------------------------------------------------------------------
      CHARACTER  TITLE*(*)     , TITLX*(*)     , TITLM*(*) , DATE*8
      CHARACTER  CINDM*6       , CFILE*8       ,
     &           CPCODE*8      , CWAVEL*5      ,
     &           CDONOR*8      , CRECVR*5
      CHARACTER  C1E*1         ,
     &           CADAS*80
      CHARACTER  CSTRNG*80
C-----------------------------------------------------------------------
      REAL*8     DIVAL         , DEREF         ,
     &           TIVAL         , TEREF         ,
     &           ZFVAL         , ZEREF         ,
     &           BMVAL         , BMREF
C-----------------------------------------------------------------------
      REAL*8     EAMU(IEVAL)   ,
     &           EATM(IEVAL)   ,
     &           ECMS(IEVAL)   ,
     &           QEFA(IEVAL)   ,
     &           COEF(KPLUS1)
C-----------------------------------------------------------------------
      LOGICAL    LERNG(IEVAL)
```

```
C-----------------------------------------------------------------------
      SAVE       CADAS
C-----------------------------------------------------------------------
      DATA       CADAS /' '/ CSTRNG/'BLK'/
C-----------------------------------------------------------------------
```

C3OUTG

```
      SUBROUTINE C3OUTG( LGHOST ,
     &                   TITLE  , TITLX  , TITLM , DATE  ,
     &                   DIVAL  , DEREF  ,
     &                   TIVAL  , TEREF  ,
     &                   ZFVAL  , ZEREF  ,
     &                   BMVAL  , BMREF  ,
     &                   CWAVEL , CDONOR ,
     &                   CRECVR , CFILE  ,
     &                   CPCODE , CINDM  ,
     &                   EAMU   , QEFA   , IEVAL ,
     &                   EFITM          , QEFM  , NMX   ,
     &                   LGRD1  , LDEF1  , LFSEL ,
     &                   XMIN   , XMAX   , YMIN  , YMAX
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: C3OUTG *********************
C
C  PURPOSE:  PIPE COMMUNICATION WITH IDL TO PLOT GRAPH
C
C            PROVIDES COMPARATIVE GRAPH OF:
C                               SPLINE INTERPOLATED POINTS: CROSSES
C                               CURVE THROUGH SPLINE POINTS: FULL CURVE
C                               MINIMAX FIT TO SPLINE DATA : DASH CURVE
C
C            PLOT IS LOG10(EFF. EMIS. COEF.) V LOG10(BM. ENRGY(EV/AMU)
C
C  CALLING PROGRAM: ADAS303
C
C  SUBROUTINE:
C
CX UNIX PORT - LGHOST RETAINED ONLY TO KEEP ARGUMENT LIST THE SAME.
C  INPUT : (L*4)  LGHOST  = .TRUE.  => GHOST80 INITIALISED
C                           .FALSE. => GHOST80 NOT INITIALISED
C
C  INPUT : (C*40) TITLE   = TITLE OF RUN (READ FROM ISPF PANEL)
CX INPUT : (C*120)TITLX   = INFORMATION STRING CONTAINING: INPUT DATA
C                           FILE-NAME, SELECTED BLOCK,TYPE AND TRANSIT.
C  INPUT : (C*80) TITLM   = DIAGNOSTIC LINE INFORMATION FROM 'MINIMAX'
C  INPUT : (C*8)  DATE    = CURRENT DATE (AS 'DD/MM/YY')
C
C  INPUT : (R*8)  DIVAL     = SELECTED OUTPUT VALUE: ION DENSITY (CM-3)
C  INPUT : (R*8)  DEREF     = REFERENCE VALUE      : ION DENSITY (CM-3)
C
C  INPUT : (R*8)  TIVAL     = SELECTED OUTPUT VALUE: ION TEMPERATURE(EV)
C  INPUT : (R*8)  TEREF     = REFERENCE VALUE      : ION TEMPERATURE(EV)
C
C  INPUT : (R*8)  ZFVAL     = SELECTED OUTPUT VALUE: Z-EFFECTIVE
C  INPUT : (R*8)  ZEREF     = REFERENCE VALUE      : Z-EFFECTIVE
C
C  INPUT : (R*8)  BMVAL     = SELECTED OUTPUT VALUE: MAGNETIC FIELD (T)
C  INPUT : (R*8)  BMREF     = REFERENCE VALUE      : MAGNETIC FIELD (T)
C
C  INPUT : (C*5)  CWAVEL  = INPUT DATA FILE: TRANSITION
C  INPUT : (C*8)  CDONOR  = INPUT DATA FILE: DONOR NEUTRAL ATOM
C  INPUT : (C*5)  CRECVR  = INPUT DATA FILE: RECEIVER NUCLEUS
C  INPUT : (C*8)  CFILE   = INPUT DATA FILE: SPECIFIC ION FILE SOURCE
C  INPUT : (C*8)  CPCODE  = INPUT DATA FILE: PROCESSING CODE
C  INPUT : (C*6)  CINDM   = FILE DATA FILE: EMISSION TYPE
C
C  INPUT : (R*8)  EAMU()  = USER ENTERED: BEAM ENERGIES (EV/AMU)
C                           DIMENSION: BEAM ENERGY INDEX
C  INPUT : (R*8)  QEFA()  = SPLINE INTERPOLATED OR  EXTRAPOLATED  EFF.
C                           EMISS. COEFFTS. FOR THE USER ENTERED BEAM
C                           ENERGIES.
C                           DIMENSION: BEAM ENERGY INDEX
C  INPUT : (I*4)  IEVAL   = NUMBER OF USER ENTERED BEAM ENERGIES.
C
C  INPUT : (R*8)  EFITM() = MINIMAX: SELECTED BEAM ENERGIES(EV/AMU)
C  INPUT : (R*8)  QEFM()  = EFF. EMISSION COEFFTS. AT 'EFITM()'
C  INPUT : (I*4)  NMX     = NUMBER OF MINIMAX GENERATED EFF. EMIS. COEF.
C
C  INPUT : (L*4)  LGRD1   = .TRUE.  => PUT GRAPH IN GRID FILE
C                           .FALSE. => DO NOT PUT GRAPH IN GRID FILE
C  INPUT : (L*4)  LDEF1   = .TRUE.  => USE DEFAULT GRAPH SCALING
C                           .FALSE. => DO NOT USE DEFAULT GRAPH SCALING
C  INPUT : (L*4)  LFSEL   = .TRUE.  => CARRY OUT MINIMAX POLYNOMIAL
C                                      FITTING
C                           .FALSE. => - DO NOT DO THE ABOVE -
C
C  INPUT : (R*8)  XMIN    = GRAPH: LOWER LIMIT FOR BEAM ENERGY
C  INPUT : (R*8)  XMAX    = GRAPH: UPPER LIMIT FOR BEAM ENERGY
C  INPUT : (R*8)  YMIN    = GRAPH: LOWER LIMIT FOR EFF. EMIS. COEFFT.
C  INPUT : (R*8)  YMAX    = GRAPH: UPPER LIMIT FOR EFF. EMIS. COEFFT.
```

```
C
C
C          (R*4)  GHZERO  = PARAMETER = VALUE BELOW WHICH GHOST80
C                           TAKES NUMBERS AS BEING ZERO = 1.0E-36
C          (R*4)  YDMIN   = PARAMETER = MINIMUM ALLOWED Y-VALUE FOR
C                           PLOTTING. (USED FOR DEFAULT GRAPH SCALING)
C                           (SET TO 'GHZERO'/ZERO TO REMOVE)
C
C          (I*4)  I4UNIT  = FUNCTION (SEE ROUTINE SECTION BELOW)
C          (I*4)  I       = GENERAL USE - ARRAY INDEX
C          (I*4)  IKEY    = NUMBER OF 'KEY()' VALUES TO BE OUTPUT
C          (I*4)  ICOUNT  = NUMBER OF POINTS PLOTTED FOR GRAPH CURVE
C
C          (R*4)  XHIGH   = UPPER X-AXIS LIMIT FOR USE WITH GHOST80
C          (R*4)  XLOW    = LOWER X-AXIS LIMIT FOR USE WITH GHOST80
C          (R*4)  YHIGH   = UPPER Y-AXIS LIMIT FOR USE WITH GHOST80
C          (R*4)  YLOW    = LOWER Y-AXIS LIMIT FOR USE WITH GHOST80
C          (R*4)  XA4()   = X-AXIS CO-ORDINATES FOR USE WITH GHOST80
C          (R*4)  YA4()   = Y-AXIS CO-ORDINATES FOR USE WITH GHOST80
C
C          (R*8)  R8VAL1()= 1-D SCAN POSITIONS - OUTPUT DATA VALUES
C                           DIMENSION: 4
C          (R*8)  R8VAL2()= 1-D SCAN POSITIONS - OUTPUT REFERENCE VALUES
C                           DIMENSION: 4
C
C
C          (C*88) ISPEC   = GRAPH TITLE (INCORPORATES 'TITLE')
C          (C*80) CADAS   = ADAS HEADER: INCLUDES RELEASE, PROGRAM, TIME
C          (C*12) DNAME   = '      DATE: '
C          (C*25) XTITE   = X-AXIS UNITS/TITLE: NEUTRAL BEAM ENERGY
C          (C*22) YTIT    = Y-AXIS UNITS/TITLE
C          (C*9)  KEY0    = '    KEY: '
C          (C*9)  MNMX0   = 'MINIMAX: '
C          (C*8)  ADAS0   = 'ADAS   :'
C          (C*28) KEY()   = DESCRIPTIVE KEY FOR GRAPH (2 TYPES)
C
C          (C*1)  GRID    = DUMMY NAME VARIABLE FOR USE WITH GHOST80
C          (C*1)  PIC     = DUMMY NAME VARIABLE FOR USE WITH GHOST80
C          (C*3)  C3BLNK  = BLANK 3 BYTE STRING
C          (C*7)  C7      =  7 BYTE STRING = 'TITLX(1:4)'//'C3BLNK'
C
C          (C*28) STRG1   =  DESCRIPTIVE STRING FOR ELEMENT SYMBOL
C          (C*28) STRG2   =  DESCRIPTIVE STRING FOR NUCLEAR CHARGE
C          (C*28) STRG3   =  DESCRIPTIVE STRING FOR CHARGE-STATE
C          (C*28) STRG4   =  DESCRIPTIVE STRING TRANSITION
C          (C*28) STRG5   =  DESCRIPTIVE STRING NEUTRAL DONOTOR ATOM
C          (C*28) STRG6   =  DESCRIPTIVE STRING BARE NUCLEUS RECEIVER
C          (C*28) STRG7   =  DESCRIPTIVE STRING QCX SOURCE FILE MEMBER
C          (C*28) STRG8   =  DESCRIPTIVE STRING PROCESSING CODE
C          (C*28) STRG9   =  DESCRIPTIVE STRING EMISSION TYPE
C          (C*13) STRG10()=  DESCRIPTIVE STRINGS: 1-D SCAN POSITIONS
C                           DIMENSION: 4
C          (C*32) HEAD1   =  HEADING FOR RECEIVER INFORMATION
C          (C*45) HEAD2A  =  FIRST  HEADER FOR RECEIVER/DONOR ENER. INFO
C          (C*45) HEAD2B  =  SECOND HEADER FOR RECEIVER/DONOR ENER. INFO
C
C ROUTINES:
C          ROUTINE     SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXADAS      ADAS      GATHERS ADAS HEADER INFORMATION
C          XXLIM8      ADAS      SETTING UP OF DEFAULT GRAPH AXES
C          XXGSEL      ADAS      SELECTS POINTS WHICH WILL FIT ON GRAPH
C          I4UNIT      ADAS      GET UNIT NUMBER FOR OUTPUT OF MESSAGES
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA 8.08
C          TEL. 0141-553-4196
C
C DATE:    23/04/95
C
C UPDATE:  03/05/95 PE BRIDEN - ADDED/MODIFIED 1-D SCAN POSITIONS TABLE.
C                               (REQD. UPDATE OF ARGUMENT LIST)
C                             + OTHER MINOR MODS.
C
C UPDATE:  15/05/95 TIM HAMMOND - UNIX PORT
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      REAL*4     GHZERO           , YDMIN
C-----------------------------------------------------------------------
      PARAMETER( GHZERO = 1.0E-36 , YDMIN = 1.0E-20 )
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
      INTEGER    IEVAL            , NMX
      INTEGER    I                , IKEY             , ICOUNT
C-----------------------------------------------------------------------
      REAL*4     XHIGH            , XLOW             ,
     &           YHIGH            , YLOW
C-----------------------------------------------------------------------
      REAL*8     XMIN             , XMAX             ,
     &           YMIN             , YMAX
C-----------------------------------------------------------------------
      REAL*8     DIVAL            , DEREF            ,
     &           TIVAL            , TEREF            ,
     &           ZFVAL            , ZEREF            ,
     &           BMVAL            , BMREF
C-----------------------------------------------------------------------
```

```
      LOGICAL    LGHOST
     &           LGRD1           , LDEF1           , LFSEL
C-----------------------------------------------------------------------
      CHARACTER  TITLE*40       , TITLX*120         , TITLM*80  ,
     &           DATE*8
      CHARACTER  CINDM*6        , CFILE*8           ,
     &           CPCODE*8       , CWAVEL*5          ,
     &           CDONOR*8       , CRECVR*5
      CHARACTER  GRID*1         , PIC*1             , C3BLNK*3  , C7*7 ,
     &           MNMX0*9        , KEY0*9            , ADAS0*8   ,
     &           DNAME*12       ,
     &           XTITE*25       , YTIT*32   ,
     &           CADAS*80       , ISPEC*88
      CHARACTER  STRG1*28       , STRG2*28          ,
     &           STRG3*28       , STRG4*28          ,
     &           STRG5*28       , STRG6*28          , STRG7*28        ,
     &           STRG8*28       , STRG9*28          ,
     &           HEAD1*32
      CHARACTER  STRG10(4)*13   ,
     &           HEAD2A*45      , HEAD2B*45
C-----------------------------------------------------------------------
      REAL*4     XA4(100)       , YA4(100)
C-----------------------------------------------------------------------
      REAL*8     R8VAL1(4)      , R8VAL2(4)
C-----------------------------------------------------------------------
      REAL*8     EAMU(IEVAL)    , QEFA(IEVAL)      ,
     &           EFITM(NMX)     , QEFM(NMX)
C-----------------------------------------------------------------------
      CHARACTER  KEY(2)*28
C-----------------------------------------------------------------------
      SAVE       ISPEC          , CADAS
C-----------------------------------------------------------------------
      DATA ISPEC(1:24)
     &           /'EFF. EMISSION COEFFTS.  '/
      DATA DNAME /'      DATE: '/
      DATA XTITE /'BEAM ENERGY (EV/AMU)     '/
      DATA YTIT  /'EFF. EMISSION COEFFT. (cm3/sec)'/
      DATA ADAS0 /'ADAS   :'/
     &     MNMX0 /'MINIMAX: '/               ,
     &     KEY0  /'KEY    : '/               ,
     &     KEY(1)/'(CROSSES/FULL LINE - SPLINE)'/  ,
     &     KEY(2)/'  (DASH LINE - MINIMAX)     '/
      DATA GRID  /' '/   ,
     &     PIC   /' '/   ,
     &     C3BLNK/'   '/ ,
     &     CADAS /' '/
      DATA HEAD1 /'--- EMITTING ION INFORMATION ---'/             ,
     &     HEAD2A/'----- ONE DIMENSIONAL SCAN POSITIONS -----' / ,
     &     HEAD2B/'  PARAMETER          VALUE        REFERENCE   ' /
      DATA STRG1 /' ELEMENT SYMBOL           = '/ ,
     &     STRG2 /' NUCLEAR CHARGE           = '/ ,
     &     STRG3 /' CHARGE STATE             = '/ ,
     &     STRG4 /' TRANSITION (N-N'')        = '/ ,
     &     STRG5 /' NEUTRAL ATOM DONOR       = '/ ,
     &     STRG6 /' BARE NUCLEUS RECEIVER    = '/
     &     STRG7 /' QCX SOURCE FILE MEMBER   = '/ ,
     &     STRG8 /' PROCESSING CODE          = '/ ,
     &     STRG9 /' EMISSION TYPE            = '/
      DATA STRG10/'DENSI (cm-3) ',
     &            'TI    (eV)   ',
     &            'ZEFF         ',
     &            'BMAG  (T)    '/
C-----------------------------------------------------------------------
      INTEGER    PIPEIN    , PIPEOU , ONE      , ZERO
      PARAMETER( PIPEIN=5  , PIPEOU=6 , ONE=1    , ZERO=0 )
      INTEGER    J        , K        , L
C
C-----------------------------------------------------------------------
```

C3SPLN

```
      SUBROUTINE C3SPLN( NEIN   , NEOUT   ,
     &                   EIN    , EOUT    ,
     &                   QEF    , QEFA    ,
     &                   LERNG
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C3SPLN *********************
C
C  PURPOSE:
C          PERFORMS CUBIC SPLINE ON LOG(BEAM ENERGY <EV/AMU> ) VERSUS
C          LOG(EFF. EMISSION COEFFICIENTS).
C          INPUT DATA FOR A GIVEN EMITTING ION EMISS. COEFF. DATA BLOCK
C
C          USING  ONE-WAY SPLINES  IT  CALCULATES  THE  EFF. EMISSION
C          COEFFICIENT  FOR  'NEOUT'  BEAM ENERGY  VALUES  FROM
C          THE LIST OF BEAM ENERGIES READ IN FROM THE INPUT FILE
C
C          IF A  VALUE  CANNOT  BE  INTERPOLATED  USING  SPLINES  IT  IS
C          EXTRAPOLATED VIA 'XXSPLE'. (SEE NOTES BELOW).
C
```

```
C  CALLING PROGRAM: ADAS303/SQEF
C
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  NEIN    = INPUT DATA FILE: NUMBER OF BEAM ENERGIES
C                           READ FOR THE DATA-BLOCK BEING ASSESSED
C  INPUT : (I*4)  NEOUT   = NUMBER OF ISPF ENTERED BEAM ENERGY
C                           VALUES FOR  WHICH  EFF. EMISS. COEFFTS.
C                           ARE REQUIRED FOR TABULAR/GRAPHICAL OUTPUT.
C
C  INPUT : (R*8)  EIN()   = INPUT DATA FILE: BEAM ENERGIES (EV/AMU)
C                           FOR THE DATA-BLOCK BEING ASSESSED.
C                           DIMENSION: ELECTRON TEMPERATURE INDEX
C  INPUT : (R*8)  EOUT()  = USER ENTERED: BEAM ENERGIES (EV/AMU)
C                           DIMENSION: BEAM ENERGY INDEX
C
C  INPUT : (R*8)  QEF()    =INPUT DATA FILE: FULL SET OF EFF. EMISS.
C                           COEFFTS FOR THE DATA-BLOCK
C                           BEING ANALYSED.
C                           1ST DIMENSION: BEAM ENERGY INDEX
C  OUTPUT: (R*8)  QEFA()  = SPLINE INTERPOLATED OR  EXTRAPOLATED  EFF.
C                           EMISS. COEFFTS FOR
C                           THE USER ENTERED BEAM ENERGIES.
C                           DIMENSION: BEAM ENERGY INDEX
C
C  OUTPUT: (L*4)  LERNG()=  .TRUE.  => OUTPUT 'QEFA()' VALUE WAS INTER-
C                                      POLATED  FOR  THE  USER  ENTERED
C                                      BEAM ENERGY 'EOUT()'.
C                           .FALSE. => OUTPUT 'QEFA()' VALUE WAS EXTRA-
C                                      POLATED  FOR  THE  USER  ENTERED
C                                      BEAM ENERGY 'EOUT()'.
C                           DIMENSION: ELECTRON TEMPERATURE INDEX
C
C          (I*4)  NIN     = PARAMETER = MAX. NO. OF INPUT  BEAM ENERGIES
C                                       VALUES. MUST BE >= 'NEIN'
C          (I*4)  NOUT    = PARAMETER = MAX. NO. OF OUTPUT BEAM ENERGY
C                                       VALUES  MUST BE >= 'NEOUT'
C          (I*4)  L1      = PARAMETER = 1
C
C          (I*4)  IET     = ARRAY SUBSCRIPT USED INPUT  FILE  BEAM
C                           ENERGIES.
C          (I*4)  IT      = ARRAY  SUBSCRIPT  USED  FOR  USER  ENTERED
C                           BEAM ENERGIES.
C          (I*4)  IOPT    = DEFINES THE BOUNDARY DERIVATIVES FOR THE
C                           SPLINE ROUTINE 'XXSPLE', SEE 'XXSPLE'.
C                           (VALID VALUES = <0, 0, 1, 2, 3, 4)
C
C          (L*4)  LSETX   = .TRUE.  => SET UP SPLINE PARAMETERS RELATING
C                                      TO 'XIN' AXIS.
C                           .FALSE. => DO NOT SET UP SPLINE PARAMETERS
C                                      RELATING TO 'XIN' AXIS.
C                                      (I.E. THEY WERE SET IN A PREVIOUS
C                                            CALL )
C                           (VALUE SET TO .FALSE. BY 'XXSPLE')
C
C          (R*8)  R8FUN1  = FUNCTION - (SEE ROUTINES SECTION BELOW)
C
C          (R*8)  XIN()   = LOG( DATA FILE ELECTRON TEMPERATURES )
C          (R*8)  YIN()   = LOG( DATA FILE SCALED ION. RATE COEFFTS.)
C          (R*8)  XOUT()  = LOG( USER ENTERED ELECTRON TEMPS.)
C          (R*8)  YOUT()  = LOG( OUTPUT GENERATED SCALED ION. RATE COEF)
C          (R*8)  DF()    = SPLINE INTERPOLATED DERIVATIVES
C
C
C NOTE:
C
C          ONE-DIMENSIONAL SPLINE CARRIED OUT BY THIS SUBROUTINE:
C
C           LOG( QEF )  VS. LOG( Te )
C
C           TE      = ELECTRON TEMPERATURE (UNITS: EV)
C           QEF     = ZERO DENSITY RADIATED POWER COEFFICIENT
C                                    (UNITS: W CM**3)
C
C           EXTRAPOLATION CRITERIA:
C
C           LOW  TE: ZERO GRADIENT  EXTRAPOLATION (I.E. DY(1)  = 0.0)
C           HIGH TE: ZERO CURVATURE EXTRAPOLATION (I.E. DDY(N) = 0.0)
C
C           (THESE CRITERIA ARE MET BY CALLING XXSPLE WITH IOPT=4)
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXSPLE     ADAS      SPLINE SUBROUTINE (EXTENDED DIAGNOSTICS)
C          R8FUN1     ADAS      REAL*8 FUNCTION: ( X -> X )
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL. 0141-553-4196
C
C DATE:    21/04/95
C
C UPDATE:  15/05/95       Tim Hammond      UNIX PORT
C                         Put under SCCS control
C
```

```
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    NIN                   , NOUT            , L1
C-----------------------------------------------------------------------
      PARAMETER( NIN    = 24           , NOUT = 24       , L1 = 1     )
C-----------------------------------------------------------------------
      INTEGER    NEIN                  , NEOUT
      INTEGER    IET                   , IT              , IOPT
C-----------------------------------------------------------------------
      REAL*8     R8FUN1
C-----------------------------------------------------------------------
      LOGICAL    LSETX
C-----------------------------------------------------------------------
      REAL*8     EIN(NEIN)             , EOUT(NEOUT)     ,
     &           QEF(NEIN)             , QEFA(NEOUT)
      REAL*8     DF(NIN)               ,
     &           XIN(NIN)              , YIN(NIN)        ,
     &           XOUT(NOUT)            , YOUT(NOUT)
C-----------------------------------------------------------------------
      LOGICAL    LERNG(NEOUT)
C-----------------------------------------------------------------------
      EXTERNAL   R8FUN1
C-----------------------------------------------------------------------
```

C3TITL

```
      SUBROUTINE C3TITL( IBSEL  , DSFULL ,
     &                   CWAVEL , CDONOR ,
     &                   CRECVR , CFILE  ,
     &                   CPCODE , CINDM  ,
     &                   TITLX
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C3TITL *********************
C
C  PURPOSE:  TO CREATE THE DESCRIPTIVE TITLE FOR SELECTED DATA-BLOCK.
C
C  CALLING PROGRAM: ADAS303/SQEF
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IBSEL    = SELECTED DATA-BLOCK: INDEX
CX INPUT : (C*(*)) DSFULL   = FULL MVS INPUT DATA SET NAME
C
C  INPUT : (C*5)  CWAVEL   = INPUT DATA FILE: TRANSITION
C  INPUT : (C*8)  CDONOR   = INPUT DATA FILE: DONOR NEUTRAL ATOM
C  INPUT : (C*5)  CRECVR   = INPUT DATA FILE: RECEIVER NUCLEUS
C  INPUT : (C*8)  CFILE    = INPUT DATA FILE: SPECIFIC ION FILE SOURCE
C  INPUT : (C*8)  CPCODE   = INPUT DATA FILE: PROCESSING CODE
C  INPUT : (C*6)  CINDM    = FILE DATA FILE: EMISSION TYPE
C
CX OUTPUT: (C*120)TITLX    = SELECTED DATA-BLOCK: DESCRIPTIVE TITLE
C
C          (C*2)  C2       = GENERAL USE 2 BYTE  CHARACTER  STRING
CX         (I*4)  LEN_NAME = LENGTH OF FILENAME
CX         (I*4)  POS_NOW  = CURRENT POSITION IN TITLE STRING
C
C ROUTINES:
C        XXSLEN                    USED TO FIND LENGTH OF FILE NAME
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL. 0141-553-4196
C
C DATE:    23/04/95
C
C UPDATE:  TIM HAMMOND 15/05/95            UNIX PORT UPDATES
C                                          Included call to xxslen to find
C                                          length of filename and edit if
C                                          required.
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER    IBSEL         , LEN_NAME
      INTEGER    IFIRST        , ILAST
      INTEGER    POS_NOW
C-----------------------------------------------------------------------
      CHARACTER  DSFULL*(*)    , TITLX*120
      CHARACTER  C2*2
      CHARACTER  CINDM*6       , CFILE*8       ,
     &           CPCODE*8      , CWAVEL*5      ,
     &           CDONOR*8      , CRECVR*5
C-----------------------------------------------------------------------
```

C4CHKZ

```
      SUBROUTINE C4CHKZ( DSNAME , TSYM , ITZ )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C4CHKZ *********************
C
C  PURPOSE: TO CHECK THAT THE STOPPING ION ELEMENT SYMBOL/CHARGE AS READ
C           FROM THE INPUT DATA SET AGREE WITH THOSE OBTAINED FROM THE
C           INPUT DATA SET MEMBER NAME.
C
CA          NOTE THAT THE INFORMATION WHICH WAS PREVIOUSLY DETERMINED
CA          FROM THE DATASET NAME IS NOW PASSED VIA UNIX PIPE FROM THE
CA          IDL ROUTINE c4chkz.pro
CA
C  CALLING PROGRAM: ADAS304
C
C  SUBROUTINE:
C
C  INPUT : (C*(*)) DSNAME  = MVS DATA SET NAME - WHERE INPUT VALUES
C                            ORIGINATE
C  INPUT : (C*2)   TSYM    = INPUT FILE DATA:EMITTING ION ELEMENT SYMBOL
C  INPUT : (I*4)   ITZ     = INPUT FILE DATA:EMITTING ION CHARGE
C
C          (I*4)   ITZM    = MEMBER NAME:EMITTING ION CHARGE
C
C          (C*2)   TSYMM   = MEMBER NAME:EMITTING ION ELEMENT SYMBOL
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES
C
C AUTHOR:  JONATHAN NASH  (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    16/12/93
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-11-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 11-12-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - TIDIED UP COMMENTS AND CODE
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER     I4UNIT
      INTEGER     PIPEIN        , PIPEOU
      PARAMETER(  PIPEIN=5      , PIPEOU=6  )
C-----------------------------------------------------------------------
      INTEGER    ITZ
      INTEGER    ITZM
C-----------------------------------------------------------------------
      CHARACTER  DSNAME*(*)  , TSYM*2
      CHARACTER  TSYMM*2
C-----------------------------------------------------------------------
```

C4DATA

```
      SUBROUTINE C4DATA( IUNIT  , MXBE   , MXTD   , MXTT   ,
     &                   ITZ    , TSYM   , BEREF  , TDREF  ,
     &                   TTREF  , SVREF  , NBE    , BE     ,
     &                   NTDENS , TDENS  , NTTEMP , TTEMP  ,
     &                   SVT    , SVED   , DSNIN
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C4DATA *********************
C
C  PURPOSE: TO READ DATA FROM AN EFFECTIVE BEAM STOPPING DATA SET.
C           (ADAS FORMAT ADF21).
C
C  CALLING PROGRAM: SBMS / ADAS304
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IUNIT     = UNIT TO WHICH DATA SET IS CONNECTED.
C  INPUT : (I*4)  MXBE      = MAXIMUM NUMBER OF BEAM ENERGIES WHICH CAN
C                             BE READ.
```

```
C  INPUT : (I*4)  MXTD      = MAXIMUM NUMBER OF TARGET DENSITIES WHICH
C                              CAN BE READ.
C  INPUT : (I*4)  MXTT      = MAXIMUM NUMBER OF TARGET TEMPERATURES
C                              WHICH CAN BE READ.
C  INPUT : (C*80) DSNIN     = NAME OF FILE TO BE READ.
C  OUTPUT: (I*4)  ITZ       = TARGET ION CHARGE.
C  OUTPUT: (C*2)  TSYM      = TARGET ION ELEMENT SYMBOL.
C  OUTPUT: (R*8)  BEREF     = REFERENCE BEAM ENERGY.
C                              UNITS: EV/AMU
C  OUTPUT: (R*8)  TDREF     = REFERENCE TARGET DENSITY.
C                              UNITS: CM-3
C  OUTPUT: (R*8)  TTREF     = REFERENCE TARGET TEMPERATURE.
C                              UNITS: EV
C  OUTPUT: (R*8)  SVREF     = STOPPING COEFFT. AT REFERENCE BEAM ENERGY,
C                              TARGET DENSITY AND TEMPERATURE.
C                              UNITS: CM3 S-1
C  OUTPUT: (I*4)  NBE       = NUMBER OF BEAM ENERGIES.
C  OUTPUT: (R*8)  BE()      = BEAM ENERGIES.
C                              UNITS: EV/AMU
C                              DIMENSION: MXBE
C  OUTPUT: (I*4)  NTDENS    = NUMBER OF TARGET DENSITIES.
C  OUTPUT: (R*8)  TDENS()   = TARGET DENSITIES.
C                              UNITS: CM-3
C                              DIMENSION: MXTD
C  OUTPUT: (I*4)  NTTEMP    = NUMBER OF TARGET TEMPERATURES.
C  OUTPUT: (R*8)  TTEMP()   = TARGET TEMPERATURES.
C                              UNITS: EV
C                              DIMENSION: MXTT
C  OUTPUT: (R*8)  SVT()     = STOPPING COEFFT. AT REFERENCE BEAM ENERGY
C                              AND TARGET DENSITY.
C                              UNITS: CM3 S-1
C                              DIMENSION: MXTT
C  OUTPUT: (R*8)  SVED(,)   = STOPPING COEFFT. AT REFERENCE TARGET
C                              TEMPERATURE.
C                              UNITS: CM3 S-1
C                              1ST DIMENSION: MXBE
C                              2ND DIMENSION: MXTD
C
C          (I*4)  I         = ARRAY / LOOP INDEX.
C          (I*4)  J         = ARRAY INDEX.
C
C          (C*80) LINE      = TEXT LINE IN DATA SET.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C
C AUTHOR:  JONATHAN NASH  (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    07/12/93
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-11-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    IUNIT   , MXBE    , MXTD    , MXTT    , ITZ     ,
     &           NBE     , NTDENS  , NTTEMP
      INTEGER    I       , J
C-----------------------------------------------------------------------
      REAL*8     BEREF   , TDREF   , TTREF   , SVREF
C-----------------------------------------------------------------------
      CHARACTER  TSYM*2
      CHARACTER  LINE*80 , DSNIN*80
C-----------------------------------------------------------------------
      REAL*8     BE(MXBE)     , TDENS(MXTD)  , TTEMP(MXTT)  ,
     &           SVT(MXTT)
C-----------------------------------------------------------------------
      REAL*8     SVED(MXBE,MXTD)
C-----------------------------------------------------------------------
```

C4MNMX

```
      SUBROUTINE C4MNMX( NSITYP , MXA , NA , A , AMNMX  )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C4MNMX ********************
C
C  PURPOSE: GIVEN A 2D ARRAY 'A' IT RETURNS THE MINIMUM AND MAXIMUM OF
C           BOTH 'A(1,I)' AND 'A(NA(I),I)', WHERE I=1,NSITYP. ITS MAIN
C           USE IS TO FIND THE RANGE ON THE MINIMUM AND MAXIMUM
```

```
C           OF THE BEAM ENERGIES, AND TARGET DENSITIES AND TEMPERATURES
C           ACROSS THE DIFFERENT ION TYPES.
C
C  CALLING PROGRAM: ADAS304
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  NSITYP    = NUMBER OF DIFFERENT ION TYPES.
C  INPUT : (I*4)  MXA       = SIZE OF FIRST DIMENSION OF 'A(,)'.
C  INPUT : (I*4)  NA()      = NO. OF ENTRIES IN EACH COLUMN OF 'A(,)'.
C                             DIMENSION: NSITYP
C  INPUT : (R*8)  A(,)      = INPUT ARRAY.
C                             1ST DIMENSION: MXA
C                             2ND DIMENSION: NSITYP
C
C  OUTPUT: (R*8)  AMNMX()   = MINIMUM/MAXIMUM VALUES.
C                             INDICES ARE AS FOLLOWS:
C                             1 => MIN OF 'A(1,I)
C                             2 => MAX OF 'A(1,I)
C                             3 => MIN OF 'A(NA(I),I)
C                             4 => MAX OF 'A(NA(I),I)
C                                  WHERE I=1,NSITYP.
C                             DIMENSION: 4
C
C          (I*4)  I         = LOOP INDEX.
C          (I*4)  J         = ARRAY INDEX.
C
C ROUTINES: NONE
C
C AUTHOR:  JONATHAN NASH  (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    17/12/93
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-11-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    NSITYP  , MXA
      INTEGER    I       , J
C-----------------------------------------------------------------------
      INTEGER    NA(NSITYP)
C-----------------------------------------------------------------------
      REAL*8     AMNMX(4)
C-----------------------------------------------------------------------
      REAL*8     A(MXA,NSITYP)
C-----------------------------------------------------------------------
```

C4OUT0

```
      SUBROUTINE C4OUT0( IWRITE , MXREQ  , MXDEG  , DATE   ,
     &                   TITLE  , NSITYP , DSNIN  , TSYM   ,
     &                   ITZ    , SIFRAC , NREQ   , UBMENG ,
     &                   UTDENS , UTTEMP , BSTOT  , LINTOT ,
     &                   BSION  , LINION , LFSEL  , IFIT   ,
     &                   NCOEF  , FCOEF  , FINFO  , CADAS  ,
     &                   LINE1  , DATASET, FACT1  , TFLAG )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: C4OUT0 *********************
C
C  PURPOSE: WRITES TEXT OUTPUT TO FILE FOR ADAS304.
C
C  CALLING PROGRAM: ADAS304
C
C  INPUT : (I*4)   IWRITE   = UNIT NO. FOR OUTPUT OF TEXT RESULTS.
C  INPUT : (I*4)   MXREQ    = MAX NO. OF USER REQUESTED TRIPLETS OF
C                             ENERGY, TEMPERATURE AND DENSITY.
C  INPUT : (I*4)   MXDEG    = MAX NO. DEGREES FOR MINIMAX FIT.
C  INPUT : (C*8)   DATE     = DATE STRING.
C  INPUT : (C*40)  TITLE    = ISPF ENTERED GENERAL TITLE FOR PROGRAM RUN
C  INPUT : (I*4)   NSITYP   = NUMBER OF STOPPING IONS TYPES.
C  INPUT : (C*80)  DSNIN()  = INPUT DATA SET NAMES (FULL MVS DSN).
C                             (IN FORM SUITABLE FOR DYNAMIC ALLOCATION)
C                             DIMENSION: NSITYP
C  INPUT : (C*2)   TSYM()   = TARGET ION ELEMENT SYMBOL.
C                             DIMENSION: NSITYP
C  INPUT : (I*4)   ITZ()    = TARGET ION CHARGE.
C                             DIMENSION: NSITYP
C  INPUT : (R*8)   SIFRAC() = FRACTION OF EACH STOPPING ION.
C                             DIMENSION: NSITYP
C  INPUT : (I*4)   NREQ     = NUMBER OF USER REQUESTED TRIPLETS OF
C                             ENERGY, TEMPERATURE AND DENSITY.
C  INPUT : (R*8)   UBMENG() = USER REQESTED BEAM ENERGIES.
```

```
C                               DIMENSION: NREQ
C  INPUT : (R*8)   UTDENS() = USER REQESTED TARGET DENSITITES.
C                               DIMENSION: NREQ
C  INPUT : (R*8)   UTTEMP() = USER REQESTED TARGET TEMPERATURES.
C                               DIMENSION: NREQ
C  INPUT : (R*8)   BSTOT()  = TOTAL BEAM STOPPING COEFFICIENTS.
C                               DIMENSION: NREQ
C  INPUT : (L*4)   LINTOT() = FLAGS IF INTERPOLATION OR EXTRAPOLATION
C                               USED IN SPLINING ROUTINE.
C                               .TRUE.  => ONLY INTERPOLATION USED.
C                               .FALSE. => AT LEAST ONE OF ENERGY, DENISTY
C                                          OR TEMPERATURE EXTRAPOLATED.
C                               DIMENSION: NREQ
C  INPUT : (R*8)   BSION(,) = BEAM STOPPING COEFFICIENTS FOR INDIVIDUAL
C                               IONS.
C                               1ST DIMENSION: MXREQ
C                               2ND DIMENSION: NSITYP
C  INPUT : (L*4)   LINION(,)= FLAGS IF INTERPOLATION OR EXTRAPOLATION
C                               USED IN SPLINING ROUTINE.
C                               .TRUE.  => ONLY INTERPOLATION USED.
C                               .FALSE. => AT LEAST ONE OF ENERGY, DENISTY
C                                          OR TEMPERATURE EXTRAPOLATED.
C                               1ST DIMENSION: MXREQ
C                               2ND DIMENSION: NSITYP
C  INPUT : (L*4)   LFSEL    = FLAGS MINIMAX POLYNOMIAL FITTING.
C                               .TRUE.  => FIT PERFORMED.
C                               .FALSE. => NO FIT.
C  INPUT : (I*4)   IFIT     = QUANTITY TO FIT AND DISPLAY.
C                               1 => BEAM ENERGY.
C                               2 => TARGET DENSITY.
C                               3 => TARGET TEMPERATURE.
C  INPUT : (I*4)   NCOEF()  = NUMBER OF TAYLOR COEFFICIENTS FROM FIT.
C                               DIMENSION: NSITYP
C  INPUT : (R*8)   FCOEF(,) = TAYLOR COEFFICIENTS FROM FIT.
C                               1ST DIMENSION: MXDEG
C                               2ND DIMENSION: NSITYP
C  INPUT : (C*80)  FINFO()  = INFORMATION STRING FROM FIT.
C                               INDICES 1 TO 'NSITYP' ARE FOR THE
C                               INDIVIDUAL IONS AND 'NSITYP+1' FOR THE
C                               TOTAL.
C                               DIMENSION: NSITYP+1
C  INPUT : I*4      TFLAG    = DETERMINES TITLE TYPE IN OUTPUT
C                                0 => 'BEAM STOPPING ... '
C                                1 => 'BEAM EMISSION ... '
C
C          (I*4)   LEN      = LENGTH OF ION NAME STRINGS.
C          (I*4)   L1       = LENGTH OF 'LINE1' STRING.
C          (I*4)   L2       = LENGTH OF 'LINE2' STRING.
C          (I*4)   I        = LOOP / ARRAY INDEX.
C          (I*4)   J        = LOOP / ARRAY INDEX.
C
C          (C*80)  CADAS    = ADAS HEADER: INCLUDES RELEASE, PROGRAM,
C                             TIME.
C          (C*133) LINE1    = LINE OF TEXT.
C          (C*133) LINE2    = LINE OF TEXT.
C          (C*100) TITLG    = TITLE FOR GRAPH.
C          (C*4)   SION     = ION NAME STRING.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXSION     ADAS      RETURNS ION STRING.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    23/12/93
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-11-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 11-12-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - TIDIED UP COMMENTS AND CODE
C
C VERSION: 1.3                          DATE: 12-03-97
C MODIFIED: RICHARD MARTIN
C               - ADDED 'TFLAG' AND 'BEAMEVENT'
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    IWRITE  , MXREQ   , MXDEG   , NSITYP  , NREQ    ,
     &           IFIT    , TFLAG
      INTEGER    LEN     , L1      , L2      , I       , J
C-----------------------------------------------------------------------
      LOGICAL    LFSEL
C-----------------------------------------------------------------------
      CHARACTER  DATE*8     , TITLE*40   ,BEAMEVENT*13
      CHARACTER  CADAS*80   , LINE1*133  , LINE2*133 , SION*4
      CHARACTER  DATASET*44
C-----------------------------------------------------------------------
      INTEGER    ITZ(NSITYP)     , NCOEF(NSITYP)
C-----------------------------------------------------------------------
      REAL*8     SIFRAC(NSITYP)  , UBMENG(NREQ)    , UTDENS(NREQ)    ,
```

```
     &           UTTEMP(NREQ)    , BSTOT(NREQ)     , FACT1
C-----------------------------------------------------------------------
      LOGICAL    LINTOT(NREQ)
C-----------------------------------------------------------------------
      CHARACTER  DSNIN(NSITYP)*80    , TSYM(NSITYP)*2      ,
     &           FINFO(NSITYP+1)*80
C-----------------------------------------------------------------------
      REAL*8     BSION(MXREQ,NSITYP)      , FCOEF(MXDEG+1,NSITYP+1)
C-----------------------------------------------------------------------
      LOGICAL    LINION(MXREQ,NSITYP)
C-----------------------------------------------------------------------
```

C4OUTG

```
      SUBROUTINE C4OUTG( LGHOST , LGRD1  , TITLE  , DATE   ,
     &                   IFIT   , NSITYP , DSNIN  , TSYM   ,
     &                   ITZ    , SIFRAC , MXREQ  , NREQ   ,
     &                   UBMENG , UTDENS , UTTEMP , BSTOT  ,
     &                   BSION  , LFSEL  , NFIT   , XFIT   ,
     &                   YFIT   , FINFO  , LDEF1  , XMIN   ,
     &                   XMAX   , YMIN   , YMAX
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C4OUTG *********************
C
C  PURPOSE:  COMMUNICATES GRAPHICS DATA TO IDL
C
C            PLOT IS LOG10(BEAM STOPPING COEFFT. (CM3 S-1) VERSUS
C                    LOG10(BEAM ENERGY (EV)) OR
C                    LOG10(TARGET DENSITY (CM-3)) OR
C                    LOG10(TARGET TEMPERATURE (EV))
C
C            BOTH THE CONTRIBUTION OF THE INDIVIDUAL IONS AND THE
C            TOTAL STOPPING COEFFICIENTS ARE PLOTTED.
C
C            FOR EACH SET OF DATA POINTS THE FOLLOWING IS DRAWN:
C               SPLINE INTERPOLATED POINTS: CROSSES
C               CURVE THROUGH SPLINE POINTS: FULL CURVE
C               MINIMAX FIT TO SPLINE DATA : DASH CURVE
C
C
C  CALLING PROGRAM: ADAS304
C
C  I/O   : (L*4)   LGHOST   = INITIALISATION FLAG FOR GHOST80.
C                             .TRUE.  => GHOST80 INITIALISED.
C                             .FALSE. => GHOST80 NOT INITIALISED.
C
C  INPUT : (L*4)   LGRD1    = FLAGS WHETHER TO PUT GRAPHS IN GRID FILE.
C                             .TRUE.  => PUT GRAPHS IN GRID FILE
C                             .FALSE. => DO NOT PUT GRAPHS IN GRID FILE
C  INPUT : (C*40)  TITLE    = ISPF ENTERED GENERAL TITLE FOR PROGRAM RUN
C  INPUT : (C*8)   DATE     = DATE STRING.
C  INPUT : (I*4)   IFIT     = QUANTITY TO FIT AND DISPLAY.
C                             1 => BEAM ENERGY.
C                             2 => TARGET DENSITY.
C                             3 => TARGET TEMPERATURE.
C  INPUT : (I*4)   NSITYP   = NUMBER OF STOPPING IONS TYPES.
C  INPUT : (C*80)  DSNIN()  = INPUT DATA SET NAMES (FULL MVS DSN).
C                             (IN FORM SUITABLE FOR DYNAMIC ALLOCATION)
C                             DIMENSION: NSITYP
C  INPUT : (C*2)   TSYM()   = TARGET ION ELEMENT SYMBOL.
C                             DIMENSION: NSITYP
C  INPUT : (I*4)   ITZ()    = TARGET ION CHARGE.
C                             DIMENSION: NSITYP
C  INPUT : (R*8)   SIFRAC() = FRACTION OF EACH STOPPING ION.
C                             DIMENSION: NSITYP
C  INPUT : (I*4)   MXREQ    = MAX NO. OF USER REQUESTED TRIPLETS OF
C                             ENERGY, TEMPERATURE AND DENSITY.
C  INPUT : (I*4)   NREQ     = NUMBER OF USER REQUESTED TRIPLETS OF
C                             ENERGY, TEMPERATURE AND DENSITY.
C  INPUT : (R*8)   UBMENG() = USER REQESTED BEAM ENERGIES.
C                             DIMENSION: NREQ
C  INPUT : (R*8)   UTDENS() = USER REQESTED TARGET DENSITITES.
C                             DIMENSION: NREQ
C  INPUT : (R*8)   UTTEMP() = USER REQESTED TARGET TEMPERATURES.
C                             DIMENSION: NREQ
C  INPUT : (R*8)   BSTOT()  = TOTAL BEAM STOPPING COEFFICIENTS.
C                             DIMENSION: NREQ
C  INPUT : (R*8)   BSION(,) = BEAM STOPPING COEFFICIENTS FOR INDIVIDUAL
C                             IONS.
C                             1ST DIMENSION: MXREQ
C                             2ND DIMENSION: NSITYP
C  INPUT : (L*4)   LFSEL    = FLAGS MINIMAX POLYNOMIAL FITTING.
C                             .TRUE.  => FIT PERFORMED.
C                             .FALSE. => NO FIT.
C  INPUT : (I*4)   NFIT     = NUMBER OF POINTS IN FIT.
C  INPUT : (R*8)   XFIT(,)  = X COORDINATES OF POINTS FROM FIT.
C                             FOR THE 2ND INDEX INDICES 1 TO 'NSITYP'
C                             ARE FOR THE INDIVIDUAL IONS AND 'NSITYP+1'
```

```
C                               FOR THE TOTAL.
C                               1ST DIMENSION: NFIT
C                               2ND DIMENSION: NSITYP+1
C  INPUT : (R*8)   YFIT(,)  = Y COORDINATES OF POINTS FROM FIT.
C                               FOR THE 2ND INDEX INDICES 1 TO 'NSITYP'
C                               ARE FOR THE INDIVIDUAL IONS AND 'NSITYP+1'
C                               FOR THE TOTAL.
C                               1ST DIMENSION: NFIT
C                               2ND DIMENSION: NSITYP+1
C  INPUT : (C*80)  FINFO()  = INFORMATION STRING FROM FIT.
C                               INDICES 1 TO 'NSITYP' ARE FOR THE
C                               INDIVIDUAL IONS AND 'NSITYP+1' FOR THE
C                               TOTAL.
C                               DIMENSION: NSITYP+1
C  INPUT : (L*4)   LDEF1    = FLAGS DEFAULT GRAPH SCALING.
C                               .TRUE.  => USE DEFAULT GRAPH SCALING.
C                               .FALSE. => DO NOT USE DEFAULT SCALING.
C  INPUT : (R*8)   XMIN     = LOWER LIMIT FOR X-AXIS OF GRAPH.
C  INPUT : (R*8)   XMAX     = UPPER LIMIT FOR X-AXIS OF GRAPH.
C  INPUT : (R*8)   YMIN     = LOWER LIMIT FOR Y-AXIS OF GRAPH.
C  INPUT : (R*8)   YMAX     = UPPER LIMIT FOR Y-AXIS OF GRAPH.
C
C  PARAM : (R*8)   GHZERO   = VALUE BELOW WHICH GHOST80 TAKES NUMBERS AS
C                               BEING ZERO = 1.0E-36.
C  PARAM : (R*8)   YDMIN    = MINIMUM ALLOWED Y-VALUE FOR PLOTTING.
C                               (USED FOR DEFAULT GRAPH SCALING)
C                               (SET TO 'GHZERO'/ZERO TO REMOVE)
C
C          (I*4)   I        = LOOP / ARRAY INDEX.
C          (I*4)   J        = ARRAY INDEX.
C
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXFLSH     IDL_ADAS  FLUSHES OUT THE UNIX PIPE
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    22/12/93
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-11-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 11-12-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - TIDIED UP COMMENTS AND CODE
C
C-----------------------------------------------------------------------
      REAL*4     GHZERO            , YDMIN
      PARAMETER( GHZERO = 1.0E-36  , YDMIN = 1.0E-20 )
C-----------------------------------------------------------------------
      INTEGER    IFIT    , NSITYP  , MXREQ   , NREQ    , NFIT
      INTEGER    I       , J
C-----------------------------------------------------------------------
      REAL*8     XMIN    , XMAX    , YMIN    , YMAX
C-----------------------------------------------------------------------
      LOGICAL    LGHOST  , LGRD1   , LFSEL   , LDEF1
C-----------------------------------------------------------------------
      CHARACTER  TITLE*40   , DATE*8
C-----------------------------------------------------------------------
      INTEGER    ITZ(NSITYP)
      INTEGER    PIPEIN   , PIPEOU
      PARAMETER( PIPEIN=5      , PIPEOU=6  )
C-----------------------------------------------------------------------
      REAL*8     SIFRAC(NSITYP)  , UBMENG(NREQ)    , UTDENS(NREQ)    ,
     &           UTTEMP(NREQ)    , BSTOT(NREQ)
C-----------------------------------------------------------------------
      CHARACTER  DSNIN(NSITYP)*80    , TSYM(NSITYP)*2      ,
     &           FINFO(NSITYP+1)*80
C-----------------------------------------------------------------------
      REAL*8     BSION(MXREQ,NSITYP)  , XFIT(NFIT,NSITYP+1)  ,
     &           YFIT(NFIT,NSITYP+1)
C-----------------------------------------------------------------------
```

C4SPLN

```
      SUBROUTINE C4SPLN( MXBE   , MXTD   , MXTT   , MXREQ  ,
     &                   NREQ   , BMENGA , DENSA  , TIA    ,
     &                   NSITYP , SVREF  , NBE    , BE     ,
     &                   NTDENS , TDENS  , NTTEMP , TTEMP  ,
     &                   SVT    , SVED   , SVREQ  , LIBMA  ,
     &                   LIDNA  , LITIA  , FACT1  , ITZ  , FACT2 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
```

```
C
C  ****************** FORTRAN77 SUBROUTINE: C4SPLN *********************
C
C  PURPOSE: CALCULATES THE BEAM STOPPING COEFFICIENT FOR EACH TRIPLET
C           OF BEAM ENERGY, ION DENSITY AND ION TEMPERATURE. IT USES
C           A ONE-WAY CUBIC SPLINE FOR THE TEMPERATURE AND A TWO-WAY
C           CUBIC SPLINE FOR THE ENERGY/DENSITY PAIR TO DETERMINE THE
C           STOPPING COEFFICIENT FROM THE INPUT DATA SET. IF A VALUE
C           CANNOT BE INTERPOLATED USING SLPINES THEN IT IS
C           EXTRAPOLATED BY 'XXSPLE'.
C
C  CALLING PROGRAM: SBMS / ADAS304
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  MXBE      = MAXIMUM NUMBER OF BEAM ENERGIES WHICH CAN
C                             BE READ.
C  INPUT : (I*4)  MXTD      = MAXIMUM NUMBER OF TARGET DENSITIES WHICH
C                             CAN BE READ.
C  INPUT : (I*4)  MXTT      = MAXIMUM NUMBER OF TARGET TEMPERATURES
C                             WHICH CAN BE READ.
C  INPUT : (I*4)  MXREQ     = MAXIMUM NUMBER OF REQUESTED TRIPLETS OF
C                             BEAM ENERGY, ION DENSITY AND ION TEMP.
C  INPUT : (I*4)  NREQ      = NUMBER OF REQUESTED TRIPLETS OF BEAM
C                             ENERGY, ION DENSITY AND ION TEMP.
C  INPUT : (R*8)  BMENGA()  = REQUESTED BEAM ENERGIES.
C                             UNITS: EV/AMU
C                             DIMENSION: NREQ
C  INPUT : (R*8)  DENSA()   = REQUESTED ION DENSITIES.
C                             UNITS: CM-3
C                             DIMENSION: NREQ
C  INPUT : (R*8)  TIA()     = REQUESTED ION TEMPERATURES.
C                             UNITS: EV
C                             DIMENSION: NREQ
C  INPUT : (I*4)  NSITYP    = NUMBER OF STOPPING ION TYPES.
C  INPUT : (R*8)  SVREF()   = STOPPING COEFFT. AT REFERENCE BEAM ENERGY,
C                             TARGET DENSITY AND TEMPERATURE.
C                             UNITS: CM3 S-1
C                             DIMENSION: NSITYP
C  INPUT : (I*4)  NBE()     = NUMBER OF BEAM ENERGIES.
C                             DIMENSION: NSITYP
C  INPUT : (R*8)  BE(,)     = BEAM ENERGIES.
C                             UNITS: EV/AMU
C                             1ST DIMENSION: MXBE
C                             2ND DIMENSION: NSITYP
C  INPUT : (I*4)  NTDENS()  = NUMBER OF TARGET DENSITIES.
C                             DIMENSION: NSITYP
C  INPUT : (R*8)  TDENS(,)  = TARGET DENSITIES.
C                             UNITS: CM-3
C                             1ST DIMENSION: MXTD
C                             2ND DIMENSION: NSITYP
C  INPUT : (I*4)  NTTEMP()  = NUMBER OF TARGET TEMPERATURES.
C                             DIMENSION: NSITYP
C  INPUT : (R*8)  TTEMP(,)  = TARGET TEMPERATURES.
C                             UNITS: EV
C                             1ST DIMENSION: MXTT
C                             2ND DIMENSION: NSITYP
C  INPUT : (R*8)  SVT(,)    = STOPPING COEFFT. AT REFERENCE BEAM ENERGY
C                             AND TARGET DENSITY.
C                             UNITS: CM3 S-1
C                             1ST DIMENSION: MXTT
C                             2ND DIMENSION: NSITYP
C  INPUT : (R*8)  SVED(,,)  = STOPPING COEFFT. AT REFERENCE TARGET
C                             TEMPERATURE.
C                             UNITS: CM3 S-1
C                             1ST DIMENSION: MXBE
C                             2ND DIMENSION: MXTD
C                             3RD DIMENSION: NSITYP
C  OUTPUT: (R*8)  SVREQ(,)  = STOPPING COEFFT. AT REQUESTED BEAM ENERGY,
C                             ION DENSITY AND ION TEMPERATURE.
C                             UNITS: CM3 S-1
C                             1ST DIMENSION: MXREQ
C                             2ND DIMENSION: NSITYP
C  OUTPUT: (L*4)  LIBMA(,)  = FLAGS IF INTERPOLATION OR EXTRAPOLATION
C                             USED FOR REQUESTED BEAM ENERGIES.
C                             .TRUE.  => INTERPOLATION USED.
C                             .FALSE. => EXTRAPOLATION USED.
C                             1ST DIMENSION: MXREQ
C                             2ND DIMENSION: NSITYP
C  OUTPUT: (L*4)  LIDNA(,)  = FLAGS IF INTERPOLATION OR EXTRAPOLATION
C                             USED FOR REQUESTED ION DENSITIES.
C                             .TRUE.  => INTERPOLATION USED.
C                             .FALSE. => EXTRAPOLATION USED.
C                             1ST DIMENSION: MXREQ
C                             2ND DIMENSION: NSITYP
C  OUTPUT: (L*4)  LITIA(,)  = FLAGS IF INTERPOLATION OR EXTRAPOLATION
C                             USED FOR REQUESTED ION TEMPERATURES.
C                             .TRUE.  => INTERPOLATION USED.
C                             .FALSE. => EXTRAPOLATION USED.
C                             1ST DIMENSION: MXREQ
C                             2ND DIMENSION: NSITYP
C
C  PARAM : (I*4)  MXI       = MAX. NO. OF STOPPING ION TYPES >= NSITYP.
C  PARAM : (I*4)  MXIN      = MAX. NO. OF INPUT DATA SET VALUES
C                             >= MXBE , MXTD , MXTT.
C  PARAM : (I*4)  MXOUT     = MAX. NO. OF OUTPUT VALUES >= NREQ.
C
C           (I*4)  IOPT      = DEFINES THE BOUNDARY DERIVATIVES FOR THE
```

