<Technical Note>

A STUDY ON DEVELOPMENT OF MONITORING & ASSESSMENT MODULE FOR SITES

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Received November 2, 2005
Accepted for Publication March 21, 2006

As the development of total management systems for sites along with site environmental information is becoming standard, the system known as the Site Information and Total Environmental database management System (SITES) has been developed over the last two years. The first result was a database management system for storing data obtained from facilities, and a site characterization in addition to an environmental assessment of a site. The SITES database is designed to be effective and practical for use with facility management and safety assessment in relation to Geographic Information Systems. SITES is a total management program, which includes its database, its data analysis system required for site characterization, a safety assessment modeling system and an environment monitoring system. It can contribute to the institutional management of the facility and to its safety reassessment. SITES is composed of two main modules: the SITES Database module (SDM) and the Monitoring & Assessment (M&A) module [1]. The M&A module is subdivided into two sub-modules: the Safety Assessment System (SAS) and the Site Environmental Monitoring System (SEMS). SAS controls the data (input and output) from the SITES DB for the site safety assessment, whereas SEMS controls the data obtained from the records of the measuring sensors and facilities. The on-line site and environmental monitoring data is managed in SEMS. The present paper introduces the procedure and function of the M&A modules.

KEYWORDS : SITES, SAS, SEMS, Safety Assessment, Project Concept, M&A Module

1. INTRODUCTION

SITES was developed for the purpose of the effective management of environmental and site information for the radioactive waste management sites. During the operation of a disposal site and after its closure, continual monitoring is needed for safety for an institutional period of time (300 years) under the demand of current regulations.

The system includes three sub-systems; the Database (DB) subsystem, and the safety assessment and environmental monitoring subsystems. SITES is aimed at achieving the following functions.

- Becoming a data analysis program for a total data management system
- Becoming a control program for safety assessments
- Becoming a data analysis program to produce input data for a safety assessment from the SITES DB
- Becoming a management program of output data derived from safety assessments
- Becoming a program for GIS applications
- Becoming a site environmental monitoring system

The SITES DB was initially developed in consideration of relevant nuclear acts, standards and guides for low and intermediate radioactive waste disposal sites. These include the regulatory guides concerning Site Characterization Reports and Environmental Reports [2]. All of the investigation and monitoring items required by the regulatory issues for the site safety assessment were reviewed for the DB system. A compositional diagram of SITES referring to the above regulatory issues is shown in Fig. 1.

SITES is divided into two sub-modules: the SITES Database Management (SDM) module and the Monitoring & Assessment (M&A) module. M&A is composed of the Safety Assessment System (SAS) and the Site & Environmental Monitoring System (SEMS). The present paper introduces the M&A module in terms of its aim and functions.

2. M & A MODULE

M&A is designed in terms of its effectiveness for SITES, and it plays the most important role in the function of SITES.

