# Development of NAME\_LSC code for DBA Accident Effects Evaluation (NAME\_LSC: <u>N</u>uclear-reactor <u>A</u>ccident's <u>M</u>odeling and effects <u>E</u>valuation by <u>L</u>EE, <u>S</u>eung-<u>C</u>han)

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## 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)

(Object I ASCAL)		
Source	Main elements of PASCAL	
Category		
File Handling	- FileHandles.pas	
	- FileHandles.dcu	
Interface Forms	- Basic forms : frmAbout.dfm	

(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	-	frmProgress.pas, frmProgress.dfm,	
(Calculation)	-	frmPowerSpray.pas,	
		frmPowerSpray.dfm, and so on.	
Others Forms	-	frmSourceTerm.pas,	
(about 30forms)		frmSourceTerm.dfm, and so on	
DLL Structure	-	A-SeungChanLEE-dll.for	
with PASCAL	-	LSC-dll.for	
linking	-	PASCAL linking Dll:NAME-LSC-	
		dll.pas	
Other	-	Compartment.for,Pathways-	
Resources		Filter.for, Aerosol.for And so on	
(about 25 files)			

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	<ul> <li>Reactor Power 1932 MWth</li> </ul>		
	- Containment V:0.1730 ft3		
	- Leak-path: Containment to		
	Environment		
	- Containment leak rate : 0.18% per		
	day		
Dispersion	- EAB(X/Q)		
Parameters	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.

😏 RADTRAD_LSC Developed by Seung Chan LEE( KHNP-CRI 이승찬 )	) - 🗆 X	C:#Program Files (x86)#RADTRAD_LSC#input#Test3.00
File Edit Help		File Edit Format
<b>≥ B</b>		
Compartments		
1 Containment	NAMELSC	BySCLEE 1.00 (Spring 2017) run on 5/10/2021 at 14:36:00
Transfer Pathways		File information
1 Leak to Environment	<b>M</b>	
-Dose Locations	Plant file Inventory tid def.ni	: = C:\Program Files (x86)\RADIRAD_LSC\Input\Test3.psf file = c:\program files (x86)\radtrad_lsc\defaults f
1 Exclusion Area Bndry	Release fi tid_def.rf	le = c:\program files (x86)\radtrad_lsc\defaults
Source Term	Dose Conve tidl4.inp	rsion file = c:\p Worst Two-Hour Doses
Source Term and DCF.		96.000 6.5330E4 01 Exclusion Area Bndry
Radtrad Calculation		720.000 6.5330E+         Time         Whole         Body         Thyroid         IEDE           01         (hr)         (rem)         (rem)         (rem)           0.0         7.9281E+00         6.5330E+02         2.8813E+01
Control Options. Calculate Print Output		Worst Two-Hour Doges
		Faclusion Area Bodry
Program Files (x86)/RADTRAD_LSCVinput/Test3.psf		(hr) (rem) (rem) (rem)
Denne Fin (-001D4DTD4D   001) anti Taria 0		0.0 7.9281E+00 6.5330E+02 2.8813E+01

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	Thyroid : 444
	TEDE:13.60	TEDE:13.601
	WB: 0.079	WB: 0.079
Test Case 2	Thyroid : 653	Thyroid: 653.1
	TEDE:28.80	TEDE:28.81
	WB: 7.9279	WB: 7.9280
Test Case 3	Thyroid : 652	Thyroid : 651.9
	TEDE:28.70	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.

