Development of NAME_LSC code for DBA Accident Effects Evaluation
(NAME_LSC: Nuclear-reactor Accident's Modeling and effects Evaluation by LEE, Seung-Chan)

Seung-Chan LEE*

Korea Hydro Nuclear Power Electricity Co., KHNP Central Research Institute, Yuseong-daero 1312, Yuseong, Daejeon 34101 Korea.

**Corresponding author: eitotheflash@khnp.co.kr*

1. Introduction

NAME_LSC code has been developed for the evaluation of "radiation dose and accident effects" in all parts of DBA (Design Basic Accidents).
This code's study has been carried out from 2018.
The preliminary study is carried out in KHNP-CRI as code version of NAME-LSC 1.0.
The purpose of NAME-LSC code is to simulate and to evaluate DBA effects analysis with same performance and additional functions against the RADTRAD as well-known program in the scope of the dose and safety in FSAR chapter 15 since 1989 after NRC approval [1].
NAME-LSC code can be implemented in the scope of free-modeling, nuclide library generation, fission products release timing library and application of input of atmospheric dispersion factors.
In first process, GUI module is made. In second process, the calculation module is dll by PASCAL compiler.
In this study, the early version and the function test results are introduced.
In this paper, the developed program package NAME-LSC is tested and compared with RADTRAD using US NRC's standard problems " Test Case 1", "Test Case2" and "Test Case3".

2. Methodology

2.1. Source Code and Compiling

In order to make NAME-LSC code, FORTRAN77 and Object PASCAL Compilers are used [3, 4].
In NAME-LSC code module, 55 files are made to create the visual program by PASCAL language (RADStudio 10.3).
In main calculation body, the 25files and 21 objects are also made by PASCAL (Object PASCAL version 10.3).
In order to connect visual part and main program, FORTRAN files are used to compile as DLL modules.
Object PASCAL's files are used to compile GUI program.
This study's key elements of source code are in Table1.

Table 1. The developed source codes from this study (Object PASCAL)

Source Category	Main elements of PASCAL
File Handling	- FileHandles.pas - FileHandles.dcu
Interface Forms (general forms)	- frmAbout.pas, frmCompart.dfm, frmCompart.pas,frmCalcOptions.pas and so on. - Calculation forms : frmData.dfm, frmData.pas, frmDoseLocation.pas, and so on
Interface Forms (Calculation)	- frmProgress.pas, frmProgress.dfm, - frmPowerSpray.pas, frmPowerSpray.dfm, and so on.
Others Forms (about 30forms)	- frmSourceTerm.pas, frmSourceTerm.dfm, and so on
DLL Structure with PASCAL linking	- A-SeungChanLEE-dll.for - LSC-dll.for - PASCAL linking Dll:NAME-LSC-dll.pas
Other Resources (about 25 files)	- Compartment.for,Pathways-Filter.for, Aerosol.for And so on

2.2. NAME-LSC Code : Calculation Process

The calculation process of NAME-LSC is shown in Fig.1.
Fig.1 is the structure of NAME-LSC code. Main calculation function is worked by Library File Package. Library File Package is consist of libraries of Nuclides, Source Term release, non-Iodine behavior and Iodine behavior. Calculation function is worked by compartments and pathways modeling.

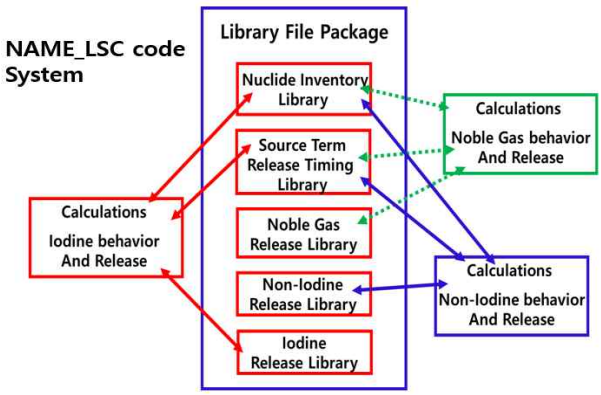

Fig. 1 Calculation Process of Design Basic Accidents in NAME-LSC code

2.3. Verification of NAME-LSC Code

US NRC made the standard problem case to verify and test RADTRAD3.03.