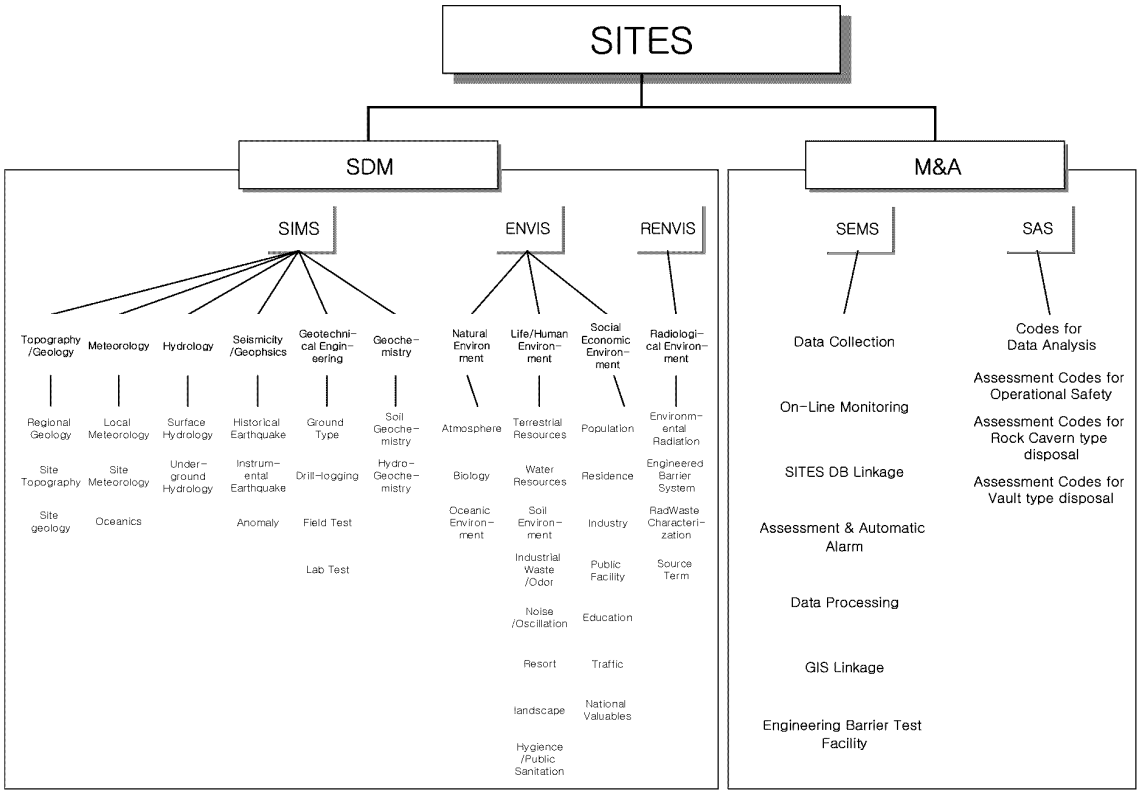


Fig. 1. Compositional Diagram of SITES [17]

The two sub-systems Safety Assessment System (SAS) and Site & Environmental Monitoring System (SEMS) fall under the M&A module in the organization of SITES. The M&A module aims to establish a standardized, configured and optimized system of SAS and SEMS. It will eventually achieve a vision of SITES as the ultimate system for public communications.

The functional aim of SAS in M&A is to unify the various safety assessment codes into one system for the convenience of users. SAS can systematically manage data resulting from safety assessments.

In addition, it also has the function of applying and analyzing data brought from the SITES DB (SDM). This indicates that it is designed to analyze the data from the SDM and create input data for safety assessments.

Another sub-system in M&A, SEMS, functions as a real-time monitoring system for the facility, and includes data analysis, statistics, prediction and automatic alarming functions. The data for SEMS is also obtainable from SDM and the SEMS DB. The detailed function and designs of SAS and SEMS are described in the next section.

2.1 Safety Assessment System

A previous study was performed on the analysis of each assessment program, its function and the system in relationship to other programs.

SAS is an integrated program that controls the safety assessment codes. It is designed to manage and use input and output data for site safety assessments in relation to the SITES database.

The initial process of developing the system involved an analysis of the safety assessment codes and their input and output data form as well as data from the SITES DB.

The analysis of the application process, including the definition of an external client, was also performed. The final process of the system development was an analysis of the possibility of connecting the system with GIS. The migration and diffusion of radionuclides through underground media will be designed to be expressed with geographic information. The scope of SAS is as follows [3:]

- An analysis program for a total data management system that uses all data.
- A control program for safety assessment codes
- A data analysis program to produce input data for safety assessments
- A program for the systematic management of the data from the safety assessments
- A program for a GIS application with SITES

The management process for each safety assessment code is designed for the optimization of its relationship with SITES. The interface for the data inputting and outputting is designed for use with input data in the assessment program that must be sorted and controlled during the input process of the management program. All the processes are aimed at designing the interface of the report and the GIS data production.

2.1.1 Safety Assessment Codes in SAS

The codes were selected from an internationally verified group, which had been used to obtain the regulatory licenses for the radwaste safety assessment or performance assessment. In addition, the codes of the site and environmental data analysis selected for this system are broadly used currently for a site characterization. They were analyzed in terms of their functions in relation with SITES. The codes in SAS are practically divided into three groups, as shown in Table 1.