```
C                               SPLINE ROUTINE 'XXSPLE'. SEE 'XXSPLE'.
C                               ( VALID VALUES = <0, 0, 1, 2, 3, 4)
C          (I*4)  NOUT      = NUMBER OF OUTPUT VALUES FOR SPLINE.
C          (I*4)  I         = LOOP INDEX.
C          (I*4)  J         = LOOP INDEX.
C          (I*4)  K         = LOOP INDEX.
C
C          (L*4)  LSETX     = FLAGS TO SPLINE ROUTINE 'XXSPLE' IF
C                             SPLINE PARAMETERS SHOULD BE SET UP.
C                             .TRUE.  => SET UP SPLINE PARAMS.
C                             .FALSE. => DO NOT SET UP SPLINE PARAMS.
C
C          (R*8)  DY()      = SPLINE INTERPOLATED DERIVATIVES.
C                             DIMENSION: MXIN
C          (R*8)  YOUT()    = Y OUTPUT ARRAY FROM SPLINE ROUTINE.
C                             DIMENSION: MXOUT
C
C          (R*8)  SVTO(,)   = STOPPING COEFFICIENTS AT REQUESTED ION
C                             TEMPERATURES.
C                             1ST DIMENSION: MXOUT
C                             2ND DIMENSION: MXI
C          (R*8)  SVEDO(,)  = STOPPING COEFFICIENTS AT REQUESTED BEAM
C                             ENERGIES AND ION DENSITY.
C                             1ST DIMENSION: MXOUT
C                             2ND DIMENSION: MXI
C          (R*8)  YPASS(,)  = STOPPING COEFFICIENTS AT REQUESTED BEAM
C                             ENERGIES.
C                             1ST DIMENSION: MXIN
C                             2ND DIMENSION: MXOUT
c           (R*8)  FACT1     = WEIGHTING FACTOR ASSOCIATED WITH THE
C                              EVALUATION OF AN EFFECTIVE DENSITY.
C           (R*8)  FACT2      = SIMILAR TO THAT OF FACT1.
C           (I*4)  ITZ()      = ARRAY CONTAINING THE NUCLEAR CHARGE OF
C                               EACH IMPURITY CONSIDERED.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          XXSPLE     ADAS      SPLINE SUBROUTINE (EXTENDED DIAGNOSTICS)
C          R8FUN1     ADAS      PERFORMS TRANSFORMATION ( X -> X )
C
C AUTHOR:  JONATHAN NASH  (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    10/12/93
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-11-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C VERSION: 1.2
C MODIFIED: HARVEY ANDERSON
C                - THE BEAM STOPPING COEFFICIENT FOR EACH
C                  INDIVIDUAL IMPURITY WAS BEING EVALUATED
C                  AT THE WRONG DENSITY. THE BEAM STOPPING
C                  COEFFICIENT SHOULD BE EVALUATED AT AN
C                  EFFECTIVE DENSITY. THIS HAS BEEN CORRECTED.
C                - THE TARGET DENSITY READ FROM ADF21 FILE IS THE
C                  ELECTRON DENSITY. THE CORRECTION TO THE EVALUATION
C                  OF THE EFFECTIVE DENSITY WAS DONE IN TERMS OF THE
C                  ION DENSITY. THIS WAS CORRECTED SO THAT THE EFFECTIVE
C                  DENSITY IS EVALUATED IN TERMS OF THE ELECTRON DENSITY.
C                  20/12/96
C                - INTRODUCED THE PARAMETER FACT2, TO ENABLE THE
C                  EFFECTIVE ELECTRON DENSITY TO BE EVALUATED.ORIGINALY
C                  THE USER WOULD ENTER THE TOTAL ION DENSITY AND
C                  THE STOPPING COEFFICIENTS WOULD BE EVALUATED AT AN
C                  EFFECTIVE ELECTRON DENSITY. NOW THE CODE HAS BEEN
C                  CHANGED TO ALLOW THE USER TO ENTER THE TOTAL ELECTRON
C                  DENSITY.
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      EXTERNAL   R8FUN1
      REAL*8     R8FUN1
C-----------------------------------------------------------------------
      INTEGER    MXI       , MXIN       , MXOUT
      PARAMETER( MXI = 10  , MXIN = 25  , MXOUT = 25 )
C-----------------------------------------------------------------------
      INTEGER    MXBE    , MXTD    , MXTT    , MXREQ   ,
     &           NREQ    , NSITYP
      INTEGER    IOPT    , NOUT    , I       , J       , K
C-----------------------------------------------------------------------
      LOGICAL    LSETX
C-----------------------------------------------------------------------
      INTEGER    NBE(NSITYP)     , NTDENS(NSITYP)  , NTTEMP(NSITYP)  ,
     &           ITZ(10)
C-----------------------------------------------------------------------
      REAL*8     BMENGA(NREQ)    , DENSA(NREQ)     , TIA(NREQ)       ,
     &           SVREF(NSITYP)
      REAL*8     DY(MXIN)        , YOUT(MXOUT)        , FACT1
C-----------------------------------------------------------------------
```

```
      REAL*8     BE(MXBE,NSITYP)       , TDENS(MXTD,NSITYP)   ,
     &           TTEMP(MXTT,NSITYP)    , SVT(MXTT,NSITYP)     ,
     &           SVREQ(MXREQ,NSITYP)
      REAL*8     SVTO(MXOUT,MXI)       , SVEDO(MXOUT,MXI)     ,
     &           YPASS(MXIN,MXOUT)
C-----------------------------------------------------------------------
      LOGICAL    LIBMA(MXREQ,NSITYP)   , LIDNA(MXREQ,NSITYP)  ,
     &           LITIA(MXREQ,NSITYP)
C-----------------------------------------------------------------------
      REAL*8     SVED(MXBE,MXTD,NSITYP) , FACT2
C-----------------------------------------------------------------------
```

C6AJTB

```
      SUBROUTINE C6AJTB( MXJSHL , IZ1 , NU , LU , NL , LL , AA )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6AJTB *********************
C
C  PURPOSE:  CALCULATES HYDRONIC LJ RESOLVED A-VALUES.
C
C            THE SUBROUTINE CHECKS TO SEE IF A-VALUE IS POSSIBLE AND
C            DIPOLE ALLOWED AND RETURNS ZEROES IF NOT.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXJSHL   = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT:  (I*4)  NU       = UPPER PRINCIPAL QUANTUM NUMBER.
C  INPUT:  (I*4)  LU       = ORBITAL QUANTUM NUMBER FOR NU.
C  INPUT:  (I*4)  NL       = LOWER PRINCIPAL QUANTUM NUMBER.
C  INPUT:  (I*4)  LL       = ORBITAL QUANTUM NUMBER FOR NL.
C
C  OUTPUT: (R*8)  AA()     = LJ RESOLVED A-VALUE.
C                            DIMENSION: TRANSITION INDEX WHERE:
C                                       1 GIVES LU+0.5 --> LL+0.5
C                                       2 GIVES LU+0.5 --> LL-0.5
C                                       3 GIVES LU-0.5 --> LL+0.5
C                                       4 GIVES LU-0.5 --> LL-0.5
C
C          (I*4)  I        = LOOP INDEX.
C
C          (R*8)  A        = L RESOLVED A VALUE.
C          (R*8)  XLU      = REAL VALUE = LU.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          R8ATAB     ADAS      RETURNS L RESOLVED HYDRONIC A-VALUE.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    08/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      REAL*8    R8ATAB
C-----------------------------------------------------------------------
      INTEGER   MXJSHL  , IZ1     , NU      , LU      , NL      ,
     &          LL
      INTEGER   I
C-----------------------------------------------------------------------
      REAL*8    A       , XL
C-----------------------------------------------------------------------
      REAL*8    AA(2*MXJSHL)
C-----------------------------------------------------------------------
```

C6CHRG

```
      SUBROUTINE C6CHRG( SYMBD , IZD   , SYMBR , IZR   , IDZ0  ,
     &                   IRZ0  , IRZ1  , IRZ2  , NGRND , NBOT
```

```
     &                )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6CHRG *********************
C
C  PURPOSE:  SETS UP NUCLEAR CHARGE OF DONOR AND NULEAR, INITIAL AND
C            FINAL CHARGES OF RECEIVER. CHECKS VALIDITY OF RECEIVER
C            CHARGES. ALSO SETS GROUND STATE N LEVEL AND LOWEST N LEVEL
C            FOR TABULAR OUTPUTS.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (C*2)  SYMBD   = DONOR ELEMENT SYMBOL.
C  INPUT : (I*4)  IZD     = DONOR ION CHARGE.
C  INPUT : (C*2)  SYMBR   = RECEIVER ELEMENT SYMBOL.
C  INPUT : (I*4)  IZR     = RECEIVER ION CHARGE.
C
C  OUTPUT: (I*4)  IDZ0    = DONOR NUCLEAR CHARGE.
C  OUTPUT: (I*4)  IRZ0    = RECEIVER NUCLEAR CHARGE.
C  OUTPUT: (I*4)  IRZ1    = RECEIVER ION INITIAL CHARGE.
C  OUTPUT: (I*4)  IRZ2    = RECEIVER ION FINAL CHARGE.
C  OUTPUT: (I*4)  NGRND   = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  OUTPUT: (I*4)  NBOT    = MINIMUM PRINCIPAL QUANTUM NUMBER.
C
C ROUTINES:
C           ROUTINE     SOURCE      BRIEF DESCRIPTION
C           ------------------------------------------------------------
C           I4UNIT      ADAS        RETURNS UNIT NO. FOR OUTPUT MESSAGES
C           CXCHRG      ADAS        RETURNS DONOR NUCLEAR CHARGE AND
C                                   RECEIVER NULEAR, INITIAL AND FINAL
C                                   CHARGES.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    11/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. NO CHANGES FROM IBM VERSION.
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    IZR     , IZD     , IDZ0    , IRZ0    , IRZ1    ,
     &           IRZ2    , NGRND   , NBOT
C-----------------------------------------------------------------------
      CHARACTER  SYMBD*2  , SYMBR*2
C-----------------------------------------------------------------------
```

C6EMIS

```
      SUBROUTINE C6EMIS( MXNSHL , MXJSHL , MXOBSL , MXPRSL ,
     &                   IZ0    , IZ1    , NGRND  , NTOT   ,
     &                   NBOT   , DENSZ  , DENS   , NOLINE ,
     &                   NU     , NL     , EMISA  , NPLINE ,
     &                   NPU    , NPL    , QTHEOR , FTHEOR ,
     &                   QTHIN  , TBQMEP , TBQMEM , TBQMIP ,
     &                   TBQMIM , TBFMP  , TBFM   , TBFMM  ,
     &                   NUMIN  , NUMAX  , EM     , QEX    ,
     &                   TOTPOP , TOTEMI , AVRGWL , QEFF   ,
     &                   TBLPOP , TBLEMI , TBLWLN
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6EMIS *********************
C
C  PURPOSE: PREDICTS THE J-RESOLVED EMMISIVITY FOR REQUESTED
C           TRANSITIONS.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL    = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  MXOBSL    = MAXIMUM NUMBER OF OBSERVED SPECTRUM
C                             LINES.
C  INPUT : (I*4)  MXPRSL    = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                             PREDICT.
```

```
C  INPUT : (I*4)  IZ0        = NUCLEAR CHARGE.
C  INPUT : (I*4)  IZ1        = ION CHARGE.
C  INPUT : (I*4)  NGRND      = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT       = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                              STATE.
C  INPUT : (I*4)  NBOT       = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  DENSZ      = PLASMA ION DENSITY.
C                              UNITS: CM-3
C  INPUT : (R*8)  DENS       = ELECTRON DENSITY.
C                              UNITS: CM-3
C  INPUT : (I*4)  NOLINE     = NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()       = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                              OF OBSERVED SPECTRUM LINES.
C                              DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()       = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                              OF OBSERVED SPECTRUM LINES.
C                              DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()    = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                              LINES.
C                              DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NPLINE     = NUMBER OF SPECTRUM LINES TO PREDICT.
C  INPUT : (I*4)  NPU()      = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                              OF SPECTRUM LINES TO PREDICT.
C                              DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NPL()      = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                              OF SPECTRUM LINES TO PREDICT.
C                              DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  QTHEOR()   = MEAN CHARGE EXCHANGE, EXCITATION RATE OR
C                              RECOMBINATION RATE COEFFICIENTS FOR
C                              N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  FTHEOR(,) = FRACTION OF N-LEVEL MEAN CHARGE EXCHANGE,
C                              EXCITATION RATE OR RECOMBINATION RATE
C                              COEFFICIENTS IN NL-LEVEL.
C                              1ST DIMENSION: J SHELL INDEX WHERE:
C                                             1 GIVES J=L+0.5
C                                             2 GIVES J=L-0.5
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  QTHIN()    = IONISATION RATE COEFFICIENT.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  TBQMEP(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                              NLJ->NL+1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                              NLJ->NL-1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                              NLJ->NL+1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                             2 ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                              NLJ->NL-1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMP(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                              NLJ->NL+1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFM(,)   = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                              NLJ->NLJ'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMM(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                              NLJ->NL-1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C  OUTPUT: (I*4)  NUMIN      = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                              FOR OBSERVED SPECTRUM LINES.
C  OUTPUT: (I*4)  NUMAX      = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                              FOR OBSERVED SPECTRUM LINES.
C  OUTPUT: (R*8)  EM         = EMMISSION MEASURE.
C  OUTPUT: (R*8)  QEX()      =
C                              DIMENSION: MXNSHL.
C  OUTPUT: (R*8)  TOTPOP()   = TOTAL COLLISION POP. FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: CM-2
C                              DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TOTEMI()   = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: PH CM-2 SEC-1
C                              DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  AVRGWL()   = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: A
C                              DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  QEFF()     = EFF. RATE COEFFICIENT FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS:
C                              DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLPOP(,,)= TABLE OF COLLISION POP. FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: CM-2
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
```

```
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C  OUTPUT: (R*8)  TBLEMI(,,)= TABLE OF COLLISION EMISSIVITIES FOR
C                               PREDICTED SPECTRUM LINE.
C                               UNITS: PH CM-2 SEC-1
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C                               3RD DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLWLN(,,)= TABLE OF WAVELENGTHS FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: A
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C                               3RD DIMENSION: PREDICTED LINE INDEX.
C
C  PARAM : (I*4)  MXN       = MXNSHL.
C  PARAM : (I*4)  MXJ       = MXJSHL.
C  PARAM : (I*4)  MXOB      = MXOBSL.
C
C          (I*4)  NREP      =
C          (I*4)  IC        = LOOP INDEX.
C
C          (I*4)  ICREP()   =
C                               DIMENSION: MXOB.
C
C          (R*8)  WHIGH(,)  =
C                               1ST DIMENSION: J SHELL INDEX.
C                               2ND DIMENSION: REFERENCED BY L+1.
C          (R*8)  WLOW(,,)  =
C                               1ST DIMENSION: J SHELL INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C                               3RD DIMENSION: REFERENCED BY L+1.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          C6WFIL     ADAS
C          C6EMQX
C          C6PRSL     ADAS      PREDICTS REQUESTED SPECTRUM LINES.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    10/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    MXN        , MXJ      , MXOB
      PARAMETER( MXN = 20   , MXJ = 2  , MXOB = 10  )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL ,
     &           MXOBSL  , MXPRSL  , IZ0     , IZ1     ,
     &           NGRND   , NTOT    , NBOT    , NOLINE  ,
     &           NPLINE  , NUMIN   , NUMAX
      INTEGER    NREP    , IC
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS    , EM
C-----------------------------------------------------------------------
      INTEGER    NU(MXOBSL)   , NL(MXOBSL)   , NPU(MXPRSL)  ,
     &           NPL(MXPRSL)
      INTEGER    ICREP(MXOB)
C-----------------------------------------------------------------------
      REAL*8     EMISA(MXOBSL)   , QTHEOR(MXNSHL)  , QTHIN(MXNSHL)   ,
     &           QEX(MXNSHL)     , TOTPOP(MXPRSL)  , TOTEMI(MXPRSL)  ,
     &           AVRGWL(MXPRSL)  , QEFF(MXPRSL)
C-----------------------------------------------------------------------
      REAL*8     FTHEOR(MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           TBQMEP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBFMP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           TBFM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           TBFMM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)
      REAL*8     WHIGH(MXJ,(MXN*(MXN+1))/2)
C-----------------------------------------------------------------------
      REAL*8     TBLPOP(2*MXJSHL,2*MXNSHL-3,MXPRSL)         ,
```

```
     &           TBLEMI(2*MXJSHL,2*MXNSHL-3,MXPRSL)         ,
     &           TBLWLN(2*MXJSHL,2*MXNSHL-3,MXPRSL)
      REAL*8     WLOW(MXJ,(MXN*(MXN+1))/2,MXN)
C-----------------------------------------------------------------------
```

C6EMQX

```
      SUBROUTINE C6EMQX( MXNSHL , MXJSHL , MXOBSL , IZ1    ,
     &                   NBOT   , NUMIN  , NUMAX  , NU     ,
     &                   NL     , EMISA  , NREP   , ICREP  ,
     &                   QTHEOR , WLOW   , EM     , QEX
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6EMQX *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C6EMIS
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL   = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  MXOBSL   = MAXIMUM NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NBOT     = MINIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NUMIN    = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()  = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                            LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NREP     =
C  INPUT : (I*4)  ICREP()  =
C                            DIMENSION: MXOBSL.
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE, EXCITATION RATE OR
C                            RECOMBINATION RATE COEFFICIENTS FOR
C                            N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  WLOW(,,) =
C                            1ST DIMENSION: J SHELL INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C                            3RD DIMENSION: REFERENCED BY L+1.
C
C  OUTPUT: (R*8)  EM       = EMMISSION MEASURE.
C  OUTPUT: (R*8)  QEX()    =
C                            DIMENSION: MXNSHL.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C  PARAM : (I*4)  MXJ      = MXJSHL.
C  PARAM : (I*4)  MXOB     = MXOBSL.
C
C          (I*4)  N        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N1       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L1       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  IDL      = TABLE INDEX.
C          (I*4)  IC       = ARRAY INDEX.
C          (I*4)  IC1      = ARRAY INDEX.
C          (I*4)  IC2      = ARRAY INDEX.
C          (I*4)  IFAIL    = RETURN FLAG FROM NAG ROUTINE.
C          (I*4)  M        = LOOP INDEX.
C          (I*4)  I        = LOOP INDEX.
C          (I*4)  J        = ARRAY INDEX.
C
C          (R*8)  XM       = REAL VALUE = M.
C          (R*8)  X1       =
C          (R*8)  X2       =
C          (R*8)  T1       =
C          (R*8)  T2       =
C          (R*8)  SUM      =
C          (R*8)  SUMEX    =
C          (R*8)  SUMTH    =
C
C          (I*4)  JLIST()  =
C                            DIMENSION: MXN.
C
C          (R*8)  AA()     = LJ RESOLVED A-VALUE.
C                            DIMENSION: TRANSITION INDEX WHERE:
C                                       1 GIVES LU+0.5 --> LL+0.5
C                                       2 GIVES LU+0.5 --> LL-0.5
C                                       3 GIVES LU-0.5 --> LL+0.5
C                                       4 GIVES LU-0.5 --> LL-0.5
```

```
C
C          (R*8)  REMISA() =
C                           DIMENSION: MXOB.
C          (R*8)  REMQ()   =
C                           DIMENSION: MXOB.
C          (R*8)  WKSPCE() = WORKSPACE FOR NAG ROUTINE.
C                           DIMENSION: MXOB.
C          (R*8)  EMQ()    =
C                           DIMENSION: MXNSHL.
C
C          (R*8)  CNDSA(,) = CONDENSED MATRIX.
C                           1ST DIMENSION: MXN.
C                           2ND DIMENSION: 2.
C          (R*8)  ARED(,)  = LINEAR CONDENSATION TRANSFORMATION ARRAY.
C                           1ST DIMENSION: MXN.
C                           2ND DIMENSION: MXN.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          C6AJTB     ADAS      CALCULATES LJ RESOLVED A-VALUES.
CX          F04ARF     NAG       FINDS SOLUTION TO A SET OF REAL LINEAR
CX                               EQUATIONS.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    09/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C VERSION: 1.2                          DATE: 29-05-96
C MODIFIED: WILLIAM OSBORN
C               - REMOVED UNUSED VARIABLES
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXN       , MXJ      , MXOB
      PARAMETER( MXN = 20  , MXJ = 2  , MXOB = 10 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , MXOBSL  , IZ1     , NBOT    ,
     &           NUMIN   , NUMAX   , NREP
      INTEGER    N       , L       , N1      , L1      , IDL     ,
     &           IC      , IC1     , IC2     , M       ,
     &           I       , J
C-----------------------------------------------------------------------
      REAL*8     EM
      REAL*8     XM      , X1      , X2      , T1      , T2      ,
     &           SUM     , SUMEX   , SUMTH
C-----------------------------------------------------------------------
      INTEGER    ICREP(MXOBSL) , NU(MXOBSL)   , NL(MXOBSL)
      INTEGER    JLIST(MXN)
C-----------------------------------------------------------------------
      REAL*8     EMISA(MXOBSL)   , QTHEOR(MXNSHL)  , QEX(MXNSHL)
      REAL*8     AA(2*MXJ)       , REMISA(MXOB)    , REMQ(MXOB)      ,
     &           EMQ(MXN)
      REAL*8     CNDSA(MXN,2)                      ,
     &           ARED(MXOB,MXOB)
      REAL*8     WLOW(MXJSHL,(MXNSHL*(MXNSHL+1))/2,MXNSHL)
C-----------------------------------------------------------------------
      INTEGER     PIPEIN        , PIPEOU
      PARAMETER(  PIPEIN=5      , PIPEOU=6)
C-----------------------------------------------------------------------
```

C6OUT0

```
      SUBROUTINE C6OUT0( IWRITE , MXNSHL , MXJSHL , MXBEAM ,
     &                   MXOBSL , MXPRSL , MXTAB  , NRTABS ,
     &                   NUMIN  , NUMAX  , NBOT   , NTOP   ,
     &                   NTAB   , IDTAB  , LRTTB  , LRTABS ,
     &                   DATE   , TITLE  , DSFULL , SYMBD  ,
     &                   IDZ0   , SYMBR  , IRZ0   , IRZ1   ,
     &                   IRZ2   , RAMSNO , TEV    , TIEV   ,
     &                   DENS   , DENSZ  , ZEFF   , BMAG   ,
     &                   NBEAM  , BMFRA  , BMENA  , NOLINE ,
     &                   NU     , NL     , EMISA  , ITHEOR ,
     &                   IBSTAT , IEMMS  , EM     , QEX    ,
     &                   TBLF   , QTHEX  , FTHEXJ , QTHCH  ,
```

```
     &                   FTHCHJ , QTHRC  , FTHRCJ , QTHIN  ,
     &                   TBQMEP , TBQMEM , TBQMIP , TBQMIM ,
     &                   TBFMP  , TBFM   , TBFMM  , NPLINE ,
     &                   NPL    , NPU    , TOTPOP , TOTEMI ,
     &                   AVRGWL , QEFF   , TBLPOP , TBLEMI ,
     &                   TBLWLN
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6OUT0 *********************
C
C  PURPOSE: WRITES TEXT OUTPUT TO FILE FOR ADAS306.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  IWRITE    = UNIT NUMBER FOR OUTPUT.
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL    = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  MXBEAM    = MAXIMUM NUMBER OF BEAM COMPONENTS.
C  INPUT : (I*4)  MXOBSL    = MAXIMUM NUMBER OF OBSERVED SPECTRUM
C                             LINES.
C  INPUT : (I*4)  MXPRSL    = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                             PREDICT.
C  INPUT : (I*4)  MXTAB     = MAXIMUM NUMBER OF TABLES FOR OUTPUT.
C  INPUT : (I*4)  NRTABS    = NUMBER OF INDIVIDUAL RATE TABLES.
C  INPUT : (I*4)  NUMIN     = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                             FOR OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NUMAX     = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                             FOR OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NBOT      = MINIMUM PRINCIPAL QUANTUM NUMBER FOR
C                             TABLES.
C  INPUT : (I*4)  NTOP      = MAXIMUM PRINCIPAL QUANTUM NUMBER FOR
C                             TABLES.
C  INPUT : (I*4)  NTAB      = NUMBER OF TABLES FOR OUTPUT.
C  INPUT : (I*4)  IDTAB()   = LIST OF INDEXES OF TABLES FOR OUTPUT.
C                             DIMENSION: MXTAB
C  INPUT : (L*4)  LRTTB     = FLAG FOR RATE TABLE PRINTING.
C                             .TRUE.  = PRINT RATE TABLES.
C                             .FALSE. = DO NOT PRINT RATE TABLES.
C  INPUT : (L*4)  LRTABS()  = FLAGS FOR INDIVIDUAL TABLES.
C                             INDEX: 1 = DIRECT CAPTURE TABLE.
C                                    2 = FIELD DYNAMIC TABLE.
C                                    3 = FIELD STATIC TABLE.
C                                    4 = ION IMPACT TABLE.
C                                    5 = ELECTRON IMPACT TABLE.
C  INPUT : (C*8)  DATE      = DATE.
C  INPUT : (C*40) TITLE     = ISPF ENTERED GENERAL TITLE FOR RUN.
C  INPUT : (C*80) DSFULL    = FILE NAME OF INPUT DATA SET.
C  INPUT : (C*2)  SYMBD     = DONOR ELEMENT SYMBOL.
C  INPUT : (I*4)  IDZ0      = DONOR NUCLEAR CHARGE.
C  INPUT : (C*2)  SYMBR     = RECEIVER ELEMENT SYMBOL.
C  INPUT : (I*4)  IRZ0      = RECEIVER NUCLEAR CHARGE.
C  INPUT : (I*4)  IRZ1      = RECEIVER ION INITIAL CHARGE.
C  INPUT : (I*4)  IRZ2      = RECEIVER ION FINAL CHARGE.
C  INPUT : (R*8)  RAMSNO    = RECEIVER ATOMIC MASS.
C  INPUT : (R*8)  TEV       = ELECTRON TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  TIEV      = ION TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  DENS      = ELECTRON DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  DENSZ     = PLASMA ION DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  ZEFF      = EFFECTIVE ION CHARGE.
C  INPUT : (R*8)  BMAG      = PLASMA MAGNETIC INDUCTION.
C                             UNITS: TESLA
C  INPUT : (I*4)  NBEAM     = NUMBER OF BEAM ENERGIES.
C  INPUT : (R*8)  BMFRA()   = BEAM COMPONENT FRACTIONS.
C                             DIMENSION: COMPONENT INDEX.
C  INPUT : (R*8)  BMENA()   = BEAM ENERGY COMPONENTS.
C                             UNITS: EV/AMU
C                             DIMENSION: COMPONENT INDEX.
C  INPUT : (I*4)  NOLINE    = NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()      = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                             OF OBSERVED SPECTRUM LINES.
C                             DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()      = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                             OF OBSERVED SPECTRUM LINES.
C                             DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()   = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                             LINES.
C                             DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  ITHEOR    = CHARGE EXCHANGE MODEL OPTION.
C                             1 => USE INPUT DATA SET.
C                             2 => USE EIKONAL MODEL.
C  INPUT : (I*4)  IBSTAT    = DONOR STATE FOR EIKONAL MODEL.
C                             1 => H(1S)
C                             2 => H(2S)
C                             3 => H(2P)
C                             4 => HE(1S2)
C                             5 => HE(1S2S)
C  INPUT : (I*4)  IEMMS     = EMISSION MEASURE MODEL OPTION.
C                             1 => CHARGE EXCHANGE.
C                             2 => ELECTRON IMPACT EXCITATION.
C                             3 => RADIATIVE RECOMBINATION.
```

```
C  INPUT : (R*8)  EM         = EMISSION MEASURE.
C                               UNITS: CM-5
C  INPUT : (R*8)  QEX()      =
C                               DIMENSION: MXNSHL.
C  INPUT : (R*8)  TBLF()     = TABLE OF RADIATIVE LIFETIMES.
C                               UNITS: SECS
C                               DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  QTHEX()    = MEAN EXCITATION RATE COEFFICIENTS FOR
C                               N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                               UNITS: CM3 SEC-1
C                               DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  FTHEXJ(,) = FRACTION OF N-LEVEL MEAN EXCITATION RATE
C                               COEFFICIENTS IN NLJ-LEVEL.
C                               1ST DIMENSION: J SHELL INDEX WHERE:
C                                              1 GIVES J=L+0.5
C                                              2 GIVES J=L-0.5
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  QTHCH()    = MEAN CHARGE EXCHANGE COEFFICIENTS FOR
C                               N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                               UNITS: CM3 SEC-1
C                               DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  FTHCHJ(,) = FRACTION OF N-LEVEL MEAN CHARGE EXCHANGE
C                               COEFFICIENTS IN NLJ-LEVEL.
C                               1ST DIMENSION: J SHELL INDEX WHERE:
C                                              1 GIVES J=L+0.5
C                                              2 GIVES J=L-0.5
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  QTHRC()    = MEAN RECOMBINATION RATE COEFFICIENTS FOR
C                               N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                               UNITS: CM3 SEC-1
C                               DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  FTHRCJ(,) = FRACTION OF N-LEVEL MEAN RECOMBINATION
C                               RATE COEFFICIENTS IN NLJ-LEVEL.
C                               1ST DIMENSION: J SHELL INDEX WHERE:
C                                              1 GIVES J=L+0.5
C                                              2 GIVES J=L-0.5
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  QTHIN()    = IONISATION RATE COEFFICIENT.
C                               UNITS: CM3 SEC-1
C                               DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  TBQMEP(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                               NLJ->NL+1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                               NLJ->NL-1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                               NLJ->NL+1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                               NLJ->NL-1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMP(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                               NLJ->NL+1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFM(,)   = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                               NLJ->NLJ'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMM(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                               NLJ->NL-1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (I*4)  NPLINE    = NUMBER OF SPECTRUM LINES TO PREDICT.
C  INPUT : (I*4)  NPU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                               OF SPECTRUM LINES TO PREDICT.
C                               DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NPL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                               OF SPECTRUM LINES TO PREDICT.
C                               DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  TOTPOP()  = TOTAL COLLISION POP. FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: CM-2
C                               DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  TOTEMI()  = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: PH CM-2 SEC-1
C                               DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  AVRGWL()  = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: A
C                               DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  QEFF()    = EFF. RATE COEFFICIENT FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS:
C                               DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  TBLPOP(,,)= TABLE OF COLLISION POP. FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: CM-2
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C                               3RD DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  TBLEMI(,,)= TABLE OF COLLISION EMISSIVITIES FOR
```

```
C                             PREDICTED SPECTRUM LINE.
C                             UNITS: PH CM-2 SEC-1
C                             1ST DIMENSION: J->J' TRANSITION INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDLI().
C                             3RD DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  TBLWLN(,,)= TABLE OF WAVELENGTHS FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: A
C                             1ST DIMENSION: J->J' TRANSITION INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDLI().
C                             3RD DIMENSION: PREDICTED LINE INDEX.
C
C          (I*4)   N        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)   L        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)   J        = LOOP INDEX FOR J QUANTUM NUMBER INDEX.
C          (I*4)   JMX      = UPPER LIMIT ON 'J' LOOP.
C          (I*4)   N1       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)   L1       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)   J1       = LOOP INDEX FOR J QUANTUM NUMBER INDEX.
C          (I*4)   J1MX     = UPPER LIMIT ON 'J' LOOP.
C          (I*4)   IDL      = L-RESOLVED TABLE INDEX.
C          (I*4)   ID       = SPECTRUM LINE TABLE INDEX.
C          (I*4)   I        = LOOP INDEX.
C          (I*4)   K        = ARRAY INDEX.
C
C          (R*8)   XJ       = J QUANTUM NUMBER.
C          (R*8)   XJ1      = J QUANTUM NUMBER.
C
C          (C*80)  CADAS    = ADAS HEADER: INCLUDES RELEASE, PROGRAM,
C                             TIME.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          I4IDLI     ADAS      RETURNS INDEX FOR PREDICTED SPECTRUM
C                               LINE TABLES.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    19/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C VERSION: 1.2                          DATE: 24-11-98
C MODIFIED: RICHARD MARTIN & MARTIN OMULLANE
C                    - CORRECTED WRITING OF ELECTRON & ION TEMPS. FROM
C                         BEING WRITTED WRONG WAY ROUND.
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4IDFL  , I4IDLI
C-----------------------------------------------------------------------
      INTEGER    IWRITE  , MXNSHL  , MXJSHL  , MXBEAM  , MXOBSL  ,
     &           MXPRSL  , MXTAB   , NRTABS  , NUMIN   , NUMAX   ,
     &           NBOT    , NTOP    , NTAB    , IDZ0    , IRZ0    ,
     &           IRZ1    , IRZ2    , NBEAM   , NOLINE  , ITHEOR  ,
     &           IBSTAT  , IEMMS   , NPLINE
      INTEGER    N       , L       , J       , JMX     , N1      ,
     &           L1      , J1      , J1MX    , IDL     , ID      ,
     &           I       , K
C-----------------------------------------------------------------------
      REAL*8     RAMSNO  , TEV     , TIEV    , DENS    , DENSZ   ,
     &           ZEFF    , BMAG    , EM
      REAL*8     XJ      , XJ1
C-----------------------------------------------------------------------
      LOGICAL    LRTTB
C-----------------------------------------------------------------------
      CHARACTER  DATE*8     , TITLE*40   , DSFULL*80  , SYMBR*2    ,
     &           SYMBD*2
      CHARACTER  CADAS*80
C-----------------------------------------------------------------------
      INTEGER    IDTAB(MXTAB)    , NU(MXOBSL)      , NL(MXOBSL)      ,
     &           NPU(MXPRSL)     , NPL(MXPRSL)
C-----------------------------------------------------------------------
      REAL*8     BMFRA(MXBEAM)   , BMENA(MXBEAM)   , QEX(MXNSHL)     ,
     &           QTHCH(MXNSHL)   , QTHEX(MXNSHL)   , QTHIN(MXNSHL)   ,
     &           QTHRC(MXNSHL)   , EMISA(MXOBSL)   , TOTPOP(MXPRSL)  ,
     &           TOTEMI(MXPRSL)  , AVRGWL(MXPRSL)  , QEFF(MXPRSL)    ,
```

```
     &           TBLF((MXNSHL*(MXNSHL+1))/2)
C-----------------------------------------------------------------------
      LOGICAL    LRTABS(NRTABS)
C-----------------------------------------------------------------------
      REAL*8     FTHCHJ(MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           FTHEXJ(MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           FTHRCJ(MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           TBQMEP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBFMP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           TBFMM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           TBFM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)
C-----------------------------------------------------------------------
      REAL*8     TBLPOP(2*MXJSHL,2*MXNSHL-3,MXPRSL)      ,
     &           TBLEMI(2*MXJSHL,2*MXNSHL-3,MXPRSL)      ,
     &           TBLWLN(2*MXJSHL,2*MXNSHL-3,MXPRSL)
C-----------------------------------------------------------------------
      SAVE       CADAS
C-----------------------------------------------------------------------
      DATA       CADAS / ' ' /
C-----------------------------------------------------------------------
```

C6OUTG

```
      SUBROUTINE C6OUTG( MXNSHL , MXJSHL , MXBEAM , MXOBSL ,
     &                   MXPRSL , MXGRF  , NGFPLN , NGRF   ,
     &                   IDGRF  , LPLT1  , LGRD1  , LDEF1  ,
     &                   DATE   , TITLE  , DSFULL , SYMBD  ,
     &                   IDZ0   , SYMBR  , IRZ0   , IRZ1   ,
     &                   IRZ2   , RAMSNO , TEV    , TIEV   ,
     &                   DENS   , DENSZ  , ZEFF   , BMAG   ,
     &                   NBEAM  , BMFRA  , BMENA  , NOLINE ,
     &                   NU     , NL     , EMISA  , ITHEOR ,
     &                   IBSTAT , IEMMS  , NPLINE , NPU    ,
     &                   NPL    , XLG    , XUG    , YLG    ,
     &                   YUG    , QEFF   , TBLEMI , TBLWLN ,
     &                   LGHOST
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6OUTG *********************
C
C  PURPOSE: PLOTS EMISSIVITY GRAPHS FOR ADAS306.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL    = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  MXBEAM    = MAXIMUM NUMBER OF BEAM COMPONENTS.
C  INPUT : (I*4)  MXOBSL    = MAXIMUM NUMBER OF OBSERVED SPECTRUM
C                             LINES.
C  INPUT : (I*4)  MXPRSL    = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                             PREDICT.
C  INPUT : (I*4)  MXGRF     = MAXIMUM NUMBER OF GRAPHS FOR OUTPUT.
C  INPUT : (I*4)  NGFPLN    = NUMBER OF GRAPHS PER PREDICTED SPECTRUM
C                             LINE.
C  INPUT : (I*4)  NGRF      = NUMBER OF GRAPHS FOR OUTPUT.
C  INPUT : (I*4)  IDGRF()   = LIST OF INDEXES OF GRAPHS FOR OUTPUT.
C                             DIMENSION: MXGRF
C  INPUT : (L*4)  LPLT1     = FLAGS WHETHER TO PLOT GRAPHS ON SCREEN.
C                             .TRUE.  => PLOT GRAPHS ON SCREEN.
C                             .FALSE. => DO NOT PLOT GRAPHS ON SCREEN.
C  INPUT : (L*4)  LGRD1     = FLAGS WHETHER TO PUT GRAPHS IN GRID FILE.
C                             .TRUE.  => PUT GRAPHS IN GRID FILE
C                             .FALSE. => DO NOT PUT GRAPHS IN GRID FILE
C  INPUT : (L*4)  LDEF1     = FLAGS DEFAULT GRAPH SCALING
C                             .TRUE.  => USE DEFAULT GRAPH SCALING.
C                             .FALSE. => DO NOT USE DEFAULT SCALING.
C  INPUT : (C*8)  DATE      = DATE.
C  INPUT : (C*40) TITLE     = ISPF ENTERED GENERAL TITLE FOR RUN.
C  INPUT : (C*80) DSFULL    = FILE NAME OF INPUT DATA SET.
C  INPUT : (C*2)  SYMBD     = DONOR ELEMENT SYMBOL.
C  INPUT : (I*4)  IDZ0      = DONOR NUCLEAR CHARGE.
C  INPUT : (C*2)  SYMBR     = RECEIVER ELEMENT SYMBOL.
C  INPUT : (I*4)  IRZ0      = RECEIVER NUCLEAR CHARGE.
C  INPUT : (I*4)  IRZ1      = RECEIVER ION INITIAL CHARGE.
C  INPUT : (I*4)  IRZ2      = RECEIVER ION FINAL CHARGE.
C  INPUT : (R*8)  RAMSNO    = RECEIVER ATOMIC MASS.
C  INPUT : (R*8)  TEV       = ELECTRON TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  TIEV      = ION TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  DENS      = ELECTRON DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  DENSZ     = PLASMA ION DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  ZEFF      = EFFECTIVE ION CHARGE.
C  INPUT : (R*8)  BMAG      = PLASMA MAGNETIC INDUCTION.
```

```
C                                     UNITS: TESLA
C  INPUT : (I*4)  NBEAM     = NUMBER OF BEAM ENERGIES.
C  INPUT : (R*8)  BMFRA()   = BEAM COMPONENT FRACTIONS.
C                                     DIMENSION: COMPONENT INDEX.
C  INPUT : (R*8)  BMENA()   = BEAM ENERGY COMPONENTS.
C                                     UNITS: EV/AMU
C                                     DIMENSION: COMPONENT INDEX.
C  INPUT : (I*4)  NOLINE    = NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()      = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                                     OF OBSERVED SPECTRUM LINES.
C                                     DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()      = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                                     OF OBSERVED SPECTRUM LINES.
C                                     DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()   = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                                     LINES.
C                                     DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  ITHEOR    = CHARGE EXCHANGE MODEL OPTION.
C                                     1 => USE INPUT DATA SET.
C                                     2 => USE EIKONAL MODEL.
C  INPUT : (I*4)  IBSTAT    = DONOR STATE FOR EIKONAL MODEL.
C                                     1 => H(1S)
C                                     2 => H(2S)
C                                     3 => H(2P)
C                                     4 => HE(1S2)
C                                     5 => HE(1S2S)
C  INPUT : (I*4)  IEMMS     = EMISSION MEASURE MODEL OPTION.
C                                     1 => CHARGE EXCHANGE.
C                                     2 => ELECTRON IMPACT EXCITATION.
C                                     3 => RADIATIVE RECOMBINATION.
C  INPUT : (I*4)  NPLINE    = NUMBER OF SPECTRUM LINES TO PREDICT.
C  INPUT : (I*4)  NPU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                                     OF SPECTRUM LINES TO PREDICT.
C                                     DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NPL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                                     OF SPECTRUM LINES TO PREDICT.
C                                     DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  XLG()     = LOWER LIMIT FOR X-AXIS OF GRAPHS.
C                                     DIMENSION: NGFPLN
C  INPUT : (R*8)  XUG()     = UPPER LIMIT FOR X-AXIS OF GRAPHS.
C                                     DIMENSION: NGFPLN
C  INPUT : (R*8)  YLG()     = LOWER LIMIT FOR Y-AXIS OF GRAPHS.
C                                     DIMENSION: NGFPLN
C  INPUT : (R*8)  YUG()     = UPPER LIMIT FOR Y-AXIS OF GRAPHS.
C                                     DIMENSION: NGFPLN
C  INPUT : (R*8)  QEFF()    = EFF. RATE COEFFICIENT FOR PREDICTED
C                                     SPECTRUM LINE.
C                                     UNITS:
C                                     DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  TBLEMI(,,)= TABLE OF COLLISION EMISSIVITIES FOR
C                                     PREDICTED SPECTRUM LINE.
C                                     UNITS: PH CM-2 SEC-1
C                                     1ST DIMENSION: J->J' TRANSITION INDEX.
C                                     2ND DIMENSION: REFERENCED BY I4IDLI().
C                                     3RD DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  TBLWLN(,,)= TABLE OF WAVELENGTHS FOR PREDICTED
C                                     SPECTRUM LINE.
C                                     UNITS: A
C                                     1ST DIMENSION: J->J' TRANSITION INDEX.
C                                     2ND DIMENSION: REFERENCED BY I4IDLI().
C                                     3RD DIMENSION: PREDICTED LINE INDEX.
C
C  I/O   : (L*4)  LGHOST    = INITIALISATION FLAG FOR GHOST80.
C                                     .TRUE.  => GHOST80 INITIALISED.
C                                     .FALSE. => GHOST80 NOT INITIALISED.
C
C  PARAM : (I*4)  NDIV      = NUMBER OF DIVISIONS ON X AXIS.
C  PARAM : (I*4)  MXA       = MAXIMUM NUMBER OF DATA POINTS FOR GRAPH A.
C  PARAM : (I*4)  MXB       = MAXIMUM NUMBER OF DATA POINTS FOR GRAPH B.
C
C  PARAM : (R*8)  ANGDIV    = NO. OF ANGSTROMS PER DIVISION.
C
C          (I*4)  N         = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L         = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  J         = LOOP INDEX FOR J QUANTUM NUMBER INDEX.
C          (I*4)  JMX       = UPPER LIMIT ON 'J' LOOP.
C          (I*4)  N1        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L1        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  J1        = LOOP INDEX FOR J QUANTUM NUMBER INDEX.
C          (I*4)  J1MX      = UPPER LIMIT ON 'J' LOOP.
CX          (I*4)  IDL       = L-RESOLVED TABLE INDEX.
C          (I*4)  NPTS      = NO. OF EMISSIVITY AND WAVELENGTH VALUES.
C          (I*4)  ID        = SPECTRUM LINE TABLE INDEX.
C          (I*4)  I         = LOOP INDEX.
C          (I*4)  K         = ARRAY INDEX.
C
C          (R*8)  CWLN      = CENTRAL WAVELENGTH ON GRAPH.
C                             UNITS: A
C          (R*8)  ERATE     = EFFECTIVE RATE COEFFICIENT.
C                             UNITS:
C
C          (C*1)  GRID      = DUMMY NAME VARIABLE FOR USE WITH GHOST80.
C          (C*1)  PIC       = DUMMY NAME VARIABLE FOR USE WITH GHOST80.
C
C          (R*8)  CEMIS()   = COLUMN EMISSIVITIES.
C                             UNITS: PHOT CM-2 SEC-1
C                             DIMENSION: MXA
C          (R*8)  WAVLN()   = WAVELENGTHS.
```

```
C                             UNITS: A
C                             DIMENSION: MXA
C          (R*8)  XA()      = X DATA POINTS FOR GRAPH A.
C                             DIMENSION: MXA
C          (R*8)  YA()      = Y DATA POINTS FOR GRAPH A.
C                             DIMENSION: MXA
C          (R*8)  XB()      = X DATA POINTS FOR GRAPH B.
C                             DIMENSION: MXB
C          (R*8)  YB()      = Y DATA POINTS FOR GRAPH B.
C                             DIMENSION: MXB
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
CX          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
CX                               NUMBERS N AND L.
C          I4IDLI     ADAS      RETURNS INDEX FOR PREDICTED SPECTRUM
C                               LINE TABLES.
C          CXGFIL     ADAS      FILLS ADAS306 / 308 GRAPH ARRAYS.
C          CXGEMI     ADAS      PLOTS ADAS306 / 308 EMISSIVITY GRAPHS.
C                     GHOST80   VARIOUS SUBROUTINES.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    24/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C VERSION: 1.2                          DATE: 29-05-96
C MODIFIED: WILLIAM OSBORN
C               - REMOVED UNUSED VARIABLES
C
C VERSION: 1.3                          DATE: 29-05-96
C MODIFIED: WILLIAM OSBORN
C               - S.C.C.S. MISTAKE
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDLI
C-----------------------------------------------------------------------
      INTEGER    MXN           , MXJ          , NDIV
      PARAMETER( MXN = 20      , MXJ = 2      , NDIV = 600 )
      INTEGER    MXA                        , MXB
      PARAMETER( MXA = (2*MXJ-1)*(2*MXN-3)  , MXB = NDIV )
C-----------------------------------------------------------------------
      REAL*8     ANGDIV
      PARAMETER( ANGDIV = 0.096D0 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , MXBEAM  , MXOBSL  , MXPRSL  ,
     &           MXGRF   , NGFPLN  , NGRF    , IDZ0    , IRZ0    ,
     &           IRZ1    , IRZ2    , NBEAM   , NOLINE  , ITHEOR  ,
     &           IBSTAT  , IEMMS   , NPLINE
      INTEGER    N       , L       , J       , JMX     , N1      ,
     &           L1      , J1      , J1MX    , NPTS    ,
     &           ID      , I       , K
C-----------------------------------------------------------------------
      REAL*8     RAMSNO  , TEV     , TIEV    , DENS    , DENSZ   ,
     &           ZEFF    , BMAG
      REAL*8     CWLN    , ERATE
C-----------------------------------------------------------------------
      LOGICAL    LPLT1   , LGRD1   , LDEF1   , LGHOST
C-----------------------------------------------------------------------
      CHARACTER  DATE*8     , TITLE*40   , DSFULL*80  , SYMBD*2    ,
     &           SYMBR*2
      CHARACTER  GRID*1     , PIC*1
C-----------------------------------------------------------------------
      INTEGER    IDGRF(MXGRF)    , NU(MXOBSL)      , NL(MXOBSL)    ,
     &           NPU(MXPRSL)     , NPL(MXPRSL)
C-----------------------------------------------------------------------
      REAL*8     BMFRA(MXBEAM)   , BMENA(MXBEAM)   , EMISA(MXOBSL) ,
     &           XLG(NGFPLN)     , XUG(NGFPLN)     , YLG(NGFPLN)   ,
     &           YUG(NGFPLN)     , QEFF(MXPRSL)
      REAL*8     CEMIS(MXA)      , WAVLN(MXA)      , XA(MXA)       ,
     &           YA(MXA)         , XB(MXB)         , YB(MXB)
C-----------------------------------------------------------------------
      REAL*8     TBLEMI(2*MXJSHL,2*MXNSHL-3,MXPRSL)      ,
     &           TBLWLN(2*MXJSHL,2*MXNSHL-3,MXPRSL)
C-----------------------------------------------------------------------
      INTEGER     PIPEIN        , PIPEOU
```

```
      PARAMETER(  PIPEIN=5      , PIPEOU=6)
C-----------------------------------------------------------------------
      DATA       GRID / ' ' / ,
     &           PIC  / ' ' /
C-----------------------------------------------------------------------
```

C6PMIN

```
      SUBROUTINE C6PMIN( MXNSHL , MXJSHL , N , VD , VDS , VDI , RHS )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6PMIN *********************
C
C  PURPOSE:  CALCULATES THE SOLUTION OF A TRIDIAGONAL PARTITIONED MATRIX
C            ORGANISED SET OF SIMULTANEOUS EQUATIONS.
C
C            THE PARTITIONS ARE 2X2 IN THE PRESENT IMPLEMENTATION. A
C            VARIANT OF OF THE DOUBLE PASS ALGORITHM (IN A PARTITIONED
C            MATRIX SENSE) IS USED WITH RECURRENCE IN TWO DIRECTIONS TO
C            THE CENTRE AND BACK. THIS IS ANALOGOUS TO THE NAG ROUTINE
C            F04EAF FOR AN ORDINARY TRIDAGONAL MATRIX THE INDEXING OF
C            THE DIAG, SUPRADIAG AND INFRADIAG ELEMENTS FOLLOWS THAT OF
C            THE NAG ROUTINE F04EAF.
C
C  CALLING PROGRAM: C6WSOL
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL   = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  N        = NUMBER OF PARTIONS ALONG THE DIAGONAL.
C  INPUT : (R*8)  VD(,)    = DIAGONAL PARTITION.
C                            1ST DIMENSION: 2 * MXJSHL
C                            2ND DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  VDS(,)   = SUPRADIAGONAL PARTITION.
C                            1ST DIMENSION: 2 * MXJSHL
C                            2ND DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  VDI(,)   = INFRADIAGONAL PARTITION.
C                            1ST DIMENSION: 2 * MXJSHL
C                            2ND DIMENSION: N SHELL INDEX.
C
C  I/O   : (R*8)  RHS(,)   = INPUT: RIGHT HAND SIDE OF VECTOR PARTITION.
C                            OUTPUT: SOLUTION OF VECTOR PARTITION.
C                            1ST DIMENSION: 2 * MXJSHL
C                            2ND DIMENSION: N SHELL INDEX.
C
C
C  PARAM : (I*4)  MXJ      = MXJSHL.
C
C          (I*4)  I        = LOOP INDEX.
C          (I*4)  K        =
C
C          (R*8)  UNIT()   =
C                            DIMENSION: 4
C          (R*8)  W1()     =
C                            DIMENSION: 4
C          (R*8)  W2()     =
C                            DIMENSION: 4
CX          (R*8)  W3()     =
CX                             DIMENSION: 4
C          (R*8)  VW1()    =
C                            DIMENSION: 2
C          (R*8)  VW2()    =
C                            DIMENSION: 2
C          (R*8)  TEMP()   = TEMPORARY STORE.
C                            DIMENSION: 4
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C
C NOTES:
C        1) THE 2X2 PARTITIONS ARE STORED AS LINEAR VECTORS BY COLUMN
C           IN THE 1ST DIMENSIONS OF VD(,), VDS(,), VDI(,).
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    11/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
```

```
C VERSION: 1.2                          DATE: 29-05-96
C MODIFIED: WILLIAM OSBORN
C               - REMOVED UNUSED VARIABLES
C
C VERSION: 1.3                          DATE: 29-05-96
C MODIFIED: WILLIAM OSBORN
C               - S.C.C.S. MISTAKE
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    MXJ
      PARAMETER( MXJ = 2 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , N
      INTEGER    I       , K
C-----------------------------------------------------------------------
      REAL*8     VD(2*MXJSHL,MXNSHL)   , VDS(2*MXJSHL,MXNSHL)  ,
     &           VDI(2*MXJSHL,MXNSHL)  , RHS(MXJSHL,MXNSHL)
      REAL*8     UNIT(2*MXJ)  , W1(2*MXJ)    , W2(2*MXJ)    ,
     &           VW1(MXJ)     , VW2(MXJ)     ,
     &           TEMP(2*MXJ)
C-----------------------------------------------------------------------
      DATA   UNIT / 1.0D0 , 0.0D0 , 0.0D0 , 1.0D0 /
C-----------------------------------------------------------------------
```

C6PRSL

```
      SUBROUTINE C6PRSL( MXNSHL , MXJSHL , MXPRSL , IZ0    ,
     &                   IZ1    , NPLINE , NPU    , NPL    ,
     &                   NUMAX  , WHIGH  , WLOW   , EM     ,
     &                   QEX    , TOTPOP , TOTEMI , AVRGWL ,
     &                   QEFF   , TBLPOP , TBLEMI , TBLWLN
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6PRSL *********************
C
C  PURPOSE:  FILLS TABLES FOR REQUESTED PREDICTIONS OF SPECTRUM LINES.
C
C  CALLING PROGRAM: C6EMIS
C
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL    = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  MXPRSL    = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                             PREDICT.
C  INPUT : (R*8)  IZ0       = NUCLEAR CHARGE.
C  INPUT : (R*8)  IZ1       = ION CHARGE.
C  INPUT : (I*4)  NPLINE    = NUMBER OF SPECTRUM LINES TO PREDICT.
C  INPUT : (I*4)  NPU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                             OF SPECTRUM LINES TO PREDICT.
C                             DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NPL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                             OF SPECTRUM LINES TO PREDICT.
C                             DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NUMAX     = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                             FOR OBSERVED SPECTRUM LINES.
C  INPUT : (R*8)  WHIGH(,)  =
C                             1ST DIMENSION: J SHELL INDEX.
C                             2ND DIMENSION: REFERENCED BY L+1.
C  INPUT : (R*8)  WLOW(,,)  =
C                             1ST DIMENSION: J SHELL INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C                             3RD DIMENSION: REFERENCED BY L+1.
C  INPUT : (R*8)  EM        = EMMISION MEASURE.
C  INPUT : (R*8)  QEX()     =
C                             DIMENSION: MXNSHL.
C
C  OUTPUT: (R*8)  TOTPOP()  = TOTAL COLLISION POP. FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: CM-2
C                             DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TOTEMI()  = TOTAL COLLISION EMISSIVITIES FOR
C                             PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: PH CM-2 SEC-1
C                             DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  AVRGWL()  = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: A
C                             DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  QEFF()    = EFF. RATE COEFFICIENT FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS:
C                             DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLPOP(,,)= TABLE OF COLLISION POP. FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: CM-2
```

```
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C  OUTPUT: (R*8)  TBLEMI(,,)= TABLE OF COLLISION EMISSIVITIES FOR
C                               PREDICTED SPECTRUM LINE.
C                               UNITS: PH CM-2 SEC-1
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C                               3RD DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLWLN(,,)= TABLE OF WAVELENGTHS FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: A
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C                               3RD DIMENSION: PREDICTED LINE INDEX.
C
C  PARAM : (I*4)  C1        = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  C2        = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  C3        = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  C4        = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  C5        = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  RZ        = PRECISION AIR WAVELENGTH PARAM.
C
C          (I*4)  IN        = LOOP INDEX FOR SPECTRUM LINES.
C          (I*4)  N         = PRINCIPAL QUANTUM NUMBER OF INITIAL
C                             STATE.
C          (I*4)  L         = LOOP INDEX FOR ORBITAL QUANTUM NUMBER OF
C          (I*4)  J         = LOOP INDEX FOR J QUANTUM NUMBER OF
C                             INITIAL STATE.
C          (I*4)  N1        = PRINCIPAL QUANTUM NUMBER OF FINAL STATE.
C          (I*4)  L1        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER OF
C                             FINAL STATE.
C          (I*4)  J1        = LOOP INDEX FOR J QUANTUM NUMBER OF
C                             FINAL STATE.
C          (I*4)  NP        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  IDL       = TABLE INDEX.
C          (I*4)  ID        = TABLE INDEX.
C
C          (R*8)  Z1        = REAL VALUE = IZ1.
C          (R*8)  ZEFF1     = EFFECTIVE ION CHARGE.
C          (R*8)  ZEFF2     = EFFECTIVE ION CHARGE.
C          (R*8)  ZEFF3     = EFFECTIVE ION CHARGE.
C          (R*8)  SUM1      = SUM OF COL. POP. FOR PREDICTED LINE.
C                             UNITS: CM-2
C          (R*8)  SUM2      = SUM OF COL. EMIS. FOR PREDICTED LINE.
C                             UNITS: PH CM-2 SEC-1
C          (R*8)  SUM3      = SUM OF WAVELENGTHS FOR PREDICTED LINE.
C                             UNITS: A
C          (R*8)  EU0       = BINDING ENERGY
C                             UNITS: RYD
C          (R*8)  T1        = COL. POP. FOR PREDICTED SPECTRUM LINE.
C                             UNITS: CM-2
C          (R*8)  T2        = COL. EMIS. FOR PREDICTED SPECTRUM LINE.
C                             UNITS: PH CM-2 SEC-1
C          (R*8)  DELTA     =
C          (R*8)  SIG2      =
C          (R*8)  RF        =
C          (R*8)  WAVAIR    = WAVELENGTH FOR PREDICTED SPECTRUM LINE.
C                             UNITS: A
C
C          (R*8)  EL()      = BINDING ENERGY.
C                             UNITS: RYD
C                             DIMENSION: J SHELL INDEX WHERE:
C                                        1 => L+0.5
C                                        2 => L-0.5
C          (R*8)  EUJ()     = INITIAL STATE J RESOLVED ENERGY.
C                             DIMENSION: J SHELL INDEX WHERE:
C                                        1 => L+0.5
C                                        2 => L-0.5
C          (R*8)  AA()      = LJ RESOLVED A-VALUE.
C                             DIMENSION: TRANSITION INDEX WHERE:
C                                        1 => L+0.5 --> L'+0.5
C                                        2 => L+0.5 --> L'-0.5
C                                        3 => L-0.5 --> L'+0.5
C                                        4 => L-0.5 --> L'-0.5
C
C          (R*8)  ELJ(,)    = FINAL STATE J RESOLVED ENERGY.
C                             1ST DIMENSION: L SHELL INDEX WHERE:
C                                          1 => L'=L+1
C                                          2 => L'=L-1
C                             2ND DIMENSION: J SHELL INDEX WHERE:
C                                          1 => J'=L'+0.5
C                                          2 => J'=L'-0.5
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          I4IDLI     ADAS      RETURNS INDEX FOR PREDICTED SPECTRUM
C                               LINE TABLES.
C          R8ZETA     ADAS
C          C6AJTB     ADAS      RETURNS LJ RESOLVED A-VALUES.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
```