In this study, the verification of NAME-LSC is carried out by using the standard test problems Test Case 1, 2, 3 which are made by US NRC.

And the standard test problem case's common conditions are below as Table2.

Test Cases1, 2, 3 include same common conditions as like Table2. But compartments modeling and pathways modeling are some different.

In compartments, deposition modeling is different in each other.

In pathways, pipes are modeled by different decontaminant factors in each other.

Table 2. Test Case common condition: Test Cases1, 2, 3

Modeling Item	Inputs Information
Source Term	- TID-14844 pattern - Release start : 0.0hr - Iodine(element:0.91, organic:0.04, aerosol:0.05)
Plant Model	- Reactor Power 1932 MWth - Containment V:0.1730 ft3 - Leak-path: Containment to Environment - Containment leak rate : 0.18% per day
Dispersion Parameters	- EAB(X/Q) 0.0hr : 0.1000E-02 2.0hrs: 0.0000E+00 - LPZ(X/Q) 0.0hr : 0.1350E-03 8.0hrs: 0.1000E-03 24hrs : 0.5400E-04 96hrs : 0.2200E-04

3. RESULTS AND DISCUSSIONS

3.1. Compiling and Execute of NAME-LSC

In compiling process and executing NAME-LSC, the calculation module, the main body program and the visual programs are combined by Fortran and Object PASCAL (RADstudio 10.3).

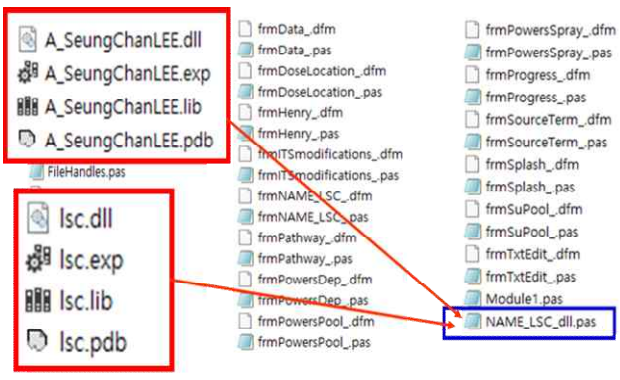

Fig.2 Development of NAME-LSC(Compiling in Object PASCAL).

Fig.3(a) Starting Main screen in NAME_LSC.

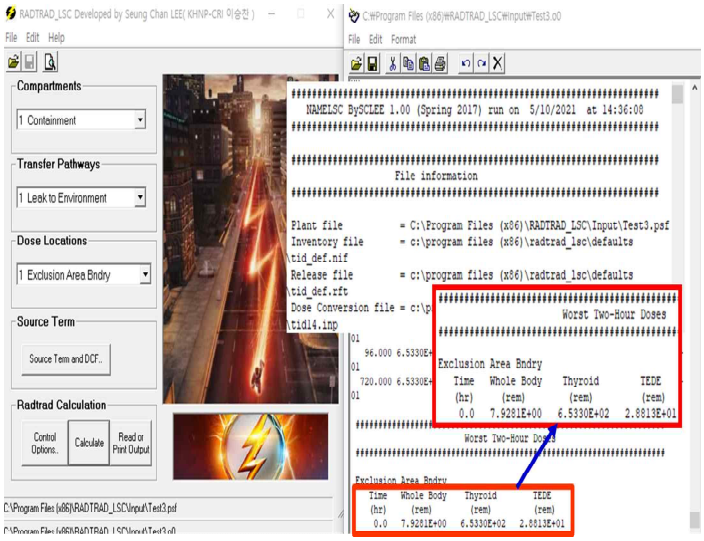

Fig.3(b) Work-starting screen in the exe file of NAME_LSC.