Five codes, the AquiferTest Pro [4], MiniTab [5], Surfer/Grapher [6,7], MODFLOW [8] and FRACMAN [9] are the programs for the site environmental data analysis in Group I, whereas another five codes, SAGE [10-12], MASCOT/MOP [13], AMBER [14], GWSCREEN /RESRAD [15,16] and GEN II [17] are the safety assessment programs in Group II.

Seven codes, HELP [18], DUST-MS [19], GENII, MODFLOW, NAMMU/NAM-DATA [20-21], NAPSAC [22,23] and HINDSITE [24] are the performance assessment programs in Group III. The codes in Group II are normally for the safety assessment of the post closure period of a site whereas the codes in Group III are composed of those for performance assessments of the ground water flow and human intrusion.

Table 1. Safety Assessment Codes in SAS

Group	Code	Purpose	OS
Group I: Site & Environmental Data Analysis Programs	**Aquifer Test Pro**	Assessment of hydraulic test and conductivity	Win
	MiniTAB	Statistical process of data from hydraulic test	Win
	SURFER/GRAPHER	Geographical/geological mapping	Win
	MODFLOW	Continuity modeling/ Analysis of ground water table and hydraulic pressure distribution	Win
	FRACMAN	Data analysis of fracture net model	Win
Group II : Safety Assessment	**GWSCREEN, RESRAD**	Assessment of total radiation effect	Dos, Win
	GEN II	Assessment of exposure by air diffusion	Dos
	SAGE	Integrated safety assessment of sub-surface disposal	Win
	MASCOT/MOP	Total assessment of radiation effect	Unix
	AMBER	Disposal safety assessment of ecology	Win
Group III: Performance Assessment	**MODFLOW**	Continuity modeling/Analysis of ground water table and hydraulic pressure distribution	Win
	HELP	Evaluation of hydraulic balance	Dos
	DUST-MS	Evaluation of source term	Win
	NAMMU/NAM-DATA	Assessment of ground water flow in porous media	Unix
	NAPSAC	Assessment of ground water flow in fractured rock media	Unix
	GEN II	Assessment of exposure by human intrusion	Dos
	HINDSITE	Assessment of human intrusion in scenario	Dos

2.1.2 System Configuration

The hardware system of SAS is configured with the SITES DB server and web application server. Data is collected from the site investigation and environmental assessment performed by the relevant organizations, and stored in the SITES DB server. The data from the SITES DB is input into the codes through the input module for the safety assessment. After the assessment, the output module sends the data to the SAS DB server. The SAS user can locate and use the data in a search module through a web browser.

The main function of SAS is to produce output results after a safety assessment according to a user's demand. For this first procedure, the system demands input data from the user after the user selects a code from the three groups. In the next procedure, the system performs the safety assessment, and finally offers the results in the form of a data list, or a chart, among others.

The above first and final procedures, the input and output dating are integrated and configured to the main client server of SAS. However the second procedure for the assessment is performed in another server, which is physically apart from the main client server. The result of the assessment using a code is sent to the SAS DB in the main system, and offered as output data to the user.

Safety assessment codes are independent from the system in terms of their function. The codes of the environmental analysis and the safety assessment operate under DOS and Windows systems, whereas the codes of the performance assessment operate under a UNIX system (See Table 2). Therefore, two types of assessment servers, a Windows and a UNIX system, are required for the system configuration of SAS [25].

Table 2. Assessment Codes with PC Operating Systems

Codes based on DOS & Windows	Codes based on UNIX
· Codes of Site environmental analysis · Safety assessment codes	· Performance assessment codes (NAMMU, NAPSAC, MASCOT, etc)

2.1.3 Schema of SAS Module

SAS is designed so that the individual function of the assessment codes in the system is mechanically related to the function of the entire system. Specifically, a data analysis is performed using an analysis code, and an individual assessment is then performed on each constitutional factors. The result from this performance is used for the entire system. For example, the result of the data analysis from the codes of the Aquifer Test or FRACMAN are input into the performance assessment using the codes of HELP, DUST-MS, MODFLOW and NAMMU, which are individual functional assessment codes. The results from those performances are input again into the safety assessment codes of SAGE, MASCOT, AMBER and GWSCREEN to obtain the total performance results. The individual codes and the system are mechanically correlated with each other, as described above.

