# An Improvement of the MIDAS Computer Code for a Point-Kinetics Model

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## 1. Introduction

KAERI has developed a localized severe accident code, MIDAS, based on MELCOR. MELCOR has difficulties in understanding all the variables due to pointer variables for a fixed-size storage management. This deteriorates a model improvement of a code. To improve these difficulties, it is necessary to restructure the storage management.

As the most important process for a localized severe accident analysis code, it needs a convenient method for a data handling[1]. So, it has used the new features in FORTRAN90 such as a dynamic allocation for the restructuring. The restructuring of the data saving and transferring method makes it easy to understand the code. As a first step, a restructuring for the entire code was undertaken and tested. And then a model improvement was processed.

In this paper, the development of MIDAS 1.1 as a windows version, which simulates a point-kinetics model, is included. The verification process was done through comparing the results before and after a model improvement.

## 2. Integration and Model Improvement

### 2.1 Integration of Restructured Package

The base code MELCOR reserves and uses four data types for an effective data storage and transfer. In these data storage, pointer variables are applied differently according to the packages, and they identify a specific location within the database[1]. Based on these contents, a module is constructed for each package.

In advance of the entire integration of each package, a restructuring of each package was done[2]. After a reorganization of each package, the whole restructuring in all packages are integrated[3]. Among each package, the data was shared in the other packages. So, the variables for the shared data can be replaced with direct variables by using a module.

In the integrating step, about 1200 subroutines restructured within 24 packages were integrated. All the packages were integrated, and the execution file named MIDAS 1.0 was completed.

### 2.2 Model Improvement for a Point-Kinetics Model

In the existing base code MELCOR , fission power (not decay heat) is basically treated as a users' input, which isn't concerned with the point-kinetics model. The simple Chexal-Layman model (not point-kinetics model) to simulate the ATWS accident model in a BWR condition is included. But the simple Chexal-Layman model was developed under the BWR condition, so it is not appropriate to apply to a PWR. The existing base code MELCOR cannot analyze the ATWS accident under a PWR condition, so we need to develop and add-on a point-kinetics model. The added point-kinetics model uses the thermal-hydraulic variables related a core which were calculated already such as the temperature, pressure, water level, and easily estimate the reactivity feedback effect.

The point-kinetics model is an independent module, which has been inserted into MIDAS 1.0 and verified. And the MIDAS 1.1 which includes a point-kinetics model for a PWR is developed via coupling the point-kinetics module with MIDAS 1.0. A comparison before and after the coupling is shown in figure 1 and 2. ATWS(Anticipated Transients Without Scram) initiated by a TLOF (Total Loss of Feedwater) transient is analyzed also using the verified MIDAS 1.1 code.

Major concern in the ATWS analysis is the primary peak pressure during the first few minutes into the accident and the MIDAS 1.1 code simulates this peak pressure quite well. Especially, this code is valuable for analyzing the ATWS performance and effects deterministically in early domestic Westinghouse plants which rely on an operator procedure instead of an AMSAC (ATWS Mitigating System Actuation Circuitry) adoption. This is also expected to be important from the point of view of an accident management and mitigation.

## 3. Result and Verification

The calculation for a fission power was modified to use the newly inserted model. MIDAS 1.1 was verified by comparing it with the RETRAN code results for a TLOF ATWS[4]. In figure 3 and 4, the results are shown for a comparison before and after a point-kinetics module addition. In the existing code, it was ended after 201 seconds when an ATWS accident had occurred. But in MIDAS 1.1, it was continued through simulating the point-kinetics model normally.

In another case, demo data is revealed in another results compared with MIDAS 1.0, which is related material properties. It is assumed to be related input deck, and is needed to be studied in future research.

## 4. Conclusions

To develop the MIDAS 1.1, MIDAS1.0 (based on MELCOR) was analyzed and a point-kinetics module was coupled into it. In this procedure, restructured variables were used instead of pointer variables.

Through a model improvement for its point-kinetics, a base was constructed for a localized code. Therefore, the appropriateness of a model improvement was verified. It is expected that MIDAS 1.1 will accelerate a code's domestication thanks to a direct understanding of each variable and an easy implementation of modified or newly developed models. In future research, it is also necessary to test MIDAS 1.1 with various input.

## REFERENCES

[1] D.H.Kim, S.H.Park, Analysis of MELCOR Code Structure, KAERI/TR-1543/00, June, 2000.

[2] S.H.Park, D.H.Kim, S.W.Cho, A Restructuring of the CAV and FDI Package for the MIDAS Computer Code, Proceedings of the Korean Nuclear Society, May Meeting 2006.

[3] S.H.Park, D.H.Kim, Y.M.Song, S.W.Cho, The MIDAS Computer Code through an Integration of the Restructured MELCOR, Proceedings of the Korean Nuclear Society, May Meeting 2007.