The GUI main program is and generated from the developed PASCAL files.
Fig. 2 shows the compiling process of PASCAL.
Fig. 3 shows the work-start of NAME-LSC in Windows 10 condition.

3.2. Performance Test of NAME-LSC

Using the Test Case1, 2, 3 of US NRC, NAME-LSC is verified. In order to verify NAME-LSC, the cross–checking is carried out by RADTRAD3.03 calculation results. The comparison results are shown in Table 3.

Table 3. Performance Test between NAME-LSC and RADTRAD 3.03 by US NRC standard problems

TestProblems	RADTRAD3.03	NAME-LSC
Test Case 1	Thyroid : 444 TEDE:13.60 WB : 0.079	Thyroid : 444 TEDE:13.601 WB : 0.079
Test Case 2	Thyroid : 653 TEDE:28.80 WB : 7.9279	Thyroid : 653.1 TEDE:28.81 WB : 7.9280
Test Case 3	Thyroid : 652 TEDE:28.70	Thyroid : 651.9 TEDE:28.71

From Table 3, US NRC's "Test Cases" are carried out by NAME-LSC.
In comparing with NRC's RADTRAD 3.03, the calculation results of NAME-LSC are perfectly matched within 0.011 percent error.
From these results, the NAME-LSC performance is verified and the results are in good agreement with RADTRAD 3.03 of US NRC.

3.3. Modeling Capacity of NAME-LSC

In performance test of NAME-LSC, the multi-modeling function is verified. 41 compartments, 50 pathways, 107isotopes library, 250 nuclides inventory library are used to calculate the some problems and simulations.
The results are shown in Fig. 4(a) and Fig. 4(b).
Fig. 4(a) shows the 41 compartments modeling in the left dot-line box and the 50 pathways modeling in the right dot-line box.

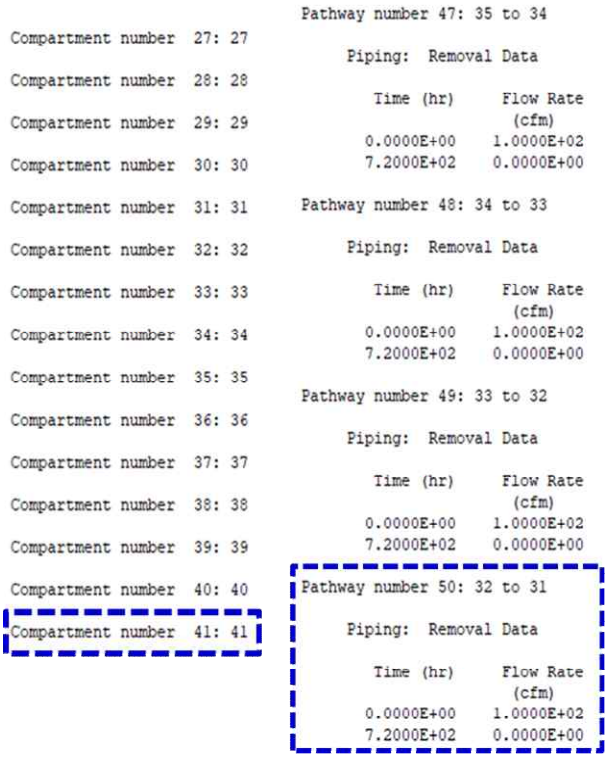

Fig. 4(a) The modeling performance for 41 compartment and 50 pathways in NAME_LSC code.