```
C             3 : J=L-0.5 -> J'=L'+0.5
C             4 : J=L-0.5 -> J'=L'-0.5
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    09/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL  , I4IDLI
      REAL*8     R8ZETA
C-----------------------------------------------------------------------
      INTEGER    MXJ
      PARAMETER( MXJ = 2 )
C-----------------------------------------------------------------------
      REAL*8     C1                , C2                ,
     &           C3                , C4                ,
     &           C5                , RZ
      PARAMETER( C1 = 6432.8D0     , C2 = 2949810.0D0  ,
     &           C3 = 25540.0D0    , C4 = 176.0D0      ,
     &           C5 = 41.0D0       , RZ = 109737.2D0    )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , MXPRSL  , IZ0     , IZ1     ,
     &           NPLINE  , NUMAX
      INTEGER    IN      , N       , L       , J       , N1      ,
     &           L1      , J1      , NP      , IDL     , ID
C-----------------------------------------------------------------------
      REAL*8     EM
      REAL*8     Z1      , ZEFF1   , ZEFF2   , ZEFF3   , SUM1    ,
     &           SUM2    , SUM3    , EU0     , T1      , T2      ,
     &           DELTA   , SIG2    , RF      , WAVAIR
C-----------------------------------------------------------------------
      INTEGER    NPU(MXPRSL)  , NPL(MXPRSL)
C-----------------------------------------------------------------------
      REAL*8     QEX(MXNSHL)     , TOTPOP(MXPRSL)  , TOTEMI(MXPRSL)  ,
     &           AVRGWL(MXPRSL)  , QEFF(MXPRSL)
      REAL*8     EL(MXJ)         , EUJ(MXJ)        , AA(2*MXJ)
C-----------------------------------------------------------------------
      REAL*8     WHIGH(MXJSHL,(MXNSHL*(MXNSHL+1))/2)
      REAL*8     ELJ(MXJ,MXJ)
C-----------------------------------------------------------------------
      REAL*8     WLOW(MXJSHL,(MXNSHL*(MXNSHL+1))/2,MXNSHL) ,
     &           TBLPOP(2*MXJSHL,2*MXNSHL-3,MXPRSL)        ,
     &           TBLEMI(2*MXJSHL,2*MXNSHL-3,MXPRSL)        ,
     &           TBLWLN(2*MXJSHL,2*MXNSHL-3,MXPRSL)
C-----------------------------------------------------------------------
```

C6QEIK(

```
      SUBROUTINE C6QEIK( MXNSHL , MXJSHL , MXBEAM , IZ1    ,
     &                   IDONOR , NBOT   , NTOP   , NBEAM  ,
     &                   BMENA  , BMFRA  , QTHCH  , FTHCHJ
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6QEIK *********************
C
C  PURPOSE:  USES THE EIKONIAL APPROXIMATION TO CALCULATE THE
C            THEORETICAL CHARGE EXCHANGE RATE COEFFICIENTS TO N SHELLS
C            AND THE NLJ FRACTIONS FROM NEUTRAL HYDROGEN OR HELLIUM IN
C            GROUND OR EXCITED STATE TO A BARE NUCLEUS TARGET.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NO. OF N SHELLS.
C  INPUT : (I*4)  MXJSHL    = MAXIMUM NO. OF J SUB-SHELLS.
C  INPUT : (I*4)  MXBEAM    = MAXIMUM NO. OF BEAM ENERGIES.
C  INPUT : (R*8)  IZ1       = CHARGE OF TARGET ION.
C  INPUT : (I*4)  IDONOR    = DONOR STATE FOR EIKONAL MODEL.
C                             1 = H(1S)    DONOR
C                             2 = H(2S)    DONOR
C                             3 = H(2P)    DONOR
C                             4 = H(1S2)   DONOR
C                             5 = HE(1S2S) DONOR
C  INPUT : (I*4)  NBOT      = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NTOP      = MAXIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NBEAM     = NUMBER OF BEAM ENERGIES.
```

```
C  INPUT : (R*8)  BMENA()   = BEAM ENERGY COMPONENTS.
C                              UNITS: EV/AMU
C                              DIMENSION: COMPONENT INDEX.
C  INPUT : (R*8)  BMFRA()   = BEAM COMPONENT FRACTIONS.
C                              DIMENSION: COMPONENT INDEX.
C
C  OUTPUT: (R*8)  QTHCH()   = MEAN RATE COEFFICIENTS FOR N-LEVELS
C                              AVERAGED OVER BEAM FRACTIONS.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: REFERENCED BY N QUANTUM NUMBER.
C  OUTPUT: (R*8)  FTHCHJ(,) = MEAN RATE COEFFICIENTS FOR NLJ-LEVELS
C                              AVERAGED OVER BEAM FRACTIONS. EXPRESSED AS
C                              FRACTIONS OF CORRESPONDING N-LEVELS.
C                              1ST DIMENSION: J SUB-SHELL
C                                             1 => J=L+0.5
C                                             2 => J=L-0.5
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L)
C
C  PARAM : (I*4)  MXN       = 'MXNSHL'.
C
C          (I*4)  N         = N-SHELL INDEX.
C          (I*4)  L         = L-SHELL INDEX.
C          (I*4)  J         = J-SHELL INDEX.
C          (I*4)  IDL       = L-RESOLVED INDEX.
C
C          (R*8)  XL        = REAL VALUE = L.
C          (R*8)  WL        =
C
C          (R*8)  FTHCH()   = MEAN RATE COEFFICIENTS FOR NL-LEVELS
C                              AVERAGED OVER BEAM FRACTIONS. EXPRESSED AS
C                              FRACTIONS OF CORRESPONDING N-LEVELS.
C                              DIMENSION: REFERENCED BY I4IDFL(N,L)
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          CXQEIK     ADAS      CALCULATES N-LEVEL AND NL-LEVEL CHARGE
C                               EXCHANGE RATE COEFFICIENTS USING EIKONAL
C                               APPROX. NL RATES ARE GIVEN AS FRACTION
C                               OF CORRESPONDING N RATE.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    22/10/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXN
      PARAMETER( MXN = 20 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , MXBEAM  , IZ1     , IDONOR  ,
     &           NBOT    , NTOP    , NBEAM
      INTEGER    N       , L       , J       , IDL
C-----------------------------------------------------------------------
      REAL*8     XL      , WL
C-----------------------------------------------------------------------
      REAL*8     BMENA(MXBEAM)                ,
     &           BMFRA(MXBEAM)                ,
     &           QTHCH(MXNSHL)
      REAL*8     FTHCH((MXN*(MXN+1))/2)
      REAL*8     FTHCHJ(MXJSHL,(MXNSHL*(MXNSHL+1))/2)
C-----------------------------------------------------------------------
```

C6QXCH

```
      SUBROUTINE C6QXCH ( MXNENG , MXNSHL , MXJSHL , MXBEAM ,
     &                    NBEAM  , BMENA  , BMFRA  , NBOT   ,
     &                    NTOP   , NMINF  , NMAXF  , NENRGY ,
     &                    ENRGYA , ALPHAA , XSECNA , FRACLA ,
     &                    QTHCH  , FTHCHJ
     &                  )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
```

```
C
C  ****************** FORTRAN77 SUBROUTINE: C6QXCH *********************
C
C  PURPOSE:  USES THE INPUT DATASET TO CALCULATE THE CHARGE EXCHANGE
C            RATE COEFFICIENTS FOR BOTH N-LEVELS AND NLJ-LEVELS AVERAGED
C            OVER THE BEAM FRACTIONS. NLJ-LEVEL RATES ARE EXPRESSED AS A
C            FRACTION OF CORRESPONDING N-LEVEL.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNENG    = MAXIMUM NO. OF ENERGIES.
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NO. OF N SHELLS.
C  INPUT : (I*4)  MXJSHL    = MAXIMUM NO. OF J SUB-SHELLS.
C  INPUT : (I*4)  MXBEAM    = MAXIMUM NO. OF BEAM ENERGIES.
C  INPUT : (I*4)  NBEAM     = NUMBER OF BEAM ENERGIES.
C  INPUT : (R*8)  BMENA()   = BEAM ENERGY COMPONENTS.
C                             UNITS: EV/AMU
C                             DIMENSION: COMPONENT INDEX.
C  INPUT : (R*8)  BMFRA()   = BEAM COMPONENT FRACTIONS.
C                             DIMENSION: COMPONENT INDEX.
C  INPUT : (I*4)  NBOT      = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NTOP      = MAXIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NMINF     = MINIMUM PRINCIPAL QUANTUM NUMBER OF INPUT
C                             DATASET.
C  INPUT : (I*4)  NMAXF     = MAXIMUM PRINCIPAL QUANTUM NUMBER OF INPUT
C                             DATASET.
C  INPUT : (I*4)  NENRGY    = NUMBER OF ENERGIES IN DATASET.
C  INPUT : (R*8)  ENRGYA()  = COLLISION ENERGIES.
C                             UNITS: EV/AMU
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  ALPHAA()  = EXTRAPOLATION PARAMETER ALPHA.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  XSECNA(,) = N-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS.
C                             UNITS: CM2
C                             1ST DIMENSION: ENERGY INDEX
C                             2ND DIMENSION: N-SHELL
C  INPUT : (R*8)  FRACLA(,) = L-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS
C                             EXPRESSED AS FRACTION OF CORRESPONDING
C                             N-RESOLVED CROSS-SECTION.
C                             1ST DIMENSION: ENERGY INDEX
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L)
C
C  OUTPUT: (R*8)  QTHCH()   = MEAN RATE COEFFICIENTS FOR N-LEVELS
C                             AVERAGED OVER BEAM FRACTIONS.
C                             UNITS: CM3 SEC-1
C                             DIMENSION: REFERENCED BY N QUANTUM NUMBER.
C  OUTPUT: (R*8)  FTHCHJ(,) = MEAN RATE COEFFICIENTS FOR NLJ-LEVELS
C                             AVERAGED OVER BEAM FRACTIONS. EXPRESSED AS
C                             FRACTIONS OF CORRESPONDING N-LEVELS.
C                             1ST DIMENSION: J SUB-SHELL
C                                            1 => J=L+0.5
C                                            2 => J=L-0.5
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L)
C
C  PARAM : (I*4)  MXN       = 'MXNSHL'.
C
C          (I*4)  N         = N-SHELL INDEX.
C          (I*4)  L         = L-SHELL INDEX.
C          (I*4)  J         = J-SHELL INDEX.
C          (I*4)  IDL       = L-RESOLVED INDEX.
C
C          (R*8)  XL        = REAL VALUE = L.
C          (R*8)  WL        =
C
C          (R*8)  FTHCH()   = MEAN RATE COEFFICIENTS FOR NL-LEVELS
C                             AVERAGED OVER BEAM FRACTIONS. EXPRESSED AS
C                             FRACTIONS OF CORRESPONDING N-LEVELS.
C                             DIMENSION: REFERENCED BY I4IDFL(N,L)
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          CXQXCH     ADAS      CALCULATES N-LEVEL AND NL-LEVEL CHARGE
C                               EXCHANGE RATE COEFFICIENTS USING INPUT
C                               DATASET. NL RATES ARE GIVEN AS FRACTION
C                               OF CORRESPONDING N RATE.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    22/10/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
```

```
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXN
      PARAMETER( MXN = 20 )
C-----------------------------------------------------------------------
      INTEGER    MXNENG  , MXNSHL  , MXJSHL  , MXBEAM  , NBEAM   ,
     &           NBOT    , NTOP    , NMINF   , NMAXF   , NENRGY
      INTEGER    N       , L       , J       , IDL
C-----------------------------------------------------------------------
      REAL*8     XL      , WL
C-----------------------------------------------------------------------
      REAL*8     BMENA(MXBEAM)                ,
     &           BMFRA(MXBEAM)                ,
     &           ENRGYA(MXNENG)               ,
     &           ALPHAA(MXNENG)               ,
     &           QTHCH(MXNSHL)
      REAL*8     FTHCH((MXN*(MXN+1))/2)
      REAL*8     XSECNA(MXNENG,MXNSHL)                ,
     &           FRACLA(MXNENG,(MXNSHL*(MXNSHL+1))/2)  ,
     &           FTHCHJ(MXJSHL,(MXNSHL*(MXNSHL+1))/2)
C-----------------------------------------------------------------------
```

C6TBEX

```
      SUBROUTINE C6TBEX( MXNSHL , MXJSHL , IZ1    , NBOT   ,
     &                   NTOP   , NGRND  , TEV    , QTHEX  ,
     &                   FTHEXJ
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6TBEX *********************
C
C  PURPOSE:  SETS UP A TABLE OF ELECTRON IMPACT EXCITATION RATE
C            COEFFICIENTS FOR A HYDROGENIC ION FROM THE GROUND STATE
C            TO EXCITED NL LEVELS.
C
C  CALLING PROGRAM: ADAS306.
C
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NO. OF N SHELLS.
C  INPUT : (I*4)  MXJSHL    = MAXIMUM NO. J SUB-SHELLS.
C  INPUT : (I*4)  IZ1       = ION CHARGE.
C  INPUT : (I*4)  NBOT      = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NTOP      = MAXIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NGRND     =
C  INPUT : (R*8)  TEV       = ELECTRON TEMPERATURE.
C                             UNITS: EV
C
C  OUTPUT: (R*8)  QTHEX()   = TABLE OF N-LEVEL EXCITATION RATE
C                             COEFFICIENTS.
C                             UNITS:
C                             DIMENSION: N-SHELL
C  OUTPUT: (R*8)  FTHEXJ(,) = TABLE OF NLJ-LEVEL EXCITATION RATE
C                             COEFFICIENTS EXPRESSED AS FRACTION OF
C                             CORRESPONDING N-LEVEL RATE.
C                             1ST DIMENSION: J SUB-SHELL
C                                            1 => J=L+0.5
C                                            2 => J=L-0.5
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L)
C
C  PARAM : (I*4)  MXN       = 'MXNSHL'.
C
C          (I*4)  N         = N-SHELL INDEX.
C          (I*4)  L         = L-SHELL INDEX.
C          (I*4)  J         = J-SHELL INDEX.
C          (I*4)  IDL       = L-RESOLVED INDEX.
C
C          (R*8)  XL        = REAL VALUE = L.
C          (R*8)  WL        =
C
C          (R*8)  TBQEX()   = TABLE OF NL-LEVEL EXCITATION RATE
C                             COEFFICIENTS.
C                             UNITS:
C                             DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  FTHEX()   = TABLE OF NL-LEVEL EXCITATION RATE
C                             COEFFICIENTS EXPRESSED AS FRACTION OF
C                             CORRESPONDING N-LEVEL RATE.
C                             DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          CXTBEX     ADAS      CALCULATES N-LEVEL AND NL-LEVEL
C                               EXCITATION RATE COEFFICIENTS. NL RATES
C                               ARE GIVEN AS FRACTION OF CORRESPONDING
C                               N RATE.
C
```

```
C AUTHOR:   JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C           K1/0/81
C           JET EXT. 5183
C
C DATE:     22/10/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXN
      PARAMETER( MXN = 20 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , IZ1     , NBOT    , NTOP   ,
     &           NGRND
      INTEGER    N       , L       , J       , IDL
C-----------------------------------------------------------------------
      REAL*8     TEV
      REAL*8     XL      , WL
C-----------------------------------------------------------------------
      REAL*8     QTHEX(MXNSHL)
      REAL*8     TBQEX((MXN*(MXN+1))/2)  ,
     &           FTHEX((MXN*(MXN+1))/2)
      REAL*8     FTHEXJ(MXJSHL,(MXNSHL*(MXNSHL+1))/2)
C-----------------------------------------------------------------------
```

C6TBFM

```
      SUBROUTINE C6TBFM( MXNSHL , MXJSHL , IZ0    , IZ1    ,
     &                   AMSSNO , NBOT   , NTOP   , BMAG   ,
     &                   TIEV   , TBLF   , TBFMP  , TBFM   ,
     &                   TBFMM
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6TBFM *********************
C
C  PURPOSE:  FILLS TABLES OF  MAGNETIC FIELD DEPENDENT MIXING RATE
C            COEFFICIENTS BETWEEN NEARLY DEGENERATE LEVELS FOR
C            HYDROGEN-LIKE, LITHIUM-LIKE AND SODIUM-LIKE IONS. RATES
C            ARE CALCULATED FOR THE SEPARATE NLJ->NL+1J', NLJ->NLJ'
C            AND NLJ->NL-1J' TRANSITIONS.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNSHL  = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL  = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  IZ0     = TARGET NUCLEAR CHARGE.
C  INPUT : (I*4)  IZ1     = ION CHARGE.
C  INPUT : (R*8)  AMSSNO  = ATOMIC MASS NO.
C  INPUT : (I*4)  NBOT    = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NTOP    = MAXIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  BMAG    = MAGNETIC INDUCTION.
C                           UNITS: TESLA
C  INPUT : (R*8)  TIEV    = TEMPERATURE (ION DISTRIBUTION).
C                           UNITS: EV
C  INPUT : (R*8)  TBLF()  = TABLE OF RADIATIVE LIFETIMES.
C                           UNITS: SECS
C                           DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  OUTPUT: (R*8)  TBFMP(,)= RATE COEFFT. FOR NLJ->NL+1J'.
C                           1ST DIMENSION: J->J' TRANSITION INDEX.
C                           2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  OUTPUT: (R*8)  TBFM(,) = RATE COEFFT. FOR NLJ->NL+1J'.
C                           1ST DIMENSION: J->J' TRANSITION INDEX.
C                           2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  OUTPUT: (R*8)  TBFMM(,)= RATE COEFFT. FOR NLJ->NLJ' FOR STATE I.
C                           1ST DIMENSION: J->J' TRANSITION INDEX.
C                           2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C  PARAM : (I*4)  MXJ     = 'MXJSHL'.
C
C          (I*4)  NI      = VALENCE ELECTRON PRINCIPAL QUANTUM NUMBER
C                           IN STATE I.
C          (I*4)  NJ      = VALENCE ELECTRON PRINCIPAL QUANTUM NUMBER
C                           IN STATE J.
C          (I*4)  LI      = VALENCE ELECTRON ORBITAL QUANTUM NUMBER IN
C                           STATE I.
C          (I*4)  LJ      = VALENCE ELECTRON ORBITAL QUANTUM NUMBER IN
```

```
C                           STATE J.
C          (I*4)  IDLI    = TABLE INDEX.
C          (I*4)  IDLJ    = TABLE INDEX.
C          (I*4)  I       = LOOP INDEX.
C          (I*4)  J       = LOOP INDEX.
C
C          (R*8)  FMP()   = RATE COEFFT. FOR NLJ->NL+1J'.
C                           DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  FMM()   = RATE COEFFT. FOR NLJ->NL+1J'.
C                           DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  FMI()   = RATE COEFFT. FOR NLJ->NLJ' FOR STATE I.
C                           DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  FMJ()   = RATE COEFFT. FOR NLJ->NLJ' FOR STATE J.
C                           DIMENSION: J->J' TRANSITION INDEX.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C       2) BEFORE CALLING C6TBQM THE LIFETIME TABLE MUST BE FILLED
C          WITH A CALL TO C6TBLF.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          CXMRDG     ADAS      CALCULATES MIXING RATE COEFFICIENTS
C                               BETWEEN NEARLY DEGENERATE LEVELS OF
C                               H-, LI- OR NA-LIKE IONS.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    04/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXJ
      PARAMETER( MXJ = 2 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , IZ0     , IZ1     , NTOP    ,
     &           NBOT
      INTEGER    NI      , NJ      , LI      , LJ      , IDLI    ,
     &           IDLJ    , I       , J
C-----------------------------------------------------------------------
      REAL*8     AMSSNO  , BMAG    , TIEV
C-----------------------------------------------------------------------
      REAL*8     TBLF((MXNSHL*(MXNSHL+1))/2)           ,
     &           TBFMP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBFM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           TBFMM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)
      REAL*8     FMP(2*MXJ)  , FMM(2*MXJ)  , FMI(2*MXJ)  ,
     &           FMJ(2*MXJ)
C-----------------------------------------------------------------------
```

C6TBIN

```
      SUBROUTINE C6TBIN( MXNSHL , IZ1 , NBOT , NTOP , TEV , QTHIN )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6TBIN *********************
C
C  PURPOSE:  SETS UP AN ELECTRON IMPACT IONISATION RATE COEFFICIENT
C            TABLE FOR N-LEVELS BASED ON THE ECIP APPROXIMATION. ENERGY
C            LEVELS ARE ASSUMED HYDROGENIC IN THE EFFECTIVE ION CHARGE.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
```

```
C  INPUT : (I*4)  NTOP     = MAXIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  TEV      = ELECTRON TEMPERATURE.
C                            UNITS: EV
C
C  OUTPUT: (R*8)  QTHIN()  = IONISATION RATE COEFFICIENT.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: N SHELL INDEX.
C
C  PARAM : (R*8)  P1       =
C
C          (I*4)  N        = LOOP INDEX.
C          (I*4)  IZC      = IZ1-1.
C
C          (R*8)  ZETA     = EFFECTIVE NUMBER OF EQUIVALENT ELECTRONS FOR
C                            SHELL.
C          (R*8)  TE       = ELECTRON TEMPERATURE.
C                            UNITS: K
C          (R*8)  XI       =
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          R8ECIP     ADAS
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    03/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      REAL*8     R8ECIP
C-----------------------------------------------------------------------
      REAL*8     P1
      PARAMETER( P1 = 1.16054D4 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , IZ1     , NBOT    , NTOP
      INTEGER    N       , IZC
C-----------------------------------------------------------------------
      REAL*8     TEV
      REAL*8     ZETA    , TE      , XI
C-----------------------------------------------------------------------
      REAL*8     QTHIN(MXNSHL)
C-----------------------------------------------------------------------
```

C6TBQM

```
      SUBROUTINE C6TBQM( MXNSHL , MXJSHL , IZ0    , IZ1    ,
     &                   NBOT   , NTOP   , TEV    , DENS   ,
     &                   ZP     , TPV    , EMP    , TBLF   ,
     &                   TBQMEP , TBQMEM , TBQMIP , TBQMIM
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6TBQM *********************
C
C  PURPOSE:  SETS UP TABLES OF ELECTRON AND POSITIVE ION COLLISIONAL
C            RATE COEFFICIENTS BETWEEN NEARLY DEGENERATE LEVELS FOR
C            H-, LI-, AND NA-LIKE IONS. THE RATES FOR THE SEPARATE
C            TRANSITIONS NLJ->NL+1J' AND NLJ->NL-1J' ARE OBTAINED.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  MXJSHL   = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  IZ0      = NUCLEAR CHARGE OF TARGET ION.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NTOP     = MAXIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  TEV      = ELECTRON TEMPERATURE.
C                            UNITS: EV
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  ZP       = CHARGE OF COLLIDING POSITIVE ION.
C  INPUT : (R*8)  TPV      = TEMPERATURE (COLLIDING POSITIVE ION
C                            DISTRIBUTION).
C                            UNITS: EV
C  INPUT : (R*8)  EMP      = REDUCED MASS FOR COLLIDING POSITIVE ION.
```

```
C                               UNITS: ELECTRON MASSES
C  INPUT : (R*8)  ZP       = CHARGE OF COLLIDING POSITIVE ION.
C  INPUT : (R*8)  TPV      = POSITIVE ION TEMPERATURE.
C                               UNITS: EV
C  INPUT : (R*8)  EMP      = REDUCED MASS FOR COLLIDING POSITIVE ION.
C                               UNITS: ELECTRON MASSES
C  INPUT : (R*8)  TBLF()   = TABLE OF RADIATIVE LIFETIMES.
C                               UNITS: SECS
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  OUTPUT: (R*8)  TBQMEP(,)= ELECTRON RATE COEFFT. FOR NLJ->NL+1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  OUTPUT: (R*8)  TBQMEM(,)= ELECTRON RATE COEFFT. FOR NLJ->NL-1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  OUTPUT: (R*8)  TBQMIP(,)= POSITIVE ION RATE COEFFT. FOR NLJ->NL+1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  OUTPUT: (R*8)  TBQMIM(,)= POSITIVE ION RATE COEFFT. FOR NLJ->NL-1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C  PARAM : (I*4)  MXJ      = 'MXJSHL'.
C
C          (I*4)  NI       = VALENCE ELECTRON PRINCIPAL QUANTUM NUMBER
C                            IN STATE I.
C          (I*4)  NJ       = VALENCE ELECTRON PRINCIPAL QUANTUM NUMBER
C                            IN STATE J.
C          (I*4)  LI       = VALENCE ELECTRON ORBITAL QUANTUM NUMBER IN
C                            STATE I.
C          (I*4)  LJ       = VALENCE ELECTRON ORBITAL QUANTUM NUMBER IN
C                            STATE J.
C          (I*4)  IDLI     = TABLE INDEX.
C          (I*4)  IDLJ     = TABLE INDEX.
C          (I*4)  I        = LOOP INDEX.
C          (I*4)  J        = LOOP INDEX.
C
C          (R*8)  GAE      = GAMA RATE PARAMETER FOR ELECTRON COLLISIONS.
C          (R*8)  GAP      = GAMA RATE PARAMETER FOR POSITIVE ION
C                            COLLISIONS.
C
C          (R*8)  QEP()    = ELECTRON RATE COEFFT. FOR NLJ->NL+1J'
C                            DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  QEM()    = ELECTRON RATE COEFFT. FOR NLJ->NL-1J'
C                            DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  QIP()    = POSITIVE ION RATE COEFFT. FOR NLJ->NL+1J'
C                            DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  QIM()    = POSITIVE ION RATE COEFFT. FOR NLJ->NL-1J'
C                            DIMENSION: J->J' TRANSITION INDEX.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C       2) BEFORE CALLING C6TBQM THE LIFETIME TABLE MUST BE FILLED
C          WITH A CALL TO C6TBLF.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          CXCRDG     ADAS      CALCULATES COLLISIONAL RATE COEFFICIENTS
C                               BETWEEN NEARLY DEGENERATE LEVELS OF
C                               H-, LI- OR NA-LIKE IONS.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    02/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXJ
      PARAMETER( MXJ = 2 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , IZ0     , IZ1     , NTOP    ,
     &           NBOT
      INTEGER    NI      , NJ      , LI      , LJ      , IDLI    ,
```

```
     &           IDLJ    , I       , J
C-----------------------------------------------------------------------
      REAL*8     TEV     , DENS    , ZP      , TPV     , EMP
      REAL*8     GAE     , GAP
C-----------------------------------------------------------------------
      REAL*8     TBLF((MXNSHL*(MXNSHL+1))/2)             ,
     &           TBQMEP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)
      REAL*8     QEP(2*MXJ)  , QEM(2*MXJ)  , QIP(2*MXJ)  ,
     &           QIM(2*MXJ)
C-----------------------------------------------------------------------
```

C6TBRC

```
      SUBROUTINE C6TBRC( MXNSHL , MXJSHL , IZ1    , NBOT   ,
     &                   NTOP   , TEV    , QTHRC  , FTHRCJ
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6TBRC *********************
C
C  PURPOSE:  SETS UP A TABLE OF RADIATIVE RECOMBINATION RATE
C            COEFFICIENTS FOR A BARE NUCLEUS, HELIUM-LIKE OR NEON-LIKE
C            ION TO EXCITED NLJ LEVELS.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  MXJSHL   = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NTOP     = MAXIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  TEV      = ELECTRON TEMPERATURE.
C                            UNITS: EV
C
C  OUTPUT: (R*8)  QTHRC()  = RECOMBINATION RATE COEFFICIENT TO LEVEL N.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: N-SHELL
C  OUTPUT: (R*8)  FTHRCJ(,)= FRACTION OF RECOMBINATION RATE OF LEVEL N
C                            TO STATE NLJ.
C                            1ST DIMENSION: J-SHELL INDEX WHERE
C                                           1 GIVES J=L+0.5
C                                           2 GIVES J=L-0.5
C                            2ND DIMENSION: REFERENCED BY I4IDFL().
C
C  PARAM : (R*8)  P1       = BOLTZMANN CONSTANT.
C                            UNITS: EV K-1
C  PARAM : (R*8)  P2       =
C
C          (I*4)  N        = PRINCIPAL QUANTUM NUMBER OF BOUND ELECTRON.
C          (I*4)  L        = ORBITAL QUANTUM NUMBER OF BOUND ELECTRON.
C          (I*4)  L1       = ORBITAL QUANTUM NUMBER OF FREE ELECTRON.
C          (I*4)  LP       = TOTAL ORBITAL ANGULAR MOMENTUM QUANTUM
C                            NUMBER OF PARENT STATE.
C          (I*4)  ISP      = 2*SP+1 WHERE SP IS TOTAL SPIN OF PAREN     T
C                            STATE.
C          (I*4)  LT       = TOTAL ORBITAL ANGULAR MOMENTUM QUANTUM
C                            NUMBER OF BOUND SYSTEM.
C          (I*4)  LT1      = TOTAL ORBITAL ANGULAR MOMENTUM QUANTUM
C                            NUMBER OF FREE SYSTEM.
C          (I*4)  IS       = 2*S+1 WHERE S IS TOTAL SPIN OF SYSTEM.
C          (I*4)  IRES     = LEVEL OF RESOLUTION.
C                          = 1 :
C                          = 2 : ABOVE LT1 SUM.
C                          = 3 : ABOVE LT SUM.
C                          = 4 : ABOVE S SUM.
C                          = 5 : UNRESOLVED GBF.
C          (I*4)  I        = LOOP INDEX.
C          (I*4)  J        = LOOP INDEX.
C          (I*4)  IDL      = TABLE INDEX.
C
C          (R*8)  Z1       = REAL VALUE = IZ1.
C          (R*8)  TE       = ELECTRON TEMPERATURE.
C                            UNITS: K
C          (R*8)  V        = EFFECTIVE PRINCIPAL QUANTUM NUMBER OF BOUND
C                            ELECTRON.
C          (R*8)  FACT     =
C          (R*8)  SUM      =
C          (R*8)  XL       = REAL VALUE = L.
C          (R*8)  WL       =
C          (R*8)  T        =
C          (R*8)  PREC1    = RADIATIVE RECOMBINATION INTEGRAL.
C          (R*8)  PION1    = PHOTOIONISATION INTEGRAL.
C          (R*8)  PSTIM1   = STIMULATED RECOMBINATION INTEGRAL.
C          (R*8)  PREC2    = RADIATIVE RECOMBINATION INTEGRAL.
C          (R*8)  PION2    = PHOTOIONISATION INTEGRAL.
C          (R*8)  PSTIM2   = STIMULATED RECOMBINATION INTEGRAL.
C
```

```
C  PARAM : (R*8)  P1       = BOLTZMANN CONSTANT.
C                            UNITS: EV K-1
C  PARAM : (R*8)  P2       =
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          CXPHOT     ADAS      CALCULATES PHOTO INTEGRALS USING GIIH
C                               BOUND-FREE GAUNT-FACTORS.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    05/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C VERSION: 1.2                          DATE: 29-05-96
C MODIFIED: WILLIAM OSBORN
C               - REMOVED UNUSED VARIABLES
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4IDFL
C-----------------------------------------------------------------------
      REAL*8     P1               , P2
      PARAMETER( P1 = 8.61663D-5  , P2 = 1.5789D5 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , IZ1     , NBOT    , NTOP
      INTEGER    N       , L       , L1      , LP      , ISP     ,
     &           LT      , LT1     , IS      , IRES    , I       ,
     &           J       , IDL
C-----------------------------------------------------------------------
      REAL*8     TEV
      REAL*8     Z1      , TE      , V       , FACT    ,
     &           SUM     , XL      , WL      , T       , PREC1   ,
     &           PION1   , PSTIM1  , PREC2   , PION2   , PSTIM2
C-----------------------------------------------------------------------
      REAL*8     QTHRC(MXNSHL)
C-----------------------------------------------------------------------
      REAL*8     FTHRCJ(MXJSHL,(MXNSHL*(MXNSHL+1))/2)
C-----------------------------------------------------------------------
```

C6WFIL

```
      SUBROUTINE C6WFIL( MXNSHL , MXJSHL , IZ1    , NGRND  ,
     &                   NTOT   , NBOT   , NUMAX  , DENSZ  ,
     &                   DENS   , QTHEOR , FTHEOR , QTHIN  ,
     &                   TBQMEP , TBQMEM , TBQMIP , TBQMIM ,
     &                   TBFMP  , TBFM   , TBFMM  , WHIGH  ,
     &                   WLOW
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6WFIL *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C6EMIS
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  MXJSHL   = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT     = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                            STATE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (R*8)  DENSZ    = PLASMA ION DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE, EXCITATION RATE OR
C                            RECOMBINATION RATE COEFFICIENTS FOR
C                            N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: REFERENCED BY N QUANTUM NUMBER.
```

```
C  INPUT : (R*8)  FTHEOR(,)= FRACTION OF N-LEVEL MEAN CHARGE EXCHANGE,
C                            EXCITATION RATE OR RECOMBINATION RATE
C                            COEFFICIENTS IN NL-LEVEL.
C                            1ST DIMENSION: J SHELL INDEX WHERE:
C                                           1 GIVES J=L+0.5
C                                           2 GIVES J=L-0.5
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  QTHIN()  = IONISATION RATE COEFFICIENT.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  TBQMEP(,)= ELECTRON COLLISIONAL RATE COEFFT. FOR
C                            NLJ->NL+1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM(,)= ELECTRON COLLISIONAL RATE COEFFT. FOR
C                            NLJ->NL-1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP(,)= POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                            NLJ->NL+1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM(,)= POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                            NLJ->NL-1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMP(,) = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                            NLJ->NL+1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFM(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                            NLJ->NLJ'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMM(,) = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                            NLJ->NL-1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C  OUTPUT: (R*8)  WHIGH(,) =
C                            1ST DIMENSION: J SHELL INDEX.
C                            2ND DIMENSION: REFERENCED BY L+1.
C  OUTPUT: (R*8)  WLOW(,,) =
C                            1ST DIMENSION: J SHELL INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C                            3RD DIMENSION: REFERENCED BY L+1.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C  PARAM : (I*4)  MXJ      = MXJSHL.
C
C          (I*4)  N       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  J       = LOOP INDEX FOR J QUANTUM NUMBER.
C          (I*4)  N1      = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L1      = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N2      = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L2      = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  LP      = ARRAY INDEX = L+1.
C          (I*4)  IDL     = ARRAY INDEX.
C
C          (R*8)  AA()    = LJ RESOLVED A-VALUE.
C                           DIMENSION: TRANSITION INDEX WHERE:
C                                      1 GIVES LU+0.5 --> LL+0.5
C                                      2 GIVES LU+0.5 --> LL-0.5
C                                      3 GIVES LU-0.5 --> LL+0.5
C                                      4 GIVES LU-0.5 --> LL-0.5
C
C          (R*8)  RHS()   = RIGHT HAND SIDE OF N LEVEL EQUATION.
C                           1ST DIMENSION: MXJ.
C                           2ND DIMENSION: MXN.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          C6WSOL     ADAS
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C       2) FOR MATRIX HANDLING PURPOSES, L=0 STATES ARE TREATED AS TWO
C          STATES OF J=0.5. RATES INTO EACH OF THESE ARE SET EQUAL TO
C          HALF THE TOTAL INTO A TRUE L=0,J=0.5 STATE. RATES OUT OF
C          EACH STATE ARE SET EQUAL TO THE TOTAL OUT OF A TRUE L=0,J=0.5
C          STATE. THUS EACH ARTIFICIAL STATE HAS THE SAME POPULATION
C          WHICH IS HALF THE TOTAL OF THE TRUE L=0,J=0.5 STATE. THE
C          POPULATIONS ARE RECOMBINED AT THE END OF THE MATRIX
C          MANIPULATIONS.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
```

```
C
C DATE:    08/10/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXN       , MXJ
      PARAMETER( MXN = 20  , MXJ = 2 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , IZ1     , NGRND   , NTOT   ,
     &           NBOT    , NUMAX
      INTEGER    N       , L       , J       , N1      , L1     ,
     &           N2      , L2      , LP      , IDL
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS
C-----------------------------------------------------------------------
      REAL*8     QTHEOR(MXNSHL)  , QTHIN(MXNSHL)
      REAL*8     AA(2*MXJ)
C-----------------------------------------------------------------------
      REAL*8     FTHEOR(MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           TBQMEP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBFMM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           TBFM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           TBFMP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           WHIGH(MXJSHL,(MXNSHL*(MXNSHL+1))/2)
      REAL*8     RHS(MXJ,MXN)
C-----------------------------------------------------------------------
      REAL*8     WLOW(MXJSHL,(MXNSHL*(MXNSHL+1))/2,MXNSHL)
C-----------------------------------------------------------------------
```

C6WSOL

```
      SUBROUTINE C6WSOL( MXNSHL , MXJSHL , IZ1    , NGRND  ,
     &                   N      , DENSZ  , DENS   , QTHIN  ,
     &                   TBQMEP , TBQMEM , TBQMIP , TBQMIM ,
     &                   TBFMM  , TBFM   , TBFMP  , RHS
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6WSOL *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C6WFIL
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL   = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  N        = PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  DENSZ    = PLASMA ION DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  QTHIN()  = IONISATION RATE COEFFICIENT.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  TBQMEP(,)= ELECTRON RATE COEFFT. FOR NLJ->NL+1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM(,)= ELECTRON RATE COEFFT. FOR NLJ->NL-1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP(,)= POSITIVE ION RATE COEFFT. FOR NLJ->NL+1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM(,)= POSITIVE ION RATE COEFFT. FOR NLJ->NL-1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMP(,) = RATE COEFFT. FOR NLJ->NL+1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFM(,)  = RATE COEFFT. FOR NLJ->NL+1J'.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
```

```
C  INPUT : (R*8)  TBFMM(,) = RATE COEFFT. FOR NLJ->NLJ' FOR STATE I.
C                            1ST DIMENSION: J->J' TRANSITION INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C  I/O   : (R*8)  RHS()    =
C                            DIMENSION: REFERENCED BY L+1.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C  PARAM : (I*4)  MXJ      = MXJSHL.
C
C          (I*4)  L        = ORBITAL QUANTUM NUMBER.
C          (I*4)  L1       = ORBITAL QUANTUM NUMBER.
C          (I*4)  J        = J->J' TRANSITION INDEX.
C          (I*4)  IDL      = TABLE INDEX.
C          (I*4)  N1       = PRINCIPAL QUANTUM NUMBER.
C          (I*4)  LP       = ARRAY INDEX = L+1.
C
C          (R*8)  AA()     = LJ RESOLVED A-VALUE.
C                            DIMENSION: TRANSITION INDEX WHERE:
C                                       1 GIVES LU+0.5 --> LL+0.5
C                                       2 GIVES LU+0.5 --> LL-0.5
C                                       3 GIVES LU-0.5 --> LL+0.5
C                                       4 GIVES LU-0.5 --> LL-0.5
C
C          (R*8)  VDS(,)  =
C          (R*8)  VDI(,)  =
C          (R*8)  VD(,)   =
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C       2) FOR MATRIX HANDLING PURPOSES, L=0 STATES ARE TREATED AS TWO
C          STATES OF J=0.5. RATES INTO EACH OF THESE ARE SET EQUAL TO
C          HALF THE TOTAL INTO A TRUE L=0,J=0.5 STATE. RATES OUT OF
C          EACH STATE ARE SET EQUAL TO THE TOTAL OUT OF A TRUE L=0,J=0.5
C          STATE. THUS EACH ARTIFICIAL STATE HAS THE SAME POPULATION
C          WHICH IS HALF THE TOTAL OF THE TRUE L=0,J=0.5 STATE.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    08/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. IBM VERSION NOT CHANGED
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXN        , MXJ
      PARAMETER( MXN = 20   , MXJ = 2 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , NGRND   , N       , IZ1
      INTEGER    L       , L1      , J       , IDL     , N1      ,
     &           LP
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS
C-----------------------------------------------------------------------
      REAL*8     QTHIN(MXNSHL)
      REAL*8     AA(2*MXJ)
C-----------------------------------------------------------------------
      REAL*8     TBQMEP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBFMM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           TBFM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           TBFMP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           RHS(MXJSHL,MXNSHL)
      REAL*8     VDS(2*MXJ,MXN)  , VDI(2*MXJ,MXN)  , VD(2*MXJ,MXN)
C-----------------------------------------------------------------------
```

C7CXEE

```
      SUBROUTINE C7CXEE( MXNENG , MXNSHL , NGRND  , NTOT   ,
     &                   NBOT   , NTOP   , IRZ0   , IRZ1   ,
     &                   RAMSNO , TEV    , TIEV   , DENS   ,
     &                   DENSZ  , ZEFF   , BMAG   , BMENG  ,
     &                   ITHEOR , IBSTAT , IEMMS  , NTU    ,
     &                   NTL    , NMINF  , NMAXF  , NENRGY ,
     &                   ENRGYA , ALPHAA , XSECNA , FRACLA ,
     &                   ERATE
     &                 )
C
       IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C7CXEE *********************
C
C  PURPOSE:  CALCULATES THE J-RESOLVED EFFECTIVE EMISSIVITY RATE
C            COEFFICIENT FOR THE GIVEN TRANSITION.
C
C            IT IS APPLICABLE TO IMPURITIES IN PLASMA TRAVERSED BY
C            NEUTRAL BEAMS OF H OR HE. THE RECOMBINED TARGET ION MAY BE
C            H, LI OR NA-LIKE.
C
C            THE MODEL INCLUDES CAPTURE, N-N' LEVEL CASCADE, AND MIXING
C            AMONG L,J LEVELS OF SAME N BY COLLISIONS OR MAGNETIC
C            FIELDS.
C
C            ELECTRON IMPACT IONISATION IS INCLUDED TO GIVE COLLISION
C            LIMIT EFFECT.
C
C            AN INTERNAL EIKONAL APPROXIMATION IS USED FOR CAPTURE FROM
C            EXCITED H OR HE STATES, ALTHOUGH NORMALLY THE EXTERNAL DATA
C            SET SHOULD BE USED.
C
C  CALLING PROGRAM: ADAS307
C
C  INPUT : (I*4)  MXNENG    = MAXIMUM NO. OF ENERGIES IN DATA SET.
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  NGRND     = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT      = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                             STATE.
C  INPUT : (I*4)  NBOT      = MINIMUM PRINCIPAL QUANTUM NUMBER FOR
C                             RATE TABLES.
C  INPUT : (I*4)  NTOP      = MAXIMUM PRINCIPAL QUANTUM NUMBER FOR
C                             RATE TABLES.
C  INPUT : (I*4)  IRZ0      = RECEIVER NUCLEAR CHARGE.
C  INPUT : (I*4)  IRZ1      = RECEIVER ION INITIAL CHARGE.
C  INPUT : (R*8)  RAMSNO    = RECEIVER ATOMIC MASS.
C  INPUT : (R*8)  TEV       = ELECTRON TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  TIEV      = ION TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  DENS      = ELECTRON DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  DENSZ     = PLASMA ION DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  ZEFF      = EFFECTIVE ION CHARGE.
C  INPUT : (R*8)  BMAG      = PLASMA MAGNETIC INDUCTION.
C                             UNITS: TESLA
C  INPUT : (R*8)  BMENG     = BEAM ENERGY.
C                             UNITS: EV/AMU
C  INPUT : (I*4)  ITHEOR    = CHARGE EXCHANGE MODEL OPTION.
C                             1 => USE INPUT DATA SET.
C                             2 => USE EIKONAL MODEL.
C  INPUT : (I*4)  IBSTAT    = DONOR STATE FOR EIKONAL MODEL.
C                             1 => H(1S)
C                             2 => H(2S)
C                             3 => H(2P)
C                             4 => HE(1S2)
C                             5 => HE(1S2S)
C  INPUT : (I*4)  IEMMS     = EMISSION MEASURE MODEL OPTION.
C                             1 => CHARGE EXCHANGE.
C                             2 => ELECTRON IMPACT EXCITATION.
C                             3 => RADIATIVE RECOMBINATION.
C  INPUT : (I*4)  NTL       = LOWER PRINCIPAL QUANTUM NUMBER OF
C                             TRANSITION.
C  INPUT : (I*4)  NTU       = UPPER PRINCIPAL QUANTUM NUMBER OF
C                             TRANSITION.
C  INPUT : (I*4)  NMINF     = LOWEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (I*4)  NMAXF     = HIGHEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (I*4)  NENRGY    = NUMBER OF ENERGIES READ FROM DATA SET.
C  INPUT : (R*8)  ENRGYA()  = COLLISION ENERGIES READ FROM INPUT DATA
C                             SET.
C                             UNITS: EV/AMU
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  ALPHAA()  = EXTRAPOLATION PARAMETER ALPHA READ FROM
C                             INPUT DATA SET.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  XSECNA(,) = N-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS
C                             READ FROM INPUT DATA SET.
C                             UNITS: CM2
C                             1ST DIMENSION: ENERGY INDEX
C                             2ND DIMENSION: N-SHELL
C  INPUT : (R*8)  FRACLA(,) = L-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS.
```

```
C                              AFTER CXDATA: ABSOLUTE VALUES (CM2).
C                              AFTER CXFRAC: FRACTION OF N-RESOLVED
C                                            DATA.
C                              1ST DIMENSION: ENERGY INDEX
C                              2ND DIMENSION: INDEXED BY I4IDFL(N,L)
C
C  OUTPUT: (R*8)  ERATE     = EFFECTIVE EMISSIVITY RATE COEFFICIENT FOR
C                              REQUESTED TRANSITION
C                              SPECTRUM LINE.
C                              UNITS: CM3 SEC-1
C
C  PARAM : (I*4)  MXN       = MXNSHL.
C  PARAM : (I*4)  MXJSHL    = MAXIMUM NUMBER OF J SUB-SHELLS.
C  PARAM : (I*4)  MXBEAM    = MAXIMUM NUMBER OF BEAM COMPONENTS.
C  PARAM : (I*4)  MXOBSL    = MAXIMUM NUMBER OF OBSERVED SPECTRUM
C                              LINES.
C  PARAM : (I*4)  MXPRSL    = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                              PREDICT.
C
C  PARAM : (R*8)  EMP       = REDUCED MASS FOR POSITIVE ION.
C                              UNITS: ELECTRON MASSES
C
C          (I*4)  NBEAM     = NUMBER OF BEAM ENERGIES.
C          (I*4)  NOLINE    = NUMBER OF OBSERVED SPECTRUM LINES.
C          (I*4)  NPLINE    = NUMBER OF SPECTRUM LINES TO PREDICT.
C          (I*4)  NUMIN     = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                              FOR OBSERVED SPECTRUM LINES.
C          (I*4)  NUMAX     = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                              FOR OBSERVED SPECTRUM LINES.
C
C          (R*8)  EM        = EMMISSION MEASURE.
C                              UNITS: CM-5
C
C          (I*4)  NL()      = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                              OF OBSERVED SPECTRUM LINES.
C                              DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NU()      = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                              OF OBSERVED SPECTRUM LINES.
C                              DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NPL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                              OF SPECTRUM LINES TO PREDICT.
C                              DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NPU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                              OF SPECTRUM LINES TO PREDICT.
C                              DIMENSION: SPECTRUM LINE INDEX.
C
C          (R*8)  BMFRA()   = BEAM COMPONENT FRACTIONS.
C                              DIMENSION: COMPONENT INDEX.
C          (R*8)  BMENA()   = BEAM ENERGY COMPONENTS.
C                              UNITS: EV/AMU
C          (R*8)  EMISA()   = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                              LINES.
C                              UNITS: PH CM-2 SEC-1
C                              DIMENSION: SPECTRUM LINE INDEX.
C          (R*8)  TBLF()    = TABLE OF RADIATIVE LIFETIMES.
C                              UNITS: SECS
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  QTHIN()   = IONISATION RATE COEFFICIENT.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: N SHELL INDEX.
C          (R*8)  QTHEX()   = MEAN EXCITATION RATE COEFFICIENTS FOR
C                              N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: N SHELL INDEX.
C          (R*8)  QTHCH()   = MEAN CHARGE EXCHANGE COEFFICIENTS FOR
C                              N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: N SHELL INDEX.
C          (R*8)  QTHRC()   = MEAN RECOMBINATION RATE COEFFICIENTS FOR
C                              N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: N SHELL INDEX.
C          (R*8)  QEX()     =
C                              DIMENSION: N SHELL INDEX.
C          (R*8)  TOTPOP()  = TOTAL COLLISION POP. FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: CM-2
C                              DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  TOTEMI()  = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: PH CM-2 SEC-1
C                              DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  AVRGWL()  = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: A
C                              DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  QEFF()    = EFF. RATE COEFFICIENT FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: PREDICTED LINE INDEX.
C
C          (R*8)  FTHEXJ(,) = FRACTION OF N-LEVEL MEAN EXCITATION RATE
C                              COEFFICIENTS IN NLJ-LEVEL.
C                              1ST DIMENSION: J SHELL INDEX WHERE:
C                                             1 GIVES J=L+0.5
C                                             2 GIVES J=L-0.5
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  FTHCHJ(,) = FRACTION OF N-LEVEL MEAN CHARGE EXCHANGE
```

```
C                               COEFFICIENTS IN NLJ-LEVEL.
C                               1ST DIMENSION: J SHELL INDEX WHERE:
C                                              1 GIVES J=L+0.5
C                                              2 GIVES J=L-0.5
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  FTHRCJ(,) = FRACTION OF N-LEVEL MEAN RECOMBINATION
C                               RATE COEFFICIENTS IN NLJ-LEVEL.
C                               1ST DIMENSION: J SHELL INDEX WHERE:
C                                              1 GIVES J=L+0.5
C                                              2 GIVES J=L-0.5
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMEP(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                               NLJ->NL+1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMEM(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                               NLJ->NL-1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMIP(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                               NLJ->NL+1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMIM(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                               NLJ->NL-1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBFMP(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                               NLJ->NL+1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBFM(,)   = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                               NLJ->NLJ'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBFMM(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                               NLJ->NL-1J'.
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C          (R*8)  TBLPOP(,,)= TABLE OF COLLISION POP. FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: CM-2
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C                               3RD DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  TBLEMI(,,)= TABLE OF COLLISION EMISSIVITIES FOR
C                               PREDICTED SPECTRUM LINE.
C                               UNITS: PH CM-2 SEC-1
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C                               3RD DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  TBLWLN(,,)= TABLE OF WAVELENGTHS FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: A
C                               1ST DIMENSION: J->J' TRANSITION INDEX.
C                               2ND DIMENSION: REFERENCED BY I4IDLI().
C                               3RD DIMENSION: PREDICTED LINE INDEX.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          CXTBLF     ADAS      FILLS L-RESOLVED RADIATIVE LIFETIME
C                               TABLE.
C          C6TBIN     ADAS      FILLS N-RESOLVED ELECTRON IMPACT
C                               IONISATION RATE TABLE.
C          C6TBEX     ADAS      FILLS N AND J-RESOLVED ELECTRON IMPACT
C                               EXCITATION RATE TABLES.
C          C6QEIK     ADAS      FILLS N AND J-RESOLVED CHARGE EXCHANGE
C                               RATE TABLES USING EIKONAL APPROXIMATION.
C          C6QXCH     ADAS      FILLS N AND J-RESOLVED CHARGE EXCHANGE
C                               RATE TABLES USING INPUT DATA SET.
C          C6TBRC     ADAS      FILLS N AND J-RESOLVED RADIATIVE
C                               RECOMBINATION RATE TABLES.
C          C6TBQM     ADAS      FILLS N AND J-RESOLVED COLLISIONAL RATE
C                               TABLES.
C          C6TBFM     ADAS      FILLS N AND J-RESOLVED B-FIELD
C                               DEPENDENT MIXING RATE TABLES.
C          C7EMIS     ADAS      PREDICTS THE J-RESOLVED EMISSIVITY FOR
C                               REQUESTED TRANSITIONS.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    26/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
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C
C DATE:    24TH MAY 1996
C
C VERSION: 1.1                          DATE: 24-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    MXN          , MXJSHL       , MXBEAM       ,
     &           MXOBSL       , MXPRSL
      PARAMETER( MXN    = 20  , MXJSHL = 2   , MXBEAM = 1   ,
     &           MXOBSL = 1   , MXPRSL = 1                   )
C-----------------------------------------------------------------------
      REAL*8     EMP
      PARAMETER( EMP = 1836.0D0 )
C-----------------------------------------------------------------------
      INTEGER    MXNENG  , MXNSHL  , NGRND   , NTOT    , NBOT    ,
     &           NTOP    , IRZ0    , IRZ1    , ITHEOR  , IBSTAT  ,
     &           IEMMS   , NTU     , NTL     , NMINF   , NMAXF   ,
     &           NENRGY
      INTEGER    NBEAM   , NOLINE  , NPLINE  , NUMIN   , NUMAX
C-----------------------------------------------------------------------
      REAL*8     RAMSNO  , TEV     , TIEV    , DENS    , DENSZ   ,
     &           ZEFF    , BMAG    , BMENG   , ERATE
      REAL*8     EM
C-----------------------------------------------------------------------
      INTEGER    NL(MXOBSL)      , NU(MXOBSL)      , NPL(MXPRSL)     ,
     &           NPU(MXPRSL)
C-----------------------------------------------------------------------
      REAL*8     ENRGYA(MXNENG)  , ALPHAA(MXNENG)
      REAL*8     BMENA(MXBEAM)   , BMFRA(MXBEAM)   , EMISA(MXOBSL)   ,
     &           QTHIN(MXN)      , QTHEX(MXN)      , QTHCH(MXN)      ,
     &           QTHRC(MXN)      , QEX(MXN)        , TOTPOP(MXPRSL)  ,
     &           TOTEMI(MXPRSL)  , AVRGWL(MXPRSL)  , QEFF(MXPRSL)    ,
     &           TBLF((MXN*(MXN+1))/2)
C-----------------------------------------------------------------------
      REAL*8     XSECNA(MXNENG,MXNSHL)                              ,
     &           FRACLA(MXNENG,(MXNSHL*(MXNSHL+1))/2)
      REAL*8     FTHEXJ(MXJSHL,(MXN*(MXN+1))/2)                     ,
     &           FTHCHJ(MXJSHL,(MXN*(MXN+1))/2)                     ,
     &           FTHRCJ(MXJSHL,(MXN*(MXN+1))/2)                     ,
     &           TBQMEP(2*MXJSHL,(MXN*(MXN+1))/2)                   ,
     &           TBQMEM(2*MXJSHL,(MXN*(MXN+1))/2)                   ,
     &           TBQMIP(2*MXJSHL,(MXN*(MXN+1))/2)                   ,
     &           TBQMIM(2*MXJSHL,(MXN*(MXN+1))/2)                   ,
     &           TBFMP(2*MXJSHL,(MXN*(MXN+1))/2)                    ,
     &           TBFMM(2*MXJSHL,(MXN*(MXN+1))/2)                    ,
     &           TBFM(2*MXJSHL,(MXN*(MXN+1))/2)
C-----------------------------------------------------------------------
      REAL*8     TBLPOP(2*MXJSHL,2*MXN-3,MXPRSL)             ,
     &           TBLEMI(2*MXJSHL,2*MXN-3,MXPRSL)             ,
     &           TBLWLN(2*MXJSHL,2*MXN-3,MXPRSL)
C-----------------------------------------------------------------------
```

C7EMIS