[4] Y.M.Song, et al., A Coupling of Kinetics Model with MELCOR Code and ATWS Analysis, KAERI/TR-1273/99, 1999.

```
!
    POWINS = ZERO
!
!
!
!
!
!
!
!
!
!
!
!
    IF (ICFFIS.GT.0) THEN
!
!     ICFFIS SPECIFIES CONTROL FUNCTION THAT GIVES LIQUID LEVEL TO BE
!     USED IN CHEXAL-LAYMAN CORRELATION
!     FOR NOW, SET TOP OF ACTIVE FUEL ELEVATION TO TOP OF CORE
      ZTAF = Z (NAXL) + DZ (NAXL)
      ZREF = ONE
      ZLL = CFRVAL (ICFFIS, JERROR) - ZTAF
      Z0 = C1301 (4) * (PVSL / C1301 (6) ) **C1301 (5)
      HCL = MAX ( (ZLL + Z0), ZERO)
      IF (HCL.GT.10.) CALL MEXSTP (CHMESA, NCHMSA)
      QFISTO = OPRPOW * C1301 (1) * (ZREF * CUNIT1) **C1301 (3)      &
      * (PVSL / C1301 (6) ) **C1301 (2) * (HCL / ZREF) **C1301 (3)
      IF (JERROR.NE.0) CALL MEXSTP (CHMESA, NCHMSA)
    ELSE
!     ICFFIS SPECIFIES CONTROL FUNCTION THAT GIVES TOTAL FISSION POWER
      QFISTO = CFRVAL ( - ICFFIS, JERROR)
      IF (JERROR.NE.0) CALL MEXSTP (CHMESA, NCHMSA)
    ENDIF
!
!   NOW HAVE TOTAL FISSION POWER.  NORMALIZE POWER DISTRIBUTION.
    FISSUM = ZERO
```

Figure 1. Subroutine CORPOW before improvement

```
!
    POWINS = ZERO
!============================================ Inserted for KINETICS
!-------------- Call PKINETIC for calculation of kinetic module
!             ITS OUTPUT IS POWER NAMED QFISTO
!          If check value was initialzed, calculate PKINETIC method
!          If not, calculate original method
    IF (ICORRN1 .EQ.0 .OR. ICVHRN3 .EQ. 0 .OR. ICVTHRM .EQ. 0) GOTO 37
       CALL PKINETIC (QFISTO)
    GOTO 38
!============================================ End of insertion
!-       Below part is done when ITCOUNT = 0
!
!    IF (ICFFIS.GT.0) THEN
37   IF (ICFFIS.GT.0) THEN
!
!     ICFFIS SPECIFIES CONTROL FUNCTION THAT GIVES LIQUID LEVEL TO BE
!     USED IN CHEXAL-LAYMAN CORRELATION
!     FOR NOW, SET TOP OF ACTIVE FUEL ELEVATION TO TOP OF CORE
      ZTAF = Z (NAXL) + DZ (NAXL)
      ZREF = ONE
      ZLL = CFRVAL (ICFFIS, JERROR) - ZTAF
      Z0 = C1301 (4) * (PVSL / C1301 (6) ) **C1301 (5)
      HCL = MAX ( (ZLL + Z0), ZERO)
      IF (HCL.GT.10.) CALL MEXSTP (CHMESA, NCHMSA)
      QFISTO = OPRPOW * C1301 (1) * (ZREF * CUNIT1) **C1301 (3) *      &
        (PVSL / C1301 (6) ) **C1301 (2) * (HCL / ZREF) **C1301 (3)
      IF (JERROR.NE.0) CALL MEXSTP (CHMESA, NCHMSA)
    ELSE
!     ICFFIS SPECIFIES CONTROL FUNCTION THAT GIVES TOTAL FISSION POWER
      QFISTO = CFRVAL ( - ICFFIS, JERROR)
      IF (JERROR.NE.0) CALL MEXSTP (CHMESA, NCHMSA)
    ENDIF
!
!!  NOW HAVE TOTAL FISSION POWER.  NORMALIZE POWER DISTRIBUTION.
!   FISSUM = ZERO
38  FISSUM = ZERO
```

Figure 2. Subroutine CORPOW after improvement

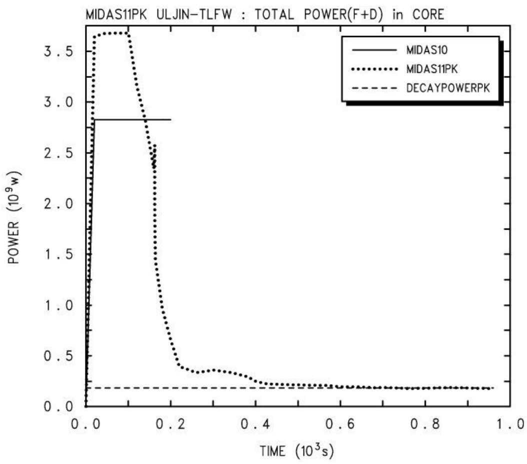


Figure 3. Total power in core

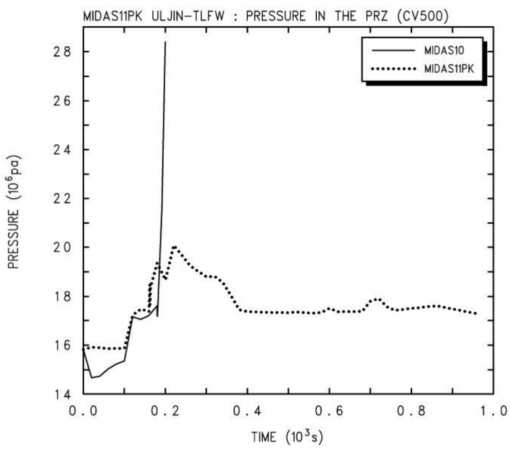


Figure 4. Pressure in pressurizer