The method of composition and correlation between the codes is used under the integration concept. The characteristics of SAS are such that it has flexibility to combine the codes with some variation and to select code combinations based on what a user wants. It then determines the optimized method from among a variety of code combinations.

SAS is fundamentally composed of three modules, the input model, assessment modeling and the reporting of its functions.

1) Input Module

As this module produces input data for assessment modeling, it works using two methods for inputting the data. The first is to collect data from the SITES DB using a search menu and to input this data. The second is to input all data generated by the users directly into the model.

Generally, each set of standardized input data for the assessment modeling is stored in the SAS database independently from the SITES database. Users can search fo standardized input data in the initial input window, and can compose primary data. In addition, they can modify data as needed. When inputting is finished, users can order performance for the safety assessment to the main SAS program. The input data produced by the users' orders is automatically stored in the SAS DB with classified file forms and input factors.

2) Assessment Modeling Module

This module orders the modeling in the two differentiated PC environments, as seen in Table 2. When users demand a safety assessment modeling after producing input data, the main program of the SAS sends input data to the assessment program and demands its modeling in this module.

A special function of this module is to communicate between the client/server and the UNIX module using the TCP/IP protocol. This module exchanges the data ordered, the performance state and the input/output data through the use of the TCP/IP protocol, and also co-uses the data. After the assessment performance is finished, it produces various forms of output results, for example text or binary and graphic menus, and it preserves these forms in the SAS DB.

3) Reporting Module

This module offers analysis results through various

methods such as charts, spreadsheets, or PDFs, among others, using relevant output data. The results produced after the assessment modeling are securely preserved in the SAS DB.

2.1.4 Technical PC Environment for SAS

The implementation of the system logic and the interface are used for the SAS technical environment.

The system logic bears a 'project' concept. This concept related to a 'project' is to generate the final results through the several performances completed by several users or several organizations simultaneously. The users perform their work under the functional name of a 'job'. The 'job' here is classified and performed by the assessment codes. The 'project' concept in SAS is shown in Fig. 2 [3].

The first user creates a 'project', several users who have access permission then individually perform a safety assessment after login. When the modeling is completed, the results are configured, registered and controlled by the reporting module. The system lets the users recognize the status of the modeling whether it is completed or not. At the same time, all of the users can search the results of the assessment according to the access authority given by the project creator.

The user interface in SAS is composed of the SAS application program installed on the user's PC and a menu mode to communicate between users.

The other interface is composed of the SAS application program and the application program of the assessment code installed on the server.

The server application program interfaces with the UNIX server for communication between the code group

Table 3. Software Components with the Steps of SAS

NO	STEP	Operating System	Technology & Language
1	**USER ↔ SAS Main Program**	· Window PC · MS Windows 2003 Server	· MS .Net Framework · MS C#.Net
2	**SAS Main Program ↔ Windows Server Program**	· Window PC · MS Windows 2003 Server	· MS .Net Framework · MS C#.Net
3	**Windows Server Program ↔ UNIX Server Program**	· MS Windows 2003 Server · UNIX System	· MS .Net Framework · MS C#.Net · ANSI-C · TCP/IP Protocol
4	**Windows Server Program ↔ DATABASE**	· MS Windows 2003 Server · MS SQL Server 2000	· MS .Net Framework · MS C#.Net