```
      SUBROUTINE C7EMIS( MXNSHL , MXJSHL , MXOBSL , MXPRSL ,
     &                   IZ0    , IZ1    , NGRND  , NTOT   ,
     &                   NBOT   , DENSZ  , DENS   , NOLINE ,
     &                   NU     , NL     , EMISA  , NPLINE ,
     &                   NPU    , NPL    , QTHEOR , FTHEOR ,
     &                   QTHIN  , TBQMEP , TBQMEM , TBQMIP ,
     &                   TBQMIM , TBFMP  , TBFM   , TBFMM  ,
     &                   NUMIN  , NUMAX  , EM     , QEX    ,
     &                   TOTPOP , TOTEMI , AVRGWL , QEFF   ,
     &                   TBLPOP , TBLEMI , TBLWLN
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6EMIS *********************
C
C  PURPOSE: PREDICTS THE J-RESOLVED EMMISIVITY FOR REQUESTED
C           TRANSITIONS.
C
C  CALLING PROGRAM: ADAS306
C
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL    = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  MXOBSL    = MAXIMUM NUMBER OF OBSERVED SPECTRUM
C                             LINES.
C  INPUT : (I*4)  MXPRSL    = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                             PREDICT.
C  INPUT : (I*4)  IZ0       = NUCLEAR CHARGE.
C  INPUT : (I*4)  IZ1       = ION CHARGE.
C  INPUT : (I*4)  NGRND     = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT      = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
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C                                 STATE.
C  INPUT : (I*4)  NBOT      = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  DENSZ     = PLASMA ION DENSITY.
C                                 UNITS: CM-3
C  INPUT : (R*8)  DENS      = ELECTRON DENSITY.
C                                 UNITS: CM-3
C  INPUT : (I*4)  NOLINE    = NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()      = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                                 OF OBSERVED SPECTRUM LINES.
C                                 DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()      = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                                 OF OBSERVED SPECTRUM LINES.
C                                 DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()   = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                                 LINES.
C                                 DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NPLINE    = NUMBER OF SPECTRUM LINES TO PREDICT.
C  INPUT : (I*4)  NPU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                                 OF SPECTRUM LINES TO PREDICT.
C                                 DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NPL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                                 OF SPECTRUM LINES TO PREDICT.
C                                 DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  QTHEOR()  = MEAN CHARGE EXCHANGE, EXCITATION RATE OR
C                                 RECOMBINATION RATE COEFFICIENTS FOR
C                                 N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                                 UNITS: CM3 SEC-1
C                                 DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  FTHEOR(,) = FRACTION OF N-LEVEL MEAN CHARGE EXCHANGE,
C                                 EXCITATION RATE OR RECOMBINATION RATE
C                                 COEFFICIENTS IN NL-LEVEL.
C                                 1ST DIMENSION: J SHELL INDEX WHERE:
C                                                1 GIVES J=L+0.5
C                                                2 GIVES J=L-0.5
C                                 2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  QTHIN()   = IONISATION RATE COEFFICIENT.
C                                 UNITS: CM3 SEC-1
C                                 DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  TBQMEP(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                                 NLJ->NL+1J'.
C                                 1ST DIMENSION: J->J' TRANSITION INDEX.
C                                 2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                                 NLJ->NL-1J'.
C                                 1ST DIMENSION: J->J' TRANSITION INDEX.
C                                 2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                                 NLJ->NL+1J'.
C                                 1ST DIMENSION: J->J' TRANSITION INDEX.
C                                2 ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                                 NLJ->NL-1J'.
C                                 1ST DIMENSION: J->J' TRANSITION INDEX.
C                                 2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMP(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                                 NLJ->NL+1J'.
C                                 1ST DIMENSION: J->J' TRANSITION INDEX.
C                                 2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFM(,)   = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                                 NLJ->NLJ'.
C                                 1ST DIMENSION: J->J' TRANSITION INDEX.
C                                 2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C  INPUT : (R*8)  TBFMM(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                                 NLJ->NL-1J'.
C                                 1ST DIMENSION: J->J' TRANSITION INDEX.
C                                 2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C  OUTPUT: (I*4)  NUMIN     = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                                 FOR OBSERVED SPECTRUM LINES.
C  OUTPUT: (I*4)  NUMAX     = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                                 FOR OBSERVED SPECTRUM LINES.
C  OUTPUT: (R*8)  EM        = EMMISSION MEASURE.
C  OUTPUT: (R*8)  QEX()     =
C                                 DIMENSION: MXNSHL.
C  OUTPUT: (R*8)  TOTPOP()  = TOTAL COLLISION POP. FOR PREDICTED
C                                 SPECTRUM LINE.
C                                 UNITS: CM-2
C                                 DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TOTEMI()  = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                                 SPECTRUM LINE.
C                                 UNITS: PH CM-2 SEC-1
C                                 DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  AVRGWL()  = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                                 SPECTRUM LINE.
C                                 UNITS: A
C                                 DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  QEFF()    = EFF. RATE COEFFICIENT FOR PREDICTED
C                                 SPECTRUM LINE.
C                                 UNITS:
C                                 DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLPOP(,,)= TABLE OF COLLISION POP. FOR PREDICTED
C                                 SPECTRUM LINE.
C                                 UNITS: CM-2
C                                 1ST DIMENSION: J->J' TRANSITION INDEX.
C                                 2ND DIMENSION: REFERENCED BY I4IDLI().
C  OUTPUT: (R*8)  TBLEMI(,,)= TABLE OF COLLISION EMISSIVITIES FOR
C                                 PREDICTED SPECTRUM LINE.
C                                 UNITS: PH CM-2 SEC-1
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C                             1ST DIMENSION: J->J' TRANSITION INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDLI().
C                             3RD DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLWLN(,,)= TABLE OF WAVELENGTHS FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: A
C                             1ST DIMENSION: J->J' TRANSITION INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDLI().
C                             3RD DIMENSION: PREDICTED LINE INDEX.
C
C  PARAM : (I*4)  MXN       = MXNSHL.
C  PARAM : (I*4)  MXJ       = MXJSHL.
C  PARAM : (I*4)  MXOB      = MXOBSL.
C
C          (I*4)  NREP      =
C          (I*4)  IC        = LOOP INDEX.
C
C          (I*4)  ICREP()   =
C                             DIMENSION: MXOB.
C
C          (R*8)  WHIGH(,)  =
C                             1ST DIMENSION: J SHELL INDEX.
C                             2ND DIMENSION: REFERENCED BY L+1.
C          (R*8)  WLOW(,,)  =
C                             1ST DIMENSION: J SHELL INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C                             3RD DIMENSION: REFERENCED BY L+1.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          C6WFIL     ADAS
C          C7EMQX     ADAS
C          C6PRSL     ADAS      PREDICTS REQUESTED SPECTRUM LINES.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    10/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    22ND MAY 1996
C
C VERSION: 1.1                          DATE: 22-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. COPIED FROM C6EMIS. CALL TO C6EMQX
C                 REPLACED BY CALL TO C7EMQX
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    MXN        , MXJ      , MXOB
      PARAMETER( MXN = 20   , MXJ = 2  , MXOB = 10  )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL ,
     &           MXOBSL  , MXPRSL  , IZ0     , IZ1     ,
     &           NGRND   , NTOT    , NBOT    , NOLINE  ,
     &           NPLINE  , NUMIN   , NUMAX
      INTEGER    NREP    , IC
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS    , EM
C-----------------------------------------------------------------------
      INTEGER    NU(MXOBSL)   , NL(MXOBSL)   , NPU(MXPRSL)  ,
     &           NPL(MXPRSL)
      INTEGER    ICREP(MXOB)
C-----------------------------------------------------------------------
      REAL*8     EMISA(MXOBSL)   , QTHEOR(MXNSHL)  , QTHIN(MXNSHL)   ,
     &           QEX(MXNSHL)     , TOTPOP(MXPRSL)  , TOTEMI(MXPRSL)  ,
     &           AVRGWL(MXPRSL)  , QEFF(MXPRSL)
C-----------------------------------------------------------------------
      REAL*8     FTHEOR(MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           TBQMEP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)  ,
     &           TBFMP(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)   ,
     &           TBFM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)    ,
     &           TBFMM(2*MXJSHL,(MXNSHL*(MXNSHL+1))/2)
      REAL*8     WHIGH(MXJ,(MXN*(MXN+1))/2)
C-----------------------------------------------------------------------
      REAL*8     TBLPOP(2*MXJSHL,2*MXNSHL-3,MXPRSL)         ,
     &           TBLEMI(2*MXJSHL,2*MXNSHL-3,MXPRSL)         ,
     &           TBLWLN(2*MXJSHL,2*MXNSHL-3,MXPRSL)
      REAL*8     WLOW(MXJ,(MXN*(MXN+1))/2,MXN)
```

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C-----------------------------------------------------------------------
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C7EMQX

```
      SUBROUTINE C7EMQX( MXNSHL , MXJSHL , MXOBSL , IZ1    ,
     &                   NBOT   , NUMIN  , NUMAX  , NU     ,
     &                   NL     , EMISA  , NREP   , ICREP  ,
     &                   QTHEOR , WLOW   , EM     , QEX
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C6EMQX *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C6EMIS
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  MXJSHL   = MAXIMUM NUMBER OF J SUB-SHELLS.
C  INPUT : (I*4)  MXOBSL   = MAXIMUM NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NBOT     = MINIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NUMIN    = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()  = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                            LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NREP     =
C  INPUT : (I*4)  ICREP()  =
C                            DIMENSION: MXOBSL.
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE, EXCITATION RATE OR
C                            RECOMBINATION RATE COEFFICIENTS FOR
C                            N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: N SHELL INDEX.
C  INPUT : (R*8)  WLOW(,,) =
C                            1ST DIMENSION: J SHELL INDEX.
C                            2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C                            3RD DIMENSION: REFERENCED BY L+1.
C
C  OUTPUT: (R*8)  EM       = EMMISSION MEASURE.
C  OUTPUT: (R*8)  QEX()    =
C                            DIMENSION: MXNSHL.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C  PARAM : (I*4)  MXJ      = MXJSHL.
C  PARAM : (I*4)  MXOB     = MXOBSL.
C
C          (I*4)  N        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N1       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L1       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  IDL      = TABLE INDEX.
C          (I*4)  IC       = ARRAY INDEX.
C          (I*4)  IC1      = ARRAY INDEX.
C          (I*4)  IC2      = ARRAY INDEX.
C          (I*4)  IFAIL    = RETURN FLAG FROM NAG ROUTINE.
C          (I*4)  M        = LOOP INDEX.
C          (I*4)  I        = LOOP INDEX.
C          (I*4)  J        = ARRAY INDEX.
C
C          (R*8)  XM       = REAL VALUE = M.
C          (R*8)  X1       =
C          (R*8)  X2       =
C          (R*8)  T1       =
C          (R*8)  T2       =
C          (R*8)  SUM      =
C          (R*8)  SUMEX    =
C          (R*8)  SUMTH    =
C
C          (I*4)  JLIST()  =
C                            DIMENSION: MXN.
C
C          (R*8)  AA()     = LJ RESOLVED A-VALUE.
C                            DIMENSION: TRANSITION INDEX WHERE:
C                                       1 GIVES LU+0.5 --> LL+0.5
C                                       2 GIVES LU+0.5 --> LL-0.5
C                                       3 GIVES LU-0.5 --> LL+0.5
C                                       4 GIVES LU-0.5 --> LL-0.5
C
C          (R*8)  REMISA() =
C                            DIMENSION: MXOB.
```

```
C          (R*8)  REMQ()   =
C                           DIMENSION: MXOB.
C          (R*8)  EMQ()    =
C                           DIMENSION: MXNSHL.
C
C          (R*8)  CNDSA(,) = CONDENSED MATRIX.
C                           1ST DIMENSION: MXN.
C                           2ND DIMENSION: 2.
C          (R*8)  ARED(,)  = LINEAR CONDENSATION TRANSFORMATION ARRAY.
C                           1ST DIMENSION: MXN.
C                           2ND DIMENSION: MXN.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          C6AJTB     ADAS      CALCULATES LJ RESOLVED A-VALUES.
C          XXMINV     ADAS      MATRIX SOLUTION REPLACING NAG ROUTINE F04ARF
CX          F04ARF     NAG       FINDS SOLUTION TO A SET OF REAL LINEAR
CX                               EQUATIONS.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    09/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    28ND MAY 1996
C
C VERSION: 1.1                          DATE: 28-05-96
C MODIFIED: WILLIAM OSBORN
C               - FIRST VERSION. COPIED FROM C6EMQX BUT WITH NAG ROUTINE
C                 REPLACED BY XXMINV.
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXN       , MXJ      , MXOB
      PARAMETER( MXN = 20  , MXJ = 2  , MXOB = 10 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXJSHL  , MXOBSL  , IZ1     , NBOT    ,
     &           NUMIN   , NUMAX   , NREP
      INTEGER    N       , L       , N1      , L1      , IDL     ,
     &           IC      , IC1     , IC2     , IFAIL   , M       ,
     &           I       , J
C-----------------------------------------------------------------------
      REAL*8     EM
      REAL*8     XM      , X1      , X2      , T1      , T2      ,
     &           SUM     , SUMEX   , SUMTH
C-----------------------------------------------------------------------
      INTEGER    ICREP(MXOBSL) , NU(MXOBSL)   , NL(MXOBSL)
      INTEGER    JLIST(MXN)
C-----------------------------------------------------------------------
      REAL*8     EMISA(MXOBSL)   , QTHEOR(MXNSHL)  , QEX(MXNSHL)
      REAL*8     AA(2*MXJ)       , REMISA(MXOB)    , REMQ(MXOB)      ,
     &           EMQ(MXN)
      REAL*8     CNDSA(MXN,2)                       ,
     &           ARED(MXOB,MXOB)
      REAL*8     WLOW(MXJSHL,(MXNSHL*(MXNSHL+1))/2,MXNSHL)
C-----------------------------------------------------------------------
      INTEGER     PIPEIN        , PIPEOU
      PARAMETER(  PIPEIN=5      , PIPEOU=6)
C-----------------------------------------------------------------------
```

C8CHRG

```
      SUBROUTINE C8CHRG( SYMBD , IZD   , SYMBR , IZR   , IDZ0  ,
     &                   IRZ0  , IRZ1  , IRZ2
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C8CHRG *********************
C
C  PURPOSE:  SETS UP NUCLEAR CHARGE OF DONOR AND NULEAR, INITIAL AND
C            FINAL CHARGES OF RECEIVER. CHECKS VALIDITY OF RECEIVER
C            CHARGES.
C
C  CALLING PROGRAM: ADAS308
C
C  INPUT : (C*2)  SYMBD   = DONOR ELEMENT SYMBOL.
C  INPUT : (I*4)  IZD     = DONOR ION CHARGE.
C  INPUT : (C*2)  SYMBR   = RECEIVER ELEMENT SYMBOL.
```

```
C  INPUT : (I*4)  IZR     = RECEIVER ION CHARGE.
C
C  OUTPUT: (I*4)  IDZ0    = DONOR NUCLEAR CHARGE.
C  OUTPUT: (I*4)  IRZ0    = RECEIVER NUCLEAR CHARGE.
C  OUTPUT: (I*4)  IRZ1    = RECEIVER ION INITIAL CHARGE.
C  OUTPUT: (I*4)  IRZ2    = RECEIVER ION FINAL CHARGE.
C
C ROUTINES:
C           ROUTINE     SOURCE      BRIEF DESCRIPTION
C           ------------------------------------------------------------
C           I4UNIT      ADAS        RETURNS UNIT NO. FOR OUTPUT MESSAGES
C           CXCHRG      ADAS        RETURNS DONOR NUCLEAR CHARGE AND
C                                   RECEIVER NULEAR, INITIAL AND FINAL
C                                   CHARGES.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    26/11/93
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    IZR     , IZD     , IDZ0    , IRZ0    , IRZ1    ,
     &           IRZ2
C-----------------------------------------------------------------------
      CHARACTER  SYMBD*2  , SYMBR*2
C-----------------------------------------------------------------------
```

C8EMIS

```
      SUBROUTINE C8EMIS( MXNSHL , MXOBSL , MXPRSL , IZ0    ,
     &                   IZ1    , NGRND  , NTOT   , NBOT   ,
     &                   DENSZ  , DENS   , NOLINE , NU     ,
     &                   NL     , EMISA  , NPLINE , NPU    ,
     &                   NPL    , QTHEOR , FTHEOR , TBQMEP ,
     &                   TBQMEM , TBQMIP , TBQMIM , NUMIN  ,
     &                   NUMAX  , EM     , QEX    , TOTPOP ,
     &                   TOTEMI , AVRGWL , QEFF   , TBLPOP ,
     &                   TBLEMI , TBLWLN
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C8EMIS *********************
C
C  PURPOSE:  PREDICTS THE L-RESOLVED EMISSIVITY FOR REQUESTED
C            TRANSITIONS.
C
C  CALLING PROGRAM: ADAS308
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  MXOBSL   = MAXIMUM NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  MXPRSL   = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                            PREDICT.
C  INPUT : (I*4)  IZ0      = NUCLEAR CHARGE.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT     = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                            STATE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  DENSZ    = PLASMA ION DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (I*4)  NOLINE   = NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()  = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                            LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NPLINES  = NUMBER OF SPECTRUM LINES TO PREDICT.
C  INPUT : (I*4)  NPU()    = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            SPECTRUM LINES TO PREDICT.
C                            DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NPL()    = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            SPECTRUM LINES TO PREDICT.
C                            DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            COEFFICIENTS FOR N-LEVELS AVERAGED OVER
C                            BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: REFERENCED BY N QUANTUM NUMBER.
C  INPUT : (R*8)  FTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
```

```
C                               FOR NL-LEVELS AS A FRACTION OF
C                               CORRESPONDING N-LEVEL.
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEP() = ELECTRON RATE COEFFT. FOR NL->NL+1.
C                               INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                               I4IDFL(N,L).
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM() = ELECTRON RATE COEFFT. FOR NL+1->NL.
C                               INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                               I4IDFL(N,L+1).
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP() = POSITIVE ION RATE COEFFT. FOR NL->NL+1.
C                               INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                               I4IDFL(N,L).
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM() = POSITIVE ION RATE COEFFT. FOR NL+1->NL.
C                               INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                               I4IDFL(N,L+1).
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  OUTPUT: (I*4)  NUMIN    = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                               OBSERVED SPECTRUM LINES.
C  OUTPUT: (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                               OBSERVED SPECTRUM LINES.
C  OUTPUT: (R*8)  EM       = EMMISSION MEASURE.
C  OUTPUT: (R*8)  QEX()    =
C                               DIMENSION: MXNSHL.
C  OUTPUT: (R*8)  TOTPOP() = TOTAL COLLISION POP. FOR PREDICTED SPECTRUM
C                               LINE.
C                               UNITS: CM-2
C                               DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TOTEMI() = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: PH CM-2 SEC-1
C                               DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  AVRGWL() = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: A
C                               DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  QEFF()   = EFF. RATE COEFFICIENT FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS:
C                               DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLPOP(,)= TABLE OF COLLISION POP. FOR PREDICTED
C                               SPECTRUM LINE.
C                               UNITS: CM-2
C                               1ST DIMENSION: PREDICTED LINE INDEX.
C                               2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C  OUTPUT: (R*8)  TBLEMI(,)= TABLE OF COLLISION EMISSIVITIES FOR
C                               PREDICTED SPECTRUM LINE.
C                               UNITS: PH CM-2 SEC-1
C                               1ST DIMENSION: PREDICTED LINE INDEX.
C                               2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C  OUTPUT: (R*8)  TBLWLN(,)= TABLE OF WAVELENGTHS FOR PREDICTED SPECTRUM
C                               LINE.
C                               UNITS: A
C                               1ST DIMENSION: PREDICTED LINE INDEX.
C                               2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C  PARAM : (I*4)  MXOB     = MXOBSL.
C
C          (I*4)  NREP     =
C          (I*4)  IC       = LOOP INDEX.
C
C          (I*4)  ICREP()  =
C                               DIMENSION: MXOB.
C
C          (R*8)  WHIGH()  =
C                               DIMENSION: REFERENCED BY L+1.
C          (R*8)  WLOW(,)  =
C                               1ST DIMENSION: REFERENCED BY I4IDFL(N,L).
C                               2ND DIMENSION: REFERENCED BY L+1.
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          CXWFIL     ADAS
C          CXEMQX
C          CXPRSL     ADAS      PREDICTS REQUESTED SPECTRUM LINES.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    15/10/93
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    MXN        , MXOB
      PARAMETER( MXN = 20   , MXOB = 10  )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXOBSL  , MXPRSL  , IZ0     , IZ1     ,
```

```
     &           NGRND   , NTOT    , NBOT    , NOLINE  , NPLINE
      INTEGER    NREP    , NUMIN   , NUMAX   , IC
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS    , EM
C-----------------------------------------------------------------------
      INTEGER    NU(MXOBSL)   , NL(MXOBSL)   , NPU(MXPRSL)  ,
     &           NPL(MXPRSL)
      INTEGER    ICREP(MXOB)
C-----------------------------------------------------------------------
      REAL*8     EMISA(MXOBSL)                ,
     &           QTHEOR(MXNSHL)               ,
     &           QEX(MXNSHL)                  ,
     &           TOTPOP(MXPRSL)               ,
     &           TOTEMI(MXPRSL)               ,
     &           AVRGWL(MXPRSL)               ,
     &           QEFF(MXPRSL)                 ,
     &           FTHEOR((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM((MXNSHL*(MXNSHL+1))/2)
      REAL*8     WHIGH((MXN*(MXN+1))/2)
C-----------------------------------------------------------------------
      REAL*8     TBLPOP(MXPRSL,2*MXNSHL-3)      ,
     &           TBLEMI(MXPRSL,2*MXNSHL-3)      ,
     &           TBLWLN(MXPRSL,2*MXNSHL-3)
      REAL*8     WLOW((MXN*(MXN+1))/2,MXN)
C-----------------------------------------------------------------------
```

C8EMQX

```
      SUBROUTINE C8EMQX( MXNSHL , MXOBSL , IZ1    , NBOT   ,
     &                   NUMIN  , NUMAX  , NU     , NL     ,
     &                   EMISA  , NREP   , ICREP  , QTHEOR ,
     &                   WLOW   , EM     , QEX
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C8EMQX *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C8EMIS
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  MXOBSL   = MAXIMUM NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NBOT     = MINIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NUMIN    = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()  = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                            LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NREP     =
C  INPUT : (I*4)  ICREP()  =
C                            DIMENSION: MXOBSL.
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            COEFFICIENTS FOR N-LEVELS AVERAGED OVER
C                            BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: PRINCIPAL QUANTUM NUMBER INDEX.
C  INPUT : (R*8)  WLOW(,)  =
C                            1ST DIMENSION: REFERENCED BY I4IDFL(N,L).
C                            2ND DIMENSION: REFERENCED BY L+1.
C
C  OUTPUT: (R*8)  EM       = EMMISSION MEASURE.
C  OUTPUT: (R*8)  QEX()    =
C                            DIMENSION: MXNSHL.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C  PARAM : (I*4)  MXOB     = MXOBSL.
C
C          (I*4)  N        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N1       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L1       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  IC       = ARRAY INDEX.
C          (I*4)  IC1      = ARRAY INDEX.
C          (I*4)  IC2      = ARRAY INDEX.
C          (I*4)  IFAIL    = RETURN FLAG FROM NAG ROUTINE.
C          (I*4)  M        = LOOP INDEX.
C          (I*4)  I        = LOOP INDEX.
```

```
C          (I*4)  J        = ARRAY INDEX.
C
C          (R*8)  XM       = REAL VALUE = M.
C          (R*8)  X1       =
C          (R*8)  X2       =
C          (R*8)  T1       =
C          (R*8)  T2       =
C          (R*8)  SUM      =
C          (R*8)  SUMEX    =
C          (R*8)  SUMTH    =
C
C          (I*4)  JLIST()  =
C                            DIMENSION: MXN.
C
C          (R*8)  REMISA() =
C                            DIMENSION: MXOB.
C          (R*8)  REMQ()   =
C                            DIMENSION: MXOB.
C          (R*8)  WKSPCE() = WORKSPACE FOR NAG ROUTINE.
C                            DIMENSION: MXOB.
C          (R*8)  EMQ()    =
C                            DIMENSION: MXNSHL.
C
C          (R*8)  CNDSA(,) = CONDENSED MATRIX.
C                            1ST DIMENSION: MXN.
C                            2ND DIMENSION: 2.
C          (R*8)  ARED(,)  = LINEAR CONDENSATION TRANSFORMATION ARRAY.
C                            1ST DIMENSION: MXN.
C                            2ND DIMENSION: MXN.
C          (I*4)   PIPEIN - PARAMETER = UNIT NUMBER FOR OUTPUT TO PIPE
C          (I*4)   PIPEOU - PARAMETER = UNIT NUMBER FOR INPUT FROM PIPE
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          R8ATAB     ADAS      RETURNS HYDRONIC L-RESOLVED A-VALUES.
C                               IF INPUT QUANTUM NUMBERS ARE INVALID
C                               THEN RETURNS ZERO.
C          XXFLSH     ADAS      FLUSHES UNIX PIPE.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    14/10/93
C
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C           CHANGED ...J.EQ.NREP... TO ...J.NE.NREP... IN THE IF
C           STATEMENT AFTER LINE 2.
C            GENERAL UNIX PORT.
C
C DATE:    20/6/95
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
      REAL*8     R8ATAB
C-----------------------------------------------------------------------
      INTEGER    MXN       , MXOB
      PARAMETER( MXN = 20  , MXOB = 10 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXOBSL  , IZ1     , NBOT    , NUMIN   ,
     &           NUMAX   , NREP
      INTEGER    N       , L       , N1      , L1      , IC      ,
     &           IC1     , IC2     , IFAIL   , M       , I       ,
     &           J
      INTEGER    PIPEOU  , PIPEIN
      PARAMETER (PIPEOU=6, PIPEIN=5)
C-----------------------------------------------------------------------
      REAL*8     EM
      REAL*8     XM      , X1      , X2      , T1      , T2      ,
     &           SUM     , SUMEX   , SUMTH
C-----------------------------------------------------------------------
      INTEGER    ICREP(MXOBSL) , NU(MXOBSL)   , NL(MXOBSL)
      INTEGER    JLIST(MXN)
C-----------------------------------------------------------------------
      REAL*8     EMISA(MXOBSL)   , QTHEOR(MXNSHL)  , QEX(MXNSHL)
      REAL*8     REMISA(MXOB)    , REMQ(MXOB)      , WKSPCE(MXOB)    ,
     &           EMQ(MXN)
      REAL*8     WLOW((MXNSHL*(MXNSHL+1))/2,MXNSHL)
      REAL*8     CNDSA(MXN,2)                      ,
     &           ARED(MXOB,MXOB)
C-----------------------------------------------------------------------
```

C8PRSL

```
      SUBROUTINE C8PRSL( MXNSHL , MXPRSL , IZ0    , IZ1    ,
     &                   NPLINE , NPU    , NPL    , NUMAX  ,
     &                   WHIGH  , WLOW   , EM     , QEX    ,
```

```
     &                   TOTPOP , TOTEMI , AVRGWL , QEFF   ,
     &                   TBLPOP , TBLEMI , TBLWLN
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C8PRSL *********************
C
C  PURPOSE:  FILLS TABLES FOR REQUESTED PREDICTIONS OF SPECTRUM LINES.
C
C  CALLING PROGRAM: C8EMIS
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  MXPRSL   = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                            PREDICT.
C  INPUT : (R*8)  IZ0      = NUCLEAR CHARGE.
C  INPUT : (R*8)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NPLINE   = NUMBER OF SPECTRUM LINES TO PREDICT.
C  INPUT : (I*4)  NPU()    = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            SPECTRUM LINES TO PREDICT.
C                            DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NPL()    = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            SPECTRUM LINES TO PREDICT.
C                            DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (R*8)  WHIGH()  =
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  WLOW(,)  =
C                            1ST DIMENSION: REFERENCED BY I4IDFL(N,L).
C                            2ND DIMENSION: REFERENCED BY L+1.
C  INPUT : (R*8)  EM       = EMMISION MEASURE.
C  INPUT : (R*8)  QEX()    =
C                            DIMENSION: MXNSHL.
C
C  OUTPUT: (R*8)  TOTPOP() = TOTAL COLLISION POP. FOR PREDICTED SPECTRUM
C                            LINE.
C                            UNITS: CM-2
C                            DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TOTEMI() = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                            SPECTRUM LINE.
C                            UNITS: PH CM-2 SEC-1
C                            DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  AVRGWL() = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                            SPECTRUM LINE.
C                            UNITS: A
C                            DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  QEFF()   = EFF. RATE COEFFICIENT FOR PREDICTED
C                            SPECTRUM LINE.
C                            UNITS:
C                            DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLPOP(,)= TABLE OF COLLISION POP. FOR PREDICTED
C                            SPECTRUM LINE.
C                            UNITS: CM-2
C                            1ST DIMENSION: PREDICTED LINE INDEX.
C                            2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C  OUTPUT: (R*8)  TBLEMI(,)= TABLE OF COLLISION EMISSIVITIES FOR
C                            PREDICTED SPECTRUM LINE.
C                            UNITS: PH CM-2 SEC-1
C                            1ST DIMENSION: PREDICTED LINE INDEX.
C                            2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C  OUTPUT: (R*8)  TBLWLN(,)= TABLE OF WAVELENGTHS FOR PREDICTED SPECTRUM
C                            LINE.
C                            UNITS: A
C                            1ST DIMENSION: PREDICTED LINE INDEX.
C                            2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C
C  PARAM : (I*4)  C1       = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  C2       = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  C3       = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  C4       = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  C5       = PRECISION AIR WAVELENGTH PARAM.
C  PARAM : (I*4)  RZ       = PRECISION AIR WAVELENGTH PARAM.
C
C          (I*4)  IN       = LOOP INDEX FOR SPECTRUM LINES.
C          (I*4)  N        = PRINCIPAL QUANTUM NUMBER OF INITIAL STATE.
C          (I*4)  L        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER OF
C                            INITIAL STATE.
C          (I*4)  N1       = PRINCIPAL QUANTUM NUMBER OF FINAL STATE.
C          (I*4)  L1       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER OF
C                            FINAL STATE.
C          (I*4)  NP       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  IDL      = ARRAY INDEX.
C          (I*4)  ID       = ARRAY INDEX.
C
C          (R*8)  Z1       = REAL VALUE = IZ1.
C          (R*8)  T1       = COL. POP. FOR PREDICTED SPECTRUM LINE.
C                            UNITS: CM-2
C          (R*8)  T2       = COL. EMIS. FOR PREDICTED SPECTRUM LINE.
C                            UNITS: PH CM-2 SEC-1
C          (R*8)  E0       = BINDING ENERGY
C                            UNITS: RYD
C          (R*8)  E10      = BINDING ENERGY
C                            UNITS: RYD
C          (R*8)  DELTA    =
C          (R*8)  SIG2     =
```

```
C          (R*8)  RF       =
C          (R*8)  WAVAIR   = WAVELENGTH FOR PREDICTED SPECTRUM LINE.
C                            UNITS: A
C          (R*8)  SUM1     = SUM OF COL. POP. FOR PREDICTED LINE.
C                            UNITS: CM-2
C          (R*8)  SUM2     = SUM OF COL. EMIS. FOR PREDICTED LINE.
C                            UNITS: PH CM-2 SEC-1
C          (R*8)  SUM3     = SUM OF WAVELENGTHS FOR PREDICTED LINE.
C                            UNITS: A
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          I4IDLI     ADAS      RETURNS INDEX FOR PREDICTED SPECTRUM
C                               LINE TABLES.
C          R8ATAB     ADAS      RETURNS HYDRONIC L-RESOLVED A-VALUES.
C                               IF INPUT QUANTUM NUMBERS ARE INVALID
C                               THEN RETURNS ZERO.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    14/10/93
C
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C           ADDED ERROR MESSAGE FOR NUMERICAL ERRORS INTRODUCED
C           BY BAD VALUES FOR THE OBSERVED SPECTRUM LINES
C            ALSO GENERAL UNIX PORT.
C
C DATE:     20/6/95
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4IDFL  , I4IDLI, I4UNIT
      REAL*8     R8ATAB
C-----------------------------------------------------------------------
      REAL*8     C1                , C2               ,
     &           C3                , C4               ,
     &           C5                , RZ
      PARAMETER( C1 = 6432.8D0     , C2 = 2949810.0D0  ,
     &           C3 = 25540.0D0    , C4 = 176.0D0      ,
     &           C5 = 41.0D0       , RZ = 109737.2D0     )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXPRSL  , IZ0     , IZ1     , NPLINE  ,
     &           NUMAX
      INTEGER    IN      , N       , L       , N1      , L1      ,
     &           NP      , IDL     , ID
C-----------------------------------------------------------------------
      REAL*8     EM
      REAL*8     Z1      , T1      , T2      , E0      , E10     ,
     &           DELTA   , SIG2    , RF      , WAVAIR  , SUM1    ,
     &           SUM2    , SUM3
C-----------------------------------------------------------------------
      INTEGER    NPU(MXPRSL)  , NPL(MXPRSL)
C-----------------------------------------------------------------------
      REAL*8     WHIGH((MXNSHL*(MXNSHL+1))/2)  ,
     &           QEX(MXNSHL)                   ,
     &           TOTPOP(MXPRSL)                ,
     &           TOTEMI(MXPRSL)                ,
     &           AVRGWL(MXPRSL)                ,
     &           QEFF(MXPRSL)
      REAL*8     WLOW((MXNSHL*(MXNSHL+1))/2,MXNSHL) ,
     &           TBLPOP(MXPRSL,2*MXNSHL-3)          ,
     &           TBLEMI(MXPRSL,2*MXNSHL-3)          ,
     &           TBLWLN(MXPRSL,2*MXNSHL-3)
C-----------------------------------------------------------------------
```

C8TBQM

```
      SUBROUTINE C8TBQM( MXNSHL , IZ0    , IZ1    , NBOT   ,
     &                   NTOP   , TEV    , DENS   , ZP     ,
     &                   TPV    , EMP    , TBLF   , TBQMEP ,
     &                   TBQMEM , TBQMIP , TBQMIM
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C8TBQM *********************
C
C  PURPOSE:  SETS UP TABLES OF ELECTRON AND POSITIVE ION IMPACT RATE
C            COEFFICIENTS BETWEEN NEARLY DEGENERATE L STATES OF THE
C            SAME N FOR HYDROGENIC IONS.
C
C  CALLING PROGRAM: ADAS308
C
```

```
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  IZ0      = NUCLEAR CHARGE OF TARGET ION.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NTOP     = MAXIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  TEV      = ELECTRON TEMPERATURE.
C                            UNITS: EV
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  ZP       = CHARGE OF COLLIDING POSITIVE ION.
C  INPUT : (R*8)  TPV      = TEMPERATURE (COLLIDING POSITIVE ION
C                            DISTRIBUTION).
C                            UNITS: EV
C  INPUT : (R*8)  EMP      = REDUCED MASS FOR COLLIDING POSITIVE ION.
C                            UNITS: ELECTRON MASSES
C  INPUT : (R*8)  ZP       = CHARGE OF COLLIDING POSITIVE ION.
C  INPUT : (R*8)  TPV      = POSITIVE ION TEMPERATURE.
C                            UNITS: EV
C  INPUT : (R*8)  EMP      = REDUCED MASS FOR COLLIDING POSITIVE ION.
C                            UNITS: ELECTRON MASSES
C  INPUT : (R*8)  TBLF()   = TABLE OF RADIATIVE LIFETIMES.
C                            UNITS: SECS
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  OUTPUT: (R*8)  TBQMEP() = ELECTRON RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  OUTPUT: (R*8)  TBQMEM() = ELECTRON RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  OUTPUT: (R*8)  TBQMIP() = POSITIVE ION RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  OUTPUT: (R*8)  TBQMIM() = POSITIVE ION RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  PARAM : (I*4)  MXJ      = MAXIMUM NUMBER OF J SUB-SHELLS.
C  PARAM : (R*8)  P1       =
C  PARAM : (R*8)  P2       =
C
C          (I*4)  NI       = VALENCE ELECTRON PRINCIPAL QUANTUM NUMBER
C                            IN STATE I.
C          (I*4)  NJ       = VALENCE ELECTRON PRINCIPAL QUANTUM NUMBER
C                            IN STATE J.
C          (I*4)  LI       = VALENCE ELECTRON ORBITAL QUANTUM NUMBER IN
C                            STATE I.
C          (I*4)  LJ       = VALENCE ELECTRON ORBITAL QUANTUM NUMBER IN
C                            STATE J.
C          (I*4)  IDLI     = TABLE INDEX.
C          (I*4)  IDLJ     = TABLE INDEX.
C          (I*4)  I        = LOOP INDEX.
C
C          (R*8)  FACE     =
C          (R*8)  FACI     =
C          (R*8)  WI       = STATISTICAL WEIGHT OF STATE I.
C          (R*8)  WJ       = STATISTICAL WEIGHT OF STATE J.
C          (R*8)  GAE      = GAMA RATE PARAMETER FOR ELECTRON COLLISIONS.
C          (R*8)  GAP      = GAMA RATE PARAMETER FOR POSITIVE ION
C                            COLLISIONS.
C          (R*8)  QEP()    = ELECTRON RATE COEFFT. FOR NLJ->NL+1J'
C                            DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  QEM()    = ELECTRON RATE COEFFT. FOR NLJ->NL-1J'
C                            DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  QIP()    = POSITIVE ION RATE COEFFT. FOR NLJ->NL+1J'
C                            DIMENSION: J->J' TRANSITION INDEX.
C          (R*8)  QIM()    = POSITIVE ION RATE COEFFT. FOR NLJ->NL-1J'
C                            DIMENSION: J->J' TRANSITION INDEX.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C              1 : J=L+0.5 -> J'=L'+0.5
C              2 : J=L+0.5 -> J'=L'-0.5
C              3 : J=L-0.5 -> J'=L'+0.5
C              4 : J=L-0.5 -> J'=L'-0.5
C
C       2) BEFORE CALLING C8TBQM THE LIFETIME TABLE MUST BE FILLED
C          WITH A CALL TO CXTBLF.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          CXCRDG     ADAS      CALCULATES COLLISIONAL RATE COEFFICIENTS
C                               BETWEEN NEARLY DEGENERATE LEVELS OF
C                               H-, LI- OR NA-LIKE IONS.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    12/10/93
C
```

```
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4IDFL
C-----------------------------------------------------------------------
      INTEGER    MXJ
      PARAMETER( MXJ = 2 )
C-----------------------------------------------------------------------
      REAL*8     P1               , P2
      PARAMETER( P1 = 2.17161D-8  , P2 = 13.6048D0  )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , IZ0     , IZ1     , NTOP    , NBOT
      INTEGER    NI      , NJ      , LI      , LJ      , IDLI    ,
     &           IDLJ    , I
C-----------------------------------------------------------------------
      REAL*8     TEV     , DENS    , ZP      , TPV     , EMP
      REAL*8     FACE    , FACI    , WI      , WJ      , GAE     ,
     &           GAP
C-----------------------------------------------------------------------
      REAL*8     TBLF((MXNSHL*(MXNSHL+1))/2)    ,
     &           TBQMEP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM((MXNSHL*(MXNSHL+1))/2)
      REAL*8     QEP(2*MXJ)  , QEM(2*MXJ)  , QIP(2*MXJ)  ,
     &           QIM(2*MXJ)
C-----------------------------------------------------------------------
```

C8WFIL

```
      SUBROUTINE C8WFIL( MXNSHL , IZ1    , NGRND  , NTOT   ,
     &                   NBOT   , NUMAX  , DENSZ  , DENS   ,
     &                   QTHEOR , FTHEOR , TBQMEP , TBQMEM ,
     &                   TBQMIP , TBQMIM , WHIGH  , WLOW
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C8WFIL *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C8EMIS
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT     = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                            STATE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (R*8)  DENSZ    = PLASMA ION DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            COEFFICIENTS FOR N-LEVELS AVERAGED OVER
C                            BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: REFERENCED BY N QUANTUM NUMBER.
C  INPUT : (R*8)  FTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            FOR NL-LEVELS AS A FRACTION OF
C                            CORRESPONDING N-LEVEL.
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEP() = ELECTRON RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM() = ELECTRON RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP() = POSITIVE ION RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM() = POSITIVE ION RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  OUTPUT: (R*8)  WHIGH()  =
C                            DIMENSION: REFERENCED BY L+1.
C  OUTPUT: (R*8)  WLOW(,)  =
C                            1ST DIMENSION: REFERENCED BY I4IDFL(N,L).
C                            2ND DIMENSION: REFERENCED BY L+1.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C
C          (I*4)  N        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
```

```
C          (I*4)  L       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N1      = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L1      = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N2      = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L2      = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  LP      = ARRAY INDEX = L+1.
C          (I*4)  IDL     = ARRAY INDEX.
C
C          (R*8)  A1      = LOCAL STORE FOR RETURN VALUE OF FUNC R8ATAB.
C
C          (R*8)  RHS()   = RIGHT HAND SIDE OF N LEVEL EQUATION.
C                           DIMENSION: MXN.
C          (I*4)   PIPEIN - PARAMETER = UNIT NUMBER FOR OUTPUT TO PIPE
C          (I*4)   PIPEOU - PARAMETER = UNIT NUMBER FOR INPUT FROM PIPE
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          R8ATAB     ADAS      RETURNS HYDRONIC L-RESOLVED A-VALUES.
C                               IF INPUT QUANTUM NUMBERS ARE INVALID
C                               THEN RETURNS ZERO.
C          CXWSOL     ADAS
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    13/10/93
C
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C           UNIX PORT
C
C DATE:    20/6/95
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
      REAL*8     R8ATAB
C-----------------------------------------------------------------------
      INTEGER    MXN
      PARAMETER( MXN = 20 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , IZ1     , NGRND   , NTOT   , NBOT    ,
     &           NUMAX
      INTEGER    N       , L       , N1      , L1     , N2      ,
     &           L2      , LP      , IDL
      INTEGER    NTIMES
      INTEGER    PIPEOU  , PIPEIN
      PARAMETER (PIPEOU=6, PIPEIN=5)
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS
      REAL*8     A1
C-----------------------------------------------------------------------
      REAL*8     QTHEOR(MXNSHL)                ,
     &           FTHEOR((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM((MXNSHL*(MXNSHL+1))/2)  ,
     &           WHIGH((MXNSHL*(MXNSHL+1))/2)
      REAL*8     RHS(MXN)
C-----------------------------------------------------------------------
      REAL*8     WLOW((MXNSHL*(MXNSHL+1))/2,MXNSHL)
C-----------------------------------------------------------------------
```

C8WSOL

```
      SUBROUTINE C8WSOL( MXNSHL , IZ1    , NGRND  , N      ,
     &                   DENSZ  , DENS   , TBQMEP , TBQMEM ,
     &                   TBQMIP , TBQMIM , RHS
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C8WSOL *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C8WFIL
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  N        = PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  DENSZ    = PLASMA ION DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
```

```
C                               UNITS: CM-3
C  INPUT : (R*8)  TBQMEP() = ELECTRON RATE COEFFT. FOR NL->NL+1.
C                               INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                               I4IDFL(N,L).
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM() = ELECTRON RATE COEFFT. FOR NL+1->NL.
C                               INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                               I4IDFL(N,L+1).
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP() = POSITIVE ION RATE COEFFT. FOR NL->NL+1.
C                               INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                               I4IDFL(N,L).
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM() = POSITIVE ION RATE COEFFT. FOR NL+1->NL.
C                               INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                               I4IDFL(N,L+1).
C                               DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  I/O   : (R*8)  RHS()    =
C                               DIMENSION: REFERENCED BY L+1.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C
C          (I*4)  L       = ORBITAL QUANTUM NUMBER.
C          (I*4)  IDL     = ARRAY INDEX.
C          (I*4)  N1      = PRINCIPAL QUANTUM NUMBER.
C          (I*4)  LP      = ARRAY INDEX = L+1.
C          (I*4)  IFAIL   = RETURN FLAG FROM NAG ROUTINE.
C
C          (R*8)  VDS()   =
C          (R*8)  VDI()   =
C          (R*8)  VD()    =
C          (I*4)   PIPEIN - PARAMETER = UNIT NUMBER FOR OUTPUT TO PIPE
C          (I*4)   PIPEOU - PARAMETER = UNIT NUMBER FOR INPUT FROM PIPE
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          R8ATAB     ADAS      RETURNS HYDRONIC L-RESOLVED A-VALUES.
C                               IF INPUT QUANTUM NUMBERS ARE INVALID
C                               THEN RETURNS ZERO.
C          XXFLSH     ADAS      FLUSHES UNIX PIPE.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    12/10/93
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C           UNIX PORT - ROUTINE NOW USES AN IDL ROUTINE TO SOLVE
C                       EQUATIONS RATHER THAN NAG
C
C DATE:    20/6/95
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
      REAL*8     R8ATAB
C-----------------------------------------------------------------------
      INTEGER    MXN
      PARAMETER( MXN = 20 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , NGRND   , N       , IZ1
      INTEGER    L       , IDL     , N1      , LP      , IFAIL
      INTEGER    I
      INTEGER    PIPEOU  , PIPEIN
      PARAMETER (PIPEOU=6, PIPEIN=5)
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS
C-----------------------------------------------------------------------
      REAL*8     TBQMEP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM((MXNSHL*(MXNSHL+1))/2)  ,
     &           RHS(MXNSHL)
      REAL*8     VDS(MXN)  , VDI(MXN)  , VD(MXN)
C-----------------------------------------------------------------------
```

C9CXEE

```
      SUBROUTINE C9CXEE( MXNENG , MXNSHL , NGRND  , NTOT   ,
     &                   NBOT   , NTOP   , IRZ0   , IRZ1   ,
     &                   RAMSNO , TEV    , TIEV   , DENS   ,
     &                   DENSZ  , ZEFF   , BMAG   , BMENG  ,
     &                   ITHEOR , IBSTAT , IEMMS  , NTU    ,
     &                   NTL    , NMINF  , NMAXF  , NENRGY ,
     &                   ENRGYA , ALPHAA , XSECNA , FRACLA ,
     &                   ERATE
     &                 )
```

```
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C9CXEE *********************
C
C  PURPOSE:  CALCULATES THE L-RESOLVED EFFECTIVE EMISSIVITY RATE
C            COEFFICIENT FOR THE GIVEN TRANSITION.
C
C            IT IS APPLICABLE TO IMPURITIES IN PLASMA TRAVERSED BY
C            NEUTRAL BEAMS OF H OR HE.
C
C            THE RECOMBINED TARGET ION IS TREATED AS H-LIKE.
C
C            THE MODEL INCLUDES CAPTURE, N-N' LEVEL CASCADE, AND MIXING
C            AMONG L LEVELS OF SAME N BY COLLISIONS.
C
C            AN INTERNAL EIKONAL APPROXIMATION IS USED FOR CAPTURE FROM
C            EXCITED H OR HE STATES, ALTHOUGH NORMALLY THE EXTERNAL DATA
C            SET SHOULD BE USED.
C
C  CALLING PROGRAM: ADAS309
C
C  INPUT : (I*4)  MXNENG    = MAXIMUM NO. OF ENERGIES IN DATA SET.
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  NGRND     = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT      = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                             STATE.
C  INPUT : (I*4)  NBOT      = MINIMUM PRINCIPAL QUANTUM NUMBER FOR
C                             RATE TABLES.
C  INPUT : (I*4)  NTOP      = MAXIMUM PRINCIPAL QUANTUM NUMBER FOR
C                             RATE TABLES.
C  INPUT : (I*4)  IRZ0      = RECEIVER NUCLEAR CHARGE.
C  INPUT : (I*4)  IRZ1      = RECEIVER ION INITIAL CHARGE.
C  INPUT : (R*8)  RAMSNO    = RECEIVER ATOMIC MASS.
C  INPUT : (R*8)  TEV       = ELECTRON TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  TIEV      = ION TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  DENS      = ELECTRON DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  DENSZ     = PLASMA ION DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  ZEFF      = EFFECTIVE ION CHARGE.
C  INPUT : (R*8)  BMAG      = PLASMA MAGNETIC INDUCTION.
C                             UNITS: TESLA
C  INPUT : (R*8)  BMENG     = BEAM ENERGY.
C                             UNITS: EV/AMU
C  INPUT : (I*4)  ITHEOR    = CHARGE EXCHANGE MODEL OPTION.
C                             1 => USE INPUT DATA SET.
C                             2 => USE EIKONAL MODEL.
C  INPUT : (I*4)  IBSTAT    = DONOR STATE FOR EIKONAL MODEL.
C                             1 => H(1S)
C                             2 => H(2S)
C                             3 => H(2P)
C                             4 => HE(1S2)
C                             5 => HE(1S2S)
C  INPUT : (I*4)  IEMMS     = EMISSION MEASURE MODEL OPTION.
C                             1 => CHARGE EXCHANGE.
C                             2 => ELECTRON IMPACT EXCITATION.
C  INPUT : (I*4)  NTL       = LOWER PRINCIPAL QUANTUM NUMBER OF
C                             TRANSITION.
C  INPUT : (I*4)  NTU       = UPPER PRINCIPAL QUANTUM NUMBER OF
C                             TRANSITION.
C  INPUT : (I*4)  NMINF     = LOWEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (I*4)  NMAXF     = HIGHEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (I*4)  NENRGY    = NUMBER OF ENERGIES READ FROM DATA SET.
C  INPUT : (R*8)  ENRGYA()  = COLLISION ENERGIES READ FROM INPUT DATA
C                             SET.
C                             UNITS: EV/AMU
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  ALPHAA()  = EXTRAPOLATION PARAMETER ALPHA READ FROM
C                             INPUT DATA SET.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  XSECNA(,) = N-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS
C                             READ FROM INPUT DATA SET.
C                             UNITS: CM2
C                             1ST DIMENSION: ENERGY INDEX
C                             2ND DIMENSION: N-SHELL
C  INPUT : (R*8)  FRACLA(,) = L-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS.
C                             AFTER CXDATA: ABSOLUTE VALUES (CM2).
C                             AFTER CXFRAC: FRACTION OF N-RESOLVED
C                                           DATA.
C                             1ST DIMENSION: ENERGY INDEX
C                             2ND DIMENSION: INDEXED BY I4IDFL(N,L)
C
C  OUTPUT: (R*8)  ERATE     = EFFECTIVE EMISSIVITY RATE COEFFICIENT FOR
C                             REQUESTED TRANSITION
C                             SPECTRUM LINE.
C                             UNITS: CM3 SEC-1
C
C  PARAM : (I*4)  MXN       = MXNSHL.
C  PARAM : (I*4)  MXJSHL    = MAXIMUM NUMBER OF J SUB-SHELLS.
C  PARAM : (I*4)  MXBEAM    = MAXIMUM NUMBER OF BEAM COMPONENTS.
C  PARAM : (I*4)  MXOBSL    = MAXIMUM NUMBER OF OBSERVED SPECTRUM
C                             LINES.
C
```

```
C  PARAM : (I*4)  MXPRSL    = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                              PREDICT.
C
C  PARAM : (R*8)  EMP       = REDUCED MASS FOR POSITIVE ION.
C                              UNITS: ELECTRON MASSES
C
C          (I*4)  NBEAM     = NUMBER OF BEAM ENERGIES.
C          (I*4)  NOLINE    = NUMBER OF OBSERVED SPECTRUM LINES.
C          (I*4)  NPLINE    = NUMBER OF SPECTRUM LINES TO PREDICT.
C          (I*4)  NUMIN     = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                              FOR OBSERVED SPECTRUM LINES.
C          (I*4)  NUMAX     = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                              FOR OBSERVED SPECTRUM LINES.
C
C          (R*8)  EM        = EMMISSION MEASURE.
C                              UNITS: CM-5
C
C          (I*4)  NL()      = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                              OF OBSERVED SPECTRUM LINES.
C                              DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NU()      = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                              OF OBSERVED SPECTRUM LINES.
C                              DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NPL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                              OF SPECTRUM LINES TO PREDICT.
C                              DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NPU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                              OF SPECTRUM LINES TO PREDICT.
C                              DIMENSION: SPECTRUM LINE INDEX.
C
C          (R*8)  BMFRA()   = BEAM COMPONENT FRACTIONS.
C                              DIMENSION: COMPONENT INDEX.
C          (R*8)  BMENA()   = BEAM ENERGY COMPONENTS.
C                              UNITS: EV/AMU
C          (R*8)  EMISA()   = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                              LINES.
C                              UNITS: PH CM-2 SEC-1
C                              DIMENSION: SPECTRUM LINE INDEX.
C          (R*8)  TBLF()    = TABLE OF RADIATIVE LIFETIMES.
C                              UNITS: SECS
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQEX()   = MEAN EXCITATION RATE COEFFICIENTS FOR
C                              NL-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  QTHEX()   = MEAN EXCITATION RATE COEFFICIENTS FOR
C                              N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: N SHELL INDEX.
C          (R*8)  FTHEX()   = FRACTION OF N-LEVEL MEAN EXCITATION RATE
C                              COEFFICIENTS IN NL-LEVEL.
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  QTHCH()   = MEAN CHARGE EXCHANGE COEFFICIENTS FOR
C                              N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: N SHELL INDEX.
C          (R*8)  FTHCH()   = FRACTION OF N-LEVEL MEAN CHARGE EXCHANGE
C                              COEFFICIENTS IN NL-LEVEL.
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMEP()  = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                              NL->NL+1.
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMEM()  = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                              NL->NL-1.
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMIP()  = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                              NL->NL+1.
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMIM()  = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                              NL->NL-1.
C                              DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  QEX()     =
C                              DIMENSION: N SHELL INDEX.
C          (R*8)  TOTPOP()  = TOTAL COLLISION POP. FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: CM-2
C                              DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  TOTEMI()  = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: PH CM-2 SEC-1
C                              DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  AVRGWL()  = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: A
C                              DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  QEFF()    = EFF. RATE COEFFICIENT FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: CM3 SEC-1
C                              DIMENSION: PREDICTED LINE INDEX.
C
C          (R*8)  TBLPOP(,) = TABLE OF COLLISION POP. FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: CM-2
C                              1ST DIMENSION: PREDICTED LINE INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDLI().
C          (R*8)  TBLEMI(,) = TABLE OF COLLISION EMISSIVITIES FOR
C                              PREDICTED SPECTRUM LINE.
C                              UNITS: PH CM-2 SEC-1
```

```
C                             1ST DIMENSION: PREDICTED LINE INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDLI().
C          (R*8)  TBLWLN(,) = TABLE OF WAVELENGTHS FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: A
C                             1ST DIMENSION: PREDICTED LINE INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDLI().
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          CXTBLF     ADAS      FILLS L-RESOLVED RADIATIVE LIFETIME
C                               TABLE.
C          CXTBEX     ADAS      FILLS N AND L-RESOLVED ELECTRON IMPACT
C                               EXCITATION RATE TABLES.
C          CXQEIK     ADAS      FILLS N AND L-RESOLVED CHARGE EXCHANGE
C                               RATE TABLES USING EIKONAL APPROXIMATION.
C          CXQXCH     ADAS      FILLS N AND L-RESOLVED CHARGE EXCHANGE
C                               RATE TABLES USING INPUT DATA SET.
C          C8TBQM     ADAS      FILLS N AND L-RESOLVED COLLISIONAL RATE
C                               TABLES.
C          C9EMIS     ADAS      PREDICTS THE L-RESOLVED EMISSIVITY FOR
C                               REQUESTED TRANSITIONS.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    03/12/93
C
C UNIX PORT: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C  DATE:   10/07/95                      VERSION 1.1
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    MXN          , MXBEAM       , MXOBSL       ,
     &           MXPRSL
      PARAMETER( MXN    = 20  , MXBEAM = 1   , MXOBSL = 1   ,
     &           MXPRSL = 1                                  )
C-----------------------------------------------------------------------
      REAL*8     EMP
      PARAMETER( EMP = 1836.0D0 )
C-----------------------------------------------------------------------
      INTEGER    MXNENG  , MXNSHL  , NGRND   , NTOT    , NBOT    ,
     &           NTOP    , IRZ0    , IRZ1    , ITHEOR  , IBSTAT  ,
     &           IEMMS   , NTU     , NTL     , NMINF   , NMAXF   ,
     &           NENRGY
      INTEGER    NBEAM   , NOLINE  , NPLINE  , NUMIN   , NUMAX
C-----------------------------------------------------------------------
      REAL*8     RAMSNO  , TEV     , TIEV    , DENS    , DENSZ   ,
     &           ZEFF    , BMAG    , BMENG   , ERATE
      REAL*8     EM
C-----------------------------------------------------------------------
      INTEGER    NL(MXOBSL)      , NU(MXOBSL)      , NPL(MXPRSL)     ,
     &           NPU(MXPRSL)
C-----------------------------------------------------------------------
      REAL*8     ENRGYA(MXNENG)  , ALPHAA(MXNENG)
      REAL*8     BMENA(MXBEAM)   , BMFRA(MXBEAM)   , EMISA(MXOBSL)   ,
     &           QTHEX(MXN)      , QTHCH(MXN)      , QEX(MXN)        ,
     &           TOTPOP(MXPRSL)  , TOTEMI(MXPRSL)  , AVRGWL(MXPRSL)  ,
     &           QEFF(MXPRSL)    ,
     &           TBLF((MXN*(MXN+1))/2)    ,
     &           TBQEX((MXN*(MXN+1))/2)   ,
     &           FTHEX((MXN*(MXN+1))/2)   ,
     &           FTHCH((MXN*(MXN+1))/2)   ,
     &           TBQMEP((MXN*(MXN+1))/2)  ,
     &           TBQMEM((MXN*(MXN+1))/2)  ,
     &           TBQMIP((MXN*(MXN+1))/2)  ,
     &           TBQMIM((MXN*(MXN+1))/2)
C-----------------------------------------------------------------------
      REAL*8     XSECNA(MXNENG,MXNSHL)             ,
     &           FRACLA(MXNENG,(MXNSHL*(MXNSHL+1))/2)
      REAL*8     TBLPOP(MXPRSL,2*MXN-3)            ,
     &           TBLEMI(MXPRSL,2*MXN-3)            ,
     &           TBLWLN(MXPRSL,2*MXN-3)
C-----------------------------------------------------------------------
```

C9EMIS

```
      SUBROUTINE C9EMIS( MXNSHL , MXOBSL , MXPRSL , IZ0    ,
     &                   IZ1    , NGRND  , NTOT   , NBOT   ,
     &                   DENSZ  , DENS   , NOLINE , NU     ,
     &                   NL     , EMISA  , NPLINE , NPU    ,
     &                   NPL    , QTHEOR , FTHEOR , TBQMEP ,
     &                   TBQMEM , TBQMIP , TBQMIM , NUMIN  ,
     &                   NUMAX  , EM     , QEX    , TOTPOP ,
     &                   TOTEMI , AVRGWL , QEFF   , TBLPOP ,
     &                   TBLEMI , TBLWLN
     &                 )
```