•				Dathway number 47: 35 to 34
Compartment	numbar	27.	27	radinary namber 47. 55 00 04
comparement	number	41.	21	Piping: Removal Data
Compartment	number	28:	28	
				Time (hr) Flow Rate
Compartment	number	29:	29	(cfm)
				0.0000E+00 1.0000E+02
Compartment	number	30:	30	7.2000E+02 0.0000E+00
Compartment	number	31:	31	Pathway number 48: 34 to 33
Compartment	number	32:	32	Piping: Removal Data
Compartment	number	33:	33	Time (hr) Flow Rate (cfm)
Compartment	number	34:	34	0.0000E+00 1.0000E+02
				7.2000E+02 0.0000E+00
Compartment	number	35:	35	
				Pathway number 49: 33 to 32
Compartment	number	36:	36	Dining, Damaus   Dama
C	numbers	27.	27	Fiping: Removal Data
Compartment	number	57:	37	Time (hr) Flow Rate
Compartment	number	38:	38	(cfm)
oomput omeno	induity of a			0.0000E+00 1.0000E+02
Compartment	number	39:	39	7.2000E+02 0.0000E+00
~~~~~		10.	10	Dathway number 50: 32 to 31
Compartment	number	40:	40	rachway number 50. 52 to 51
Compartment	number	41:	41	Piping: Removal Data
				Time (hr) Flow Rate (cfm)
				0.0000E+00 1.0000E+02
				7,2000F+02 0,0000F+00

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.

5.000	1.21136-02	1.3/206-01	2.09406-02	3.3/U/E-02
5.900	7.2113E-02	1.3720E-01	2.8355E-02	5.9025E-02
6.200	7.2113E-02	1.3720E-01	2.9768E-02	6.2377E-02
6.500	7.2113E-02	1.3720E-01	3.1177E-02	6.5763E-02
6.800	7.2113E-02	1.3720E-01	3.2584E-02	6.9182E-02
7.100	7.2113E-02	1.3720E-01	3.3988E-02	7.2634E-02
7.400	7.2113E-02	1.3720E-01	3.5389E-02	7.6119E-02
7.700	7.2113E-02	1.3720E-01	3.6788E-02	7.9637E-02
8.000	7.2113E-02	1.3720E-01	3.8183E-02	8.3189E-02
8.300	7.2113E-02	1.3720E-01	3.8704E-02	8.5156E-02
8.600	7.2113E-02	1.3720E-01	3.9223E-02	8.7149E-02
8.900	7.2113E-02	1.3720E-01	3.9741E-02	8.9167E-02
9.200	7.2113E-02	1.3720E-01	4.0258E-02	9.1212E-02
9.500	7.2113E-02	1.3720E-01	4.0775E-02	9.3282E-02
9.800	7.2113E-02	1.3720E-01	4.1290E-02	9.5377E-02
10.001	7.2113E-02	1.3720E-01	4.1634E-02	9.6795E-02
10.401	7.2113E-02	1.3720E-01	5.1100E-02	1.1166E-01
12.001	7.2113E-02	1.3720E-01	2.6379E-01	4.1062E-01
24.000	7.2113E-02	1.3720E-01	2.8005E+00	3.9405E+00
96.000	7.2113E-02	1.3720E-01	1.1286E+01	1.5654E+01
20.000	7.2113E-02	1.3720E-01	1.7474E+01	2.4195E+01

# Worst Two-Hour Doses

Exclusion Area Bnd	iry
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Time	Whole Body	Thyroid	TEDE
(hr)	(rem)	(rem)	(rem)
0.0	4.0146E-02	7.2113E-02	1.3720E-01
Fig.4(b)	The calculation	on results fro	m 41 compartment

Table 4. Modeling Capacity between NAME-LSC and

and 50 pathways in NAME LSC code.

RAD I RAD 5.05			
Modeling	RADTRAD3.03	NAME-LSC	
Conditions			
41	Error and not	Non-Error and good	
Compartments	working	working	
50	Error and not	Non-Error and good	
Pathways	working	working	
250 DCF	Error and not	Non-Error and good	
library	working	working	
250isotopes	Error and not	Non-Error and good	
	working	working	
Modeling	Less than 25	More than 500	
component	Pathways	Pathways	
capacity			

#### 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

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[4] RADStudio Rio 10.3 User manual