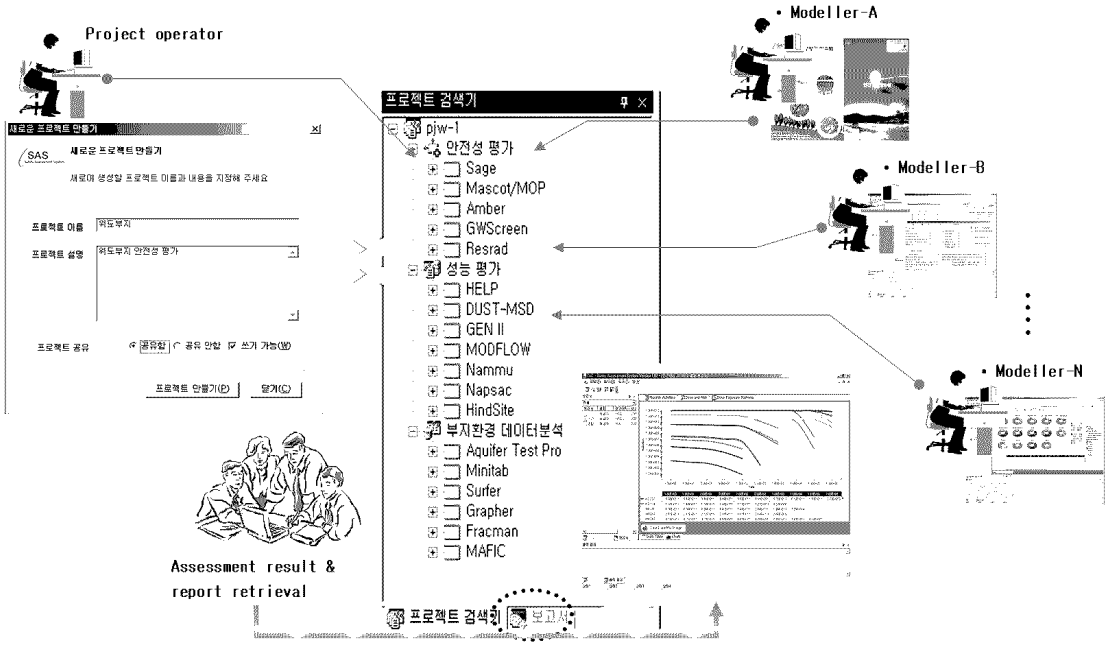


Fig. 2. Configuration Diagram of the SAS Project Concept [18]