```
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C9EMIS *********************
C
C  PURPOSE:  PREDICTS THE L-RESOLVED EMISSIVITY FOR REQUESTED
C            TRANSITIONS.
C
C  CALLING PROGRAM: C9CXEE
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  MXOBSL   = MAXIMUM NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  MXPRSL   = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                            PREDICT.
C  INPUT : (I*4)  IZ0      = NUCLEAR CHARGE.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT     = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                            STATE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  DENSZ    = PLASMA ION DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (I*4)  NOLINE   = NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()  = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                            LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NPLINES  = NUMBER OF SPECTRUM LINES TO PREDICT.
C  INPUT : (I*4)  NPU()    = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            SPECTRUM LINES TO PREDICT.
C                            DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (I*4)  NPL()    = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            SPECTRUM LINES TO PREDICT.
C                            DIMENSION: PREDICTED LINE INDEX.
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            COEFFICIENTS FOR N-LEVELS AVERAGED OVER
C                            BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: REFERENCED BY N QUANTUM NUMBER.
C  INPUT : (R*8)  FTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            FOR NL-LEVELS AS A FRACTION OF
C                            CORRESPONDING N-LEVEL.
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEP() = ELECTRON RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM() = ELECTRON RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP() = POSITIVE ION RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM() = POSITIVE ION RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  OUTPUT: (I*4)  NUMIN    = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  OUTPUT: (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  OUTPUT: (R*8)  EM       = EMMISSION MEASURE.
C  OUTPUT: (R*8)  QEX()    =
C                            DIMENSION: MXNSHL.
C  OUTPUT: (R*8)  TOTPOP() = TOTAL COLLISION POP. FOR PREDICTED SPECTRUM
C                            LINE.
C                            UNITS: CM-2
C                            DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TOTEMI() = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                            SPECTRUM LINE.
C                            UNITS: PH CM-2 SEC-1
C                            DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  AVRGWL() = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                            SPECTRUM LINE.
C                            UNITS: A
C                            DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  QEFF()   = EFF. RATE COEFFICIENT FOR PREDICTED
C                            SPECTRUM LINE.
C                            UNITS:
C                            DIMENSION: PREDICTED LINE INDEX.
C  OUTPUT: (R*8)  TBLPOP(,)= TABLE OF COLLISION POP. FOR PREDICTED
C                            SPECTRUM LINE.
C                            UNITS: CM-2
C                            1ST DIMENSION: PREDICTED LINE INDEX.
C                            2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C  OUTPUT: (R*8)  TBLEMI(,)= TABLE OF COLLISION EMISSIVITIES FOR
```

```
C                             PREDICTED SPECTRUM LINE.
C                             UNITS: PH CM-2 SEC-1
C                             1ST DIMENSION: PREDICTED LINE INDEX.
C                             2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C  OUTPUT: (R*8)  TBLWLN(,)= TABLE OF WAVELENGTHS FOR PREDICTED SPECTRUM
C                             LINE.
C                             UNITS: A
C                             1ST DIMENSION: PREDICTED LINE INDEX.
C                             2ND DIMENSION: REFERENCED BY FUNC I4IDLI().
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C  PARAM : (I*4)  MXOB     = MXOBSL.
C
C          (I*4)  NREP     =
C          (I*4)  IC       = LOOP INDEX.
C
C          (I*4)  ICREP()  =
C                             DIMENSION: MXOB.
C
C          (R*8)  WHIGH()  =
C                             DIMENSION: REFERENCED BY L+1.
C          (R*8)  WLOW(,)  =
C                             1ST DIMENSION: REFERENCED BY I4IDFL(N,L).
C                             2ND DIMENSION: REFERENCED BY L+1.
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          C9WFIL     ADAS
C          C9EMQX
C          CXPRSL     ADAS      PREDICTS REQUESTED SPECTRUM LINES.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    15/10/93
C
C DATE:     30/06/95              VERSION:1.1
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C                - UNIX PORT FOR ADAS309, CREATED C9EMIS FROM C8EMIS
C                  ONLY DIFFERENCE IS IT CALLS C9WFIL RATHER THAN C8WFIL
C
C DATE:     10/07/95              VERSION:1.2
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - CHANGED CALL FROM C8EMQX TO C9EMQX
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT
C-----------------------------------------------------------------------
      INTEGER    MXN        , MXOB
      PARAMETER( MXN = 20   , MXOB = 10  )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXOBSL  , MXPRSL  , IZ0     , IZ1     ,
     &           NGRND   , NTOT    , NBOT    , NOLINE  , NPLINE
      INTEGER    NREP    , NUMIN   , NUMAX   , IC
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS    , EM
C-----------------------------------------------------------------------
      INTEGER    NU(MXOBSL)   , NL(MXOBSL)   , NPU(MXPRSL)  ,
     &           NPL(MXPRSL)
      INTEGER    ICREP(MXOB)
C-----------------------------------------------------------------------
      REAL*8     EMISA(MXOBSL)                 ,
     &           QTHEOR(MXNSHL)                ,
     &           QEX(MXNSHL)                   ,
     &           TOTPOP(MXPRSL)                ,
     &           TOTEMI(MXPRSL)                ,
     &           AVRGWL(MXPRSL)                ,
     &           QEFF(MXPRSL)                  ,
     &           FTHEOR((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM((MXNSHL*(MXNSHL+1))/2)
      REAL*8     WHIGH((MXN*(MXN+1))/2)
C-----------------------------------------------------------------------
      REAL*8     TBLPOP(MXPRSL,2*MXNSHL-3)      ,
     &           TBLEMI(MXPRSL,2*MXNSHL-3)      ,
     &           TBLWLN(MXPRSL,2*MXNSHL-3)
      REAL*8     WLOW((MXN*(MXN+1))/2,MXN)
C-----------------------------------------------------------------------
```

C9EMQX

```
      SUBROUTINE C9EMQX( MXNSHL , MXOBSL , IZ1    , NBOT   ,
     &                   NUMIN  , NUMAX  , NU     , NL     ,
     &                   EMISA  , NREP   , ICREP  , QTHEOR ,
     &                   WLOW   , EM     , QEX
```

```
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C9EMQX *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C8EMIS
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  MXOBSL   = MAXIMUM NUMBER OF OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NBOT     = MINIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NUMIN    = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (I*4)  NU()     = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NL()     = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS OF
C                            OBSERVED SPECTRUM LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (R*8)  EMISA()  = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                            LINES.
C                            DIMENSION: SPECTRUM LINE INDEX.
C  INPUT : (I*4)  NREP     =
C  INPUT : (I*4)  ICREP()  =
C                            DIMENSION: MXOBSL.
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            COEFFICIENTS FOR N-LEVELS AVERAGED OVER
C                            BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: PRINCIPAL QUANTUM NUMBER INDEX.
C  INPUT : (R*8)  WLOW(,)  =
C                            1ST DIMENSION: REFERENCED BY I4IDFL(N,L).
C                            2ND DIMENSION: REFERENCED BY L+1.
C
C  OUTPUT: (R*8)  EM       = EMMISSION MEASURE.
C  OUTPUT: (R*8)  QEX()    =
C                            DIMENSION: MXNSHL.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C  PARAM : (I*4)  MXOB     = MXOBSL.
C
C          (I*4)  N        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N1       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L1       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  IC       = ARRAY INDEX.
C          (I*4)  IC1      = ARRAY INDEX.
C          (I*4)  IC2      = ARRAY INDEX.
C          (I*4)  IFAIL    = RETURN FLAG FROM NAG ROUTINE.
C          (I*4)  M        = LOOP INDEX.
C          (I*4)  I        = LOOP INDEX.
C          (I*4)  J        = ARRAY INDEX.
C
C          (R*8)  XM       = REAL VALUE = M.
C          (R*8)  X1       =
C          (R*8)  X2       =
C          (R*8)  T1       =
C          (R*8)  T2       =
C          (R*8)  SUM      =
C          (R*8)  SUMEX    =
C          (R*8)  SUMTH    =
C
C          (I*4)  JLIST()  =
C                            DIMENSION: MXN.
C
C          (R*8)  REMISA() =
C                            DIMENSION: MXOB.
C          (R*8)  REMQ()   =
C                            DIMENSION: MXOB.
C          (R*8)  WKSPCE() = WORKSPACE FOR NAG ROUTINE.
C                            DIMENSION: MXOB.
C          (R*8)  EMQ()    =
C                            DIMENSION: MXNSHL.
C
C          (R*8)  CNDSA(,) = CONDENSED MATRIX.
C                            1ST DIMENSION: MXN.
C                            2ND DIMENSION: 2.
C          (R*8)  ARED(,)  = LINEAR CONDENSATION TRANSFORMATION ARRAY.
C                            1ST DIMENSION: MXN.
C                            2ND DIMENSION: MXN.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          R8ATAB     ADAS      RETURNS HYDRONIC L-RESOLVED A-VALUES.
C                               IF INPUT QUANTUM NUMBERS ARE INVALID
C                               THEN RETURNS ZERO.
CX         F04ARF     NAG       FINDS SOLUTION TO A SET OF REAL LINEAR
```

```
CX                              EQUATIONS.
C           XXMINV     ADAS     MATRIX SOLUTION - REPLACES ABOVE NAG
C                               ROUTINE
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    14/10/93
C
C DATE:    10/07/95                        VERSION 1.1
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C            - CREATED C9EMQX FROM C8EMQX - ONLY DIFFERENCE IS CALL TO
C              FORTRAN ROUTINE F04ARF IS REPLACED WITH CALL TO XXMINV
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
      REAL*8     R8ATAB
C-----------------------------------------------------------------------
      INTEGER    MXN       , MXOB
      PARAMETER( MXN = 20  , MXOB = 10 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , MXOBSL  , IZ1     , NBOT    , NUMIN   ,
     &           NUMAX   , NREP
      INTEGER    N       , L       , N1      , L1      , IC      ,
     &           IC1     , IC2     , IFAIL   , M       , I       ,
     &           J
C-----------------------------------------------------------------------
      REAL*8     EM
      REAL*8     XM      , X1      , X2      , T1      , T2      ,
     &           SUM     , SUMEX   , SUMTH
C-----------------------------------------------------------------------
      INTEGER    ICREP(MXOBSL) , NU(MXOBSL)   , NL(MXOBSL)
      INTEGER    JLIST(MXN)
C-----------------------------------------------------------------------
      REAL*8     EMISA(MXOBSL)   , QTHEOR(MXNSHL)  , QEX(MXNSHL)
      REAL*8     REMISA(MXOB)    , REMQ(MXOB)      , WKSPCE(MXOB)    ,
     &           EMQ(MXN)
      REAL*8     WLOW((MXNSHL*(MXNSHL+1))/2,MXNSHL)
      REAL*8     CNDSA(MXN,2)                      ,
     &           ARED(MXOB,MXOB)
C-----------------------------------------------------------------------
```

C9OUT0

```
      SUBROUTINE C9OUT0( IWRITE , MXSCAN , DATE   , DSNIN  ,
     &                   DSNPAS , IPSET  , TITLE  , SYMBD  ,
     &                   IDZ0   , SYMBR  , IRZ0   , IRZ1   ,
     &                   IRZ2   , RAMSNO , TEV    , TIEV   ,
     &                   DENS   , DENSZ  , ZEFF   , BMAG   ,
     &                   BMENG  , NTU    , NTL    , ITHEOR ,
     &                   IBSTAT , IEMMS  , NBMENG , BMENGA ,
     &                   NTIEV  , TIEVA  , NDENSZ , DENSZA ,
     &                   NZEFF  , ZEFFA  , NBMAG  , BMAGA  ,
     &                   CADAS
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C9OUT0 *********************
C
C  PURPOSE: WRITES TEXT OUTPUT TO FILE FOR ADAS309.
C
C  CALLING PROGRAM: ADAS309
C
C  INPUT : (I*4)  IWRITE    = UNIT NUMBER FOR OUTPUT.
C  INPUT : (I*4)  MXSCAN    = MAXIMUM NUMBER OF VALUES IN A SCAN.
C  INPUT : (C*8)  DATE      = DATE STRING.
C  INPUT : (C*80) DSNIN     = FULL INPUT DATA SET NAME.
C  INPUT : (C*80) DSNPAS    = FULL OUTPUT PASSING DATA SET NAME.
C  INPUT : (I*4)  IPSET     = INPUT PARAMETER SET NUMBER FOR CURRENT.
C  INPUT : (C*40) TITLE     = ISPF ENTERED GENERAL TITLE FOR RUN.
C  INPUT : (C*2)  SYMBD     = DONOR ELEMENT SYMBOL.
C  INPUT : (I*4)  IDZ0      = DONOR NUCLEAR CHARGE.
C  INPUT : (C*2)  SYMBR     = RECEIVER ELEMENT SYMBOL.
C  INPUT : (I*4)  IRZ0      = RECEIVER NUCLEAR CHARGE.
C  INPUT : (I*4)  IRZ1      = RECEIVER ION INITIAL CHARGE.
C  INPUT : (I*4)  IRZ2      = RECEIVER ION FINAL CHARGE.
C  INPUT : (R*8)  RAMSNO    = RECEIVER ATOMIC MASS.
C  INPUT : (R*8)  TEV       = ELECTRON TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  TIEV      = ION TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  DENS      = ELECTRON DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  DENSZ     = PLASMA ION DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  ZEFF      = EFFECTIVE ION CHARGE.
C  INPUT : (R*8)  BMAG      = PLASMA MAGNETIC INDUCTION.
```

```
C                               UNITS: TESLA
C  INPUT : (R*8)  BMENG     = REFERNCE VALUE FOR BEAM ENERGY.
C                               UNITS: EV/AMU
C  INPUT : (I*4)  NTU       = UPPER PRINCIPAL QUANTUM NUMBER OF
C                               TRANSITION.
C  INPUT : (I*4)  NTL       = LOWER PRINCIPAL QUANTUM NUMBER OF
C                               TRANSITION.
C  INPUT : (I*4)  ITHEOR    = CHARGE EXCHANGE MODEL OPTION.
C                               1 => USE INPUT DATA SET.
C                               2 => USE EIKONAL MODEL.
C  INPUT : (I*4)  IBSTAT    = DONOR STATE FOR EIKONAL MODEL.
C                               1 => H(1S)
C                               2 => H(2S)
C                               3 => H(2P)
C                               4 => HE(1S2)
C                               5 => HE(1S2S)
C  INPUT : (I*4)  IEMMS     = EMISSION MEASURE MODEL OPTION.
C                               1 => CHARGE EXCHANGE.
C                               2 => ELECTRON IMPACT EXCITATION.
C  INPUT : (I*4)  NBMENG    = NUMBER OF BEAM ENERGIES IN SCAN.
C  INPUT : (R*8)  BMENGA()  = BEAM ENERGIES FOR SCAN.
C                               UNITS: EV/AMU
C                               DIMENSION: MXSCAN
C  INPUT : (I*4)  NTIEV     = NUMBER OF ION TEMPERATURES IN SCAN.
C  INPUT : (R*8)  TIEVA()   = ION TEMPERATURES FOR SCAN.
C                               UNITS: EV
C                               DIMENSION: MXSCAN
C  INPUT : (I*4)  NDENSZ    = NUMBER OF ION DENSZTIES IN SCAN.
C  INPUT : (R*8)  DENSZA()  = ION DENSZTIES FOR SCAN.
C                               UNITS: CM-3
C                               DIMENSION: MXSCAN
C  INPUT : (I*4)  NZEFF     = NUMBER OF PLASMA EFFECTIVE Z IN SCAN.
C  INPUT : (R*8)  ZEFFA()   = PLASMA EFFECTIVE Z FOR SCAN.
C                               DIMENSION: MXSCAN
C  INPUT : (I*4)  NBMAG     = NUMBER OF PLASMA MAGNETIC FIELDS IN SCAN.
C  INPUT : (R*8)  BMAGA()   = PLASMA MAGNETIC FIELDS FOR SCAN.
C                               UNITS: TESLA
C                               DIMENSION: MXSCAN
C
C  I/O   : (C*80) CADAS     = ADAS HEADER: INCLUDES RELEASE, PROGRAM,
C                               TIME.
C
C          (I*4)  I         = ARRAY INDEX.
C
C          (L*4)  LFIRST    = FLAGS IF FIRST CALL OF SUBROUTINE.
C                               .TRUE.  => FIRST CALL.
C                               .FALSE. => NOT FIRST CALL.
C
C ROUTINES: NONE
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    03/12/93
C
C UNIX PORT: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C DATE:    10/07/95                     VERSION 1.1
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    IWRITE  , MXSCAN  , IDZ0    , IRZ0    ,
     &           IRZ1    , IRZ2    , NTU     , NTL     , ITHEOR  ,
     &           IBSTAT  , IEMMS   , NBMENG  , NTIEV   , NDENSZ  ,
     &           NZEFF   , NBMAG
      INTEGER    I       , IPSET
C-----------------------------------------------------------------------
      REAL*8     RAMSNO  , TEV     , TIEV    , DENS    , DENSZ   ,
     &           ZEFF    , BMAG    , BMENG
C-----------------------------------------------------------------------
      LOGICAL    LFIRST
C-----------------------------------------------------------------------
      CHARACTER  DATE*8     , DSNIN*80   , DSNPAS*80  , TITLE*40   ,
     &           SYMBR*2    , SYMBD*2
      CHARACTER  CADAS*80
C-----------------------------------------------------------------------
      REAL*8     BMENGA(MXSCAN)  , DENSZA(MXSCAN)  , TIEVA(MXSCAN)   ,
     &           ZEFFA(MXSCAN)   , BMAGA(MXSCAN)
C-----------------------------------------------------------------------
      SAVE       LFIRST
C-----------------------------------------------------------------------
      DATA       LFIRST / .TRUE. /
C-----------------------------------------------------------------------
```

C9OUT1

```
      SUBROUTINE C9OUT1( IWRITE , MXSCAN , DATE   , DSNIN  ,
     &                   IPSET  , SYMBD  , SYMBR  , IRZ1   ,
     &                   NTU    , NTL    , ITHEOR , IBSTAT ,
     &                   IEMMS  , BMENG  , TIEV   , DENSZ  ,
     &                   ZEFF   , BMAG   , QEFREF , NBMENG ,
     &                   BMENGA , QEFBEA , NTIEV  , TIEVA  ,
```

```
     &                    QEFTIA , NDENSZ , DENSZA , QEFDZA ,
     &                    NZEFF  , ZEFFA  , QEFZEA , NBMAG  ,
     &                    BMAGA  , QEFBMA
     &                  )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C9OUT0 *********************
C
C  PURPOSE: WRITES DATA OUTPUT TO FILE FOR ADAS309.
C
C  CALLING PROGRAM: ADAS309
C
C  INPUT : (I*4)  IWRITE    = UNIT NUMBER FOR OUTPUT.
C  INPUT : (I*4)  MXSCAN    = MAXIMUM NUMBER OF VALUES IN A SCAN.
C  INPUT : (C*8)  DATE      = DATE STRING.
C  INPUT : (C*80) DSNIN     = FULL INPUT DATA SET NAME.
C  INPUT : (I*4)  IPSET     = INPUT PARAMETER SET NUMBER FOR CURRENT
C                             RUN.
C  INPUT : (C*2)  SYMBD     = DONOR ELEMENT SYMBOL.
C  INPUT : (C*2)  SYMBR     = RECEIVER ELEMENT SYMBOL.
C  INPUT : (I*4)  IRZ1      = ION CHARGE OF RECEIVER.
C  INPUT : (I*4)  NTU       = UPPER PRINCIPAL QUANTUM NUMBER OF
C                             TRANSITION.
C  INPUT : (I*4)  NTL       = LOWER PRINCIPAL QUANTUM NUMBER OF
C                             TRANSITION.
C  INPUT : (I*4)  ITHEOR    = CHARGE EXCHANGE MODEL OPTION.
C                             1 => USE INPUT DATA SET.
C                             2 => USE EIKONAL MODEL.
C  INPUT : (I*4)  IBSTAT    = DONOR STATE FOR EIKONAL MODEL.
C                             1 => H(1S)
C                             2 => H(2S)
C                             3 => H(2P)
C                             4 => HE(1S2)
C                             5 => HE(1S2S)
C  INPUT : (I*4)  IEMMS     = EMISSION MEASURE MODEL OPTION.
C                             1 => CHARGE EXCHANGE.
C                             2 => ELECTRON IMPACT EXCITATION.
C  INPUT : (R*8)  BMENG     = REFERNCE VALUE FOR BEAM ENERGY.
C                             UNITS: EV/AMU
C  INPUT : (R*8)  TIEV      = REFERENCE VALUE FOR ION TEMPERATURE.
C                             UNITS: EV
C  INPUT : (R*8)  DENSZ     = REFERENCE VALUE FOR PLASMA ION DENSITY.
C                             UNITS: CM-3
C  INPUT : (R*8)  ZEFF      = REFERENCE VALUE FOR EFFECTIVE ION CHARGE.
C  INPUT : (R*8)  BMAG      = REFERENCE VALUE FOR PLASMA MAGNETIC
C                             FIELD.
C                             UNITS: TESLA
C  INPUT : (R*8)  QEFREF    = REFERENCE VALUE FOR EFFECTIVE RATE COEFFT.
C                             UNITS: CM3 SEC-1
C  INPUT : (I*4)  NBMENG    = NUMBER OF BEAM ENERGIES IN SCAN.
C  INPUT : (R*8)  BMENGA()  = BEAM ENERGIES FOR SCAN.
C                             UNITS: EV/AMU
C                             DIMENSION: MXSCAN
C  INPUT : (R*8)  QEFBEA()  = EFFECTIVE RATE COEFFICIENTS FOR BEAM
C                             ENERGY SCAN.
C                             UNITS: CM3 SEC-1
C                             DIMENSION: MXSCAN
C  INPUT : (I*4)  NTIEV     = NUMBER OF ION TEMPERATURES IN SCAN.
C  INPUT : (R*8)  TIEVA()   = ION TEMPERATURES FOR SCAN.
C                             UNITS: EV
C                             DIMENSION: MXSCAN
C  INPUT : (R*8)  QEFTIA()  = EFFECTIVE RATE COEFFICIENTS FOR ION
C                             TEMPERATURE SCAN.
C                             UNITS: CM3 SEC-1
C                             DIMENSION: MXSCAN
C  INPUT : (I*4)  NDENSZ    = NUMBER OF ION DENSZTIES IN SCAN.
C  INPUT : (R*8)  DENSZA()  = ION DENSZTIES FOR SCAN.
C                             UNITS: CM-3
C                             DIMENSION: MXSCAN
C  INPUT : (R*8)  QEFDZA()  = EFFECTIVE RATE COEFFICIENTS FOR ION
C                             DENSITY SCAN.
C                             UNITS: CM3 SEC-1
C                             DIMENSION: MXSCAN
C  INPUT : (I*4)  NZEFF     = NUMBER OF PLASMA EFFECTIVE Z IN SCAN.
C  INPUT : (R*8)  ZEFFA()   = PLASMA EFFECTIVE Z FOR SCAN.
C                             DIMENSION: MXSCAN
C  INPUT : (R*8)  QEFZEA()  = EFFECTIVE RATE COEFFICIENTS FOR PLASMA
C                             EFFECTIVE Z SCAN.
C                             UNITS: CM3 SEC-1
C                             DIMENSION: MXSCAN
C  INPUT : (I*4)  NBMAG     = NUMBER OF PLASMA MAGNETIC FIELDS IN SCAN.
C  INPUT : (R*8)  BMAGA()   = PLASMA MAGNETIC FIELDS FOR SCAN.
C                             UNITS: TESLA
C                             DIMENSION: MXSCAN
C  INPUT : (R*8)  QEFBMA()  = EFFECTIVE RATE COEFFICIENTS FOR PLASMA
C                             MAGNETIC FIELD SCAN.
C                             UNITS: CM3 SEC-1
C                             DIMENSION: MXSCAN
C
C          (I*4)  I         = ARRAY INDEX.
C          (I*4)  I1        = ARRAY INDEX.
C          (I*4)  I2        = ARRAY INDEX.
C
C          (C*8)  DONOR     = DONOR SYMBOL AND ION CHARGE (OR STATE IF
C                             EIKONAL MODEL.
```

```
C          (C*5)  RECVR     = RECEIVER SYMBOL AND ION CHARGE.
C          (C*5)  TRANS     = N LEVELS OF TRANSITION.
C          (C*7)  FILE      = INPUT DATA SET MEMBER NAME.
C          (C*2)  MODEL     = EMISSION MEASURE MODEL.
C
C ROUTINES:  NONE
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    03/12/93
C
C UNIX PORT: TIM HAMMOND(TESSELLA SUPPORT SERVICES PLC)
C DATE:    10/07/95                      VERSION 1.1
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    IWRITE  , MXSCAN  , IZD     , IRZ1    , NTU     ,
     &           NTL     , ITHEOR  , IBSTAT  , IEMMS   , IPSET   ,
     &           NBMENG  , NTIEV   , NDENSZ  , NZEFF   , NBMAG
      INTEGER    I       , I1      , I2
C-----------------------------------------------------------------------
      REAL*8     BMENG   , TIEV    , DENSZ   , ZEFF    , BMAG    ,
     &           QEFREF
C-----------------------------------------------------------------------
      CHARACTER  DATE*8     , DSNIN*80   , SYMBD*2    , SYMBR*2
      CHARACTER  DONOR*8    , RECVR*5    , TRANS*5    , FILE*7     ,
     &           MODEL*2
C-----------------------------------------------------------------------
      REAL*8     BMENGA(MXSCAN)  , DENSZA(MXSCAN)  , TIEVA(MXSCAN)   ,
     &           ZEFFA(MXSCAN)   , BMAGA(MXSCAN)   , QEFBEA(MXSCAN)  ,
     &           QEFTIA(MXSCAN)  , QEFDZA(MXSCAN)  , QEFZEA(MXSCAN)  ,
     &           QEFBMA(MXSCAN)
C-----------------------------------------------------------------------
```

C9WFIL

```
      SUBROUTINE C9WFIL( MXNSHL , IZ1    , NGRND  , NTOT   ,
     &                   NBOT   , NUMAX  , DENSZ  , DENS   ,
     &                   QTHEOR , FTHEOR , TBQMEP , TBQMEM ,
     &                   TBQMIP , TBQMIM , WHIGH  , WLOW
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C9WFIL *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C9EMIS
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT     = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                            STATE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  NUMAX    = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER FOR
C                            OBSERVED SPECTRUM LINES.
C  INPUT : (R*8)  DENSZ    = PLASMA ION DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  QTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            COEFFICIENTS FOR N-LEVELS AVERAGED OVER
C                            BEAM FRACTIONS.
C                            UNITS: CM3 SEC-1
C                            DIMENSION: REFERENCED BY N QUANTUM NUMBER.
C  INPUT : (R*8)  FTHEOR() = MEAN CHARGE EXCHANGE OR EXCITATION RATE
C                            FOR NL-LEVELS AS A FRACTION OF
C                            CORRESPONDING N-LEVEL.
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEP() = ELECTRON RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM() = ELECTRON RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP() = POSITIVE ION RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM() = POSITIVE ION RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
```

```
C  OUTPUT: (R*8)  WHIGH()  =
C                           DIMENSION: REFERENCED BY L+1.
C  OUTPUT: (R*8)  WLOW(,)  =
C                             1ST DIMENSION: REFERENCED BY I4IDFL(N,L).
C                             2ND DIMENSION: REFERENCED BY L+1.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C
C          (I*4)  N        = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L        = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N1       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L1       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  N2       = LOOP INDEX FOR PRINCIPAL QUANTUM NUMBER.
C          (I*4)  L2       = LOOP INDEX FOR ORBITAL QUANTUM NUMBER.
C          (I*4)  LP       = ARRAY INDEX = L+1.
C          (I*4)  IDL      = ARRAY INDEX.
C
C          (R*8)  A1       = LOCAL STORE FOR RETURN VALUE OF FUNC R8ATAB.
C
C          (R*8)  RHS()    = RIGHT HAND SIDE OF N LEVEL EQUATION.
C                            DIMENSION: MXN.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          R8ATAB     ADAS      RETURNS HYDRONIC L-RESOLVED A-VALUES.
C                               IF INPUT QUANTUM NUMBERS ARE INVALID
C                               THEN RETURNS ZERO.
C          CXWSOL     ADAS
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    13/10/93
C
C DATE:    30/06/95              VERSION:1.1
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C            - UNIX PORT FOR ADAS309, CREATED THIS C9WFIL FROM C8WFIL
C              WHICH COMMUNICATED VIA UNIX PIPE WITH IDL. REMOVED THIS.
C
C DATE:    10/07/95            VERSION:1.2
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C            - TIDIED CODE AND COMMENTS UP.
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
      REAL*8     R8ATAB
C-----------------------------------------------------------------------
      INTEGER    MXN
      PARAMETER( MXN = 20 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , IZ1     , NGRND   , NTOT   , NBOT    ,
     &           NUMAX
      INTEGER    N       , L       , N1      , L1     , N2      ,
     &           L2      , LP      , IDL
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS
      REAL*8     A1
C-----------------------------------------------------------------------
      REAL*8     QTHEOR(MXNSHL)                ,
     &           FTHEOR((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM((MXNSHL*(MXNSHL+1))/2)  ,
     &           WHIGH((MXNSHL*(MXNSHL+1))/2)
      REAL*8     RHS(MXN)
C-----------------------------------------------------------------------
      REAL*8     WLOW((MXNSHL*(MXNSHL+1))/2,MXNSHL)
C-----------------------------------------------------------------------
```

C9WSOL

```
      SUBROUTINE C9WSOL( MXNSHL , IZ1    , NGRND  , N      ,
     &                   DENSZ  , DENS   , TBQMEP , TBQMEM ,
     &                   TBQMIP , TBQMIM , RHS
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C9WSOL *********************
C
C  PURPOSE:
C
C  CALLING PROGRAM: C8WFIL
```

```
C
C  INPUT : (I*4)  MXNSHL   = MAXIMUM VALUE OF PRINCIPAL QUANTUM NUMBER.
C  INPUT : (I*4)  IZ1      = ION CHARGE.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  N        = PRINCIPAL QUANTUM NUMBER.
C  INPUT : (R*8)  DENSZ    = PLASMA ION DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
C                            UNITS: CM-3
C  INPUT : (R*8)  TBQMEP() = ELECTRON RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMEM() = ELECTRON RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIP() = POSITIVE ION RATE COEFFT. FOR NL->NL+1.
C                            INDEX FOR NL->NL+1 TRANSITION GIVEN BY
C                            I4IDFL(N,L).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C  INPUT : (R*8)  TBQMIM() = POSITIVE ION RATE COEFFT. FOR NL+1->NL.
C                            INDEX FOR NL+1->NL TRANSITION GIVEN BY
C                            I4IDFL(N,L+1).
C                            DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).
C
C  I/O   : (R*8)  RHS()    =
C                            DIMENSION: REFERENCED BY L+1.
C
C  PARAM : (I*4)  MXN      = MXNSHL.
C
C          (I*4)  L        = ORBITAL QUANTUM NUMBER.
C          (I*4)  IDL      = ARRAY INDEX.
C          (I*4)  N1       = PRINCIPAL QUANTUM NUMBER.
C          (I*4)  LP       = ARRAY INDEX = L+1.
C          (I*4)  IFAIL    = RETURN FLAG FROM NAG ROUTINE.
C
C          (R*8)  VDS()    =
C          (R*8)  VDI()    =
C          (R*8)  VD()     =
C          (R*8)  VDNEW(,)= NEW (TEMPORARY?) VARIABLE WHICH IS
C                           USED TO HOLD THE FULL MATRIX BUILT FROM
C                           ZEROES AND THE THREE DIAGONALS VDS, VDI
C                           AND VD
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX GIVEN QUANTUM
C                               NUMBERS N AND L.
C          R8ATAB     ADAS      RETURNS HYDRONIC L-RESOLVED A-VALUES.
C                               IF INPUT QUANTUM NUMBERS ARE INVALID
C                               THEN RETURNS ZERO.
C           XXGTSL     IDL_ADAS  TRIDIAGONAL MATRIX SOLVER.
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    12/10/93
C
C DATE:    10/07/95                        VERSION 1.1
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C           - UNIX PORT OF ADAS309 - HAVE CREATED C9WSOL FROM C8WSOL
C             THE ORIGINAL C8WSOL CALLED A NAG ROUTINE TO SOLVE LINEAR
C             EQUATIONS AND THE UPDATED C8WSOL USED PIPE COMMUNICATIONS
C             WITH IDL. THIS VERSION OF C9WSOL CALLS THE FORTRAN
C             ROUTINE XXGTSL INSTEAD.
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    I4UNIT  , I4IDFL
      REAL*8     R8ATAB
C-----------------------------------------------------------------------
      INTEGER    MXN
      PARAMETER( MXN = 20 )
C-----------------------------------------------------------------------
      INTEGER    MXNSHL  , NGRND   , N       , IZ1
      INTEGER    L       , IDL     , N1      , LP      , IFAIL
      INTEGER    I       , J
C-----------------------------------------------------------------------
      REAL*8     DENSZ   , DENS
C-----------------------------------------------------------------------
      REAL*8     TBQMEP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMEM((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIP((MXNSHL*(MXNSHL+1))/2)  ,
     &           TBQMIM((MXNSHL*(MXNSHL+1))/2)  ,
     &           RHS(MXNSHL)
      REAL*8     VDS(MXN)  , VDI(MXN)  , VD(MXN)
      REAL*8     VDNEW(MXN,MXN)
C-----------------------------------------------------------------------
```

CACHKB

```
      SUBROUTINE CACHKB( IUNIT  , NBSEL  , IBSEL  ,
     &                   IZ0IN  , IZ0    ,
     &                   LOPEN  , IRCODE , DLPATH
     &                 )
C
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CACHKB *********************
C
C  PURPOSE: TO CHECK THE SELECTED BLOCK (IBSEL) OF DATA  EXISTS  IN  THE
C           INPUT DATA SET AND IF SO IT REPRESENTS THE ENTERED VALUES OF
C           'IZ0IN' (NUCLEAR CHARGE OF SELECTED IONISING ION ELEMENT).
C
C           IT ALSO CLOSES THE INPUT DATA SET ALLOCATION IF OPEN.
C
C  CALLING PROGRAM: CASSZD
C
C  SUBROUTINE:
C
C  INPUT : (I*4)   IUNIT   = UNIT TO WHICH INPUT DATA SET IS ALLOCATED
C  INPUT : (I*4)   NBSEL   = TOTAL NUMBER OF DATA-BLOCKS READ FROM INPUT
C                            DATA SET.
C  INPUT : (I*4)   IBSEL   = INDEX OF DATA-BLOCK SELECTED FOR ANALYSIS
C
C  INPUT : (I*4)   IZ0IN   = REQUESTED: NUCLEAR CHARGE OF ELEMENT
C  INPUT : (I*4)   IZ0     = INPUT FILE: NUCLEAR CHARGE OF ELEMENT
C
C  I/O   : (L*4)   LOPEN   = INPUT : .TRUE.  => INPUT DATA SET OPEN.
C                                    .FALSE. => INPUT DATA SET CLOSED.
C                            OUTPUT: ALWAYS RETURNED AS .FALSE.
C  OUTPUT: (I*4)   IRCODE  = RETURN CODE FROM SUBROUTINE:
C                            0 => NO ERROR DETECTED.
C                            2 => DISCREPANCY BETWEEN REQUESTED ELEMENT
C                                 AND THAT IN INPUT DATA FILE.
C                            3 => SELECTED DATA-BLOCK  OUT OF RANGE  OR
C                                 DOES NOT EXIST.
C
C           (I*4)   I4UNIT  = FUNCTION (SEE ROUTINE SECTION BELOW)
C
CX          (C*44)  DSNAME  = FULL MVS NAME OF DATA SET OPENED
CA          (c*80)  DSNAME  = DATA FILE NAME UNDER UNIX, INCLUDING PATH.
C
C ROUTINES:
C           ROUTINE    SOURCE    BRIEF DESCRIPTION
C           ------------------------------------------------------------
C           E2FILE     ADAS      OPEN DATA SET FOR SELECTED ELEMENT
C           I4UNIT     ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C
C AUTHOR:  PAUL E. BRIDEN (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/37
C          JET EXT. 2620
C
C DATE:    06/06/91
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 25-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - CREATED FROM E2CHKB TO WHICH IT IS ESSENTIALLY
C                 IDENTICAL EXCEPT IT CALLS CAFILE RATHER THAN E2FILE
C                 AND HAS THE EXTRA PATHNAME VARIABLE DLPATH INCLUDED
C                 IN THE ARGUMENT LIST.
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER     I4UNIT
      INTEGER     IUNIT          , IRCODE           ,
     &            NBSEL          , IBSEL            ,
     &            IZ0IN          , IZ0
C-----------------------------------------------------------------------
      LOGICAL     LOPEN
C-----------------------------------------------------------------------
CX    CHARACTER   DSNAME*44
      CHARACTER   DSNAME*80 , DLPATH*80
C-----------------------------------------------------------------------
```

CAFILE

```
      SUBROUTINE CAFILE( IUNIT , IZ0 , IRCODE , DSNAME , DLPATH)
C
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CAFILE *********************
C
C  PURPOSE: TO OPEN AN IONIZATION RATE-COEFFT 'IONELEC' DATA SET
```

```
C           BY DEFAULT, OR AN ALTERNATIVE DATA SET IF REQUIRED, FOR
C           IONIZING ION WITH NUCLEAR CHARGE 'IZ0'
C           THIS WILL BE CONNECTED TO UNIT 'IUNIT'.
C
C   DATA SET OPENED: DLPATH/adf07/<DEFADF>/<GROUP>(OPTIONAL)/<TYPE>/
C                         <GROUP_EXT>#<ELEMENT SYMBOL>'
C
C  CALLING PROGRAM: CASSZD
C
C  SUBROUTINE:
C
C  INPUT : (I*4)   IUNIT   = UNIT TO WHICH DATA SET WILL BE CONNECTED
C  INPUT : (I*4)   IZ0     = NUCLEAR CHARGE OF EMITTING ION REQUESTED
C  INPUT : (C*80) DLPATH  = PATH NAME TO THE RELEVANT DATA FILES
C
C  OUTPUT: (I*4)   IRCODE  = RETURN CODE FROM SUBROUTINE:
C                            0 => DATA SET SUCCESSFULLY CONNECTED
C                            1 => REQUESTED DATA  SET  MEMBER  DOES  NOT
C                                 EXISTS - DATA SET NOT CONNECTED.
C                            9 => REQUESTED DATA  SET  EXISTS BUT CANNOT
C                                 BE OPENED.
CX OUTPUT: (C*44)  DSNAME  = FULL MVS NAME OF OPENED DATA SET
C  OUTPUT: (C*80)  DSNAME  = NAME OF OPENED DATA SET UNDER UNIX
C
C          (I*4)   IDLEN   = LENGTH, IN BYTES, OF FIXED 'DSNAME' PREFIX
C          (I*4)   LENF1   = FIRST NON-BLANK CHR OF 'DSNAME' GROUP PART
C          (I*4)   LENF2   = LAST  NON-BLANK CHR OF 'DSNAME' GROUP PART
C          (I*4)   LENF3   = FIRST NON-BLANK CHR OF 'DSNAME' TYPE PART
C          (I*4)   LENF4   = LAST  NON-BLANK CHR OF 'DSNAME' TYPE PART
C          (I*4)   LENF5   = LAST  NON-BLANK CHR OF 'DSNAME' USERID PART
C          (I*4)   LENF6   = LAST  NON-BLANK CHR OF 'DSNAME' USERID PART
C          (I*4)   LENF7   = LAST  NON-BLANK CHR OF 'DSNAME' EXTENSION PART
C          (I*4)   LENF8   = LAST  NON-BLANK CHR OF 'DSNAME' EXTENSION PART
CA         (C*1)   HASH    = '#'   IF NON-BLANK EXT, ELSE ' '.
C          (C*2)   XFESYM  = FUNCTION - (SEE ROUTINES SECTION BELOW)
C          (C*2)   ESYM    = ELEMENT SYMBOL FOR NUCLEAR CHARGE 'IZ0'
C          (C*3)   USREXT  = ADAS SOURCE DATA FILE EXTENSION
CA         (C*80)  USERID  = ADAS SOURCE DATA USER ID
C          (C*8)   USRGRP  = ADAS SOURCE DATA GROUPNAME
CA         (C*80)  USRTYP  = ADAS SOURCE DATA TYPENAME
C          (C*5)   DEFADF  = DEFAULT DATA DIRECTORY, I.E. ADF13
C
C          (L*4)   LEXIST  = .TRUE.  => REQUESTED  DATA  SET  EXISTS.
C                            .FALSE. => REQUESTED  DATA  SET  DOES  NOT
C                                       EXIST.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C           XXUID      ADAS      FETCHES/SETS ADAS SOURCE DATA USER ID
C          XXSSZD     ADAS      FETCHES/SETS ADAS SOURCE DATA FILENAME
C                               AND FILE EXTENSION
C          XFESYM     ADAS      CHARACTER*2 FUNCTION -
C                               GATHERS ELEMENT SYMBOL FOR NUC. CHARGE
C           XXSLEN     ADAS      FINDS FIRST AND LAST NON-BLANK
C                                  CHARACTERS IN STRING.
C
C AUTHOR:  H.P. SUMMERS
C          K1/1/57
C          JET EXT. 4941
C DATE:    11/10/91
C
C UPDATE:  10/03/93 - PE BRIDEN: ADDED CALL TO XXUID AND USERID VARIABLE
C                                - NOW ALLOWS ANY INPUT DATASET USER ID.
C UPDATE:   2/09/93 - HPS      : ADDED CALL TO XXSSZD AND USRGRP, USRTYP
C                                  AND USREXT NAMES
C                                - NOW ALLOWS ANY INPUT DATASET FILENAME
C                                  AND EXTENSION
C UPDATE:  23/11/93 - PEB      : CORRECT ERROR - A '.' HAD MISTAKENLY
C                                BEEN PLACED BEFORE THE MEMBER NAME IN
C                                VARIABLE DSNAME.
C
C UPDATE:  10/11/94 - L. JALOTA: MODIFIED CODE FOR RUNNING UNDER UNIX
C                                  USING NEW FILE NAMING CONVENTION.
C                                  "ACTION" KEYWORD IN OPEN COMMAND IS IBM
C                                  SO REMOVED HERE.
C                                  ADDED DEFADF
C UPDATE:  22/11/94 - L. JALOTA: TIDIED UP CHARACTER LENGTH DEFINITIONS
C
C UPDATE:  24/03/95 - HPS      : INTRODUCED HASH TO ELIMINATE # IN FILE IF
C                                THERE IS NO EXTENSION PART OF THE FILE NAME
C                                ALTER LOGIC TO ALLOW USRTYP, USREXT TO BE A
C                                SINGLE CHARACTER.
C
C VERSION: 1.1                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
      INTEGER     IUNIT         , IZ0           ,
     &            IRCODE        , IDLEN         ,
     &            LENF1         , LENF2         ,
     &            LENF3         , LENF4            ,
     &             LENF5         , LENF6          ,
     &            LENF7          , LENF8
      INTEGER     IF1           ,
     &            IL1
C-----------------------------------------------------------------------
```

```
      CHARACTER   XFESYM*2      , ESYM*2       ,
     &            USERID*80     , DSNAME*80    , DEFADF*5   ,
     &            USRGRP*8      , USRTYP*80    , USREXT*3   ,
     &            HASH*1        , DLPATH*80
C-----------------------------------------------------------------------
      LOGICAL     LEXIST
C-----------------------------------------------------------------------
C SET DEFAULT DIRECTORY.
      PARAMETER (DEFADF = 'adf07')
C
C-----------------------------------------------------------------------
```

CAPASF

```
      SUBROUTINE CAPASF( IUPS1  , IUPS2  , IUPS3  , IUPS4  , IURUN ,
     &                   DSNPS1 , DSNPS2 , DSNPS3 , DSNPS4 , DSNRUN,
     &                   LPASS1 , LPASS2 , LPASS3 , LPASS4 , LRUN  ,
     &                   IRCODE  )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CAPASF *********************
C
C  PURPOSE: HANDLES OPENING OF OUTPUT PASSING FILES.
C
C  CALLING PROGRAM: ADAS310
C
C  SUBROUTINE:
C
C  INPUT : (I*4)   IUPS1    = UNIT NO. FOR FIRST PASSING FILE.
C  INPUT : (I*4)   IUPS2    = UNIT NO. FOR SECOND PASSING FILE.
C  INPUT : (I*4)   IUPS3    = UNIT NO. FOR THIRD PASSING FILE.
C  INPUT : (I*4)   IUPS4    = UNIT NO. FOR FOURTH PASSING FILE.
C  INPUT : (I*4)   IURUN    = UNIT NO. FOR RUN SUMMARY FILE.
C  INPUT : (C*80)  DSNPS1   = FIRST PASSING FILE DATA SET NAME.
C  INPUT : (C*80)  DSNPS2   = SECOND PASSING FILE DATA SET NAME.
C  INPUT : (C*80)  DSNPS3   = THIRD PASSING FILE DATA SET NAME.
C  INPUT : (C*80)  DSNPS4   = FOURTH PASSING FILE DATA SET NAME.
C  INPUT : (C*80)  DSNRUN   = RUN SUMMARY FILE DATA SET NAME.
C  INPUT : (L*4)   LPASS1   = FLAG FOR WHETHER OR NOT 1ST PASSING FILE
C                             HAS BEEN REQUESTED
C  INPUT : (L*4)   LPASS2   = FLAG FOR WHETHER OR NOT 2ND PASSING FILE
C                             HAS BEEN REQUESTED
C  INPUT : (L*4)   LPASS3   = FLAG FOR WHETHER OR NOT 3RD PASSING FILE
C                             HAS BEEN REQUESTED
C  INPUT : (L*4)   LPASS4   = FLAG FOR WHETHER OR NOT 4TH PASSING FILE
C                             HAS BEEN REQUESTED
C
C  OUTPUT: (I*4)   IRCODE   = RETURN CODE AFTER ATTEMPTING TO OPEN FILES.
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    17/01/94
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 02-04-96
C MODIFIED: TIM HAMMOND/PAUL BRIDEN
C               - REMOVED FILE= ARGUMENT FROM SCRATCH FILE OPEN
C                 STATEMENTS AS IT CAN CAUSE A COMPILATION ERROR OF
C                 WARNING MESSAGE UNDER AIX.
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER     IUPS1   , IUPS2   , IUPS3   , IUPS4 , IURUN
      INTEGER     IRCODE
C-----------------------------------------------------------------------
      CHARACTER   DSNPS1*80  , DSNPS2*80  , DSNPS3*80  , DSNPS4*80,
     &            DSNRUN*80
C-----------------------------------------------------------------------
      LOGICAL    LPASS1  , LPASS2  , LPASS3  , LPASS4 , LRUN
C-----------------------------------------------------------------------
```

CASSZD

```
      SUBROUTINE CASSZD( IBSEL  , IZ0IN  ,
     &                   ITVAL  , TVAL   ,
     &                   BWNO   , IZ     , IZ1  ,
     &                   METI   , METF   ,
     &                   SZDA   , LTRNG  ,
     &                   TITLX  , IRCODE , DLPATH
     &                 )
C
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CASSZD *******************
C
C  PURPOSE: TO EXTRACT AND  INTERPOLATE  ZERO-DENSITY  IONIZATION  RATE-
C           COEFFICIENTS FOR GIVEN ELEMENT NUCLEAR CHARGE AND DATA-BLOCK
C           FOR AN INPUT SET OF ELECTRON TEMPERATURES (eV).
C           - USES THE SAME ROUTINES USED BY SSZD, EXCEPT FOR:
C
C           'CAFILE' - WHICH OPENS THE REQUESTED FILE.
C           'CACHKB' - WHICH CHECKS INPUT  VALUES  ARE  CONSISTENT  WITH
C                      THE SELECTED DATA-BLOCK 'IBSEL' AND   'IBSEL'  IS
C                      IN RANGE.
C
C            THE FIRST OF THESE FUNCTIONS IS CARRIED  OUT  IN  'ADAS502'
C            VIA ISPF PANELS USING THE ROUTINE 'E2SPF0'  -  ADAS502 DOES
C            NOT REQUIRE THE ROUTINE 'CACHKB' AS THE USER CANNOT  SELECT
C            AN INVALID VALUE FOR 'IBSEL' OR 'IBSEL'/ELEMENT COMBINATION
C
C
C  CALLING PROGRAM: NSUPH1
C
C  SUBROUTINE:
C
C  INPUT : (I*4)  IBSEL   = INDEX OF DATA-BLOCK SELECTED FOR ANALYSIS
C  INPUT : (I*4)  IZ0IN   = NUCLEAR CHARGE OF REQUIRED ELEMENT
C
C  INPUT : (I*4)  ITVAL   = NUMBER OF ELECTRON TEMPERATURE VALUES
C  INPUT : (R*8)  TVAL()  = ELECTRON TEMPERATUIRES (UNITS: EV)
C                           DIMENSION: ELECTRON TEMPERATURE INDEX
C  INPUT : (C*80) DLPATH  = PATH NAME TO THE RELEVANT DATA FILES
C                           (PASSED THROUGH TO CAFILE TO BUILD FILENAME)
C
C  OUTPUT: (R*8)  BWNO    = INPUT FILE - SELECTED DATA-BLOCK:
C                           EFFECTIVE IONIZATION POTENTIAL (cm-1).
C  OUTPUT: (I*4)  IZ      = INPUT FILE - SELECTED DATA BLOCK:
C                           IONIZING ION - INITIAL CHARGE
C  OUTPUT: (I*4)  IZ1     = INPUT FILE - SELECTED DATA BLOCK:
C                           IONIZING ION - FINAL   CHARGE
C
C  OUTPUT: (I*4)  METI    = INPUT FILE - SELECTED DATA-BLOCK:
C                           INITIAL STATE METSTABLE INDEX
C  OUTPUT: (I*4)  METF    = INPUT FILE - SELECTED DATA-BLOCK:
C                           FINAL   STATE METSTABLE INDEX
C
C  OUTPUT: (R*8)  SZDA()  = ZERO-DENSITY IONIZATION RATE-COEFFICIENTS
C                           DIMENSION: ELECTRON TEMPERATURE INDEX
C  OUTPUT: (L*4)  LTRNG() =.TRUE.  => OUTPUT 'SZDA()'  VALUE WAS INTER-
C                                     POLATED  FOR  THE  USER  ENTERED
C                                     ELECTRON TEMPERATURE 'TVAL()'.
C                          .FALSE. => OUTPUT 'SZDA()'  VALUE WAS EXTRA-
C                                     POLATED  FOR  THE  USER  ENTERED
C                                     ELECTRON TEMPERATURE 'TVAL()'.
C                           DIMENSION: ELECTRON TEMPERATURE INDEX
C
C  OUTPUT: (C*80) TITLX   = INFORMATION STRING (DSN ETC.)
C  OUTPUT: (I*4)  IRCODE  = RETURN CODE FROM SUBROUTINE:
C                           0 => NORMAL COMPLETION - NO ERROR DETECTED
C                           1 => DATA SET MEMBER FOR IONIZING ION WITH
C                                NUCLEAR CHARGE  'IZ0IN'  CAN  NOT  BE
C                                FOUND/DOES NOT EXIST.
C                           2 => DISCREPANCY BETWEEN REQUESTED CHARGES
C                                AND THOSE IN INPUT FILE.
C                           3 => THE SELECTED DATA-BLOCK 'IBSEL' IS OUT
C                                OF RANGE OR DOES NOT EXIST.
C                           4 => INVALID VALUE FOR 'IZ0IN' ENTERED.
C                                ('IZ0MIN' <= 'IZ0IN' <= 'IZ0MAX')
C                           9 => ERROR ENCOUNTERED WHEN TRYING TO OPEN
C                                INPUT DATA-SET.
C
C          (I*4)  NSTORE  = PARAMETER= MAXIMUM NUMBER  OF  DATA-BLOCKS
C                                      WHICH CAN BE READ FROM THE INPUT
C                                      DATA-SET.
C          (I*4)  NTDIM   = PARAMETER= MAXIMUM NUMBER OF ELECTRON TEMP-
C                                      ERATURES THAT CAN BE READ  FROM
C                                      AN INPUT DATA-SET DATA-BLOCK.
C          (I*4)  IZ0MIN  = PARAMETER: MIN. ALLOWED VALUE FOR 'IZ0IN'
C          (I*4)  IZ0MAX  = PARAMETER: MAX. ALLOWED VALUE FOR 'IZ0IN'
C
C          (I*4)  IZ0LST  = LAST VALUE OF 'IZ0IN' FOR  WHICH  INPUT
C                           DATA WAS READ.
C          (I*4)  IUNIT   = UNIT TO WHICH INPUT DATA SET IS ALLOCATED
C          (I*4)  NBSEL   = TOTAL NUMBER OF DATA-BLOCKS READ FROM INPUT
C                           DATA SET.
C          (I*4)  IZ0     = INPUT FILE - EMITTING ION - NUCLEAR CHARGE
C
C          (L*4)  LOPEN   = .TRUE.  => INPUT DATA SET OPEN.
C                           .FALSE. => INPUT DATA SET CLOSED.
C
```

```
C          (C*2)  ESYM    = INPUT FILE - IONIZING ION - ELEMENT SYMBOL
C          (C*3)  EXTIN   = CURRENT ADAS SOURCE DATA FILE EXTENSION
C          (C*3)  EXTLST  = ADAS SOURCE DATA FILE EXT. USED LAST TIME
C                           DATA WAS READ.
C          (C*6)  UIDIN   = CURRENT ADAS SOURCE DATA USER ID.
CX
CA         (C*80) UIDIN   = CURRENT ADAS SOURCE DATA FILE PATH
CA         (C*80) UIDLST  = ADAS SOURCE DATA FILE PATH USED LAST TIME
C                           DATA WAS READ.
C          (C*8)  GRPIN   = CURRENT ADAS SOURCE DATA GROUPNAME
C          (C*8)  GRPLST  = ADAS SOURCE DATA GROUPNAME USED LAST TIME
C                           DATA WAS READ.
CX         (C*6)  TYPIN   = CURRENT ADAS SOURCE DATA TYPENAME
CX         (C*6)  TYPLST  = ADAS SOURCE DATA TYPENAME USED LAST TIME
CA         (C*80) TYPIN   = CURRENT ADAS FILE SUBDIRECTORY( OPTIONAL)
CA         (C*80) TYPLST  = ADAS FILE SUBDIRECTORY USED LAST TIME (OPT)
C                           DATA WAS READ.
CX         (C*44) DSNREQ  = FULL MVS NAME OF DATA SET REQUESTED
CA          (C*80) DSNREQ  = DATAFILE NAME UNDER UNIX INCLUDING PATH
C                           (MAY OR MAY NOT EXIST)
CX         (C*44) DSNAME  = FULL MVS NAME OF DATA SET INTERROGATED
CA         (C*80) DSNAME  = DATAFILE NAME UNDER UNIX INCLUDING PATH
C
C          (I*4)  ISELA() = INPUT DATA FILE: DATA-BLOCK ENTRY INDICES.
C                           DIMENSION: DATA-BLOCK INDEX
C          (I*4)  ITA()   = INPUT DATA SET-NUMBER OF ELECTRON TEMPERA-
C                           TURES.
C                           DIMENSION: DATA-BLOCK INDEX
C          (I*4)  IZOUT() = INPUT DATA FILE: IONIZING ION INITIAL CHARGE
C                           DIMENSION: DATA-BLOCK INDEX
C          (I*4)  IZ1OUT()= INPUT DATA FILE: IONIZING ION FINAL   CHARGE
C                           DIMENSION: DATA-BLOCK INDEX
C
C          (R*8)  BWNOUT()= INPUT DATA FILE: EFFECTIVE IONIZATION POT.
C                           (UNITS: cm-1).
C                           DIMENSION: DATA-BLOCK INDEX
C          (R*8)  TETA(,) = INPUT DATA SET -
C                           ELECTRON TEMPERATURES (UNITS: eV)
C                           1st DIMENSION: ELECTRON TEMPERATURE INDEX
C                           2nd DIMENSION: DATA-BLOCK INDEX
C          (R*8)  SZD(,)    =INPUT DATA SET -
C                            FULL SET OF IONIZATIONS RATE-COEFFICIENTS
C                            1st DIMENSION: ELECTRON TEMPERATURE INDEX
C                            3rd DIMENSION: DATA-BLOCK INDEX
C
C          (C*2)  CICODE()= INPUT DATA FILE - INITIAL STATE META. INDEX
C                           DIMENSION: DATA-BLOCK INDEX
C          (C*2)  CFCODE()= INPUT DATA FILE - FINAL   STATE META. INDEX
C                           DIMENSION: DATA-BLOCK INDEX
C          (C*6)  CIION() = INPUT DATA FILE - INITIAL ION
C                           DIMENSION: DATA-BLOCK INDEX
C          (C*6)  CFION() = INPUT DATA FILE - FINAL   ION
C                           DIMENSION: DATA-BLOCK INDEX
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          CAFILE     ADAS      OPEN DATA SET FOR SELECTED ELEMENT
C          E2DATA     ADAS      FETCH INPUT DATA FROM SELECTED DATA SET
C          CACHKB     ADAS      CHECK VALIDITY OF ELEMENT AND 'IBSEL'
C          E2SPLN     ADAS      INTERPOLATE DATA WITH ONE-WAY SPLINES
C          E2TITL     ADAS      CREATE DESCRIPTIVE TITLE FOR OUTPUT
C          XXUID      ADAS      FETCHES/SETS ADAS SOURCE DATA USER ID
C          XXSPEC     ADAS      FETCHES/SETS ADAS SOURCE DATA FILE NAME+
C
C AUTHOR:  PAUL E. BRIDEN (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/37
C          JET EXT. 6023
C
C DATE:    07/06/91
C
C UPDATE:  06/12/91 - PE BRIDEN: 'NSTORE' INCREASED FROM 10 TO 100
C
C UPDATE:  28/02/92 - PE BRIDEN: 'NSTORE' INCREASED FROM 100 TO 160
C
C UPDATE:  10/03/93 - PE BRIDEN: INTRODUCED CALL TO XXUID TO ESTABLISH
C                                IF USERID OF INPUT DATASET CHANGES
C                                BETWEEN CALLS.
C                                SAVE NAME OF LAST READ DATASET.
C                                (ADDED VARIABLES UIDIN,UIDLST,DSNREQ)
C
C UPDATE:   2/09/93 - HPS      : INTRODUCED CALL TO XXSSZD TO ESTABLISH
C                                IF USRGRP, USRTYP AND USREXT OF INPUT
C                                DATASET CHANGES BETWEEN CALLS.
C                                SAVE NAME OF LAST READ DATASET.
C                                (ADDED VARIABLES GRPIN,GRPLST,TYPIN,
C                                 TYPLST, EXTIN, EXTLST)
C
C UPDATE:   10/11/94 - L. JALOTA: MODIFIED TO RUN UNDER UNIX, SIZE OF
C                                   DSNAME AND DSNREQ INCREASED TO 80
C                                   CHARACTERS
C
C UPDATE:   21/11/94 - L/ JALOTA: TIDIED UP CHARACTER LENGTHS.
C
C UNIX-IDL PORT:
C
C
```