Fig. 4(b) shows the estimation results of the condition of Fig. 4(a) by NAME-LSC. In this conditions, NAME-LSC code is good working, but RADTRAD 3.03 is not working.
In Table 4, NAME-LSC working capacity is shown comparing with RADTRAD 3.03.
From this study, RADTRAD 3.03 is very efficient less than 25 Pathways modeling, but more detailed modeling is not working.
Otherwise, NAME-LSC code is in good agreement with RADTRAD 3.03 in verification test, and also NAME-LSC code is good working in the condition more than 25 Pathways modeling and the detailed modeling more than RADTRAD 3.03.

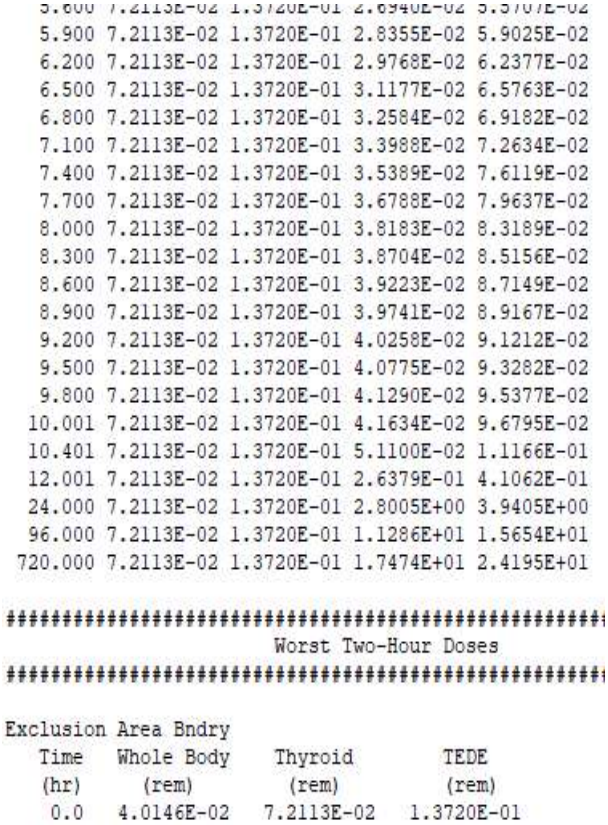

Fig.4(b) The calculation results from 41 compartment and 50 pathways in NAME_LSC code.

Table 4. Modeling Capacity between NAME-LSC and RADTRAD 3.03

Modeling Conditions	RADTRAD3.03	NAME-LSC
41 Compartments	Error and not working	Non-Error and good working
50 Pathways	Error and not working	Non-Error and good working
250 DCF library	Error and not working	Non-Error and good working
250isotopes	Error and not working	Non-Error and good working
Modeling component capacity	Less than 25 Pathways	More than 500 Pathways

4. CONCLUSIONS

In this study, the NAME-LSC code for DBA effects analysis is developed.
The performance of NAME-LSC code is in good agreement with NRC's RADTRAD code in the standard test problems Test Case 1, 2, 3.
The developed NAME-LSC code is equivalent to RADTRAD 3.03.
The NAME-LSC performance test results are perfectly matched within 0.011% error.

In the case of modeling capacity test, in the condition more than 25 Pathways modeling, RADTRAD code is not working, but NAME-LSC code is good working.
The modeling capacity of NAME-LSC code is more than 500compartments, 700pathways, 300 isotopes inventory and 500 isotopes DCF library and so on.
NAME-LSC code is very useful in DBA effects analysis in the same condition of RADTRAD 3.03 in verification test. And also NAME-LSC code is more helpful in the detailed calculation more than 25 Pathways modeling.

REFERENCES

[1] KHNP-CRI, Seung-Chan LEE, “The review document for RADTRAD intrinsic characteristics”, May(2018).
[2]http://docs.embarcadero.com/products/rad_studio/cbuilder6/EN/CB6_ObjPascalLangGuide_EN.pdf, “Object Pascal Language Guide”, (2002).
[3] Intel Fortran Compiler User manual
[4] RADStudio Rio 10.3 User manual