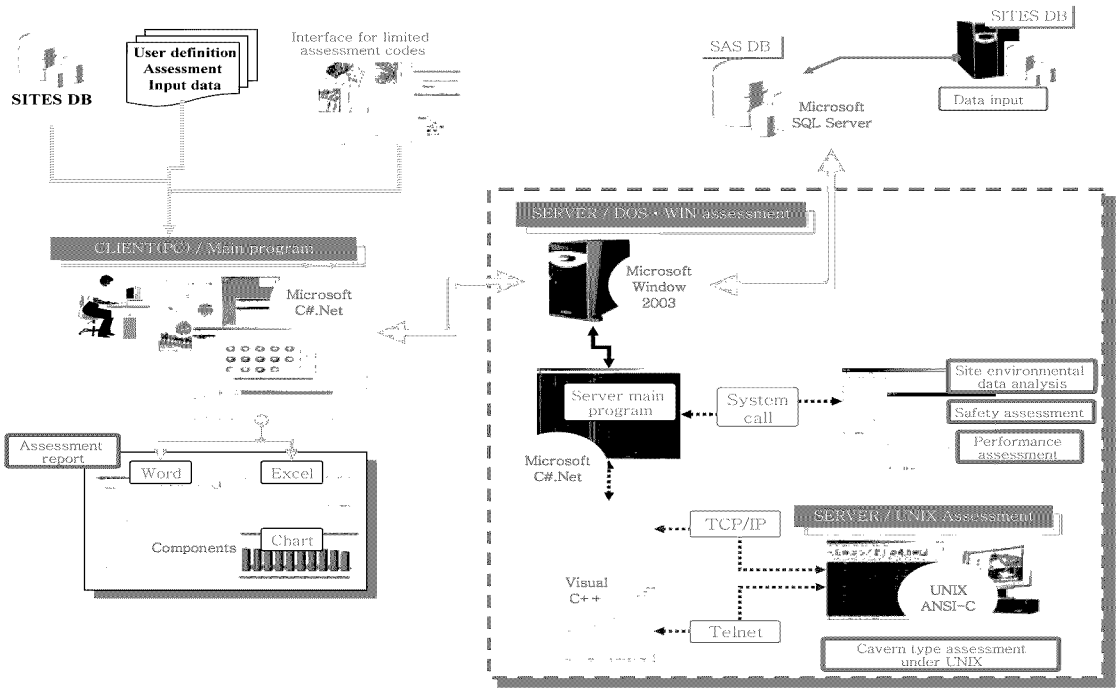


Fig. 3. Flow Diagram of a Technical PC Environment of the SAS Development

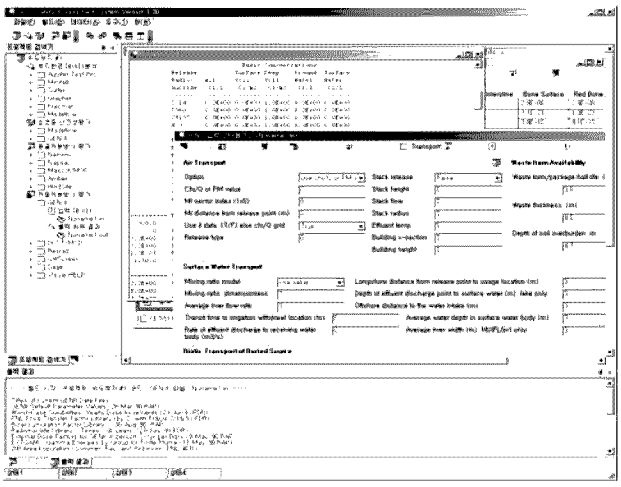


Fig. 4. Window of the Assessment Performance

composed of NAMMU, NAPSAC and the aforementioned others, in addition to the groups of other assessments codes. The results produced by the above two interfaces, which are of SAS and of SAS application program generate the output data. The interface that inputs the data into the DB is also performed in the server application program. Table 3 shows all of the information technology used in each step for the SAS project.

The flow diagram of the technical pc environment of SAS is shown in Fig. 3. Arrows in Fig. 3 indicate the data flow in the system.

2.1.5 Main Window of SAS

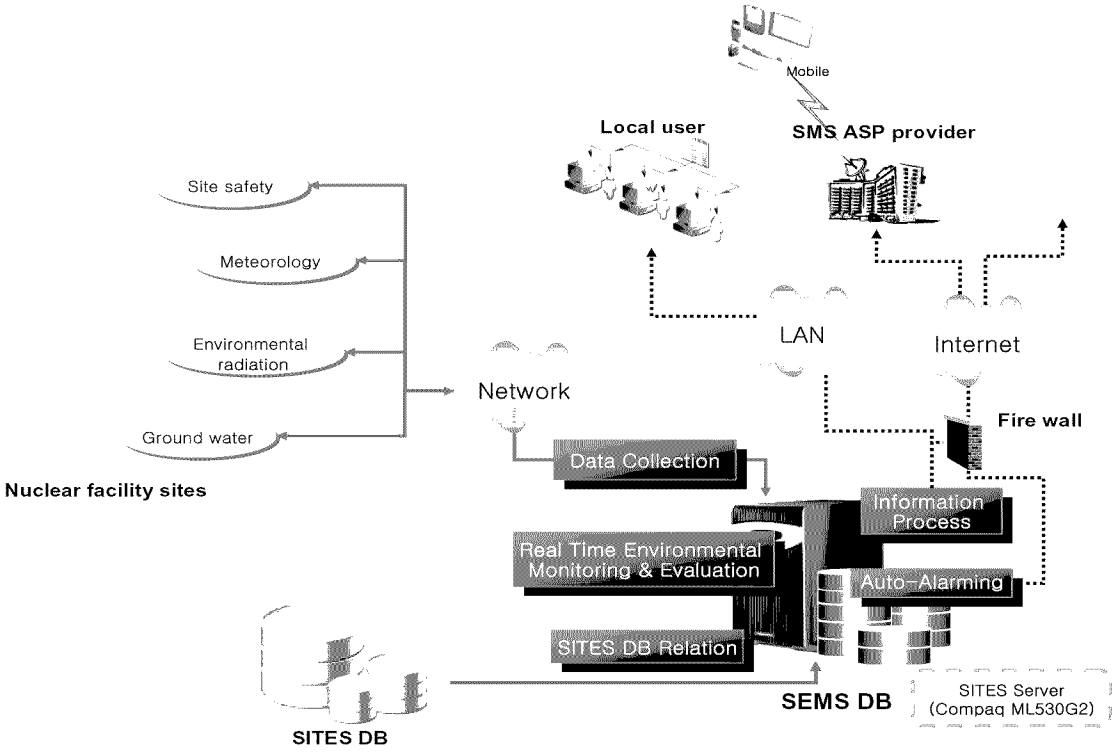
The main window of SAS functions to select an assessment code from the code list and demands performance from it by producing input data for it, as shown in Fig. 4. It also produces a report using the output data when an assessment is completed.