```
C VERSION: 1.1                          DATE: 25-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - CREATED FROM SSZD.FOR WITH SPECIFIC USE IN ADAS 310
C                 AS GOAL. ALL FUNCTIONALITY IS MAINTAINED, BUT
C                 ROUTINE CALLS A NEW FILE CAFILE.FOR TO OPEN
C                 THE REQUESTED FILE IF IT IS AVAILABLE, THIS
C                 HAS ALSO NECESSITATED BRINGING IN THE VARIABLE
C                 DLPATH WHICH HOLDS THE PATH TO THE DATA FILES.
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER     NSTORE         , NTDIM
      INTEGER     IZ0MIN         , IZ0MAX
C-----------------------------------------------------------------------
      PARAMETER(  NSTORE = 160   , NTDIM  = 24       )
      PARAMETER(  IZ0MIN =   1   , IZ0MAX = 60       )
C-----------------------------------------------------------------------
      INTEGER     IBSEL          , IZ0IN             , ITVAL       ,
     &            IZ             , IZ1               ,
     &            METI           , METF              ,
     &            IRCODE
      INTEGER     IZ0LST         , IUNIT             , NBSEL       ,
     &            IZ0
C-----------------------------------------------------------------------
      REAL*8      BWNO
C-----------------------------------------------------------------------
      LOGICAL     LOPEN
C-----------------------------------------------------------------------
      CHARACTER   ESYM*2         , EXTIN*3           , EXTLST*3     ,
CX   &                             UIDIN*6           , UIDLST*6     ,
     &                             UIDIN*80          , UIDLST*80    ,
     &                             GRPIN*8           , GRPLST*8     ,
     &                             TYPIN*80          , TYPLST*80    ,
CX   &            DSNREQ*44      , DSNAME*44         , TITLX*80
     &            DSNREQ*80      , DSNAME*80         , TITLX*80     ,
     &            DLPATH*80
C-----------------------------------------------------------------------
      INTEGER     ISELA(NSTORE)             , ITA(NSTORE)          ,
     &            IZOUT(NSTORE)             , IZ1OUT(NSTORE)
C-----------------------------------------------------------------------
      REAL*8      TVAL(ITVAL)               , SZDA(ITVAL)          ,
     &            BWNOUT(NSTORE)
C-----------------------------------------------------------------------
      LOGICAL     LTRNG(ITVAL)
C-----------------------------------------------------------------------
      CHARACTER   CICODE(NSTORE)*2          , CFCODE(NSTORE)*2     ,
     &            CIION(NSTORE)*6           , CFION(NSTORE)*6
C-----------------------------------------------------------------------
      REAL*8      TETA(NTDIM,NSTORE)        , SZD(NTDIM,NSTORE)
C-----------------------------------------------------------------------
      SAVE        DSNAME      , UIDLST     , GRPLST    , TYPLST    ,
     &            EXTLST      , IZ0LST     ,
     &            IUNIT
C-----------------------------------------------------------------------
      DATA        DSNAME /' '/   , UIDLST /' '/ , GRPLST /' '/     ,
     &            TYPLST /' '/   ,
     &            EXTLST /' '/   , IZ0LST /0/   ,
     &            IUNIT  /16/
C-----------------------------------------------------------------------
```

CATMPF

```
      SUBROUTINE CATMPF( IUTMP  , NUCCHG , DSNEX  , DSNCX  ,
     &                   JDENSM , JTEM   , TS     , W      ,
     &                   Z      , CION   , CPY    , W1     ,
     &                   NIP    , INTD   , IPRS   , ILOW   ,
     &                   IONIP  , NIONIP , ILPRS  , IVDISP ,
     &                   ZEFF   , NOSCAN , NIMP   , ZIMPA  ,
     &                   AMIMPA , FRIMPA , DENSA  , TEA    ,
     &                   DENPA  , TPA    , BMENER , DENSH  ,
     &                   NMIN   , NMAX   , IMAX   , NREP   ,
     &                   WBREP  , JCOR   , COR    , JMAX   ,
     &                   EPSIL  , FIJ    , WIJ    , JDEF   ,
     &                   DEFECT
     &                 )
C
      IMPLICIT NONE
C
C-----------------------------------------------------------------------
C
C ******************* FORTRAN77 SUBROUTINE: CATMPF *********************
C
C PURPOSE: TO WRITE TEMPORARY FILE CONTAINING PARAMETERS TO BE READ BY
C          SUBROUTINE 'V2BNDLN'. THIS ROUTINE IS A TEMPORARY MEASURE TO
C          ALLOW 'V2BNDLN' TO RUN WITHIN THE FRAMEWORK OF ADAS WITHOUT
C          HAVING TO EDIT 'V2BNDLN'. THE PARAMETERS SHOULD REALLY BE
C          PASSED INTO 'V2BNDLN' THROUGH ITS ARGUMENT LIST.
C
C CALLING PROGRAM: ADAS310
C
C  INPUT : (I*4)   IUTMP    = UNIT NUMBER OF TEMPORARY FILE.
```

```
C  INPUT : (I*4)   NUCCHG   = NUCLEAR CHARGE.
C  INPUT : (C*80)  DSNEX    = FULL MVS DATA SET NAME FOR EXPANSION FILE
C                             (SUITABLE FOR DYNAMIC ALLOCATION).
C  INPUT : (C*80)  DSNCX    = FULL MVS DATA SET NAME FOR CHARGE EXCHANGE
C                             DATA SET (SUITABLE FOR DYNAMIC ALLOCATION)
C  INPUT : (I*4)   JDENSM   = NUMBER OF DENSITIES.
C  INPUT : (I*4)   JTEM     = NUMBER OF TEMPERATURES.
C  INPUT : (R*8)   TS       = EXTERNAL RADIATION FIELD TEMPERATURE.
C                             UNITS: K
C  INPUT : (R*8)   W        = EXTERNAL RADIATION FIELD DILUTION FACTOR
C                             (HIGHER LEVELS).
C  INPUT : (R*8)   Z        = RECOMBINING ION CHARGE.
C  INPUT : (R*8)   CION     = MULTIPLIER OF GROUND LEVEL ELECTRON IMPACT
C                             IONISATION RATE COEFFICIENT.
C  INPUT : (R*8)   CPY      = MULTIPLIER OF ELECTRON EXCITATION RATE
C                             COEFFICIENT FROM THE GOUND LEVEL.
C  INPUT : (R*8)   W1       = EXTERNAL RADIATION FIELD DILUTION FACTOR
C                             FOR PHOTO-IONISATION FROM THE GROUND
C                             LEVEL.
C  INPUT : (R*8)   NIP      = RANGE OF DELTA N FOR IMPACT PARAMETER
C                             XSECTS. (.LE. 4)
C  INPUT : (R*8)   INTD     = ORDER OF MAXWELL QUADRATURE FOR XSECTS.
C                             (.LE. 3)
C  INPUT : (R*8)   IPRS     = CONTROLS XSECTS BEYOND NIP RANGE.
C                             0 => DEFAULT TO VAN REGEMORTER XSECTS.
C                             1 => USE PERCIVAL-RICHARDS XSECTS.
C  INPUT : (R*8)   ILOW     = CONTROLS ACCESS OF SPECIAL LOW LEVEL DATA.
C                             0 => NO SPECIAL LOW LEVEL DATA ACCESSED.
C                             1 => SPECIAL LOW LEVEL DATA ACCESSED.
C  INPUT : (R*8)   IONIP    = CONTROLS INCLUSION OF ION IMPACT
C                             COLLISIONS.
C                             0 => NO ION IMPACT COLLISIONS INCLUDED.
C                             1 => ION IMPACT EXCITATION AND IONISATION
C                                  INCLUDED.
C  INPUT : (R*8)   NIONIP   = RANGE OF DELTA N FOR ION IMPACT EXCITATION
C                             XSECTS.
C  INPUT : (R*8)   ILPRS    = CONTROLS USE OF LODGE-PERCIVAL-RICHARDS
C                             XSECTS.
C                             0 => DEFAULT TO VAINSHTEIN XSECTS.
C                             1 => USE LODGE-PERCIVAL-RICHARDS XSECTS.
C  INPUT : (R*8)   IVDISP   = CONTROLS USE OF BEAM ENERGY IN CALCULATION
C                             OF XSECTS.
C                             0 => ION IMPACT AT THERMAL MAXWELLIAN
C                                  ENERGIES.
C                             1 => ION IMPACT AT DISPLACED THERMAL
C                                  ENERGIES ACCORDING TO THE NEUTRAL
C                                  BEAM ENERGY PARAMETER.
C                             NB:  IF IVDISP=0 THEN SPECIAL LOW LEVEL
C                                  DATA FOR ION IMPACT IS NOT
C                                  SUBSTITUTED - ONLY VAINSHTEIN AND
C                                  LODGE ET AL. OPTIONS ARE OPEN.
C                                  ELECTRON IMPACT DATA SUBSTITUTION
C                                  DOES OCCUR.
C  INPUT : (R*8)   ZEFF     = NUCLEAR CHARGE OF IMPURITY.
C                             (ONLY SET IF 'NOSCAN'=0 )
C  INPUT : (I*4)   NOSCAN   = CONTROLS MODE OF OPERATION.
C                             0 => SINGLE IMPURITY.
C                             1 => MULTIPLE IMPURITIES.
C  INPUT : (I*4)   NIMP     = NUMBER OF IMPURITY SPECIES
C                             (ONLY SET IF 'NOSCAN'=1 )
C  INPUT : (R*8)   ZIMPA()  = NUCLEAR CHARGE OF IMPURITIES.
C                             (ONLY SET IF 'NOSCAN'=1 )
C                             DIMENSION: NIMP
C  INPUT : (R*8)   AMIMPA() = ATOMIC MASS NUMBERS OF IMPURITIES.
C                             (ONLY SET IF 'NOSCAN'=1 )
C                             DIMENSION: NIMP
C  INPUT : (R*8)   FRIMPA() = IMPURITY FRACTIONS.
C                             (ONLY SET IF 'NOSCAN'=1 )
C                             DIMENSION: NIMP
C  INPUT : (R*8)   DENSA()  = ELECTRON DENSITIES.
C                             UNITS: CM-3
C                             DIMENSION: JDENSM
C  INPUT : (R*8)   TEA()    = ELECTRON TEMPERATURES.
C                             UNITS: K
C                             DIMENSION: JTEM
C  INPUT : (R*8)   DENPA()  = PROTON DENSITIES.
C                             UNITS: CM-3
C                             DIMENSION: JDENSM
C  INPUT : (R*8)   TPA()    = PROTON TEMPERATURES.
C                             UNITS: K
C                             DIMENSION: JTEM
C  INPUT : (R*8)   BMENER   = NEUTRAL BEAM PARTICLE ENERGY.
C                             UNITS: EV / AMU
C  INPUT : (R*8)   DENSH    = NEUTRAL HYDROGEN DENSITY IN BEAM.
C                             UNITS: CM-3
C  INPUT : (I*4)   NMIN     = LOWEST N-SHELL.
C  INPUT : (I*4)   NMAX     = HIGHEST N-SHELL.
C  INPUT : (I*4)   IMAX     = NUMBER OF REPRESENTATIVE N-SHELL LEVELS.
C  INPUT : (I*4)   NREP()   = SET OF REPRESENTATIVE N-SHELL LEVELS.
C                             DIMENSION: IMAX
C  INPUT : (R*8)   WBREP()  =
C                             DIMENSION: IMAX
C  INPUT : (I*4)   JCOR     =
C  INPUT : (R*8)   COR()    =
C                             DIMENSION: JCOR
C  INPUT : (I*4)   JMAX     =
C  INPUT : (R*8)   EPSIL()  =
C                             DIMENSION: JMAX
```

```
C  INPUT : (R*8)   FIJ()    =
C                             DIMENSION: JMAX
C  INPUT : (R*8)   WIJ()    =
C                             DIMENSION: JMAX
C  INPUT : (I*4)   JDEF     = NUMBER OF QUAMTUM DEFECTS.
C  INPUT : (R*8)   DEFECT() = SET OF QUANTUM DEFECT.
C                             DIMENSION: JDEF
C
C          (I*4)   I        = ARRAY INDEX.
C
C          (L*4)   LOPEN    = FLAGS IF SCRATCH FILE OPEN.
C                             .TRUE.  => SCRATCH FILE OPEN.
C                             .FALSE. => SCRATCH FILE CLOSED.
C
C AUTHOR:  JONATHAN NASH  (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/81
C          JET EXT. 5183
C
C DATE:    17/01/94
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    IUTMP   , NUCCHG  , JDENSM  , JTEM    , NIP     ,
     &           INTD    , IPRS    , ILOW    , IONIP   , NIONIP  ,
     &           ILPRS   , IVDISP  , NOSCAN  , NIMP    , NMIN    ,
     &           NMAX    , IMAX    , JCOR    , JMAX    , JDEF
      INTEGER    I
C-----------------------------------------------------------------------
      REAL*8     TS      , W       , Z       , CION    , CPY     ,
     &           W1      , ZEFF    , BMENER  , DENSH
C-----------------------------------------------------------------------
      LOGICAL    LOPEN
C-----------------------------------------------------------------------
      CHARACTER  DSNEX*80   , DSNCX*80
C-----------------------------------------------------------------------
      INTEGER    NREP(IMAX)
C-----------------------------------------------------------------------
      REAL*8     ZIMPA(NIMP)    , AMIMPA(NIMP)   , FRIMPA(NIMP)   ,
     &           DENSA(JDENSM)  , TEA(JTEM)      , DENPA(JDENSM)  ,
     &           TPA(JTEM)      , WBREP(IMAX)    , COR(JCOR)      ,
     &           EPSIL(JMAX)    , FIJ(JMAX)      , WIJ(JMAX)      ,
     &           DEFECT(JDEF)
C-----------------------------------------------------------------------
```

CCDATA

```
       SUBROUTINE CCDATA( TERAY  , NERAY  , EBRAY  , N1N    , SRAY  ,
     &                    F1     , F2     , F3     , BN     ,
     &                      NN     , IZ     , INFILE , INUNIT ,
     &                    MAXNE  , MAXTE  , MAXEB  ,
     &                      INCOUNT, ITCOUNT, IECOUNT, LEVEL  ,
     &                    EBREF  , TEREF  , NEREF  ,
     &                    INA    , IEA    , ITA    , NLEVEL
     &                  )
       IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CCDATA *********************
C
C  PURPOSE:  TO  FETCH  DATA  FROM  BUNDLE-N POPULATION
C            FILES OF TYPE ADF26.
C
C  CALLING PROGRAM: ADAS312
C
C  SUBROUTINE:
C
C  INPUT : (C*80) INFILE   = MVS DATA SET NAME OF DATA SET BEING READ
C  INPUT : (I*4)  INUNIT   = UNIT TO WHICH INPUT FILE IS ALLOCATED.
C  INPUT : (I*4)  MAXNE    = MAXIMUM NUMBER OF DENSITIES
C  INPUT : (I*4)  MAXTE    = MAXIMUM NUMBER OF TEMPERATURES
C  INPUT : (I*4)  MAXEB    = MAXIMUM NUMBER OF BEAM ENERGIES
C
C  OUTPUT: (R*8)  TERAY()  = TEMPERATURE SET   (EV)
C                            1ST. DIM.: TEMPERATURE INDEX
C  OUTPUT: (R*8)  NERAY()  = DENSITY SET       (CM-3)
C                            1ST. DIM.: DENSITY INDEX
C  OUTPUT: (R*8)  EBRAY()  = BEAM ENERGY SET   (EV/AMU)
C                            1ST. DIM.: BEAM ENERGY INDEX
C  OUTPUT: (R*8)  N1N(,,)  = ???
C                            1ST. DIM.: BEAM ENERGY INDEX
C                            2ND. DIM.: DENSITY INDEX
C                            3RD. DIM.: TEMPERATURE INDEX
C  OUTPUT: (R*8)  SRAY(,,) = COLL. RAD. IONIS COEFFT.   (CM3 S-1)
C                            1ST. DIM.: BEAM ENERGY INDEX
C                            2ND. DIM.: DENSITY INDEX
C                            3RD. DIM.: TEMPERATURE INDEX
```

```
C  OUTPUT: (R*8)  F1(,,,)  = F1 EXPANSION FACTOR OF BN
C                             1ST. DIM.: BEAM ENERGY INDEX
C                             2ND. DIM.: DENSITY INDEX
C                             3RD. DIM.: TEMPERATURE INDEX
C                             4TH. DIM.: REPRES. PRINC. QUANTUM SHELL INDEX
C  OUTPUT: (R*8)  F2(,,,)  = F2 EXPANSION FACTOR OF BN
C                             1ST. DIM.: BEAM ENERGY INDEX
C                             2ND. DIM.: DENSITY INDEX
C                             3RD. DIM.: TEMPERATURE INDEX
C                             4TH. DIM.: REPRES. PRINC. QUANTUM SHELL INDEX
C  OUTPUT: (R*8)  F3(,,,)  = F3 EXPANSION FACTOR OF BN
C                             1ST. DIM.: BEAM ENERGY INDEX
C                             2ND. DIM.: DENSITY INDEX
C                             3RD. DIM.: TEMPERATURE INDEX
C                             4TH. DIM.: REPRES. PRINC. QUANTUM SHELL INDEX
C  OUTPUT: (R*8)  BN(,,,)  = BN FACTOR
C                             1ST. DIM.: BEAM ENERGY INDEX
C                             2ND. DIM.: DENSITY INDEX
C                             3RD. DIM.: TEMPERATURE INDEX
C                             4TH. DIM.: REPRES. PRINC. QUANTUM SHELL INDEX
C  OUTPUT: (R*8)  NN(,,,)  = POPULATION CONVERSION FACTOR
C                             1ST. DIM.: BEAM ENERGY INDEX
C                             2ND. DIM.: DENSITY INDEX
C                             3RD. DIM.: TEMPERATURE INDEX
C                             4TH. DIM.: REPRES. PRINC. QUANTUM SHELL INDEX
C  OUTPUT: (I*4)  IZ       = IMPURITY ION CHARGE
C  OUTPUT: (I*4)  INCOUNT  = NUMBER OF DENSITIES
C  OUTPUT: (I*4)  ITCOUNT  = NUMBER OF TEMPERATURES
C  OUTPUT: (I*4)  IECOUNT  = NUMBER OF BEAM ENERGIES
C  OUTPUT: (I*4)  LEVEL    = ??? APPEARS UNUSED ???
C  OUTPUT: (R*8)  EBREF    = REFERENCE BEAM ENERGY (EV/AMU)
C  OUTPUT: (R*8)  TEREF    = REFERENCE TEMPERATURE (EV)
C  OUTPUT: (R*8)  NEREF    = REFERENCE DENSITY     (CM-3)
C  OUTPUT: (I*4)  INA()    = NUMBER OF LEVELS
C                             1ST. DIM.: DENSITY INDEX
C  OUTPUT: (I*4)  ITA()    = NUMBER OF LEVELS
C                             1ST. DIM.: TEMPERATURE INDEX
C  OUTPUT: (I*4)  IEA()    = NUMBER OF LEVELS
C                             1ST. DIM.: BEAM ENERGY INDEX
C  OUTPUT: (I*4)  NLEVEL   = NUMBER OF LEVELS
C
C          (I*4)  IT       = GENERAL INDEX
C          (I*4)  IN       = GENERAL INDEX
C          (I*4)  IE       = GENERAL INDEX
C          (R*8)  TE       = GENERAL REAL VARIABLE
C          (R*8)  NE       = GENERAL REAL VARIABLE
C          (R*8)  EB       = GENERAL REAL VARIABLE
C          (C*132)LINE     = GENERAL STRING
C          (C*2)  LEVELS() = PRINC. QU. SHELL STRINGS
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C          CCFIND     ADAS      ???
C
C
C
C AUTHOR:  HARVEY ANDERSON, UNIVERSITY OF STRATHCLYDE/JET
C          JA8.08
C          TEL. 0141-553-4196
C
C
C DATE:    16/05/97
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 10-07-97
C MODIFIED: HUGH SUMMERS, UNIVERSITY OF STRATHCLYDE
C            - PUT UNDER S.C.C.S. CONTROL
C
C
C
C-----------------------------------------------------------------------
       INTEGER   MAXTE     , MAXNE     , MAXEB    ,
     &           INUNIT    , ITCOUNT   , INCOUNT  ,
     &           IECOUNT    , IZ        , IT       ,
     &          IN         , IE        , LEVEL    , NLEVEL
C-----------------------------------------------------------------------
       INTEGER  INA(MAXNE)     ,IEA(MAXEB)       , ITA(MAXTE)
C-----------------------------------------------------------------------
       REAL*8   TE         , EB         , Z         ,
     &          EBREF     , NEREF     , TEREF     , NE
C-----------------------------------------------------------------------
       REAL*8   NERAY(MAXNE)   , TERAY(MAXTE)     , EBRAY(MAXEB)   ,
     &           SRAY(MAXEB,MAXNE,MAXTE)  , N1N(MAXEB,MAXNE,MAXTE)  ,
     &          F1(MAXEB,MAXNE,MAXTE,NLEVEL)      ,
     &           F2(MAXEB,MAXNE,MAXTE,NLEVEL)      ,
     &          F3(MAXEB,MAXNE,MAXTE,NLEVEL)      ,
     &           BN(MAXEB,MAXNE,MAXTE,NLEVEL)         ,
     &          NN(MAXEB,MAXNE,MAXTE,NLEVEL)
C-----------------------------------------------------------------------
       CHARACTER LINE*132     , INFILE*80         , LEVELS(20)*2
C-----------------------------------------------------------------------
       DATA  LEVELS/' 1',' 2',' 3',' 4',' 5',' 6',' 7',' 8',' 9','10',
     &              '11','12','13','14','15','16','17','18','19','20'/
C-----------------------------------------------------------------------
```

CCFILL

```
      SUBROUTINE CCFILL( NTA   , M )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CCFILL *********************
C
C  PURPOSE:  TO FILL AN INTEGER ARRAY WITH ITS OWN INDEX.
C
C  CALLING PROGRAM: ADAS312
C
C  SUBROUTINE:
C
C  I/O   : (I*4)  NTA()    = ARRAY TO BE FILLED
C  INPUT : (I*4)  M        = NUMBER OF ELEMENTS TO BE FILLED
C
C          (I*4)  I        = GENERAL INTEGER
C
C
C ROUTINES:
C          NONE
C
C
C AUTHOR:  HARVEY ANDERSON, UNIVERSITY OF STRATHCLYDE/JET
C          JA8.08
C          TEL. 0141-553-4196
C
C
C DATE:    16/05/97
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                              DATE: 10-07-97
C MODIFIED: HUGH SUMMERS, UNIVERSITY OF STRATHCLYDE
C            - PUT UNDER S.C.C.S. CONTROL
C
C-----------------------------------------------------------------------
      INTEGER    M      , I
C-----------------------------------------------------------------------
      INTEGER    NTA(*)
C-----------------------------------------------------------------------
```

CCFIND

```
      SUBROUTINE CCFIND( ARR    , VALUE  , IMAX   , INDEX  )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CCFIND *********************
C
C  PURPOSE:  TO  ISOLATE DATA FROM ADF26 DATASET
C
C  CALLING PROGRAM: CCDATA
C
C  SUBROUTINE:
C
C  INPUT : (R*8)  ARR()    = ARRAY TO BE SEARCHED
C                            1ST. DIM.:
C  INPUT : (R*8)  VALUE    = ???
C  INPUT : (I*4)  IMAX     = NUMBER OF VALUES IN ARR
C
C  OUTPUT: (I*4)  INDEX    = LOCATED POSITION
C
C          (L*4)  FOUND    = ???
C          (C*2)  OVER     = ???
C
C
C ROUTINES:
C          NONE
C
C
C
C AUTHOR:  HARVEY ANDERSON, UNIVERSITY OF STRATHCLYDE/JET
C          JA8.08
C          TEL. 0141-553-4196
C
C
C DATE:    16/05/97
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                              DATE: 10-07-97
C MODIFIED: HUGH SUMMERS, UNIVERSITY OF STRATHCLYDE
C            - PUT UNDER S.C.C.S. CONTROL
C
C
```

```
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER  IMAX    , INDEX
C-----------------------------------------------------------------------
      REAL*8   VALUE
C-----------------------------------------------------------------------
      REAL*8   ARR(99)
C---------------------- ------------------------------------------------
      LOGICAL  OVER    , FOUND
C-----------------------------------------------------------------------
```

CCINTP

```
      SUBROUTINE CCINTP( ZDATA   , YDATA   , XDATA    , SRAY    ,
     &                   ITREF   , IEREF   , INREF    ,
     &                     TVAL    , MAXEB   , MAXNE    , MAXTE   ,
     &                   EBRAY   , NERAY   , BMSTOP   , BMEMIS  ,
     &                     IECOUNT , INCOUNT ,
     &                   F1      , NN      , AVALUE   , LEVEL   ,
     &                     NLEVEL  , IEA     , INA      , ITA
     &                 )
       IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CCDATA *********************
C
C  PURPOSE:  TO INTERPOLATE BETWEEN THE EFFECTIVE STOPPING
C                 OR EMISSION COEFFICIENTS.
C
C  CALLING PROGRAM: ADAS312
C
C  SUBROUTINE:
C
C  INPUT : (R*8)  ZDATA(,)   =
C  INPUT : (R*8)  YDATA()    =
C  INPUT : (R*8)  XDATA()    =
C  INPUT : (R*8)  SRAY(,,)   =
C  INPUT : (I*4)  ITREF      =
C  INPUT : (I*4)  IEREF      =
C  INPUT : (I*4)  INREF      =
C  INPUT : (I*4)  TVAL       =
C  INPUT : (I*4)  MAXEB      =
C  INPUT : (I*4)  MAXNE      = MAXIMUM NUMBER OF DENSITIES
C  INPUT : (I*4)  MAXTE      =
C  INPUT : (R*8)  EBRAY()    =
C  INPUT : (R*8)  NERAY()    =
C  INPUT : (I*4)  BMSTOP     =
C  INPUT : (I*4)  BMEMIS     =
C  INPUT : (I*4)  IECOUNT    =
C  INPUT : (I*4)  INCOUNT    =
C  INPUT : (R*8)  F1(,,,)    =
C  INPUT : (R*8)  NN(,,,)    =
C  INPUT : (R*8)  AVALUE     =
C  INPUT : (I*4)  LEVEL      =
C  INPUT : (I*4)  NLEVEL     =
C  INPUT : (I*4)  IEA()      =
C  INPUT : (I*4)  INA()      =
C  INPUT : (I*4)  ITA()      =
C
C          (I*4)  I          = GENERAL INTEGER VARIABLE
C          (I*4)  J          = GENERAL INTEGER VARIABLE
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C
C
C
C AUTHOR:  HARVEY ANDERSON, UNIVERSITY OF STRATHCLYDE/JET
C          JA8.08
C          TEL. 0141-553-4196
C
C
C DATE:    16/05/97
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 10-07-97
C MODIFIED: HUGH SUMMERS, UNIVERSITY OF STRATHCLYDE
C            - PUT UNDER S.C.C.S. CONTROL
C
C
C
C-----------------------------------------------------------------------
       INTEGER  MAXEB         , MAXNE      , MAXTE     ,
     &          IECOUNT       , INCOUNT    , IEREF     ,
     &          INREF         , ITREF      , I         ,
     &           J             , BMSTOP     , BMEMIS    ,
     &           TVAL          , NLEVEL     , LEVEL
C-----------------------------------------------------------------------
```

```
       INTEGER  IEA(MAXEB)    , INA(MAXNE) , ITA(MAXTE)
C-----------------------------------------------------------------------
       REAL*8   AVALUE
C-----------------------------------------------------------------------
       REAL*8    NERAY(MAXNE)       , EBRAY(MAXEB)      ,
     &           XDATA(MAXEB)       , YDATA(MAXNE)      ,
     &          ZDATA(MAXEB,MAXNE) ,
     &           SRAY(MAXEB,MAXNE,MAXTE)                ,
     &          F1(MAXEB,MAXNE,MAXTE,NLEVEL)           ,
     &           NN(MAXEB,MAXNE,MAXTE,NLEVEL)
C-----------------------------------------------------------------------
```

CCOUT0

```
      SUBROUTINE CCOUT0( OFILE  , OUNIT  , IZ     , IECOUNT , INCOUNT ,
     &                    TEREF  , EBRAY  , NERAY  , XRAY    ,
     &                   IEA    , INA    , ITREF  ,
     &                    ITCOUNT,
     &                   EBREF  , NEREF  , TERAY  ,
     &                   MAXTE  , MAXNE  , MAXEB  ,
     &                    ITA    , IEREF  , INREF  ,
     &                   DATE   , TITLE  , BMSTOP , BMEMIS  ,
     &                    F1     , NN     , AVALUE , NLEVEL  , LEVEL,
     &                   INFILE )
       IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CCOUT0 *********************
C
C  PURPOSE:  TO WRITE OUTPUT TO DATA FORMAT ADF21/22 SPECIFICATIONS.
C
C  CALLING PROGRAM: ADAS312
C
C  SUBROUTINE:
C
C  INPUT : (R*8)   TEREF     = THE REFERENCE TARGET TEMPERATURE (eV).
C  INPUT : (R*8)   EBREF     = THE REFERENCE NEUTRAL BEAM ENERGY
C                              (eV/amu).
C  INPUT : (R*8)   NEREF     = THE REFERENCE TARGET ELECTRON DENSITY.
C                              (CM-**3)
C  INPUT : (R*8)   TERAY()   = ARRAY CONTAINING THE TARGET TEMPERATURE.
C  INPUT : (R*8)   EBRAY()   = ARRAY CONTAINING THE NEUTRAL BEAM
C                              ENERGY ( eV/amu ).
C  INPUT : (R*8)   NERAY()   =  ARRAY CONTAINING THE TARGET DENSITY.
C  INPUT : (R*8)   XRAY()    = ARRAY CONTAINING EITHER THE BEAM STOPPING
C                              OR EMISSION COEFFICIENTS (CM**3/S).
C
C  INPUT : (R*8)   IZ        = THE EFFECTIVE NUCLEAR CHARGE OF THE
C                              TARGET PLASMA.
C  INPUT : (I*4)   ITCOUNT   = THE NUMBER OF TARGET TEMPERATURES.
C  INPUT : (I*4)   IECOUNT   = THE NUMBER OF BEAM ENERGIES.
C  INPUT : (I*4)   INCOUNT   = THE NUMBER OF TARGET DENSITIES.
C  INPUT : (I*4)   ITA()     = ARRAY CONTAINING THE INDEX VALUES
C                              OF THE TEMPERATURE ARRAY TERAY().
C  INPUT : (I*4)   ITREF     = THE INDEX VALUE AT WHICH THE REFERENCE
C                              TEMPERATURE CORRESPONDS TO IN THE ARRAY
C                              TERAY.
C  INPUT : (I*4)   IEA()     = ARRAY CONTAINING THE INDEX VALUES
C                              OF THE ENERGY ARRAY EBRAY().
C  INPUT : (I*4)   IEREF     = THE INDEX VALUE AT WHICH THE REFERENCE
C                              ENERGY CORRESPONDS TO IN THE ARRAY
C                              EBRAY().
C  INPUT : (I*4)   INA()     = ARRAY CONTAINING THE INDEX VALUES
C                              OF TEH DENSITY ARRAY NERAY().
C  INPUT : (I*4)   INREF     = THE INDEX VALUE AT WHICH THE REFERENCE
C                              DENSITY CORRESPONDS TO IN THE ARRAY
C                              NERAY.
C  INPUT : (I*4)   MAXTE     = THE MAXIMUM NUMBER OF TARGET TEMPERATURES.
C  INPUT : (I*4)   MAXNE     = THE MAXIMUM NUMBER OF TARGET DENSITIES.
C  INPUT : (I*4)   MAXEB     = THE MAXIMUM NUMBER OF BEAM ENERGIES.
C  INPUT : (I*4)   NUM       = THE NUMBER OF ELEMENT SYMBOLS CONTAINED
C                              IN THE ARRAY SPEC().
C
C
C        (CHR)    OFILE        = OUTPUT FILENAME.
C        (CHR)    SPEC()       = ARRAY CONTAING THE CHEMICAL SYMBOLS
C                                OF THE ELEMENTS UP TO THE FIRST
C                                PERIOD.
C        (CHR)    HEADER       = STRING CONTAINING THE ADAS VERSION,
C                                THE EXECUTING PROGRAM AND DATE.
C          (C*2)  LEVELS() = PRINC. QU. SHELL STRINGS
C
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4UNIT     ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C          CCFIND     ADAS      ???
C
C
C
C AUTHOR:  HARVEY ANDERSON, UNIVERSITY OF STRATHCLYDE/JET
C          JA8.08
```

```
C          TEL. 0141-553-4196
C
C
C DATE:    16/05/97
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 10-07-97
C MODIFIED: HUGH SUMMERS, UNIVERSITY OF STRATHCLYDE
C            - PUT UNDER S.C.C.S. CONTROL
C VERSION: 1.2                          DATE: 28-07-97
C MODIFIED: HARVEY ANDERSON, UNIVERSITY OF STRATHCLYDE
C            - INCLUDED PROGRAM NAME IN THE OUTPUT FILE.
C            - ADDED ADDITIONAL INFORMATION AT THE BOTTOM OF
C              THE ADF21/22 TYPE FILE.
C VERSION: 1.3 RICHARD MARTIN           DATE: 1-11-97
C               CORRECTED SYNTAX ERROR IN GETENV COMMAND.
C
C
C
C-----------------------------------------------------------------------
      INTEGER   MAXTE       , MAXNE         , MAXEB
C-----------------------------------------------------------------------
      INTEGER  IEA(MAXEB)  ,   ITA(MAXTE)  ,    INA(MAXNE)  ,
     &           IEREF       ,    INREF       ,   ITREF           ,
     &           ITCOUNT     ,    INCOUNT     ,    IECOUNT        ,
     &           OUNIT       ,    IZ          ,    BMSTOP         ,
     &           BMEMIS      ,    J           ,   I               ,
     &           NLEVEL      ,    LEVEL
C-----------------------------------------------------------------------
      REAL*8    EBREF
C-----------------------------------------------------------------------
      REAL*8    EBRAY(MAXNE),     NERAY(MAXNE),    TERAY(MAXTE)     ,
     &           TEREF       ,    NEREF           ,
     &           XRAY(MAXEB,MAXNE,MAXTE)                           ,
     &           F1(MAXEB,MAXNE,MAXTE,NLEVEL)                      ,
     &           NN(MAXEB,MAXNE,MAXTE,NLEVEL),   AVALUE          ,
     &           F1REF       ,   NNREF         ,   ECREF
C-----------------------------------------------------------------------
      CHARACTER*2 SPEC(10), DATE*24 ,TITLE*24
      CHARACTER OFILE*80 , INFILE*80 , USERID*16
C-----------------------------------------------------------------------
      DATA SPEC/'H ','HE','LI','BE','B ','C ','N ','O ','F ','NE'/
C-----------------------------------------------------------------------
```

CCSORT

```
      SUBROUTINE CCSORT( XA   , IA   , N )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: CCSORT *********************
C
C  PURPOSE:  TO SORT AN ARRAY SO THAT XA IS INCREASING ORDER.
C
C  CALLING PROGRAM: ADAS312
C
C  SUBROUTINE:
C
C  I/O   : (R*8) XA()     = X-VALUES INITIAL THEN SORTED
C  I/O   : (I*4) IA()     = I-VALUES INITIAL THEN SORTED
C  INPUT : (I*4) N        = NUMBER OF VALUES
C
C          (I*4) N1       = GENERAL INTEGER VARIABLE
C          (I*4) I        = GENERAL INTEGER VARIABLE
C          (I*4) I1       = GENERAL INTEGER VARIABLE
C          (I*4) J        = GENERAL INTEGER VARIABLE
C          (I*4) ISWAP    = GENERAL INTEGER VARIABLE
C          (R*8) SWAP     = GENERAL REAL VARIABLE
C
C
C ROUTINES:
C          NONE
C
C
C
C AUTHOR:  HARVEY ANDERSON, UNIVERSITY OF STRATHCLYDE/JET
C          JA8.08
C          TEL. 0141-553-4196
C
C
C DATE:    16/05/97
C
C UNIX-IDL PORT: H.P.SUMMERS
C
C VERSION: 1.1                          DATE: 10-07-97
C MODIFIED: HUGH SUMMERS, UNIVERSITY OF STRATHCLYDE
C            - PUT UNDER S.C.C.S. CONTROL
C
C
C
C-----------------------------------------------------------------------
      INTEGER   ISWAP    , N     , I     , J     , I1     , N1
```

```
C-----------------------------------------------------------------------
      INTEGER   IA(*)
C-----------------------------------------------------------------------
      REAL*8    SWAP
C-----------------------------------------------------------------------
      REAL*8    XA(*)
C-----------------------------------------------------------------------
```

CEECON

```
      SUBROUTINE CEECON( INTYP , OUTTYP, IEVAL, EIN,
     &                   AMDON , AMREC , EOUT
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C  ****************** FORTRAN77 SUBROUTINE: CEECON *********************
C  PURPOSE: TO CONVERT AN ARRAY OF ENERGIES INTO A  SPECIFIED form.
C  CALLING PROGRAM: ADAS314
C  SUBROUTINE:
C  INPUT :    (I*4)  INTYP   = 1 => 'EIN(array)' UNITS: eV (Donor temp.)
C                              = 2 => 'EIN(array)' UNITS: eV (Recvr temp.)
C                              = 3 => 'EIN(array)' UNITS: eV/AMU  (ENERGY)
C  INPUT :    (I*4)  OUTTYP  = 1 => 'EOUT(array)' UNITS: eV (Donor temp)
C                              = 2 => 'EOUT(array)' UNITS: eV (Recvr temp)
C                              = 3 => 'EOUT(array)' UNITS: EV/AMU (ENERGY)
C  INPUT :    (I*4)  IEVAL   = NO. OF ENERGIES IN EIN(array)
C  INPUT :    (R*8)  EIN()   = INPUT  ENERGIES (STATED UNITS)
C  INPUT :    (R*8)  AMDON   = DONOR MASS NUMBER
C  INPUT :    (R*8)  AMREC   = RECEIVER MASS NUMBER
C  OUTPUT:    (R*8)  EOUT()  = OUTPUT ENERGIES (STATED UNITS)
C             (I*4)  I       = GENERAL USE
C             (R*8)  ECONV() = ENERGY CONVERSION PARAMETERS
C ROUTINES:  NONE
C NOTE:
C            ENERGY CONVERSION PARAMETERS:
C            INTYP = 1 ; ECONV(1) =>  ENERGY  : EV       -> OUTPUT FORM
C            INTYP = 2 ; ECONV(2) =>  ENERGY  : EV       -> OUTPUT FORM
C            INTYP = 3 ; ECONV(3) =>  ENERGY  : EV/AMU   -> OUTPUT FORM
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL. 0141-553-4196
C DATE:    19/09/95
C UPDATE:  27/08/97  HP SUMMERS - CHANGED NAME FROM CCECON TO CDECON
C MODIFIED: Martin O'Mullane
C DATE:    9-07-98
C VERSION: 1.0 - ported to IDL
C
C VERSION:       1.1                                    DATE: 01-12-98
C MODIFIED: RICHARD MARTIN
C                - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      REAL*8     AMDON                , AMREC
C-----------------------------------------------------------------------
      INTEGER    INTYP                , OUTTYP                ,
     &           IEVAL
      INTEGER    I
C-----------------------------------------------------------------------
      REAL*8     EIN(IEVAL)           , EOUT(IEVAL)
      REAL*8     ECONV(3)
C-----------------------------------------------------------------------
```

CEEVTH

```
      SUBROUTINE CEEVTH ( NDENR  ,
     &                    LSETX  , LPASS  ,
     &                    AMDON  , AMREC  , CATYP  , DREN   , ILTYP  ,
     &                    NENIN  , ENIN   , NENOUT , ENOUT  ,
     &                    SGIN   , RCOUT
     &                  )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C  ********************* FORTRAN77 SUBROUTINE: CEEVTH ****************
C  VERSION: 1.0
C  PURPOSE:  OBTAINS RATE COEFFICIENTS FOR DONOR/RECEIVER CHARGE
C            EXCHANGE COLLISIONS FOR CASES OF
C            MONOENERGETIC DONOR/THERMAL RECEIVER, THERMAL
C            DONOR/MONOENERGETIC RECEIVER, THERMAL DONOR/THERMAL
C            RECEIVER (SAME TEMPERATURE) FROM CROSS-SECTION TABULATIONS.
C            A MONO-ENERGETIC CASE IS ALLOWED WHICH CONVERTS INPUT
C            CROSS-SECTIONS TABULATED AT A SET OF ENERGIES/AMU TO
C            OUTPUT CROSS-SECTIONS TABULATED A DIFFERENT SET OF
C            ENERGIES/AMU.
C  CALLING PROGRAM:  ADAS314
C  SUBROUTINE:
C  INPUT :  (I*4)  NDENR    = MAX. NUMBER OF ENERGIES/TEMPERATURES
```

```
C                               IN INPUT/OUTPUT ENERGY/TEMPERATURE
C                               VECTORS
C  INPUT :  (L*4)  LSETX    = .TRUE. => SPLINE PRESET FOR THESE KNOTS
C                               .FLSE. => SPLINE NOT SET FOR THESE KNOTS
C  INPUT :  (L*4)  LPASS    = .TRUE. => DO NOT CONVERT INTO LOG10 FOR
C                                       ENERGIES AND X-SECTS. FOR SPLINE
C                               .FLSE. => CONVERT INTO LOG10 FOR
C                                       ENERGIES AND X-SECTS. FOR SPLINE
C  INPUT :  (R*8)  AMDON    = DONOR MASS NUMBER
C  INPUT :  (R*8)  AMREC    = RECEIVER MASS NUMBER
C  INPUT :  (C2)   CATYP    = 'TT' THERMAL/THERMAL (EQUAL TEMPERATURES
C                                    FOR DONOR AND RECEIVER ONLY)
C                               'TR' THERMAL RECEIVER, MONOENERGETIC DONOR
C                               'TD' THERMAL DONOR, MONOENERGETIC RECEIVER
C                               'ME' SPECIAL MONOENERGETIC CASE
C  INPUT : (R*8)   DREN     = DONOR ENERGY    ( 'TR' CASE )
C                               RECEIVER ENERGY ( 'TD' CASE )
C  INPUT : (I*4)   ILTYP    = TYPE FOR LOW AND HIGH ENERGY CROSS-
C                               SECTION EXTRAPOLATION
C  INPUT : (I*4)   NENIN    = NUMBER OF ENERGIES IN INPUT DATA SET
C  INPUT : (R*8)   ENIN()   = ENERGIES (EV/AMU) IN INPUT DATA SET
C  INPUT : (I*4)   NENOUT   = NUMBER OF TEMPERATURES FOR OUTPUT DATA SET
C  INPUT : (R*8)   ENOUT()  = TEMPERATURES (EV) FOR OUTPUT DATA SET FOR
C                               'TT', 'TD', 'TR' CASES.
C                             = ENERGY/AMU FOR OUTPUT DATA SET FOR
C                               'ME' CASE.
C  INPUT : (R*8)   SGIN()   = INPUT X-SECTIONS (CM2) FROM INPUT DATA SET
C                               1ST.DIM: ENERGY INDEX
C  OUTPUT: (R*8)   RCOUT()  = RATE COEFF. (CM3 S-1) IN OUTPUT DATA SET
C                               1ST.DIM: TEMPERATURE INDEX
C          (I*4)   I        = GENERAL INDEX
C          (I*4)   IT       = GENERAL INDEX
C          (I*4)   ITHETA   = GENERAL INDEX
C          (I*4)   IOPT     = SPLINE END POINT CURVATURE/GRADIENT OPTION
C                               1 => DDY1 = 0, DDYN = 0
C                               4 => DY1 = 0 , DDYN = 0
C          (I*4)   IXD      = DONOR GAUSSIAN QUADRATURE INDEX
C          (I*4)   IXR      = RECEIVER GAUSSIAN QUADRATURE INDEX
C          (I*4)   NGS      = GAUSSIAN QUARATURE DIMENSION
C          (I*4)   NTHETA   = NUMBER OF ANGLE VALUES FOR QUADRATURE
C          (I*4)   LTHETA   = NTHETA+1
C          (I*4)   L1       = PARAMETER = 1
C          (R*8)   ETHD     = THERMAL ENERGY OF DONOR       (JOULES)
C          (R*8)   ETHR     = THERMAL ENERGY RECEIVER       (JOULES)
C          (R*8)   HSIMP    = SIMPSON'S RULE STEP INTERVAL
C          (R*8)   THETA    = ANGLE BETWEEN PARTICLE VELOCITIES (RAD)
C          (R*8)   FAC      = GENERAL VARIABLE
C          (R*8)   FLAG     = GENERAL VARIABLE
C          (R*8)   XMDKG    = DONOR MASS    (KG)
C          (R*8)   XMRKG    = RECEIVER MASS (KG)
C          (R*8)   VD       = DONOR SPEED    (M S-1)
C          (R*8)   VR       = RECEIVER SPEED (M S-1)
C          (R*8)   RATE     = EVALUATED RATE COEFFICIENT (CM3 S-1)
C          (R*8)   PART1    = GENERAL VARIABLE
C          (R*8)   PART2    = GENERAL VARIABLE
C          (R*8)   PART3    = GENERAL VARIABLE
C          (R*8)   PART12   = GENERAL VARIABLE
C          (R*8)   PART23   = GENERAL VARIABLE
C          (R*8)   PART123  = GENERAL VARIABLE
C          (R*8)   VREL1    = GENERAL RELATIVE SPEED VARIABLE
C          (R*8)   XSEC1    = GENERAL CROSS-SECTION VARIABLE
C          (R*8)   VAL      = GENERAL VARIABLE
C          (R*8)   XGS()    = GAUSSIAN QUADRATURE NODES
C          (R*8)   WGS()    = GAUSSIAN QUADRATURE WEIGHTS
C          (R*8)   VREL()   = RELATIVE SPEED OF PARTICLES FOR DIFFERENT
C                               ANGLES (CM S-1)
C          (R*8)   XSEC()   = CHARGE EXCHANGE CROSS-SECTIONS FOR
C                               RELATIVE SPEEDS AT DIFFERENT ANGLES (CM2)
C  ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          SIGCX      ADAS      INTERPOLATES CX CROSS-SECTION TABLES
C
C  AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C           JA8.08
C           TEL. 0141-553-4196
C  DATE:    02/11/95
C
C  UPDATE:  09/07/98  Martin O'Mullane
C           CHANGED NAME FROM CXTHER TO CDEVTH. SIMILAR FUNCTIONALITY
C           BUT IS EXTENDED TO DEAL WITH EXTRA AVERAGING METHODS.
C
C VERSION:       1.1                                    DATE: 01-12-98
C MODIFIED: RICHARD MARTIN
C               - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
      INTEGER     NGS           , NTHETA        , LTHETA
      INTEGER     IOPT          , L1
C-----------------------------------------------------------------------
      REAL*8      CMSAMU   , PI
C-----------------------------------------------------------------------
      PARAMETER ( NGS = 8  , NTHETA = 180  , LTHETA =NTHETA+1  )
      PARAMETER ( IOPT = 4 , L1 = 1                            )
      PARAMETER ( CMSAMU = 1.389209D6 , PI = 3.141592654       )
C-----------------------------------------------------------------------
      INTEGER     NDENR
      INTEGER     NENIN         , NENOUT
```

```
      INTEGER     IXD           , IXR           , I           ,
     &            IT            , ITHETA
      INTEGER     ILTYP
C-----------------------------------------------------------------------
      REAL*8      AMDON         , AMREC         , DREN
      REAL*8      ETHD          , ETHR          , HSIMP
      REAL*8      RATE
      REAL*8      THETA         , FAC           , FLAG
      REAL*8      XMDKG         , XMRKG         , VD          , VR
      REAL*8      PART1         , PART2         , PART3
      REAL*8      PART12        , PART23        , PART123
      REAL*8      VREL1         , XSEC1         , VAL
C-----------------------------------------------------------------------
      REAL*8      XGS(NGS)      , WGS(NGS)
      REAL*8      ENIN(NDENR)   , SGIN(NDENR)   ,
     &            ENOUT(NDENR)  , RCOUT(NDENR)
      REAL*8      VREL(LTHETA)  , XSEC(LTHETA)
C-----------------------------------------------------------------------
      LOGICAL     LSETX         , LPASS
C-----------------------------------------------------------------------
      CHARACTER   CATYP*2
C-----------------------------------------------------------------------
      DATA XGS/  0.170279632305   ,  0.903701776799  ,  2.251086629866,
     &           4.266700170288   ,  7.045905402393  , 10.758516010181,
     &          15.740678641278   , 22.863131736889   /
      DATA WGS/  3.69188589342D-01,  4.18786780814D-01,
     &           1.75794986637D-01,  3.33434922612D-02,
     &           2.79453623523D-03,  9.07650877336D-05,
     &           8.48574671627D-07,  1.04800117487D-09 /
C-----------------------------------------------------------------------
```

CEFILL

```
       SUBROUTINE CEFILL( MXNENG , MXNSHL , TITLED ,
     &                    SYMBR  , SYMBD  , IZR    , IZD    ,
     &                    INDD   , NENRGY , NMIN   , NMAX   ,
     &                    LPARMS , LSETL  , LSETM  , ENRGYA ,
     &                    ALPHAA , LFORMA , XLCUTA , PL2A   ,
     &                    PL3A   , SIGTA  , SIGNA  , SIGLA  ,
     &                    SIGMA
     &                  )
       IMPLICIT NONE
C-----------------------------------------------------------------------
C  ****************** FORTRAN77 SUBROUTINE: CDFILL *********************
C  PURPOSE:  FILL HIGH N ZEROES IN AN ADF01 IF PRESENT.
C  CALLING PROGRAM: ADAS314
C  DATA:
C           THE UNITS USED IN THE DATA FILE ARE TAKEN AS FOLLOWS:
C           COLLISION ENERGIES  : KEV/AMU
C           ALPHA               :
C           TOTAL XSECTS.       : CM2
C           N-SHELL XSECTS.     : CM2
C           NL-SHELL DATA       : CM2
C           NLM-SHELL DATA      : CM2
C  SUBROUTINE:
C  INPUT : (I*4)  MXNENG    = MAXIMUM NO. OF ENERGIES.
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NO. OF N SHELLS.
C  INPUT : (C*80) TITLED    = NOT SET - TITLE FOR DATA SOURCE.
C  INPUT : (C*2)  SYMBR     = READ - RECEIVER ION ELEMENT SYMBOL.
C  INPUT : (C*2)  SYMBD     = READ - DONOR ION ELMENT SYMBOL.
C  INPUT : (I*4)  IZR       = READ - ION CHARGE OF RECEIVER.
C  INPUT : (I*4)  IZD       = READ - ION CHARGE OF DONOR.
C  INPUT : (I*4)  INDD      = READ - DONOR STATE INDEX.
C  INPUT : (I*4)  NENRGY    = NUMBER OF ENERGIES READ.
C  INPUT : (I*4)  NMIN      = LOWEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (I*4)  NMAX      = HIGHEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (L*4)  LPARMS    = FLAGS IF L-SPLITTING PARAMETERS PRESENT.
C                               .TRUE.  => L-SPLITTING PARAMETERS PRESENT.
C                               .FALSE  => L-SPLITTING PARAMETERS ABSENT.
C  INPUT : (L*4)  LSETL     = FLAGS IF L-RESOLVED DATA PRESENT.
C                               .TRUE.  => L-RESOLVED DATA PRESENT.
C                               .FALSE  => L-RESOLVED DATA ABSENT.
C  INPUT : (L*4)  LSETM     = FLAGS IF M-RESOLVED DATA PRESENT.
C                               .TRUE.  => M-RESOLVED DATA PRESENT.
C                               .FALSE  => M-RESOLVED DATA ABSENT.
C  INPUT : (R*8)  ENRGYA()  = READ - COLLISION ENERGIES.
C                               UNITS: EV/AMU (READ AS KEV/AMU)
C                               DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  ALPHAA()  = READ - EXTRAPOLATION PARAMETER ALPHA.
C                               DIMENSION: ENERGY INDEX
C  INPUT : (I*4)  LFORMA()  = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                               DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  XLCUTA()  = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                               DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  PL2A()    = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                               DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  PL3A()    = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                               DIMENSION: ENERGY INDEX
C  I/O   : (R*8)  SIGTA()   = READ - TOTAL CHARGE EXCHANGE
```

```
C                                       CROSS-SECTION.
C                                 UNITS: CM2
C                                 DIMENSION: ENERGY INDEX
C  I/O   : (R*8)  SIGNA(,)  = READ - N-RESOLVED CHARGE EXCHANGE
C                                       CROSS-SECTIONS.
C                                 UNITS: CM2
C                                 1ST DIMENSION: ENERGY INDEX
C                                 2ND DIMENSION: N-SHELL
C  I/O   : (R*8)  SIGLA(,)  = READ - L-RESOLVED CHARGE EXCHANGE
C                                       CROSS-SECTIONS.
C                                 UNITS: CM2
C                                 1ST DIMENSION: ENERGY INDEX
C                                 2ND DIMENSION: INDEXED BY I4IDFL(N,L)
C  I/O   : (R*8)  SIGMA(,)  = READ - M-RESOLVED CHARGE EXCHANGE
C                                       CROSS-SECTIONS.
C                                 UNITS: CM2
C                                 1ST DIMENSION: ENERGY INDEX
C                                 2ND DIMENSION: INDEXED BY I4IDFM(N,L,M)
C                                                WITH M >= 0 ONLY
C          (I*4)  I        = N QUANTUM NUMBER.
C          (I*4)  J        = L QUANTUM NUMBER.
C          (I*4)  K        = M QUANTUM NUMBER.
C          (I*4)  N        = N QUANTUM NUMBER.
C          (I*4)  L1       = L QUANTUM NUMBER + 1
C          (I*4)  M1       = M QUANTUUM NUMBER + 1
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX FROM QUANTUM
C                               NUMBERS N AND L.
C          I4IDFM     ADAS      RETURNS UNIQUE INDEX FROM QUANTUM
C                               NUMBERS N, L AND M.
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL 0141-553-4196
C DATE:    21/09/95
C UPDATE:  27/08/97  HP SUMMERS - CHANGED NAME FROM CCFILL TO CDFILL
C
C VERSION:       1.1                                        DATE: 01-12-98
C MODIFIED: RICHARD MARTIN
C               - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER   I4FCTN  , I4UNIT  , I4IDFL  , I4IDFM
C-----------------------------------------------------------------------
      INTEGER   IUNIT   , MXNSHL  , MXNENG   ,
     &          IZR     , IZD     , INDD     ,
     &          NENRGY  , NMIN    , NMAX
      INTEGER   I       , J       , K        ,
     &          N       , L1      , M1
C-----------------------------------------------------------------------
      REAL*8    FACTN
C-----------------------------------------------------------------------
      LOGICAL   LPARMS  , LSETL   , LSETM
C-----------------------------------------------------------------------
      CHARACTER TITLED*80  , SYMBR*2    , SYMBD*2
      CHARACTER CLINE*133  , CIZR*2     , CIZD*2     , CINDD*1
C-----------------------------------------------------------------------
      INTEGER   LFORMA(MXNENG)
C-----------------------------------------------------------------------
      REAL*8    ENRGYA(MXNENG)  , ALPHAA(MXNENG)  , XLCUTA(MXNENG)  ,
     &          PL2A(MXNENG)    , PL3A(MXNENG)    , SIGTA(MXNENG)
      REAL*8    SIGNA(MXNENG,MXNSHL)                                 ,
     &          SIGLA(MXNENG,(MXNSHL*(MXNSHL+1))/2)                  ,
     &          SIGMA(MXNENG,(MXNSHL*(MXNSHL+1)*(MXNSHL+2))/6)
C-----------------------------------------------------------------------
```

CEPARM

```
      SUBROUTINE CEPARM ( NDENR  ,
     &                    LPARMS ,
     &                    NENIN  , ENIN   , NENOUT , ENOUT  ,
     &                    ALFIN  , XLCIN  , PL2IN  , PL3IN  , LFMIN  ,
     &                    ALFOUT , XLCOUT , PL2OUT , PL3OUT , LFMOUT
     &                  )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C  ********************** FORTRAN77 SUBROUTINE: CEPARM *****************
C  VERSION: 1.0
C  PURPOSE:  CONVERTS ALPHA, PL2, PL3 AND LFORM CHARGE EXCHANGE
C            PARAMETER VALUES AT INPUT ENERGIES TO VALUES AT OUTPUT
C            ENERGIES
C  CALLING PROGRAM:  ADAS314
C  SUBROUTINE:
C  INPUT :  (I*4)  NDENR   = MAX. NUMBER OF ENERGIES
C                            ALLOWED IN CROSS-SECTION FILE
C                            OR TEMPERATURES IN THERMAL
C                            AVERAGED RATE COEFFT. OUTPUT FILE.
C  INPUT : (I*4)   LPARMS   = .TRUE.  => INPUT DATA HAS L-FIT PARAMETERS
C                             .FALSE. => INPUT DATA HAS L-FIT PARAMETERS
C  INPUT : (I*4)   NENIN    = NUMBER OF ENERGIES IN INPUT DATA SET
C  INPUT : (R*8)   ENIN()   = ENERGIES (EV/AMU) IN INPUT DATA SET
```

```
C  INPUT : (I*4)   NENOUT   = NUMBER OF ENERGIES FOR OUTPUT DATA SET
C  INPUT : (R*8)   ENOUT()  = TEMPERATURES (EV/AMU) FOR OUTPUT DATA SET
C  INPUT : (R*8)   ALFIN()  = ALPHA PARAMETER IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C  INPUT : (R*8)   XLCIN()  = NON-INTEGER L-CUT-OFF PARAMETER
C                             1ST.DIM: ENERGY INDEX
C  INPUT : (R*8)   PL2IN(,) = P2 L-FIT PARAMETER IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C  INPUT : (R*8)   PL3IN(,) = P3 L-FIT PARAMETER IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C  INPUT : (I*4)   LFMIN(,) = L-FIT FORM TYPE INDEX IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C  OUTPUT: (R*8)   ALFOUT() = ALPHA PARAMETER IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C  OUTPUT: (R*8)   XLCOUT() = NON-INTEGER L-CUT-OFF PARAMETER
C                             1ST.DIM: ENERGY INDEX
C  OUTPUT: (R*8)   PL2OUT() = P2 L-FIT PARAMETER IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C  OUTPUT: (R*8)   PL3OUT() = P3 L-FIT PARAMETER IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C  OUTPUT: (I*4)   LFMOUT() = L-FIT FORM TYPE INDEX IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C          (L*4)   LSETX    = .TRUE. => SPLINE PRESET FOR THESE KNOTS
C                             .FLSE. => SPLINE NOT SET FOR THESE KNOTS
C          (L*4)   LPASS    = .TRUE. => DO NOT CONVERT INTO LOG10 FOR
C                                       ENERGIES AND X-SECTS. FOR SPLINE
C                             .FLSE. => CONVERT INTO LOG10 FOR
C                                       ENERGIES AND X-SECTS. FOR SPLINE
C          (I*4)   IOPT     = SPLINE END POINT CURVATURE/GRADIENT OPTION
C                             1 => DDY1 = 0, DDYN = 0
C                             4 => DY1 = 0 , DDYN = 0
C          (R*8)   CMSAMU   = PARAMETER = CONVERSION FACTOR FOR ENERGY
C                                         (AMU) TO VELOCITY (CM S-1)
C          (I*4)   I        = GENERAL INDEX
C          (I*4)   IT       = GENERAL INDEX
C          (R*8)   XIN()    = INTERNAL SPLINE INDEPENDENT VARIABLE
C          (R*8)   YIN()    = INTERNAL SPLINE DEPENDENT VARIABLE
C          (R*8)   VIN()    = INTERNAL VECTOR
C          (R*8)   DY()     = DERIVATIVES AT SPLINE KNOTS
C          (R*8)   XOUT()   = INTERNAL OUTPUT INDEPENDENT VARIABLE
C          (R*8)   YOUT()   = INTERNAL OUTPUT DEPENDENT VARIABLE
C          (L*4)   LINTRP() = .TRUE.  => POINT INTERPOLATED
C                           = .FALSE. => POINT EXTRAPOLATED
C  ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXSPLE     ADAS      INTERPOLATES USING CUBIC SPLINES
C          R8FUN1      ADAS      EXTERNAL FUNCTION FOR XXSPLE
C  AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C           JA8.08
C           TEL. 0141-553-4196
C  DATE:    13/11/95
C  UPDATE:  27/08/97  HP SUMMERS - CHANGED NAME FROM CCPARM TO CDPARM
C
C VERSION:       1.1                                        DATE: 01-12-98
C MODIFIED: RICHARD MARTIN
C                - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER  MAXENS
C-----------------------------------------------------------------------
      REAL*8   CMSAMU   , ZERO
C-----------------------------------------------------------------------
      PARAMETER ( MAXENS = 50 )
      PARAMETER ( CMSAMU = 1.389209D+06      , ZERO = 1.0D-30     )
C-----------------------------------------------------------------------
      INTEGER     NDENR
      INTEGER     NENIN         , NENOUT
      INTEGER     IT            , I            , IOPT
C-----------------------------------------------------------------------
      REAL*8      R8FUN1
C-----------------------------------------------------------------------
      LOGICAL     LPARMS        , LSETX         , LPASS
C-----------------------------------------------------------------------
      INTEGER     LFMIN(NDENR)
      INTEGER     LFMOUT(NDENR)
C-----------------------------------------------------------------------
      REAL*8      ENIN(NDENR)   , XLCIN(NDENR)
      REAL*8      ENOUT(NDENR)  , XLCOUT(NDENR)
      REAL*8      ALFIN(NDENR)  , PL2IN(NDENR)  , PL3IN(NDENR)
      REAL*8      ALFOUT(NDENR) , PL2OUT(NDENR) , PL3OUT(NDENR)
      REAL*8      XOUT(MAXENS)  , YOUT(MAXENS)
      REAL*8      DY(MAXENS)
      REAL*8      XIN(MAXENS)   , YIN(MAXENS)
C-----------------------------------------------------------------------
      LOGICAL     LINTRP(MAXENS)
C-----------------------------------------------------------------------
      EXTERNAL    R8FUN1
C-----------------------------------------------------------------------
```

```
      SUBROUTINE CETHER ( NDENR  , NDSHL  ,
     &                    AMDON  , AMREC  , CATYP  , DREN   , ILTYP  ,
     &                    LSETL  , LSETM  , NMIN   , NMAX   ,
     &                    NENIN  , ENIN   , NENOUT , ENOUT  ,
     &                    SGTIN  , SGNIN  , SGLIN  , SGMIN  ,
     &                    RCTOUT , RCNOUT , RCLOUT , RCMOUT
     &                  )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C  ********************* FORTRAN77 SUBROUTINE: CETHER *****************
C  VERSION: 1.0
C  PURPOSE:  OBTAINS RATE COEFFICIENTS FOR DONOR/RECEIVER CHARGE
C            EXCHANGE COLLISIONS FOR CASES OF
C            MONOENERGETIC DONOR/THERMAL RECEIVER, THERMAL
C            DONOR/MONOENERGETIC RECEIVER, THERMAL DONOR/THERMAL
C            RECEIVER (SAME TEMPERATURE) FROM CROSS-SECTION TABULATIONS
C  CALLING PROGRAM:  ADAS314
C  SUBROUTINE:
C  INPUT :  (I*4)  NDENR   = MAX. NUMBER OF ENERGIES
C                            ALLOWED IN CROSS-SECTION FILE
C                            OR TEMPERATURES IN THERMAL
C                            AVERAGED RATE COEFFT. OUTPUT FILE.
C  INPUT :  (I*4)  NDSHL   = PARAMETER = MAX. NUMBER OF N-SHELLS
C                                        ALLOWED IN CROSS-SECTION FILE
C  INPUT :  (R*8)  AMDON    = DONOR MASS NUMBER
C  INPUT :  (R*8)  AMREC    = RECEIVER MASS NUMBER
C  INPUT :  (C2)   CATYP    = 'TT' THERMAL/THERMAL (EQUAL TEMP. CASE)
C                             'TR' THERMAL RECEIVER, MONOENERGETIC DONOR
C                             'TD' THERMAL DONOR, MONOENERGETIC RECEIVER
C  INPUT : (R*8)   DREN     = DONOR ENERGY    ( 'TR' CASE )
C                             RECEIVER ENERGY ( 'TD' CASE )
C  INPUT : (I*4)   ILTYP    = TYPE FOR LOW ENERGY CROSS-SECTION EXTRAPOL
C  INPUT : (L*4)   LSETL    = .TRUE.  => L-RESOLVED DATA READ
C                             .FALSE. => NO L-RESOLVED DATA READ
C  INPUT : (L*4)   LSETM    = .TRUE.  => M-RESOLVED DATA READ
C                             .FALSE. => NO M-RESOLVED DATA READ
C  INPUT : (I*4)   NMIN     = LOWEST N-SHELL IN DATA SET
C  INPUT : (I*4)   NMAX     = HIGHEST N-SHELL IN DATA SET
C  INPUT : (I*4)   NENIN    = NUMBER OF ENERGIES IN INPUT DATA SET
C  INPUT : (R*8)   ENIN()   = ENERGIES (EV/AMU) IN INPUT DATA SET
C  INPUT : (I*4)   NENOUT   = NUMBER OF ENERGIES FOR OUTPUT DATA SET
C  INPUT : (R*8)   ENOUT()  = TEMPERATURES (EV/AMU) FOR OUTPUT DATA SET
C  INPUT : (R*8)   SGTIN()  = TOTAL X-SECTIONS (CM2) IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C  INPUT : (R*8)   SGNIN(,) = N-SHELL X-SECTIONS (CM2) IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C                             2ND.DIM: PRINCIPAL QUANTUM NUMBER
C  INPUT : (R*8)   SGLIN(,) = L-SHELL X-SECTIONS (CM2) IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C                             2ND.DIM: NL REFERENCE INDEX
C  INPUT : (R*8)   SGMIN(,) = M-SHELL X-SECTIONS (CM2) IN INPUT DATA SET
C                             1ST.DIM: ENERGY INDEX
C                             2ND.DIM: NLM REFERENCE INDEX
C  OUTPUT: (R*8)   RCTOUT() = TOTAL RATE COEFFT. (CM3 S-1) FOR OUTPUT
C                             1ST.DIM: TEMPERATURE INDEX
C  OUTPUT: (R*8)   RCNOUT(,)= N-SHELL RATE COEFFT. (CM3 S-1) FOR OUTPUT
C                             1ST.DIM: TEMPERATURE INDEX
C                             2ND.DIM: PRINCIPAL QUANTUM NUMBER
C  OUTPUT: (R*8)   RCLOUT(,)= L-SHELL RATE COEFFT. (CM3 S-1) FOR OUTPUT
C                             1ST.DIM: TEMPERATURE INDEX
C                             2ND.DIM: NL REFERENCE INDEX
C  OUTPUT: (R*8)   RCMOUT(,)= M-SHELL RATE COEFFT. (CM3 S-1) FOR OUTPUT
C                             1ST.DIM: TEMPERATURE INDEX
C                             2ND.DIM: NLM REFERENCE INDEX
C                  LSETX    = .TRUE. => SPLINE PRESET FOR THESE KNOTS
C                             .FLSE. => SPLINE NOT SET FOR THESE KNOTS
C                  LPASS    = .TRUE. => DO NOT CONVERT INTO LOG10 FOR
C                                       ENERGIES AND X-SECTS. FOR SPLINE
C                             .FLSE. => CONVERT INTO LOG10 FOR
C                                       ENERGIES AND X-SECTS. FOR SPLINE
C          (I*4)   PIPEOU   = STANDARD OUTPUT
C  ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          CDEVTH     ADAS      EVALUATES THERMAL AVERAGE RATE COEFFTS.
C          I4FCTN     ADAS      RETURNS CHARACTER STRING AS AN INTEGER.
C          I4UNIT     ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX FROM QUANTUM
C                               NUMBERS N AND L.
C          I4IDFM     ADAS      RETURNS UNIQUE INDEX FROM QUANTUM
C                               NUMBERS N, L AND M.
C  AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C           JA8.08
C           TEL. 0141-553-4196
C  DATE:    10/10/95
C  UPDATE:  27/08/97  HP SUMMERS - CHANGED NAME FROM CCTHER TO CDTHER
C
C VERSION:       1.1                                        DATE: 01-12-98
C MODIFIED: RICHARD MARTIN
C               - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER     PIPEOU        , ONE
C-----------------------------------------------------------------------
      PARAMETER ( PIPEOU = 6    , ONE = 1)
C-----------------------------------------------------------------------
      INTEGER     NDENR         , NDSHL        ,
```

```
     &            ILTYP         , NMIN          , NMAX
      INTEGER     NENIN         , NENOUT
      INTEGER     I4FCTN        , I4UNIT        , I4IDFL      ,
     &            I4IDFM
      INTEGER     N             , L             , M           , IREF
C-----------------------------------------------------------------------
      REAL*8      AMDON         , AMREC         , DREN
C-----------------------------------------------------------------------
      REAL*8      ENIN(NDENR)   , SGTIN(NDENR)  ,
     &            ENOUT(NDENR)  , RCTOUT(NDENR)
      REAL*8      SGNIN(NDENR,NDSHL)                ,
     &            SGLIN(NDENR,(NDSHL*(NDSHL+1))/2)            ,
     &            SGMIN(NDENR,(NDSHL*(NDSHL+1)*(NDSHL+2))/6)
      REAL*8      RCNOUT(NDENR,NDSHL)               ,
     &            RCLOUT(NDENR,(NDSHL*(NDSHL+1))/2)           ,
     &            RCMOUT(NDENR,(NDSHL*(NDSHL+1)*(NDSHL+2))/6)
C-----------------------------------------------------------------------
      CHARACTER   CATYP*2
C-----------------------------------------------------------------------
      LOGICAL     LSETL       , LSETM        , LSETX       , LPASS
C-----------------------------------------------------------------------
```

CEWR11

```
      SUBROUTINE CEWR11( DSFULL , DATE   ,
     &                   IUNIT  , MXNENG , MXNSHL , TITLED ,
     &                   CATYP  , AMDON  , AMREC  , DREN   ,
     &                   SYMBR  , SYMBD  , IZR    , IZD    ,
     &                   INDD   , NENRGY , NMIN   , NMAX   ,
     &                   LPARMS , LSETL  , LSETM  , ENRGYA ,
     &                   ALPHAA , LFORMA , XLCUTA , PL2A   ,
     &                   PL3A   , SIGTA  , SIGNA  , SIGLA  ,
     &                   SIGMA
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C  ****************** FORTRAN77 SUBROUTINE: CEWR11 *********************
C  PURPOSE:  TO OUTPUT DATA TO MODIFIED ADF01 FILE. IF THE ADF01 FILE
C            IS FOR THERMAL/THERMAL THERMAL/DONOR OR THERMAL/RECEIVER
C            THEN THE RATE (PASSED AS SIGMA) IS DIVIDED BY
C                  1.384D4 * 100 * DSQRT(TE)
C            IN ORDER TO ALLOW THE FILE TO BE USED WITH UNMODIFIED
C            SERIES 3 PROGRAMS.
C  CALLING PROGRAM: ADAS314
C  DATA:
C           THE UNITS USED IN THE DATA FILE ARE TAKEN AS FOLLOWS:
C           COLLISION ENERGIES  : KEV/AMU
C           ALPHA               :
C           TOTAL XSECTS.       : CM2
C           N-SHELL XSECTS.     : CM2
C           NL-SHELL DATA       : CM2
C           NLM-SHELL DATA      : CM2
C  SUBROUTINE:
C  INPUT : (I*4)  IUNIT     = INPUT  UNIT NUMBER FOR RESULTS
C  INPUT : (I*4)  MXNENG    = MAXIMUM NO. OF ENERGIES.
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NO. OF N SHELLS.
C  INPUT : (C*80) TITLED    = NOT SET - TITLE FOR DATA SOURCE.
C  INPUT : (C*80) DSFULL    = SOURCE DATASET
C  INPUT : (C2)   CATYP     = 'TT' THERMAL/THERMAL (EQUAL TEMPERATURES
C                                   FOR DONOR AND RECEIVER ONLY)
C                              'TR' THERMAL RECEIVER, MONOENERGETIC DONOR
C                              'TD' THERMAL DONOR, MONOENERGETIC RECEIVER
C                              'ME' SPECIAL MONOENERGETIC CASE
C  INPUT : (R*8)  AMDON     = DONOR MASS NUMBER
C  INPUT : (R*8)  AMREC     = RECEIVER MASS NUMBER
C  INPUT : (R*8)  DREN      = DONOR ENERGY    ( 'TR' CASE )
C                             RECEIVER ENERGY ( 'TD' CASE )
C  INPUT : (C*2)  SYMBR     = READ - RECEIVER ION ELEMENT SYMBOL.
C  INPUT : (C*2)  SYMBD     = READ - DONOR ION ELMENT SYMBOL.
C  INPUT : (I*4)  IZR       = READ - ION CHARGE OF RECEIVER.
C  INPUT : (I*4)  IZD       = READ - ION CHARGE OF DONOR.
C  INPUT : (I*4)  INDD      = READ - DONOR STATE INDEX.
C  INPUT : (I*4)  NENRGY    = NUMBER OF ENERGIES READ.
C  INPUT : (I*4)  NMIN      = LOWEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (I*4)  NMAX      = HIGHEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (L*4)  LPARMS    = FLAGS IF L-SPLITTING PARAMETERS PRESENT.
C                             .TRUE.  => L-SPLITTING PARAMETERS PRESENT.
C                             .FALSE  => L-SPLITTING PARAMETERS ABSENT.
C  INPUT : (L*4)  LSETL     = FLAGS IF L-RESOLVED DATA PRESENT.
C                             .TRUE.  => L-RESOLVED DATA PRESENT.
C                             .FALSE  => L-RESOLVED DATA ABSENT.
C  INPUT : (L*4)  LSETM     = FLAGS IF M-RESOLVED DATA PRESENT.
C                             .TRUE.  => M-RESOLVED DATA PRESENT.
C                             .FALSE  => M-RESOLVED DATA ABSENT.
C  INPUT : (R*8)  ENRGYA()  = READ - COLLISION ENERGIES.
C                             UNITS: EV/AMU (READ AS KEV/AMU)
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  ALPHAA()  = READ - EXTRAPOLATION PARAMETER ALPHA.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (I*4)  LFORMA()  = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  XLCUTA()  = READ - PARAMETERS FOR CALCULATING L-RES
```

```
C                                     X-SEC.
C                                   DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  PL2A()    = READ - PARAMETERS FOR CALCULATING L-RES
C                                     X-SEC.
C                                   DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  PL3A()    = READ - PARAMETERS FOR CALCULATING L-RES
C                                     X-SEC.
C                                   DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  SIGTA()   = READ - TOTAL CHARGE EXCHANGE
C                                     CROSS-SECTION.
C                                   UNITS: CM2
C                                   DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  SIGNA(,)  = READ - N-RESOLVED CHARGE EXCHANGE
C                                     CROSS-SECTIONS.
C                                   UNITS: CM2
C                                   1ST DIMENSION: ENERGY INDEX
C                                   2ND DIMENSION: N-SHELL
C  INPUT : (R*8)  SIGLA(,)  = READ - L-RESOLVED CHARGE EXCHANGE
C                                     CROSS-SECTIONS.
C                                   UNITS: CM2
C                                   1ST DIMENSION: ENERGY INDEX
C                                   2ND DIMENSION: INDEXED BY I4IDFL(N,L)
C  INPUT : (R*8)  SIGMA(,)  = READ - M-RESOLVED CHARGE EXCHANGE
C                                     CROSS-SECTIONS.
C                                   UNITS: CM2
C                                   1ST DIMENSION: ENERGY INDEX
C                                   2ND DIMENSION: INDEXED BY I4IDFM(N,L,M)
C                                                  WITH M >= 0 ONLY
C          (I*4)  NWIDTH   = NUMBER OF ENERGY VALUES PER LINE
C          (I*4)  IVALUE   = USED TO PARSE FOR END OF DATA FLAG (-1).
C          (I*4)  N        = N QUANTUM NUMBER.
C          (I*4)  L        = L QUANTUM NUMBER.
C          (I*4)  M        = M QUANTUM NUMBER.
C          (I*4)  I        = LOOP COUNTER.
C          (I*4)  K        = LOOP COUNTER.
C          (I*4)  IERR     = ERROR RETURN CODE.
C          (C*1)  INDD     = DONOR STATE INDEX.
C          (C*28) UID      = USER IDENTIFIER.
C          (C*8)  DATE     = CURRENT DATE.
C          (R*8)  FMUL     = MULTIPLER 1.384D4 * 100
C
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4FCTN     ADAS      RETURNS CHARACTER STRING AS AN INTEGER.
C          I4UNIT     ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX FROM QUANTUM
C                               NUMBERS N AND L.
C          I4IDFM     ADAS      RETURNS UNIQUE INDEX FROM QUANTUM
C                               NUMBERS N, L AND M.
C          XXIDTL     ADAS      INVERSE OF I4IDFL. RETURNS QUANTUM
C                               NUMBERS N AND L FROM INDEX.
C          XXIDTM     ADAS      INVERSE OF I4IDFM. RETURNS QUANTUM
C                               NUMBERS N, L AND M FROM INDEX.
C          XXNAME     ADAS      FINDS REAL NAME OF USER
C          XXSLEN     ADAS      FINDS NON BLANK PART OF STRING
C
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL. 0141-553-4196
C DATE:    19/09/95
C
C UPDATE:  27/08/97  HP SUMMERS - CHANGED NAME FROM CCWR11 TO CDWR11
C                                 REMOVED REDUNDANT FORMATS 2000, 2006
C UPDATE:  09/07/98  Martin O'Mullane  - added DATE to input list and
C                                        removed call to xxuid
C
C VERSION:       1.1                                        DATE: 01-12-98
C MODIFIED: RICHARD MARTIN
C                - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER   I4FCTN  , I4UNIT  , I4IDFL  , I4IDFM
C-----------------------------------------------------------------------
      INTEGER   IUNIT   , MXNSHL  , MXNENG   ,
     &          IZR     , IZD     , INDD     ,
     &          NENRGY  , NMIN    , NMAX
      INTEGER   NEMORE  , NWIDTH  , IVALUE   ,
     &          N       , L       , M        , I     , K       ,
     &          IERR
      INTEGER   L1      , L2
C-----------------------------------------------------------------------
      REAL*8    AMDON   , AMREC   , DREN    , fmul
C-----------------------------------------------------------------------
      LOGICAL   LPARMS  , LSETL   , LSETM
C-----------------------------------------------------------------------
      CHARACTER TITLED*80  , SYMBR*2    , SYMBD*2    , CATYP*2
      CHARACTER CLINE*133  , CIZR*2     , CIZD*2     , CINDD*1
      CHARACTER BLANKS*133
      CHARACTER DSFULL*80  , UID*28     , DATE*8     , REALNAME*30
C-----------------------------------------------------------------------
      INTEGER   LFORMA(MXNENG)
C-----------------------------------------------------------------------
      REAL*8    ENRGYA(NENRGY)  , ALPHAA(MXNENG)  , XLCUTA(MXNENG)  ,
     &          PL2A(MXNENG)    , PL3A(MXNENG)    , SIGTA(MXNENG)
      REAL*8    SIGNA(MXNENG,MXNSHL)                                 ,
     &          SIGLA(MXNENG,(MXNSHL*(MXNSHL+1))/2)                  ,
```

```
     &          SIGMA(MXNENG,(MXNSHL*(MXNSHL+1)*(MXNSHL+2))/6)
C-----------------------------------------------------------------------
      DATA      BLANKS /' '/
C-----------------------------------------------------------------------
```

CEWR12

```
      SUBROUTINE CEWR12( IUNIT  , MXNENG , MXNSHL , ILTYP  ,
     &                   TITLED , DSFULL , DATE   ,
     &                   CATYP  ,
     &                   SYMBR  , SYMBD  , IZR    , IZD    ,
     &                   INDD   , NENRGY , NMIN   , NMAX   ,
     &                   LPARMS , LSETL  , LSETM  , ENRGYA ,
     &                   ALPHAA , LFORMA , XLCUTA , PL2A   ,
     &                   PL3A   , SIGTA  , SIGNA  , SIGLA  ,
     &                   SIGMA
     &                 )
      IMPLICIT NONE
C-----------------------------------------------------------------------
C  ****************** FORTRAN77 SUBROUTINE: CEWR12 *********************
C  PURPOSE:  TO OUTPUT DATA TO ADF24 FILE.
C  CALLING PROGRAM: ADAS314
C  DATA:
C           THE UNITS USED IN THE DATA FILE ARE TAKEN AS FOLLOWS:
C           COLLISION ENERGIES  : KEV/AMU
C           ALPHA               :
C           TOTAL XSECTS.       : CM2
C           N-SHELL XSECTS.     : CM2
C           NL-SHELL DATA       : CM2
C           NLM-SHELL DATA      : CM2
C  SUBROUTINE:
C  INPUT : (I*4)  IUNIT     = INPUT  UNIT NUMBER FOR RESULTS
C  INPUT : (I*4)  MXNENG    = MAXIMUM NO. OF ENERGIES.
C  INPUT : (I*4)  MXNSHL    = MAXIMUM NO. OF N SHELLS.
C  INPUT : (I*4)  ILTYPL    = TYPE FOR LOW ENERGY X-SECT. EXTRAPOLATION
C  INPUT : (C*80) TITLED    = NOT SET - TITLE FOR DATA SOURCE.
C  INPUT : (C*44) DSFULL    = SOURCE DATASET
C  INPUT : (C2)   CATYP     = 'TT' THERMAL/THERMAL (EQUAL TEMPERATURES
C                                   FOR DONOR AND RECEIVER ONLY)
C                              'TR' THERMAL RECEIVER, MONOENERGETIC DONOR
C                              'TD' THERMAL DONOR, MONOENERGETIC RECEIVER
C                              'ME' SPECIAL MONOENERGETIC CASE
C  INPUT : (C*2)  SYMBR     = READ - RECEIVER ION ELEMENT SYMBOL.
C  INPUT : (C*2)  SYMBD     = READ - DONOR ION ELMENT SYMBOL.
C  INPUT : (I*4)  IZR       = READ - ION CHARGE OF RECEIVER.
C  INPUT : (I*4)  IZD       = READ - ION CHARGE OF DONOR.
C  INPUT : (I*4)  INDD      = READ - DONOR STATE INDEX.
C  INPUT : (I*4)  NENRGY    = NUMBER OF ENERGIES READ.
C  INPUT : (I*4)  NMIN      = LOWEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (I*4)  NMAX      = HIGHEST N-SHELL FOR WHICH DATA READ.
C  INPUT : (L*4)  LPARMS    = FLAGS IF L-SPLITTING PARAMETERS PRESENT.
C                               .TRUE.  => L-SPLITTING PARAMETERS PRESENT.
C                               .FALSE  => L-SPLITTING PARAMETERS ABSENT.
C  INPUT : (L*4)  LSETL     = FLAGS IF L-RESOLVED DATA PRESENT.
C                               .TRUE.  => L-RESOLVED DATA PRESENT.
C                               .FALSE  => L-RESOLVED DATA ABSENT.
C  INPUT : (L*4)  LSETM     = FLAGS IF M-RESOLVED DATA PRESENT.
C                               .TRUE.  => M-RESOLVED DATA PRESENT.
C                               .FALSE  => M-RESOLVED DATA ABSENT.
C  INPUT : (R*8)  ENRGYA()  = READ - COLLISION ENERGIES.
C                             UNITS: EV/AMU (READ AS KEV/AMU)
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  ALPHAA()  = READ - EXTRAPOLATION PARAMETER ALPHA.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (I*4)  LFORMA()  = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  XLCUTA()  = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  PL2A()    = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  PL3A()    = READ - PARAMETERS FOR CALCULATING L-RES
C                                    X-SEC.
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  SIGTA()   = READ - TOTAL CHARGE EXCHANGE
C                                    CROSS-SECTION.
C                             UNITS: CM2
C                             DIMENSION: ENERGY INDEX
C  INPUT : (R*8)  SIGNA(,)  = READ - N-RESOLVED CHARGE EXCHANGE
C                                    CROSS-SECTIONS.
C                             UNITS: CM2
C                             1ST DIMENSION: ENERGY INDEX
C                             2ND DIMENSION: N-SHELL
C  INPUT : (R*8)  SIGLA(,)  = READ - L-RESOLVED CHARGE EXCHANGE
C                                    CROSS-SECTIONS.
C                             UNITS: CM2
C                             1ST DIMENSION: ENERGY INDEX
C                             2ND DIMENSION: INDEXED BY I4IDFL(N,L)
C  INPUT : (R*8)  SIGMA(,)  = READ - M-RESOLVED CHARGE EXCHANGE
C                                    CROSS-SECTIONS.
C                             UNITS: CM2
```

```
C                            1ST DIMENSION: ENERGY INDEX
C                            2ND DIMENSION: INDEXED BY I4IDFM(N,L,M)
C                                           WITH M >= 0 ONLY
C          (I*4)  NWIDTH   = NUMBER OF ENERGY VALUES PER LINE
C          (I*4)  IBLK     = CURRENT DATA BLOCK.
C          (I*4)  IVALUE   = USED TO PARSE FOR END OF DATA FLAG (-1).
C          (I*4)  N        = N QUANTUM NUMBER.
C          (I*4)  L        = L QUANTUM NUMBER.
C          (I*4)  M        = M QUANTUM NUMBER.
C          (I*4)  I        = LOOP COUNTER.
C          (I*4)  K        = LOOP COUNTER.
C          (I*4)  IERR     = ERROR RETURN CODE.
C          (R*8)  ALPH0    = LOW ENERGY PARAMETER FOR ILTYP = 1
C          (C*1)  INDD     = DONOR STATE INDEX.
C          (C*9)  FST      = FINAL STATE NAME.
C          (C*9)  BLK9     = BLANK STRING OF LENGTH 9.
C          (C*1)  LCHRA()  = CHARACTER FOR L ANG.MOM.INDEXED BY L+1
C ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          I4FCTN     ADAS      RETURNS CHARACTER STRING AS AN INTEGER.
C          I4UNIT     ADAS      FETCH UNIT NUMBER FOR OUTPUT OF MESSAGES
C          I4IDFL     ADAS      RETURNS UNIQUE INDEX FROM QUANTUM
C                               NUMBERS N AND L.
C          I4IDFM     ADAS      RETURNS UNIQUE INDEX FROM QUANTUM
C                               NUMBERS N, L AND M.
C          XXIDTL     ADAS      INVERSE OF I4IDFL. RETURNS QUANTUM
C                               NUMBERS N AND L FROM INDEX.
C          XXIDTM     ADAS      INVERSE OF I4IDFM. RETURNS QUANTUM
C                               NUMBERS N, L AND M FROM INDEX.
C          XXNAME     ADAS      FINDS REAL NAME OF USER
C          XXSLEN     ADAS      FINDS NON BLANK PART OF STRING
C AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C          JA8.08
C          TEL. 0141-553-4196
C DATE:    13/11/95
C UPDATE:  27/08/97  HP SUMMERS - CHANGED NAME FROM CCWR12 TO CDWR12
C UPDATE:  09/07/98  Martin O'Mullane  - added DATE to input list and
C                                        removed call to xxuid
C
C VERSION:       1.1                                        DATE: 01-12-98
C MODIFIED: RICHARD MARTIN
C               - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
      INTEGER   NDSEL
C-----------------------------------------------------------------------
      PARAMETER ( NDSEL = 300 )
C-----------------------------------------------------------------------
      INTEGER   I4FCTN  , I4UNIT  , I4IDFL  , I4IDFM
C-----------------------------------------------------------------------
      INTEGER   IUNIT   , MXNSHL  , MXNENG   , ILTYP  ,
     &          IZR     , IZD     , INDD     ,
     &          NENRGY  , NMIN    , NMAX
      INTEGER   NEMORE  , NWIDTH  , IBLK    , IVALUE  ,
     &          N       , L       , M       , I       , K       ,
     &          ISEL    , IERR
      INTEGER   L1      , L2
C-----------------------------------------------------------------------
      REAL*8    ALPH0
C-----------------------------------------------------------------------
      LOGICAL   LPARMS  , LSETL   , LSETM
C-----------------------------------------------------------------------
      CHARACTER TITLED*80  , SYMBR*2    , SYMBD*2     , CATYP*2
      CHARACTER CLINE*80   , CIZR*2     , CIZD*2      , CINDD*1
      CHARACTER BLANKS*80  , DSFULL*80  , UID*28      , DATE*8
      CHARACTER FST*9      , BLK9*9     , REALNAME*30
C-----------------------------------------------------------------------
      INTEGER   LFORMA(MXNENG)
C-----------------------------------------------------------------------
      REAL*8    ENRGYA(NENRGY)  , ALPHAA(MXNENG)  , XLCUTA(MXNENG)  ,
     &          PL2A(MXNENG)    , PL3A(MXNENG)    , SIGTA(MXNENG)
      REAL*8    SIGNA(MXNENG,MXNSHL)                                ,
     &          SIGLA(MXNENG,(MXNSHL*(MXNSHL+1))/2)                 ,
     &          SIGMA(MXNENG,(MXNSHL*(MXNSHL+1)*(MXNSHL+2))/6)
C-----------------------------------------------------------------------
      CHARACTER CINFO(NDSEL)*80   , LCHR(16)*1
C-----------------------------------------------------------------------
      DATA      BLANKS /' '/
      DATA      BLK9   /' '/
      DATA      LCHR   /'s' , 'p' , 'd' , 'f' , 'g' , 'h', 'i' , 'k' ,
     &                  'l' , 'm' , 'n' , 'o' , 'q' , 'r', 't' , 'u' /
C-----------------------------------------------------------------------
```

CLDLBN2

```
       SUBROUTINE CLDLBN2(EXMEMB,Z0,Z1,ZEFF,DENS,TE,DENSP,TP,BMENER,
     &                    DENSH,W1,NMIN,NMAX,NREP,IMAX,ARED,
     &                    RHS,CIONPT,DRECPT,RRECPT,XRECPT,IECION,
     &                    IEDREC,IERREC,IEXREC,DVEC,ACNST,A1CNST)
C
       IMPLICIT REAL*8(A-H,O-Z)
```

```
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CLDLBN2 ********************
C
C-----------------------------------------------------------------------
C  SUBROUTINE TO ESTABLISH THE PROJECTED INFLUENCE OF HIGH N-SHELLS IN
C  THE BUNDLE-N COLLISIONAL DIELECTRONIC MODEL ON A SET OF LS OR LSJ
C  RESOLVED LOW LEVEL POPULATION EQUATIONS
C
C  BOTH THE RECOMBINATION AND IONISATION PATHWAYS THROUGH THE HIGH
C  LEVELS ARE TAKEN INTO ACCOUNT AS WELL AS THE INDIRECT COUPLINGS OF
C  LOW RESOLVED LEVELS VIA THE HIGH BUNDLE-N LEVELS.
C
C  THE SUBROUTINE IS USED AS AN ARBITRARY CALL FROM WITHIN THE
C  CONVENTIONAL BNDLEN ROUTINE FOLLOWING ESTABLISHMENT OF THE
C  CONDENSED COLLISIONAL-DIELECTRONIC MATRIX AND RIGHT-HAND SIDE
C
C  THE EXPANSION OF THE PROJECTED MATRICES OVER THE RESOLVED LOWER
C  LEVELS IS DEFINED THROUGH RESOLVED - BUNDLEN INDEXING AND
C  WEIGHTING FRACTION TABLES STORED IN DATA STATEMENTS.
C  THESE ARE HELD FOR COMBINATIONS BASED ON THE A-D-A-S DATA BASE
C  MEMBERS.
C
C  THE ROUTINE PROVIDES TABULAR OUTPUT AND FOR THE MOMENT PREPARES A
C  PASSING FILE FOR FURTHER PROCESSING IN THE A-D-A-S STRUCTURE
C
C  PROCESSING CONTINUES WITH EXECUTION OF THE LOW LEVEL POPULATION
C  CALCULATION PROVIDED THE LOW LEVEL DATA FILE 'REFMEM' IS NON-BLANK
C  OTHERWISE ONLY THE PASSING FILE IS PRODUCED
C
C  INPUT
C      EXMEMB   = DATA SET NAME OF EXPANSION FILE
C      Z0       = NUCLEAR CHARGE
C      Z1       = RECOMBINING ION CHARGE
C      ZEFF     = PLASMA Z EFFECTIVE
C      DENS     = ELECTRON DENSITY (CM-3)
C      TE       = ELECTRON TEMPERATURE (K)
C      DENSP    = PROTON   DENSITY (CM-3)
C      TP       = PROTON   TEMPERATURE (K)
C      BMENER   = NEUTRAL HYDROGEN BEAM ENERGY (EV/AMU)
C      DENSH    = NEUTRAL BEAM HYDROGEN DENSITY (CM-3)
C      W1       = GROUND STATE RADIATION DILUTION FACTOR
C      NMIN     = LOWEST N-SHELL
C      NMAX     = HIGHEST N-SHELL
C      NREP(I)  = SET OF REPRESENTATIVE LEVELS
C      IMAX     = NUMBER OF REPRESENTATIVE LEVELS
C      ARED(I,J)= CONDENSED COLLISONAL-DIELECTRONIC MATRIX (CN SOLUTION)
C      RHS(I)   = CONDENSED RIGHT-HAND-SIDE              (CN SOLUTION)
C      CIONPT(I)= COLLISIONAL IONISATION CONTRIBUTION TO ARED(I,I)
C      DRECPT(I)= DIELECTRONIC RECOMBINATION CONTRIBUTION TO RHS(I)
C      RRECPT(I)= RADIATIVE    RECOMBINATION CONTRIBUTION TO RHS(I)
C      XRECPT(I)= CHARGE EXCHANGE RECOMB.    CONTRIBUTION TO RHS(I)
C      IECION   = 0 ELIMINATE CIONPT FOR LOW LEVELS IN PROJECTION
C                 1 DO NOT ELIMINATE CIONPT.
C      IEDREC   = 0 ELIMINATE DRECPT FOR LOW LEVEL PROJECTION
C                 1 DO NOT ELIMINATE DRECPT.
C      IERREC   = 0 ELIMINATE RRECPT FOR LOW LEVEL PROJECTION
C                 1 DO NOT ELIMINATE RRECPT.
C      IEXREC   = 0 ELIMINATE XRECPT FOR LOW LEVEL PROJECTION
C                 1 DO NOT ELIMINATE XRECPT.
C      DVEC(I)  = CONVERSION FACTOR FOR BN --> POPULATION
C      ACNST    = 1.03928D-13*Z*ATE*DSQRT(ATE)
C      A1CNST   = 6.60074D-24*DENS*(157890.0/TE)**1.5
C
C  OUTPUT
C
C
C  ********** H.P. SUMMERS, JET              8 FEB 1990    ************
C  **********                                24 APR 1990    ************
C  **********                                18 JUL 1991    ************
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
C
C UPDATE:  19/01/94 - JONATHAN NASH - TESSELLA SUPPORT SERVICES PLC
C
C          THE FOLLOWING MODIFICATIONS HAVE BEEN MADE TO THE SUBROUTINE:
C
C          1) THE COMPLETE EXPANSION FILE DATA SET NAME IS NOW PASSED
C             INTO THE ROUTINE RATHER THAN JUST THE MEMBER NAME.
C
C          2) THE OUTPUT FILE (UNIT 18) IS NOW OPENED EXTERNAL TO THIS
C             ROUTINE.
C
C  NOTES:  NO ATTEMPT HAS BEEN MADE TO RESTRUCTURE THE ROUTINE. RATHER
C          THE MINIMUM AMOUNT OF WORK TO INTEGRATE THE ROUTINE INTO
C          ADAS310 HAS BEEN COMPLETED.
C
C-----------------------------------------------------------------------
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 17-1-96
```

```
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - CHANGED ACTION=READ TO STATUS=UNKNOWN IN OPEN
C                 STATEMENT
C
C VERSION: 1.3                          DATE: 24-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - COMMENTED OUT CALL TO USINFO AS NO LONGER NEEDED
C
C VERSION: 1.4                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REMOVED SUPERFLUOUS VARIABLES
C
C-----------------------------------------------------------------------
C
       PARAMETER (NDIM=30,NLDIM=30,NDMAX=550,NDMET=5)
       CHARACTER SEQ*2,SYMBA*2,REFMEM*8
       CHARACTER EXMEMB*80
       CHARACTER STRING*80,STRNG1*80,PTSYMA*11,SUBSTRG*11,LVSYMA*26
       CHARACTER LSTRING*133,STRNG2*60
C
C
       DIMENSION NREP(NDIM+1),ARED(NDIM,NDIM),RHS(NDIM),DVEC(NDIM)
CX     DIMENSION ARED2(NDIM,NDIM),RHS2(NDIM)
       DIMENSION CIONPT(NDIM),DRECPT(NDIM),RRECPT(NDIM),XRECPT(NDIM)
       DIMENSION AREDL(NDIM,NDIM),AREDH(NDIM,NDIM),RHSL(NDIM),RHSH(NDIM)
       DIMENSION BREDL(NDIM,NDIM),VEC(NDIM)
       DIMENSION IPOINTA(NDMAX)
       DIMENSION PCRMAT(NDIM,NDIM),PCRRHS(NDIM),LVSYMA(NDIM)
       DIMENSION PEXMAT(NLDIM,NLDIM),PEXRHS(NLDIM)
       DIMENSION AMAT(NDIM,NDIM),RS(NDIM),CHMAT(NDIM,5),RH(NDIM)
       DIMENSION PCION(NDIM),PDREC(NDIM),PRREC(NDIM),PXREC(NDIM)
       DIMENSION PECION(NLDIM),PEDREC(NLDIM),PERREC(NLDIM),PEXREC(NLDIM)
       DIMENSION LSPA(NLDIM),LSHA(NLDIM),LPTA(NLDIM),WGHTA(NLDIM,5)
       DIMENSION SYMBA(30),PTSYMA(5),NSHELA(5),NSPNA(5,5),NLWSTA(5,5)
       DIMENSION PLWSTA(5,5),NPTSPA(5),NSPSYS(5),NCUTP(5),DEPA(5)
       DIMENSION IMETR(NDMET+1)
       NAMELIST /SEQINF/SEQ,REFMEM,NPARNT,NSHEL,NLEV
       DATA LSTRING/'
     &
     &               '/
       DATA IPASS/0/
       DATA SYMBA/'H ','HE','LE','BE','B ','C ','N ','O ','F ','NE',
     &            'NA','MG','AL','SI','P ','S ','CL','AR','K ','CA',
     &            'SC','TI','V ','CR','MN','FE','CO','NI','CU','ZN'/
C-----------------------------------------------------------------------
```

CMPRSS

```
      SUBROUTINE CMPRSS(IUIN,IUOUT,DATE,IECOUNT,INCOUNT,ITCOUNT)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: CMPRSS *******************
C
C PURPOSE:
C  READ OUTPUT FROM V2BNLDN1 AND PRODUCE TABLES OF BEAM STOPPING RATES
C  AS A FUNCTION OF PLASMA DENSITY AND TEMPERATURE AND OF BEAM ENERGY
C  (FOR USE IN KS4FIT BY QHIOCH)
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
C
C UPDATE:  20/01/94 - JONATHAN NASH - TESSELLA SUPPORT SERVICES PLC
C
C          THIS SUBROUTINE WAS ADAPTED FROM THE PROGRAM
C          'JETXJS.BMSTOP.FORT(COMPRESS)'.
C
C          THE FOLLOWING MODIFICATIONS HAVE BEEN MADE:
C
C          1) THE MAXIMUM NUMBER OF BEAM ENERGIES HAS BEEN INCREASED
C             FROM 13 TO 20.
C
C          2) THE UNIT NUMBERS OF THE INPUT AND OUTPUT FILES ARE PASSED
C             INTO THE ROUTINE AS ARGUMENTS.
C
C          3) THE REFERENCE ELECTRON DENSITY AND TEMPERATURE AND BEAM
C             ENERGY ARE DETERMINED RATHER THAN BEING DECLARED AS
C             PARAMETERS. THESE ASSIGMENTS ARE BASED ON KNOWING THE
C             ORDER OF THE DATA IN THE INPUT FILE.
C
C  NOTES:  NO ATTEMPT HAS BEEN MADE TO RESTRUCTURE THE ROUTINE. RATHER
C          THE MINIMUM AMOUNT OF WORK TO INTEGRATE THE ROUTINE INTO
C          ADAS310 HAS BEEN COMPLETED.
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 01-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - PUT UNDER SCCS CONTROL
C
C VERSION: 1.2                          DATE: 01-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
```

```
C               - ALLOWED FOR CASE WHERE ZEFF=0.0
C
C VERSION: 1.3                          DATE: 05-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - ADDED NUMBER OF ENERGIES, TEMPS. AND DENSITIES
C                 AS OUTPUT.
C
C VERSION: 1.4                          DATE: 05-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - CORRECTED SCCS KEYWORDS.
C
C VERSION: 1.5                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REMOVED SUPERFLUOUS VARIABLES
C
C VERSION: 1.6                          DATE: 14-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - CHANGED FORMAT 1004 TO READ 97X RATHER THAN
C                 98X AS THIS WAS NOT BEING READ CORRECTLY
C
C VERSION: 1.7                          DATE: 23-09-96
C MODIFIED: WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C               - CHANGED FORMAT 1004 TO READ E12.5 RATHER THAN
C                 E11.5 AS THIS WAS NOT BEING READ CORRECTLY
C VERSION: 1.8
C MODIFIED: HARVEY ANDERSON
C DATE: 23/01/96
C       - MODIFIED THE VALUE OF MAXTE, MAXNE, AND MAXEB FROM 10
C         TO 25.
C
C-----------------------------------------------------------------------
C
C  INPUT:  (I*4)  IUIN      = UNIT NO. OF INPUT FILE.
C  INPUT:  (I*4)  IUOUT     = UNIT NO. OF OUTPUT FILE.
C  INPUT:  (C*8)  DATE      = DATE STRING.
C  OUTPUT: (I*4)  IECOUNT   = NUMBER OF BEAM ENERGIES
C  OUTPUT: (I*4)  INCOUNT   = NUMBER OF DENSITIES
C  OUTPUT: (I*4)  ITCOUNT   = NUMBER OF TEMPERATURES
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      INTEGER    IUIN    , IUOUT
C-----------------------------------------------------------------------
      CHARACTER  DATE*8
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
      PARAMETER( MAXTE=25, MAXNE=25, MAXEB=25)
C
      CHARACTER LINE*132
      REAL NERAY(MAXNE),TERAY(MAXTE),EBRAY(MAXEB)
      REAL SRAY(MAXEB,MAXNE,MAXTE)
      INTEGER IEA(MAXEB),ITA(MAXTE),INA(MAXNE)
      REAL TEREF,NEREF,SREF
      REAL NE,TE,EB
      INTEGER IZ
      REAL Z
      CHARACTER*2 SPEC(11)
      DATA SPEC/'H ','HE','LI','BE','B ','C ','N ','O ','F ','NE','NA'/
C-----------------------------------------------------------------------
C
C   S  = IONISATION COEFFICIENT
C   NE = ELECTRON DENSITY (CM -3)
C   TE = ELECTRON TEMPERATURE (EV)
C   EB = BEAM ENERGY (EV/AMU)
C   TEREF = REFERENCE TEMPERATURE FOR NE/EB MATRIX
C   NEREF = REFERENCE DENSITY FOR TE VECTOR
C   EBREF = REFERENCE BEAM ENERGY FOR TE VECTOR
C   SREF = RATE COEFFICIENT ASSOCIATED WITH THESE REFERENCE VALUES
C
C                       C.F. MAGGI 22 JULY 1991
C                       L.D. HORTON 31 JULY 91
C-----------------------------------------------------------------------
```

COLINT

```
       SUBROUTINE COLINT(Y,Z,EN,AI)
C
       IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: COLINT *********************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
```

```
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REPLACED 0.0 ARGUMENT IN CALL TO YIP
C                 WITH A DUMMY VARIABLE INSTEAD.
C
C-----------------------------------------------------------------------
C
       DIMENSION X(5),W(5)
```

DIEL

```
       SUBROUTINE DIEL(Z,EIJ,F,T,COR,JCOR,N,AD)
       IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 PROGRAM: DIEL ***************************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
C
       DIMENSION THETA(1000),COR(20)
```

EIQIP

```
       SUBROUTINE EIQIP(EI,EIJ,EM,Z,PHI,SC,WI,WJ,R,EIQ,FLAG)
C
       IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: EIQIP ***********************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```

FIND

```
      SUBROUTINE FIND(ARR,VALUE,IMAX,INDEX)

C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: FIND ************************
C
C  PURPOSE:
C  SUBROUTINE TO FIND VALUES FROM LINE AND STORE ONLY NOT REPEATED
C  VALUES
C
C
C  INPUT
C      ARR = NAME OF ARRAY TO STORE ELEMENTS
C      VALUE = VALUE TO BE FOUND IN LINE
C      IMAX = TOTAL NUMBER OF NOT REPEATED ELEMENTS IN ARRAY
C      INDEX = COUNTER OF ELEMENT POSITION IN ARRAY
C  OUTPUT
C       ARR = ARRAY CONTAINING NOT REPEATED VALUES READ FROM LINE
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 01-02-96
```

```
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
      LOGICAL OVER,FOUND
      REAL ARR(*),VALUE
      INTEGER IMAX,INDEX
C
```

FINTER

```
       FUNCTION FINTER(EN)
       IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 FUNCTION: FINTER ***********************
C
C  PURPOSE:  UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```

FITSP

```
       SUBROUTINE FITSP(X,XA,N,YAA,Y,DY,I0,C1,C2,C3,C4,ISW)
C
       IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: FITSP ***********************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C
       DIMENSION YAA(10),TA(10),XA(10)
       DIMENSION C1(10,9),C2(10,9),C3(10,9),C4(10,9)
       DIMENSION CT1(9),CT2(9),CT3(9),CT4(9)
```

GBB

```
       FUNCTION GBB(EN,EN1,X2,X)
C
       IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 FUNCTION: GBB ***********************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```

GBF

```
       FUNCTION GBF(EN,U)
       IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 FUNCTION: GBF *************************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```

GENTAB

```
       SUBROUTINE GENTAB(NREP,IMAX,DENS,TE,BMENER,F1,F2,F3)
C
       IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: GENTAB *********************
C
C PURPOSE : SEND DATA TO STREAM '10' FOR SUBSEQUENT TABLE PRODUCTION
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 25-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
C
       DIMENSION NREP(31),F1(30),F2(30),F3(30)
```

GSPC

```
       SUBROUTINE GSPC(XA,N,C1,C2,C3,C4)
C
       IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: GSPC ***********************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C
       DIMENSION HA(10),XA(10),W(10,10),C1(10,9)
       DIMENSION C2(10,9),C3(10,9),C4(10,9)
```

INITPOS

```
      SUBROUTINE INITPOS(NTA,M)
C
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: INITPOS ********************
C
C PURPOSE UNKNOWN
```

```
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 01-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - PUT UNDER SCCS CONTROL
C
C-----------------------------------------------------------------------
C
      INTEGER NTA(*)
```

LOWPOP

```
      SUBROUTINE LOWPOP(SEQ,REFMEM,Z0,Z1,ZEFF,NMET,IMETR,TE,DENS,TP,
     &                  DENSP,DENSH,NPARNT,DEPA,LPTA,
     &                  PEXMAT,PEXRHS,PECION,PEDREC,PERREC,
     &                  PEXREC,IECION,IEDREC,IERREC,IEXREC)
      IMPLICIT REAL*8(A-H,O-Z)
      PARAMETER (NDLEV=30,NDTEM=20,NDDEN=20,NDMET=5,NDTRN=300)
      PARAMETER (NDSPL=10)
      PARAMETER (ICODE=0)
C -----------------------------------------------------------------------
C  SUBROUTINE TO CALCULATE POPULATIONS OF LOW EXCITED POPULATIONS OF
C  IONS INCLUDING
C
C          (A) COUPLING TO HIGH LEVELS AND CONTINUUM VIA PRELIMINARY
C              BUNDLE-N CALCULATION (V2BNDLN) AND PROJECTION/EXPANSION
C              MATRIX CALCULATION (CLDLBN2)
C
C          (B) DEPENDENCE ON METASTABLES.
C
C
C  PROCESSES CAN INCLUDE ELECTRON & PROTON IMPACT, SPONTANEOUS EMISSION,
C  FREE ELECTRON RECOMBINATION AND CHARGE EXCHANGE RECOMBINATION
C  DEPENDING ON THE INPUT DATA SET
C
C  THE BASIC LOW LEVEL ATOMIC DATA IS ENTERED FROM COMPILATION
C  DATA SETS OF THE FORM
C
C            'JETSHP.<SE>LIKE.DATA(<TITLE><EL>)'
C
C       WHERE <SE> DENOTES THE ISOLELECTRONIC SEQUENCE, <TITLE> IS AN
C       ARBITRARY IDENTIFIER FOR THE SOURCE AND YEAR, <EL> IS THE
C       ELEMENT SYMBOL. <SE> AND <TITLE><EL> ARE PRESENTED TO THE
C       SUBROUTINE AS PARAMETERS FROM CLDLBN2
C
C
C  MAIN OUTPUT TABLES ARE GENERATED ON STREAM 7
C  POPULATION DATA FOR DIAGNOSTIC USE ON STREAM 19
C
C  THE SUBROUTINE WAS DEVELOPED FROM THE ORIGINAL PROGRAM SPMETPOP
C
C
C  INPUT
C      Z0      = NUCLEAR CHARGE
C      Z1      = RECOMBINING ION CHARGE
C      ZEFF    = PLASMA Z EFFECTIVE
C      NMET    = NUMBER OF METASTABLES (1.LE.NMET.LE.5)
C      IMETR(I)= INDEX OF METASTABLE I IN COMPLETE LEVEL LIST
C      TE      = ELECTRON TEMPERATURE (K)
C      DENS    = ELECTRON DENSITY (CM-3)
C      TP      = PROTON TEMPERATURE   (K)
C      DENSP   = PROTON DENSITY (CM-3)
C      DENSH   = NEUTRAL HYDROGEN DENSITY(IN BEAMS)  (CM-3)
C      PEXMAT(I,J) = EXPANDED PROJECTION MATRIX FOR LOW LEVELS
C      PEXRHS(I)   = EXPANDED PROJECTED RIGHT HAND SIDE VECTOR
C      PECION(I)   = DENS*IONISATION RATE COEFFT  FOR LOW LEVEL I
C      PEDREC(I)   = DIELECTRONIC RECOMB. COEFFT. FOR LOW LEVEL I
C      PERREC(I)   = RADIATIVE RECOMB. COEFFT.    FOR LOW LEVEL I
C      PEXREC(I)   = DENSH*(CX RATE COEFFT)/DENS  FOR LOW LEVEL I
C      IECION      = 0  IONISATION     ELIMINATED     FROM LEVEL I
C                  = 1  IONISATION     NOT ELIMINATED FROM LEVEL I
C      IEDREC      = 0  DIEL. RECOMB. ELIMINATED     FOR LEVEL I
C                  = 1  DIEL. RECOMB. NOT ELIMINATED FOR LEVEL I
C      IERREC      = 0  RAD.  RECOMB. ELIMINATED     FOR LEVEL I
C                  = 1  RAD.  RECOMB. NOT ELIMINATED FOR LEVEL I
C      IEXREC      = 0  CX.   RECOMB. ELIMINATED     FOR LEVEL I
C                  = 1  CX.   RECOMB. NOT ELIMINATED FOR LEVEL I
C
C
C
C  ********** H.P. SUMMERS, JET                26 APR 1990  **********
C         OPEN FILE ON STREAM 9 UNDER DIVUID   19 FEB 1991
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
C
C UPDATE:  19/01/94 - JONATHAN NASH - TESSELLA SUPPORT SERVICES PLC
C
C          THE FOLLOWING MODIFICATIONS HAVE BEEN MADE TO THE SUBROUTINE:
C
```

```
C          1) THE INPUT UNIT NUMBER WAS CHANGE FROM 10 TO 9 AND THE
C             DIAGNOSTIC OUTPUT UNIT FROM 11 TO 19.
C
C  NOTES:  NO ATTEMPT HAS BEEN MADE TO RESTRUCTURE THE ROUTINE. RATHER
C          THE MINIMUM AMOUNT OF WORK TO INTEGRATE THE ROUTINE INTO
C          ADAS310 HAS BEEN COMPLETED.
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - PUT UNDER SCCS CONTROL
C
C VERSION: 1.2                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - COMMENTED OUT LINE 'EXTERNAL GAMMA' AS IT APPEARS
C                 TO SERVE NO PURPOSE AND THERE IS NO CORRESPONDING
C                 GAMMA ROUTINE.
C
C VERSION: 1.3                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - COMMENTED OUT LINE 'CALL ERRSET'
C
C-----------------------------------------------------------------------
C
       CHARACTER*40 TITLE,GTIT1,STRG1
       CHARACTER*20 TIT2
       CHARACTER*1 LCODE,GRAPH,TEXT,TCODE
       CHARACTER ANS*3,CSTRGA*12,STRGA*22,ITITLE*3
       CHARACTER SEQ*2,REFMEM*8,DSNAME*30
       CHARACTER STRGB*36,STRGC*36,STRGD*36,BLANKS*36
C
       CHARACTER JOBNAME*8,DIVUID*6,ACCT*4,POINT*2,SECLEV*2
       DOUBLE PRECISION LOGTEA,LOGTPA,LOGTHA
       REAL*4 XL14,XU14,YL14,YU14,SDENSA,STK4,STEV
C
       DIMENSION IA(NDLEV),ISA(NDLEV),ILA(NDLEV),XJA(NDLEV),WA(NDLEV)
       DIMENSION ER(NDLEV),RHS(NDLEV),XIA(NDLEV),CIE(NDLEV)
       DIMENSION CRHS(NDLEV,5),LPTA(NDLEV),DEPA(5)
       DIMENSION CRA(NDLEV,NDLEV),CRCE(NDLEV,NDLEV),CRCP(NDLEV,NDLEV)
       DIMENSION IORDR(NDLEV),CC(NDLEV,NDLEV),CMAT(NDLEV,NDLEV)
       DIMENSION POPAR(NDLEV),CSTRGA(NDLEV)
       DIMENSION TEA(NDTEM),TPA(NDTEM),TEVA(NDTEM),TPVA(NDTEM)
       DIMENSION THA(NDTEM),THVA(NDTEM)
       DIMENSION ATEA(NDTEM),ATPA(NDTEM),ATHA(NDTEM)
       DIMENSION LOGTEA(NDTEM),LOGTPA(NDTEM),LOGTHA(NDTEM)
       DIMENSION SQATEA(NDTEM),SQATPA(NDTEM),SQATHA(NDTEM)
       DIMENSION EXPTE(NDLEV,NDTEM),EXPTP(NDLEV,NDTEM)
       DIMENSION VECH(NDTEM,NDLEV),VECR(NDTEM,NDLEV)
       DIMENSION DENSA(NDDEN),DENSPA(NDDEN),RATHA(NDDEN),RATIA(NDDEN)
       DIMENSION SDENSA(NDDEN),STK4(NDLEV,NDMET,NDDEN)
       DIMENSION SIONA(NDMET),STVRH(NDMET,5),ALFG(5)
       DIMENSION IMETR(NDMET+1),VRHRED(NDMET,5)
       DIMENSION CRED(NDMET,NDMET)
       DIMENSION IE1A(NDTRN),IE2A(NDTRN),IP1A(NDTRN),IP2A(NDTRN)
       DIMENSION AA(NDTRN)
       DIMENSION DEXCRA(NDTEM,NDTRN),DEXCRP(NDTEM,NDTRN)
       DIMENSION STACK(NDLEV,NDMET,NDTEM,NDDEN)
       DIMENSION STCKM(NDMET,NDTEM,NDDEN)
       DIMENSION STVRHM(NDMET,5)
       DIMENSION C1(NDSPL,NDSPL-1),C2(NDSPL,NDSPL-1)
       DIMENSION C3(NDSPL,NDSPL-1),C4(NDSPL,NDSPL-1)
       DIMENSION XA(NDSPL)
       DIMENSION SCEF(8),SCOM(8),ERG(4),OM(4)
       DIMENSION PAR(18,17)
       DIMENSION STRGA(NDLEV)
       DIMENSION PEXMAT(NDLEV,NDLEV),PEXRHS(NDLEV),PECION(NDLEV)
       DIMENSION PEDREC(NDLEV),PERREC(NDLEV),PEXREC(NDLEV)
C
CX     EXTERNAL GAMMA
C
       DATA TIT2/'SPDFGHIJK           '/
       DATA BLANKS/'                                  '/
C
CX     CALL ERRSET(208,256,-1)
C-----------------------------------------------------------------------
```

NSUPH1

```
       SUBROUTINE NSUPH1(TEV,EBEAM,TIEV,NIMP ,ZIMPA ,FRIMPA,AMIMPA,
     &                   ITYP1 ,ITYP2 ,ITYP3 ,ITYP4 ,ITYP5 ,ITYP6 ,
     &                   XTBE  ,XTBP  ,XTBZ  ,STBE  ,STBP  ,STBZ  ,
     &                   LXTBE ,LXTBP ,LXTBZ ,LSTBE ,LSTBP ,LSTBZ ,
     &                   PXTBE ,PXTBP ,PXTBZ ,PSTBE ,PSTBP ,PSTBZ ,
     &                   LPXTBE,LPXTBP,LPXTBZ,LPSTBE,LPSTBP,LPSTBZ,
     &                   DSLPATH)
C
       IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: NSUPH1 *********************
C-----------------------------------------------------------------------
```

```
C  SUBROUTINE TO ACCESS SPECIFIC HIGHER QUALITY DATA FOR
C
C  H
C
C  POPULATION STRUCTURE CALCULATION IN THE BUNDLE-N APPROXIMATION.
C
C  DATA TYPES ARE:
C
C         (1) ELECTRON IMPACT EXCITATION - SPECIFIC ION FILE IS OPENED.
C         (2) ELECTRON IMPACT IONISATION - SPECIFIC FIT IS USED.
C         (3) H+  IMPACT EXCITATION      - QHIEXDAT FILE IS OPENED.
C         (4) H+  IMPACT IONIS + CX      - QHIEXDAT FILE IS OPENED.
C         (5) ZIMP ION IMPACT EXCITATION - QHIEXDAT FILE IS OPENED.
C         (6) ZIMP ION IMPACT IONIS + CX - QHIEXDAT FILE IS OPENED.
C
C  INPUT
C      TEV      = ELECTRON TEMPERATURE (EV)
C      EBEAM    = BEAM ENERGY (EV/AMU)  USED AS A UNIFORM VELOCITY SHIFT
C                 FOR ION COLLISIONS
C      TIEV     = ION TEMPERATURE (EV)
C      NIMP     = NUMBER OF IMPURITY IONS (EXCLUDING H+)
C      ZIMPA()  = Z OF EFFECTIVE IMPURITY FOR ION COLLISIONS(EXCEPT H+)
C      FRIMPA() = FRACTION OF TOTAL IMPURITY NUMBER DENSITY (EXCL H+)
C      AMIMPA() = ATOMIC MASS NUMBER OF IMPURITY
C      ITYP1    = 0   DO NOT OBTAIN TYPE 1 DATA
C               = 1   OBTAIN TYPE 1 DATA
C      ITYP2    = 0   DO NOT OBTAIN TYPE 2 DATA
C               = 1   OBTAIN TYPE 2 DATA
C      ITYP3    = 0   DO NOT OBTAIN TYPE 3 DATA
C               = 1   OBTAIN TYPE 3 DATA
C      ITYP4    = 0   DO NOT OBTAIN TYPE 4 DATA
C               = 1   OBTAIN TYPE 1 DATA
C      ITYP5    = 0   DO NOT OBTAIN TYPE 5 DATA
C               = 1   OBTAIN TYPE 2 DATA
C      ITYP6    = 0   DO NOT OBTAIN TYPE 6 DATA
C               = 1   OBTAIN TYPE 3 DATA
C      DSLPATH  =     STRING CONTAINING PATH FOR INPUT FILE FOR UNIT 15
C
C  OUTPUT
C      XTBE(N,N'')  = TYPE 1 RATE COEFFICIENT
C      XTBP(N,N'')  = TYPE 3 RATE COEFFICIENT
C      XTBZ(N,N'')  = TYPE 5 RATE COEFFICIENT
C      STBE(N)      = TYPE 2 RATE COEFFICIENT
C      STBP(N)      = TYPE 4 RATE COEFFICIENT
C      STBZ(N)      = TYPE 6 RATE COEFFICIENT
C      LXTBE(N,N'') = TYPE 1 MARKER  (0 =NO VALUE, 1=VALUE)
C      LXTBP(N,N'') = TYPE 3 MARKER
C      LXTBZ(N,N'') = TYPE 5 MARKER
C      LSTBE(N)     = TYPE 2 MARKER
C      LSTBP(N)     = TYPE 4 MARKER
C      LSTBZ(N)     = TYPE 6 MARKER
C      PXTBE(N)     = TYPE 1 PROJECTION MULTIPLIER
C      PXTBP(N)     = TYPE 3 PROJECTION MULTIPLIER
C      PXTBZ(N)     = TYPE 5 PROJECTION MULTIPLIER
C      PSTBE        = TYPE 2 PROJECTION MULTIPLIER
C      PSTBP        = TYPE 4 PROJECTION MULTIPLIER
C      PSTBZ        = TYPE 6 PROJECTION MULTIPLIER
C      LPXTBE(N)    = TYPE 1 PROJECTION MULTIPLIER USED ABOVE THIS N'
C      LPXTBP(N)    = TYPE 3 PROJECTION MULTIPLIER USED ABOVE THIS N'
C      LPXTBZ(N)    = TYPE 5 PROJECTION MULTIPLIER USED ABOVE THIS N'
C      LPSTBE       = TYPE 2 PROJECTION MULTIPLIER USED ABOBE THIS N
C      LPSTBP       = TYPE 4 PROJECTION MULTIPLIER USED ABOVE THIS N
C      LPSTBZ       = TYPE 6 PROJECTION MULTIPLIER USED ABOBE THIS N
C
C  ********** H.P. SUMMERS, JET                9 MAY 1990   ***********
C  **********                                  20 JUL 1990   ***********
C  **********                                  13 AUG 1990   ***********
C  **********      NEW ELECTRON EXCIT. DATA    22 JAN 1991   ***********
C  **********      NEW ION IMPACT EXCIT. DATA   3 JUL 1991   ***********
C  **********      NEW ELEC. IMPACT ION. DATA   3 JUL 1991   ***********
C  **********      DATA EXTENSION BY ADDING     1 MAR 1992   ***********
C                  SOME INTERMEDIATE VALUES +
C                  ADDITION OF B, N, NE ION. +
C                  CHARGE EXCHANGE.
C  **********      MULTIPLE, SIMULTANEOUS      11 JAN 1994   ***********
C                  IMPURITY EXTENSION
C                  ERROR CORRECTED IN IMPURITY
C                  REDUCED MASSES
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
C
C UPDATE:  19/01/94 - JONATHAN NASH - TESSELLA SUPPORT SERVICES PLC
C
C          THE FOLLOWING MODIFICATIONS HAVE BEEN MADE TO THE SUBROUTINE:
C
C          1) A PARAMETER FLAG HAS BEEN ADDED TO SWITCH ON/OFF
C             DIAGNOSTIC PRINTING (UNIT 6).
C
C  NOTES:  NO ATTEMPT HAS BEEN MADE TO RESTRUCTURE THE ROUTINE. RATHER
C          THE MINIMUM AMOUNT OF WORK TO INTEGRATE THE ROUTINE INTO
C          ADAS310 HAS BEEN COMPLETED.
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
```

```
C
C VERSION: 1.2                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - ADDED VARIABLE DSLPATH AND CHANGED NAME OF INPUT FILE
C
C VERSION: 1.3                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - CORRECTED STRING HANDLING SYNTAX IN CONSTRUCTION OF
C                 DSNAME, COMMENTED OUT REFERENCES TO DEBUG LOGICAL
C                 VARIABLE AND INSERTED 'CALL' BEFORE XXSLEN.
C
C VERSION: 1.4                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - MODIFIED CONSTRUCTION OF DSNAME
C
C VERSION: 1.5                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - ADDED DSLPATH IN CALL TO QH.FOR
C
C VERSION: 1.6                          DATE: 22-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REPLACED CALLS TO NAG ROUTINE E02BBF WITH ADAS ROUTINE
C                 DXNBBF
C
C VERSION: 1.7                          DATE: 23-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REPLACED CALLS TO NAG ROUTINE E01BAF WITH ADAS ROUTINE
C                 DXNBAF
C
C VERSION: 1.8                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REMOVED SUPERFLUOUS VARIABLES
C
C VERSION: 1.9                          DATE: 03-04-97
C MODIFIED: H.ANDERSON
C               - ALTERED TO USE RESTRUCTURED ADF02 DATASET sia#h_rfm.dat
C
C VERSION: 1.10                            DATE: 03/04/97
C MODIFIED: HARVEY ANDERSON.
C           ALTERED TO USE NEW PREFERRED ADF02 DATASET sia#h_j97.dat
C
C VERSION: 1.11                            DATE: 08-04-97
C MODIFIED: RICHARD MARTIN
C           CHANGED NAME OF ADF02 FILE FROM sia#h_j97.dat TO
C           sia#h_j97#h.dat
C
C-----------------------------------------------------------------------
C
C  PARAM : (L*4)  DEBUG     = FLAGS DIAGNOSTIC PRINTING.
C                             .TRUE.  => PRINT DIAGNOSTICS.
C                             .FALSE. => DO NOT PRINT DIAGNOSTICS.
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
CX    LOGICAL    DEBUG
CX    PARAMETER( DEBUG = .FALSE. )
      PARAMETER (NCDIM=30,NDLOW=10)
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
       CHARACTER DSNAME*80,TITLF*80,TITLX*80,DSLPATH*80,
     &           DSTEMP2*80
C
       LOGICAL LTRNG(1)
C
       DIMENSION NA(NCDIM),N1A(NCDIM),ICODEA(NCDIM)
       DIMENSION COEFFA(NCDIM),COEFFB(NCDIM)
       DIMENSION EA(24),OA(24)
       DIMENSION TEA(8),TEALG(24),GAMA(24)
       DIMENSION XKA(28),C(28)
CX     DIMENSION WRK(160)
       DIMENSION WTS(24),B(24),A(28,4),DIAG(28)
       DIMENSION TVAL(1),SZDA(1)
       DIMENSION ZIMPA(10),FRIMPA(10),AMIMPA(10)
C
       DIMENSION XTBE(NDLOW,NDLOW),LXTBE(NDLOW,NDLOW)
       DIMENSION XTBP(NDLOW,NDLOW),LXTBP(NDLOW,NDLOW)
       DIMENSION XTBZ(NDLOW,NDLOW),LXTBZ(NDLOW,NDLOW)
       DIMENSION PXTBE(NDLOW),LPXTBE(NDLOW)
       DIMENSION PXTBP(NDLOW),LPXTBP(NDLOW)
       DIMENSION PXTBZ(NDLOW),LPXTBZ(NDLOW)
       DIMENSION STBE(NDLOW),LSTBE(NDLOW)
       DIMENSION STBP(NDLOW),LSTBP(NDLOW)
       DIMENSION STBZ(NDLOW),LSTBZ(NDLOW)
C
       DATA LCK,LWRK/28,160/
C
C-----------------------------------------------------------------------
```

PYPR

```
       SUBROUTINE PYPR(E,E11,N,N11,EM,Z1,PHI,WI,WJ,TE,INTD,PY,RDEXC)
```

```
C
      IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: PYPR ***********************
C
C  CALCULATES PY FACTOR (CF. VAN REGEMORTER,1962) USING PERCIVAL,RICHARD
C  AND COWORKER CROSS-SECTIONS.
C  VALID ONLY FOR ELECTRON INDUCED TRANSITIONS BETWEEN WHOLE PRINCIPAL
C  QUANTUM SHELLS IN HYDROGEN AND HYDROGENIC IONS, FOR N,N11>4
C  HOWEVER ADJUSTMENTS MADE TO ALLOW USE OF FORMULAE FOR N<4
C  ********* H.P.SUMMERS, JET  12 NOVEMBER 1984  ***************
C  INPUT
C      E=1/V**2 WITH V THE INITIAL EFFECTIVE PRINCIPAL QUANTUM NUMBER
C      E11=1/V11**2 WITH V11 THE FINAL EFFECTIVE PRINCIPAL QUANTUM NUMBE
C      N=INITIAL PRINCIPAL QUANTUM NUMBER
C      N11=FINAL PRINCIPAL QUANTUM NUMBER (REQUIRE N11>N AND V11>V)
C      EM=REDUCED MASS OF COLLIDING PARTICLE (MUST BE 1.0 IN THIS CASE)
C      Z1=TARGET ION CHARGE +1
C      PHI=(IH/EIJ)F WITH EIJ=TRANSITION ENERGY, F=ABS. OSCILL. STRENGTH
C      WI=STATISTICAL WEIGHT OF INITIAL LEVEL
C      WJ=STATISTICAL WEIGHT OF FINAL LEVEL
C      TE=ELECTRON TEMPERATURE(K)
C      INTD=<3 FOR TWO POINT GAUSSIAN QUADRATURE.
C           = 3 FOR THREE POINT GAUSSIAN QUADRATURE
C           =>3 FOR FOUR POINT GAUSSIAN QUADRATURE
C  OUTPUT
C      PY=P FACTOR
C      RDEXC=DEXCITATION RATE COEFFICIENT (CM+3 SEC-1)
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
C
      DIMENSION A(4),H(4)
```

PYVR

```
      SUBROUTINE PYVR(Y,Z1,PY)
C
      IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: PYVR ***********************
C
C  CALCULATES VAN REGEMORTER'S P FACTOR FOR ELECTRON COLLISIONS WITH
C  ATOMS AND IONS.
C  INPUT
C      Y=ATE*(1/V1**2+1/V2**2)  WHERE
C                ATE=1.5789D5*Z1*Z1/TE
C                TE=ELECTRON TEMPERATURE (K)
C                V1=INITIAL EFFECTIVE PRINCIPAL QUANTUM NUMBER
C                V2=FINAL EFFECTIVE PRINCIPAL QUANTUM NUMBER
C      Z1=TARGET ION CHARGE+1
C      PY=P-FACTOR
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```

QH

```
      FUNCTION QH(EPRO,TTAR,ISEL,ZSEL,NSEL,IORD,EA,OA,N,IPASS,
     &            TITLF, DSLPATH)
C
      IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 FUNCTION: QH ***************************
C
C-----------------------------------------------------------------------
C
```

```
C        WARNING: DO NOT USE THIS PROGRAM WITH ADAS, IT HAS BEEN
C                 ALTERED TO ACCOMADATE THE COMPARATIVE ADF02 FILE
C                 AS WELL AS THE TOSHIMA & TAWARA ADF02 FILE.
C
C       14/3/97 HARVEY ANDERSON.
C
C FUNCTION TO EVALUATE MAXWELL AVERAGED TOTAL IONISATION, EXCITATION
C  AND CHARGE EXCHANGE RATE COEFFICIENTS.
C
C  THE FUNCTION ALSO RETURNS THE RAW CROSS-SECTION DATA FOR VERIFICATION
C  AND GRAPHING PURPOSES.
C
C  THE INCIDENT PARTICLE IS A MONOENERGETIC BEAM AND THE TARGET IS A
C  MAXWELL DISTRIBUTION. THE TARGET AND PROJECTILE ROLES MAY BE
C  REVERSED. ARBITRARY RELATIVE SPEEDS ARE ALLOWED.
C
C  THE RATE COEFFICIENT REQUIRED IS SELECTED FROM A LIST.  THERE IS SOME
C  SCALED DATA. ALL X-SECTS INVOLVE HYDROGEN AS ONE OF THE SPECIES.
C
C  NB.  QH IS DESIGNED TO TAKE HYDROGEN XSECT DATA FROM
C
C                 'JETSHP.IONATOM.DATA(H)'
C
C
C
C  INPUT
C      EPRO  = INCIDENT PARTICLE ENERGY (EV/AMU)
C      TTAR  = MAXWELL TEMPERATURE OF TARGET PARTICLES (EV)
C              IF (TTAR.LE.0) THEN ONLY RAW SOURCE VALUES ARE RETURNED
C              IN ARRAYS (EA(I),OA(I), I=1,N)
C      ISEL  = SELECTOR FOR PARTICULAR RATE COEFFT. CHOSEN FROM TABLE
C              BELOW (SEE ALSO NOTES ON DATA)
C      ZSEL  = NUCLEAR CHARGE (REQUIRED ONLY FOR PARTICULAR ISEL)
C      NSEL  = PRINC. QUANTUM NO. (REQUIRED ONLY FOR PARTICULAR ISEL
C              NB. NSEL SHOULD BE ZERO ON ENTRY OTHERWISE)
C      IORD  = 1 FOR 1ST PARTICLE INCIDENT AND MONOENERGETIC
C            = 2 FOR 2ND PARTICLE INCIDENT AND MONOENERGETIC
C      IPASS = 0 IF DATA FILE TO BE READ IN AFRESH
C            = 1 IF DATA FILE IS NOT TO BE READ IN AGAIN
C  OUTPUT
C      QH    = RATE COEFFICIENT (CM3 SEC-1)
C      EA(I) = SET OF ENERGIES (EV/AMU) FOR SELECTED SOURCE DATA
C      OA(I) = CROSS-SECTIONS (CM**2) FOR SELECTED SOURCE DATA
C      N     = NUMBER OF SOURCE DATA VALUES
C      TITLF = INFORMATION STRING
C
C
C  ********** H.P.SUMMERS,JET             20 JUL 1990  ***************
C  **********                         COR  31 JUL 1990  ***************
C  **********                         ADD   3 JUL 1991  ***************
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - PUT UNDER SCCS CONTROL
C                - MODIFIED NAME OF INPUT FILE BY ADDING INPUT
C                 PARAMETER DSLPATH CONTAINING THE PATH TO THE
C                 FILE AND INCREASING THE LENGTH OF THE VARIABLE DSNAME
C
C VERSION: 1.2                          DATE: 18-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - MODIFIED CONSTRUCTION OF DSLPATH
C
C VERSION: 1.3                          DATE: 22-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REPLACED CALLS TO NAG ROUTINE E02BBF WITH CALL
C                 TO ADAS REPLACEMENT ROUTINE DXNBBF
C
C VERSION: 1.4                          DATE: 23-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REPLACED CALL TO NAG ROUTINE E01BAF WITH CALL
C                 TO ADAS REPLACEMENT ROUTINE DXNBAF (NOTE THAT
C                 THIS IS NOT A DIRECT REPLACEMENT ROUTINE BUT
C                 HOPEFULLY IT WILL NOW GIVE THE SAME RESULTS)
C
C VERSION: 1.5                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REMOVED SUPERFLUOUS VARIABLES
C
C VERSION: 1.6                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - CORRECTED NAME "TRING" TO "STRING"
C
C VERSION: 1.7                    DATE: 26/11/96
C MODIFIED: HARVEY ANDERSON
C                 MODIFIED FORMAT STATEMENT 1001 AND THE READ
C                 STATEMENT BEGINING ON LINE 146 TO ACCOMODATE
C                 FOR THE NEW FORMAT OF THE ADF02 FILE
C                 /SIA#H/SIA#H_RFM#H.DAT. ALSO MODIFIED THE
C                 DSNAME ON LINE 143. ALSO SLIGHTLY MODIFIED
C                 LINE 152 AND 153 DUE TO THE NEW FORMAT OF
C                 THE FILE. ALSO MODIFIED THE SELECT NUMBERS
C                 ASSOCIATED WITH THE SCALING.
C
C VERSION: 1.8                            DATE: 03-04-97
```

```
C MODIFIED: HARVEY ANDERSON
C                 MODIFIED TO USE NEW PREFERRED ADF02 FILE sia#h_j97.dat
C
C VERSION: 1.9                              DATE: 08-04-97
C MODIFIED: RICHARD MARTIN
C                 CHANGED NAME OF ADF02 FILE FROM sia#h_j97.dat TO
C                 sia#h_j97#h.dat
C
C VERSION: 1.10                             DATE: 08-04-97
C MODIFIED: RICHARD MARTIN
C                 CORRECTED MISTAKE MADE IN PREVIOUS MODIFICATION
C
C-----------------------------------------------------------------------
       PARAMETER (NSTORE=80)
       DIMENSION XA(9),WXA(9),NA(NSTORE)
       DIMENSION SIGA(24,NSTORE),ERELA(24,NSTORE)
       DIMENSION EM1A(NSTORE),EM2A(NSTORE),ALFA(NSTORE)
       DIMENSION ETHRA(NSTORE),EA(24),OA(24),YA(24),FA(24)
       DIMENSION XSA(24),YSA(24),XKA(28),C(28),WTS(24)
CX     DIMENSION WRK(160)
       CHARACTER DSNAME*80, STRING*80, TITLF*80, DSLPATH*80
       DIMENSION B(24),A(28,4),DIAG(28)
C-----------------------------------------------------------------------
C  GAUSS-LAGUERRE DATA (9PT)
C-----------------------------------------------------------------------
       DATA XA/0.1523222277D0,0.8072200227D0,2.0051351556D0,
     &         3.7834739733D0,6.2049567778D0,9.3729852516D0,
     &        13.4662369110D0,18.8335977889D0,26.3740718909D0/
       DATA WXA/3.36126421798D-1,4.11213980424D-1,1.99287525371D-1,
     &          4.74605627657D-2,5.59962661079D-3,3.05249767093D-4,
     &          6.59212302608D-6,4.11076933035D-8,3.29087403035D-11/
C-----------------------------------------------------------------------
C  XSECT STORAGE - NA(ISEL),EM1A(ISEL),EM2A(ISEL),ALFA(ISEL),
C                           ETHRA(ISEL),ISEL
C                  ERELA(IVAL,ISEL), SIGA(IVAL,ISEL)  WHERE
C                         NA=NUMBER OF ENERGIES FOR CROSS-SECTION
C                         EM1=1ST PARTICLE MASS (AT.MASS UNITS)
C                         EM2=2ND PARTICLE MASS (AT.MASS UNITS)
C                         ALF=HIGH ENERGY SLOPE (AS EREL**-ALF)
C                         ETHR=THRESHOLD ENERGY FOR REACTION (EV)
C                         EREL=RELATIVE ENERGY (EV/AMU)
C                         SIG=X-SECT (CM2)
C  WHERE THERE ARE UP TO 24 VALUES FOR EACH X-SECT
C
C  N.B. IT ASSUMED FOR POWER LAW INTERPOLATION PURPOSES THAT THE
C  CROSS-SECTION AT ERELA(1) IS FINITE.
C-----------------------------------------------------------------------
       DATA LCK,LWRK/28,160/
C
```

QLPR

```
       FUNCTION QLPR(Z1,N1,N2,E1,ZP,ATMSSP)
C
       IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 FUNCTION: QLPR ************************
C
C-----------------------------------------------------------------------
C  LODGE-PERCIVAL-RICHARDS ION IMPACT EXCITATION CROSS-SECTIONS IN
C  ORIGINAL FORM  (J.PHYS.B. (1976)9,239).
C
C  EXCITATION CROSS-SECTION IS EVALUATED AND DE-EXCITATION CROSS-SECTION
C  OBTAINED BY DETAILED BALANCE
C
C  SCALING TO ARBITRARY PROJECTILE CHARGE FOLLOWS RECOMMENDATIONS
C  OF RIENHOLD,, OLSEN & FRITSCH (1990)PHYS.REV.A 41,4837
C
C
C  INPUT
C      Z1=TARGET ION CHARGE +1
C      N1=INITIAL PRINCIPAL QUANTUM NUMBER
C      N2=FINAL PRINCIPAL QUANTUM NUMBER
C      E1=ENERGY OF EQUIVALENT ELECTRON IN RYDBERGS
C         (CORRESPONDS TO ACTUAL PROJECTILE ENERGY/25KEV)
C      ZP=PROJECTILE CHARGE
C      ATMSSP= PROJECTILE MASS IN PROTON UNITS
C  OUTPUT
C      QLPR=CROSS-SECTION IN PI*A0**2 UNITS
C
C
C  ***********  H.P.SUMMERS, JET            16/ 7/90 ***************
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
```

```
C-----------------------------------------------------------------------
```

QPR78

```
      FUNCTION QPR78(Z1,N1,N2,E1,PHI)
C
      IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 FUNCTION: QPR78 ************************
C
C-----------------------------------------------------------------------
C  PERCIVAL AND RICHARDS-MNRAS(1978)183,329.
C  ELECTRON COLLISION CROSS-SECTIONS FOR TRANSITIONS BETWEEN PRINCIPAL
C  QUANTUM SHELLS IN HYDROGEN AND HYDROGENIC IONS.
C  VALID FOR INCIDENT ELECTRON ENERGIES IN RANGE (Z1/N1)**2<E1<137**2
C  AND FOR N1,N2>4.
C  ANOMALIES DEVELOP IN ORIGINAL SPECIFICATION OF PERCIVAL RICHARDS FOR
C  S=N2-N1 LARGE OR IF N1 IS <5.  HENCE A MODIFIED PRESCRIPTION IS USED
C  IN THESE CASES CONSISTENT WITH BANKS ET AL (1973) ASTR. LETT 14,161
C
C
C  INPUT
C      Z1=TARGET ION CHARGE +1
C      N1=INITIAL PRINCIPAL QUANTUM NUMBER
C      N2=FINAL PRINCIPAL QUANTUM NUMBER
C      E1=ENERGY OF INCIDENT ELECTRON IN RYDBERGS
C
C  OUTPUT
C      QPR78=CROSS-SECTION IN PI*A0**2 UNITS
C
C
C  ***********  H.P.SUMMERS, JET          12 NOV 1984        ***********
C  ****                               COR  28 FEB 1990               ****
C-----------------------------------------------------------------------
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```

QVAIN

```
      FUNCTION QVAIN(Z1,N1,N2,VION,PHI,ZP)
C
      IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 FUNCTION: QVAIN ************************
C
C  ION COLLISION CROSS-SECTIONS FOR TRANSITIONS BETWEEN PRINCIPAL
C  QUANTUM SHELLS IN HYDROGEN AND HYDROGENIC IONS.
C  INPUT
C      Z1   = TARGET ION CHARGE +1
C      N1   = INITIAL PRINCIPAL QUANTUM NUMBER
C      N2   = FINAL PRINCIPAL QUANTUM NUMBER
C      VION = VELOCITY OF INCIDENT ION (CM/SEC)
C      ZP   = PROJECTILE CHARGE
C  OUTPUT
C      QVAIN=CROSS-SECTION IN PI*A0**2 UNITS
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```

RQLNEW

```
      FUNCTION RQLNEW(Z,N11,N,PHI,ZP, AMSIMP,TP,VDISP)
C
      IMPLICIT REAL*8(A-H,O-Z)
```

```
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 FUNCTION: RQLNEW ***********************
C
C-----------------------------------------------------------------------
C  EVALUATES ION IMPACT RATE COEFFICIENTS OF LODGE, PERCIVAL & RICHARDS
C  (ALTERNATIVE TO RQLPR  WITH BETTER MAXWELL AVERAGING BUT SLOWER)
C
C  ROUTINE MUST RETURN EXCITATION RATE COEFFICIENT IF N11.LT.N   AND
C  DEXCITATION RATE COEFFICIENT IF N11.GT.N
C
C  NOTE THAT THE RELATION BETWEEN INVERSE PROCESSES IS DETERMINED BY THE
C  TEMPERATURE TP AND THE SPEED VDISP
C  THE TREATMENT GIVEN IS APPROXIMATE EXCEPT IN THE LIMITS VDISP=0 OR
C  VDISP >> DSQRT(2*TP/AMSIMP)
C
C  INPUT
C      Z      = TARGET ION CHARGE+1
C      N11    = PRINCIPAL QUANTUM  NUMBER OF INITIAL LEVEL
C      N      = PRINCIPAL QUANTUM  NUMBER OF FINAL   LEVEL
C      PHI    = (IH/EIJ)F(N ---> N'')
C      ZP     = PROJECTILE CHARGE
C      AMSIMP = PROJECTILE MASS (PROTON UNITS)
C      TP     = PROJECTILE ION TEMPERATURE (K)
C      VDISP  = CONSTANT MEAN SPEED SHIFT FOR THE COLLISION (CM/SEC)
C                     (DESCRIBES BEAM PLASMA SITUATIONS)
C
C  OUTPUT
C      RQLNEW = RATE COEFFICIENT (CM**3 SEC-1)
C
C
C  ********* H.P. SUMMERS, JET                2 JUL 1991   ************
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REMOVED SUPERFLUOUS VARIABLES
C
C-----------------------------------------------------------------------
C
       DIMENSION XA(9),WXA(9)
       DIMENSION EA(24),OA(24),YA(24),FA(24)
C-----------------------------------------------------------------------
C  GAUSS-LAGUERRE DATA (9PT)
C-----------------------------------------------------------------------
       DATA XA/0.1523222277D0,0.8072200227D0,2.0051351556D0,
     &         3.7834739733D0,6.2049567778D0,9.3729852516D0,
     &         13.4662369110D0,18.8335977889D0,26.3740718909D0/
       DATA WXA/3.36126421798D-1,4.11213980424D-1,1.99287525371D-1,
     &          4.74605627657D-2,5.59962661079D-3,3.05249767093D-4,
     &          6.59212302608D-6,4.11076933035D-8,3.29087403035D-11/
C-----------------------------------------------------------------------
       DATA LCK,LWRK/28,160/
C-----------------------------------------------------------------------
       DATA NN/22/
       DATA (EA(I),I=1,24)/1.00D3,1.50D3,2.00D3,3.00D3,5.00D3,7.00D3,
     &                     1.00D4,1.50D4,2.00D4,3.00D4,4.00D4,5.00D4,
     &                     6.00D4,7.00D4,8.00D4,1.00D5,1.50D5,2.00D5,
     &                     3.00D5,5.00D5,7.00D5,1.00D6,0.00D0,0.00D0/
       DATA IORD,EM1,ALFA /1,2.0D0,1.0D0/
C-----------------------------------------------------------------------
```

RQVNEW

```
       FUNCTION RQVNEW(Z,N11,N,PHI,ZP, AMSIMP,TP,VDISP)
C
       IMPLICIT REAL*8(A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 FUNCTION: RQVNEW ***********************
C
C-----------------------------------------------------------------------
C  EVALUATES ION IMPACT RATE COEFFICIENTS OF VAINSHTEIN ET AL 1981
C  (ALTERNATIVE TO RQVAIN WITH BETTER MAXWELL AVERAGING BUT SLOWER)
C
C  ROUTINE MUST RETURN EXCITATION RATE COEFFICIENT IF N11.LT.N   AND
C  DEXCITATION RATE COEFFICIENT IF N11.GT.N
C
C  NOTE THAT THE RELATION BETWEEN INVERSE PROCESSES IS DETERMINED BY THE
C  TEMPERATURE TP AND THE SPEED VDISP
C  THE TREATMENT GIVEN IS APPROXIMATE EXCEPT IN THE LIMITS VDISP=0 OR
C  VDISP >> DSQRT(2*TP/AMSIMP)
C
C  INPUT
```

```
C      Z      = TARGET ION CHARGE+1
C      N11    = PRINCIPAL QUANTUM  NUMBER OF INITIAL LEVEL
C      N      = PRINCIPAL QUANTUM  NUMBER OF FINAL   LEVEL
C      PHI    = (IH/EIJ)F(N ---> N'')
C      ZP     = PROJECTILE CHARGE
C      AMSIMP = PROJECTILE MASS (PROTON UNITS)
C      TP     = PROJECTILE ION TEMPERATURE (K)
C      VDISP  = CONSTANT MEAN SPEED SHIFT FOR THE COLLISION (CM/SEC)
C                     (DESCRIBES BEAM PLASMA SITUATIONS)
C
C  OUTPUT
C      RQVNEW = RATE COEFFICIENT (CM**3 SEC-1)
C
C
C  ********* H.P. SUMMERS, JET                2 JUL 1991   ************
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C VERSION: 1.2                          DATE: 08-02-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REMOVED SUPERFLUOUS VARIABLES
C
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
C
       DIMENSION XA(9),WXA(9)
       DIMENSION EA(24),OA(24),YA(24),FA(24)
C-----------------------------------------------------------------------
C  GAUSS-LAGUERRE DATA (9PT)
C-----------------------------------------------------------------------
       DATA XA/0.1523222277D0,0.8072200227D0,2.0051351556D0,
     &         3.7834739733D0,6.2049567778D0,9.3729852516D0,
     &         13.4662369110D0,18.8335977889D0,26.3740718909D0/
       DATA WXA/3.36126421798D-1,4.11213980424D-1,1.99287525371D-1,
     &          4.74605627657D-2,5.59962661079D-3,3.05249767093D-4,
     &          6.59212302608D-6,4.11076933035D-8,3.29087403035D-11/
C-----------------------------------------------------------------------
       DATA LCK,LWRK/28,160/
C-----------------------------------------------------------------------
       DATA NN/22/
       DATA (EA(I),I=1,24)/1.00D3,1.50D3,2.00D3,3.00D3,5.00D3,7.00D3,
     &                     1.00D4,1.50D4,2.00D4,3.00D4,4.00D4,5.00D4,
     &                     6.00D4,7.00D4,8.00D4,1.00D5,1.50D5,2.00D5,
     &                     3.00D5,5.00D5,7.00D5,1.00D6,0.00D0,0.00D0/
       DATA IORD,EM1,ALFA /1,2.0D0,1.0D0/
C-----------------------------------------------------------------------
```

SIGIA

```
      SUBROUTINE SIGIA ( LSETX    , LPASS    ,
     &                   ALPH     , ETH      , ILTYP    , IOPT     ,
     &                   NENIN    , ENIN     , SGIN     ,
     &                   LTHETA   , VREL     , XSEC
     &                 )
       IMPLICIT NONE
C-----------------------------------------------------------------------
C
C  ********************** FORTRAN77 SUBROUTINE: SIGIA *****************
C
C  VERSION: 1.0 (ADAS91)
C
C  PURPOSE:  INTERPOLATES CROSS-SECTION DATA FROM AN INPUT VECTOR OF
C            VALUES USING CUBIC SPLINES.  EXTRAPOLATES FOR RELATIVE
C            SPEEDS OUT OF DATA RANGE ACCORDING TO VARIOUS TYPES
C            (ILTYP).  LOGARITHMIC INTERPOLATION MAY BE USED (LPASS).
C            SPEED ECONOMY IS POSSIBLE FOR REPEATS WITH THE SAME
C            SPLINE KNOTS (LSETX).
C
C  CALLING PROGRAM:  CXTHER
C
C  NOTES:
C        (1) FOR  ILTYP.EQ.0, EXTRAPOLATION IS AS FOLLOWS:
C
C
C  SUBROUTINE:
C
C  INPUT : (L*4)   LSETX    = .TRUE. => SPLINE NOT SET FOR THESE KNOTS
C                             .FLSE. => SPLINE NOT FOR THESE KNOTS
C  INPUT : (L*4)   LPASS    = .TRUE. => DO NOT CONVERT INTO LOG10 FOR
C                                       ENERGIES AND X-SECTS. FOR SPLINE
C                             .FLSE. => CONVERT INTO LOG10 FOR
C                                       ENERGIES AND X-SECTS. FOR SPLINE
C  INPUT : (R*8)   ALPH     = HIGH ENERGY EXTRAPOLATION PARAMETER
C  INPUT : (R*8)   ETH      = THRESHOLD ENERGY (RYD.)
C  INPUT : (I*4)   ILTYP    = TYPE FOR LOW AND HIGH ENERGY CROSS-
C                             -SECTION EXTRAPOLATION.
```

```
C  INPUT : (I*4)   IOPT     = SPLINE END POINT CURVATURE/GRADIENT OPTION
C                              1 => DDY1 = 0, DDYN = 0
C                              4 => DY1 = 0 , DDYN = 0
C
C  INPUT : (I*4)   NENIN    = NUMBER OF ENERGIES IN INPUT DATA SET
C  INPUT : (R*8)   ENIN()   = ENERGIES (EV/AMU) IN INPUT DATA SET
C  INPUT : (R*8)   SGIN()   = INPUT X-SECTIONS (CM2) FROM INPUT DATA SET
C                              1ST.DIM: ENERGY INDEX
C  INPUT : (I*4)   LTHETA   = NUMBER OF VALUES IN VREL VECTOR
C  INPUT : (R*8)   VREL()   = RELATIVE SPEEDS FOR OUTPUT (CM S-1)
C
C  OUTPUT: (R*8)   XSEC()   = OUTPUT CROSS-SECTION (CM2)
C
C          (I*4)   MAXENS   = PARAMETER = MAX. LENGTH OF TABULAR XSECT.
C                                         VECTOR
C          (I*4)   LDTHET   = PARAMETER = MAX. LENGTH OF INTERNAL
C                                         VECTORS
C          (R*8)   CMSAMU   = PARAMETER = CONVERSION FACTOR FOR ENERGY
C                                         (AMU) TO VELOCITY (CM S-1)
C
C          (I*4)   I        = GENERAL INDEX
C          (I*4)   N        = GENERAL INDEX
C          (R*8)   ALPH0    = LOW VELOCITY EXTRAPOLATION PARAMETER
C          (R*8)   EXPON    = EXPONENT OF EXPONENTIAL
C          (R*8)   VSLOPE   = HIGH VELOCITY EXTRAPOLATION PARAMETER
C          (R*8)   XIN()    = INTERNAL SPLINE INDEPENDENT VARIABLE
C          (R*8)   YIN()    = INTERNAL SPLINE DEPENDENT VARIABLE
C          (R*8)   VIN()    = INTERNAL VECTOR
C          (R*8)   DY()     = DERIVATIVES AT SPLINE KNOTS
C          (R*8)   XOUT()   = INTERNAL OUTPUT INDEPENDENT VARIABLE
C          (R*8)   YOUT()   = INTERNAL OUTPUT DEPENDENT VARIABLE
C          (L*4)   LINTRP() = .TRUE.  => POINT INTERPOLATED
C                           = .FALSE. => POINT EXTRAPOLATED
C
C
C  ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          XXSPLE     ADAS      INTERPOLATES USING CUBIC SPLINES
C          R8FUN1     ADAS      EXTERNAL FUNCTION FOR XXSPLE
C
C
C  AUTHOR:  H. P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C           JA8.08
C           TEL. 0141-553-4196
C
C  DATE:    18/11/96
C
C VERSION: 1.1                          DATE: 18-11-96
C MODIFIED: HUGH P. SUMMERS, UNIVERSITY OF STRATHCLYDE
C            - FIRST EDITION
C
C
C-----------------------------------------------------------------------
      INTEGER  MAXENS   , LDTHET
C-----------------------------------------------------------------------
      REAL*8   CMSAMU   , ZERO
C-----------------------------------------------------------------------
      PARAMETER ( MAXENS = 50 , LDTHET = 181 )
      PARAMETER ( CMSAMU = 1.389209D+06      , ZERO = 1.0D-30     )
C-----------------------------------------------------------------------
      INTEGER  I      , N      , NENIN
      INTEGER  IOPT   , LTHETA , ILTYP  , I4UNIT
C-----------------------------------------------------------------------
      REAL*8   ALPH0  , VSLOPE , EXPON
      REAL*8   R8FUN1 , ALPH   , ETH
C-----------------------------------------------------------------------
      LOGICAL  LSETX  , LPASS
C-----------------------------------------------------------------------
      REAL*8   VREL(LTHETA)    , XSEC(LTHETA)
      REAL*8   XOUT(LDTHET)    , YOUT(LDTHET)
      REAL*8   ENIN(NENIN)     , SGIN(NENIN)     , DY(MAXENS)
      REAL*8   XIN(MAXENS)     , YIN(MAXENS)     , VIN(MAXENS)
C-----------------------------------------------------------------------
      LOGICAL  LINTRP(LDTHET)
C-----------------------------------------------------------------------
      EXTERNAL R8FUN1
C-----------------------------------------------------------------------
```

V2BNMOD

```
        SUBROUTINE V2BNMOD(IPOSNT , JDENS  , JTE    , NREP   , F1     ,
     &                     F2     , F3     , BNCALC , BNACT  , XPOP   ,
     &                     IMAX   , DENSH  , DENS   , DENSP  , TE     ,
     &                     TP     , BMENER , FLUX   , DEXPTE , ALFA   ,
     &                     S      , DSLPATH, NIMP   , ZIMPA  , ZEFF   ,
     &                     DNIMPA)
C
        IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 SUBROUTINE: V2BNMOD ********************
```

```
C
C  VERSION:  (ADAS91) - SEE SC CS COMMENTS FOR VERSION NO.
C
C  PURPOSE:  THIS CODE PERFORMS THE ACTUAL CALCULATIONS FOR ADAS 310
C            IT IS IN AN INCOMPLETE VERSION AND THESE COMMENTS DO NOT
C            YET FOLLOW THE STANDARD ADAS PATTERN.
C-----------------------------------------------------------------------
C      CALCULATION OF BN -1 CASE A,B
C
C      EXCIT. XSECT. OPTIONS:
C      ----------------------
C                     (A) VAN REGEMORTER    - ELECTRONS
C                     (B) IMPACT PARAMETER  - ELECTRONS
C                                             PROTONS
C                     (C) PERCIVAL-RICHARDS - ELECTRONS
C                                           - PROTONS & ZIMP IONS
C                     (D) VAINSHTEIN        - PROTONS & ZIMP IONS
C                     (E) SPECIAL LOW LEVEL - ELECTRONS
C                                           - PROTONS & ZIMP IONS
C      IONIS. XSECT. OPTIONS:
C      ----------------------
C                     (A) ECIP              - ELECTRONS
C                     (B) PERCIVAL-RICHARDS - PROTONS & ZIMP IONS
C                     (C) SPECIAL LOW LEVEL - ELECTRONS
C                                           - PROTONS & ZIMP IONS
C      CX RECOM. XSECT. OPTIONS:
C      -------------------------
C                     (A) SPECIAL           - H(1S) DONOR
C
C
C  NOTES
C  -----
C      (A) SPECIAL LOW LEVEL DATA ACCESSED BY SPECIFIC ION ROUTINE
C
C          ION   ROUTINE    ACCESSED FILE              ACQUIS. ROUTINE
C          ---   -------    -------------              ---------------
C           H0    NSUPH1    IONATOM.DATA(H)                 QH
C                           HLIKE.DATA(AGG1984)              -
C
C
C      (B) SPECIAL CHARGE EXCHANGE DATA FROM  CHEXDATA.DATA
C
C          ION    DONOR     ROUTINE    DATA MEMBER     ACQUIS. ROUTINE
C          ---    -----     -------    -----------     ---------------
C           H0    H(1S)     BNQCTB       H1NEW1            BNQCTB
C
C
C
C
C  INPUT
C      IPOSNT   = 0  BYPASS
C               = 1  LEAVE W1.NE.0 AND FORCE DENSH.EQ.0
C               = 2  FORCE W1.EQ.0 AND FORCE DENSH.EQ.0
C               = 3  LEAVE W1.NE.0 AND LEAVE DENSH.NE.0
C               = 4  FORCE W1.EQ.0 AND LEAVE DENSH.NE.0
C               = 5  BYPASS
C      JDENS    = DENSITY     SELECTOR
C      JTE      = TEMPERATURE SELECTOR
C      NREP(I)  = PRINCIPAL QUANTUM NUMBER OF ITH REPRESENTATIVE LEVEL
C      XPOP(I)  = POPULATIONS OF REPRESENTATIVE LEVELS
C      IMAX     = NUMBER OF REPRESENTATIVE LEVELS
C      DENSH    = NEUTRAL HYDROGEN DENSITY IN BEAM  (CM-3)
C      DENS     = ELECTRON DENSITY  (CM-3)
C      DENSP    = PROTON/DEUTERON DENSITY  (CM-3)
C      TE       = ELECTRON TEMPERATURE (K)
C      TP       = PROTON/DEUTERON TEMPERATURE (K)   (SAME FOR ZIMP IONS)
C      BMENER   = NEUTRAL BEAM PARTICLE ENERGY  (EV/AMU)
C      FLUX     = NEUTRAL BEAM FLUX  (CM-2 SEC-1)
C      DEXPTE(I)= EXP(ATE/NREP(I)**2) FOR ITHE REPRESENTATIVE LEVEL
C      DSLPATH  = STRING CONTAINING PATH TO THE REQUIRED INPUT FILES
C                 CALLED BY NSUPH1.FOR
C
C  OUTPUT
C      F1       =
C      F2       =
C      F3       =
C      BNCALC   =
C      BNACT    =
C      ALPHA    =
C      S        =
C
C  INPUT SPECIFICATION FOR STREAM 51 DATA FILE
C
C      NUCCHG = NUCLEAR CHARGE
C      EXMEMB = DATA SET NAME OF EXPANSION FILE USED BY CLDLBN2
C      CXMEMB = DATA SET NAME FOR CHARGE EXCHANGE DATA TO BE USED BY
C               BNQCTB
C      IBLOCK = SUB-BLOCK SELECTOR FOR CXMEMB
C
C      JDENSM = NUMBER OF DENSITIES
C      JTEM   = NUMBER OF TEMPERATURES
C      TS     = EXTERNAL RADIATION FIELD TEMPERATURE (K)
C      W      = EXTERNAL RADIATION FIELD DILUTION FACTOR (HIGH LEVELS)
C      Z      = RECOMBINING ION CHARGE  (Z1 IN USUAL NOTATION)
C      CION   = MULTIPLIER OF GROUND LEVEL ELECTRON IMPACT IONISATION
C               RATE COEFFICIENT
C      CPY    = MULTIPIER ON ELECTRON IMPACT EXCITATION RATE COEFFICIENT
C               FORM THE GROUND LEVEL
```

```
C      W1     = EXTERNAL RADIATION FIELD DILUTION FACTOR FOR PHOTO-IONI
C               SATION FORM THE GROUND LEVEL.
C
C      NIP    = RANGE OF DELTA N FOR IMPACT PARAMETER XSECTS. (LE.4)
C      INTD   = ORDER OF MAXWELL QUADRATURE FOR XSECTS. (LE.3)
C      IPRS   = 0   DEFAULT TO VAN REGEMORTER XSECTS. BEYOND NIP RANGE
C               1   USE PERCIVAL-RICHARDS XSECTS.     BEYOND NIP RANGE
C      ILOW   = 0   NO SPECIAL LOW LEVEL DATA ACCESSED
C               1      SPECIAL LOW LEVEL DATA ACCESSED
C      IONIP  = 0   NO ION IMPACT COLLISIONS INCLUDED
C               1      ION IMPACT EXCITATION AND IONISATION INCLUDED
C      NIONIP = RANGE OF DELTA N FOR ION IMPACT EXCITATION XSECTS.
C      ILPRS  = 0   DEFAULT TO VAINSHTEIN XSECTS.
C               1   USE LODGE-PERCIVAL-RICHARDS XSECTS.
C      IVDISP = 0   ION IMPACT AT THERMAL MAXWELLIAN ENERGIES
C               1   ION IMPACT AT DISPLACED THERMAL ENERGIES ACCORDING
C                   TO THE NEUTRAL BEAM ENERGY PARAMETER
C                   *   IF(IVDISP=0 THEN SPECIAL LOW LEVEL DATA FOR ION
C                       IMPACT IS NOT SUBSTITUTED - ONLY VAINSHTEIN AND
C                       LODGE ET AL. OPTIONS ARE OPEN.  ELECTRON IMPACT
C                       DATA SUBSTITUTION DOES OCCUR.
C      1   = PLASMA Z EFFECTIVE
C      NOSCAN = 0   EXECUTE SCANNING VERSION OF CODE
C               1   EXECUTE SIMULTANEOUS IMPURITY NO SCAN RUN
C      NIMP   = NUMBER OF IMPURITIES (EXCL.H+) IN NO SCAN CASE
C  ROUTINES:
C          ROUTINE    SOURCE    BRIEF DESCRIPTION
C          ------------------------------------------------------------
C          MATINV     ADAS      MATRIX INVERSION WITH ACCOMPANYING
C                               SOLUTION OF LINEAR EQUATIONS
C          DIEL       ????
C
C
C
C  ********* H.P.SUMMERS, JET              11 APR 1990  ***************
C  *********                          ALT. 17 JUL 1991  SUB. RQINEW,
C                                                       RQLNEW, RQVNEW
C  *********                          ALT. 10 JAN 1994  ALLOW MULTIPLE
C                                                       SIMULT.IMPURITY
C-----------------------------------------------------------------------
C
C-----------------------------------------------------------------------
C
C UPDATE:  19/01/94 - JONATHAN NASH - TESSELLA SUPPORT SERVICES PLC
C
C          THE FOLLOWING MODIFICATIONS HAVE BEEN MADE TO THE SUBROUTINE:
C
C          1) THE INPUT FILE UNIT NUMBER HAS BEEN CHANGED FROM 5 TO 51.
C
C          2) THE SIZES OF 'EXMEMB' AND 'CXMEMB' HAVE BEEN INCREASED
C             AS THEY NOW CONTAIN THE FULL DATA SET NAMES RATHER THAN
C             JUST THE MEMBER NAMES.
C
C          3) A PARAMETER FLAG HAS BEEN ADDED TO SWITCH ON/OFF
C             DIAGNOSTIC PRINTING (UNIT 6).
C
C  NOTES:  NO ATTEMPT HAS BEEN MADE TO RESTRUCTURE THE ROUTINE. RATHER
C          THE MINIMUM AMOUNT OF WORK TO INTEGRATE THE ROUTINE INTO
C          ADAS310 HAS BEEN COMPLETED.
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 12-12-95
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C               - REPLACED ALL HOLLERITH CONSTANTS H0 ANF H1 WITH
C                 H<SPACE>
C               - REPLACED HOLLERITH CONSTANTS WITH STANDARD STRINGS
C                 IN FORMAT STATEMENTS 117, 128 AND 129.
C               - TIDIED UP PARTS OF THE COMMENTS AND CODE
C               - ADDED STRING DSLPATH TO BE USED TO CONSTRUCT UNIX
C                 STYLE FILENAMES IN NSUPH1.FOR
C
C VERSION: 1.2                          DATE: 24-01-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - ADDED NBENG TO INPUT LIST AND CALL TO BNQCTB
C
C VERSION: 1.3                          DATE: 24-01-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - REVERSED ABOVE CHANGE
C
C VERSION: 1.4                          DATE: 27-09-96
C MODIFIED: WILLIAM OSBORN + HUGH SUMMERS
C               - REMOVED MISTAKEN TEST FOR 1.LE.0.0D0 IN
C                 THE CASE OF MULTIPLE IMPURITIES.
C VERSION: 1.5
C MODIFIED: HARVEY ANDERSON
C                - IMPROVED THE HANDLING OF MULTIPLE IMPURITIES TO
C                  INCLUDE HYDROGEN.
C                - ALTERED THE CALLING STRUCTURE OF THIS ROUTINE TO
C                  ALLOW ADDITIONAL VARIABLES TO BE PASSED TO RUN310.
C                - INCREASED THE SIZE OF THE ARRAYS DENSA, DENPA, TEA
C                  AND TPA FROM 10 TO 25.
C
C-----------------------------------------------------------------------
       PARAMETER (NDLOW=10)
       CHARACTER ELSYMB*2,SYMBA*2,EXMEMB*80,CXMEMB*80
       CHARACTER DSLPATH*80
```

```
      DIMENSION EN2(550),EN3(550),DEXPTE(550),DEXPTS(550),OGARL(1100)
      DIMENSION A(550),ARED(30,30),AGRL(550,3),NREP(31),INTER(550)
      DIMENSION RHS(30),BREP(30),DEXPBN(30),EN23(550),FLAG(550)
      DIMENSION COR(20),EPSIL(10),FIJ(10),POP(30),DEFECT(10)
      DIMENSION DENSA(25),TEA(25),DENPA(25),TPA(25)
      DIMENSION WIJ(10),EEIJ(10),WEIJ(10)
      DIMENSION PYMAT(550,4,2),DELCN(30),WBREP(30),WB(550),WBLOG(30)
      DIMENSION BNCALC(30),BNACT(30),F1(30),F2(30),F3(30),XPOP(2)
      DIMENSION SYMBA(30),QTHREP(31)
      DIMENSION BMENA(6),BMFRA(6)
      DIMENSION DVEC(30),CIONPT(30),DRECPT(30),RRECPT(30),XRECPT(30)
      DIMENSION IMPA(10),ZIMPA(10),AMIMPA(10),FRIMPA(10),DNIMPA(10)
C
      DIMENSION XTBE(NDLOW,NDLOW),LXTBE(NDLOW,NDLOW)
      DIMENSION XTBP(NDLOW,NDLOW),LXTBP(NDLOW,NDLOW)
      DIMENSION XTBZ(NDLOW,NDLOW),LXTBZ(NDLOW,NDLOW)
      DIMENSION PXTBE(NDLOW),LPXTBE(NDLOW)
      DIMENSION PXTBP(NDLOW),LPXTBP(NDLOW)
      DIMENSION PXTBZ(NDLOW),LPXTBZ(NDLOW)
      DIMENSION STBE(NDLOW),LSTBE(NDLOW)
      DIMENSION STBP(NDLOW),LSTBP(NDLOW)
      DIMENSION STBZ(NDLOW),LSTBZ(NDLOW)
      LOGICAL   DEBUG
C
      DATA SYMBA/'H ','HE','LI','BE','B ','C ','N ','O ','F ','NE',
     &           'NA','MG','AL','SI','P ','S ','CL','AR','K ','CA',
     &           'SC','TI','V ','CR','MN','FE','CO','NI','CU','ZN'/
      NAMELIST /FILINFO/NUCCHG,EXMEMB,CXMEMB,IBLOCK
```

XIP

```
      FUNCTION XIP(XI,DELTA)
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 FUNCTION: XIP *************************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```

YIP

```
      FUNCTION YIP(XI,DELTA)
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
C
C  ***************** FORTRAN77 FUNCTION: YIP *************************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
C
      DIMENSION A(20),B(20)
```

ZERO1

```
      SUBROUTINE ZERO1(A,B,VA,VB,D1,X,XI,Z,E,TIF,T2)
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
C-----------------------------------------------------------------------
```

```
C
C  ****************** FORTRAN77 SUBROUTINE: ZERO1 *********************
C
C PURPOSE UNKNOWN
C
C NOTES: THIS ROUTINE IS NOT YET PROPERLY ANNOTATED
C
C UNIX-IDL PORT:
C
C VERSION: 1.1                          DATE: 16-1-96
C MODIFIED: TIM HAMMOND (TESSELLA SUPPORT SERVICES PLC)
C               - FIRST VERSION
C
C-----------------------------------------------------------------------
```