2.2 Site and Environmental Monitoring System (SEMS)

The main purposes of SEMS are to develop a system of real-time monitoring, analysis, statistics, prediction and automatic alarming for the site in its environment and facility. SEMS was designed with several sub-modules having functions to meet the above requirements.

Six sub-modules, data collection, real-time environmental monitoring, a SITES DB relational module, assessment and automatic alarming, data processing, and the GIS relational module comprise the main functional systems in SEMS [26].

SEMS is one of the most important systems in the SITES application. This can be a tool for the enhancement



Legend;
- solid arrows: data flow
- dotted arrows: data flow but future work

Fig. 5. Compositional Structure of the SEMS System

of public confidence. The compositional structure of SEMS is shown in Fig. 5. Six sub-modules are described in terms of their functions, as follows.

2.2.1 Data Collection Module

The data of meteorological, environmental radiation and groundwater monitoring are generated from the data measuring sensors. This module collects these data sets using a communication server.

Real-time monitoring data from the relevant sensors is collected, and the data is considered in terms of such characteristics as the data frequency and data form, among others. Meteorological information such as the wind direction, wind velocity, precipitation and atmospheric stability is managed with 5-to-10 minute frequency intervals produced from the on-site meteorological station. The measurement frequency is decided for the optimized site management through experience during site operation in the future.

A data collection system for the environmental radiation is established for the purpose of monitoring the transportation of radioactive materials, as well as their packing, storage facility, worker's buildings and locations found to have been impacted ecologically. The data collection frequency is planned at 15-minute intervals, however its optimum level will be decided in the future with the benefit of site operational experience (after IERNet) [27].

Ground water data is collected and managed in terms of its velocity, water table, and other factors measured from several monitoring wells. This is related to the impact of precipitation on the site.

The system for data collection requires compositional items such as a communication server for data exchange with monitors, communication equipment and circuits, and a program for physical data exchange. Current environmental monitors generally offer a serial protocol of a low speed under the internal communication regulation, however the TCP/IP protocol that speeds up the Internet has recently become commercialized. Accordingly the telecommunication equipment and programs for this module have to encompass both the TCP/IP system and the serial protocol system, which is able to monitor and control it remotely.

Another important factor in data collection is to maintain correctness of frequency and reliability in the data. Therefore, a stable telecommunication server, as well as stable programs and management of its circuits, also in

addition to high reliability and high accuracy of monitors are all required. When failure occurs in data collection due to different frequencies of monitors, the cause should be discovered immediately and automatically. The system demands an appropriate data frequency for each monitor. An automatic estimation of a failure should be relayed to the system manager so this person can decide upon the degree of the failure and then work to recover it. This automatic estimation system has to be related to the auto-alarming module in order to make system flow possible.

2.2.2 Real Time Environmental Monitoring Module

This module monitors in real-time the data of the weather, environmental radiation and ground water information obtained from the on-site monitoring sensors through the data collection module. The data form and possibility of its use will be evaluated for the reliability of data. When this procedure is completed, the physical verification of the data will be completed. This data monitoring procedure is based on environmental monitoring guides. When abnormal data above a limited range is observed, the real-time environment monitoring module evaluates the abnormality automatically. It then produces input data for the automatic alarming. To evaluate the abnormality, this module defines the causes of the abnormal data. The reliability of the data is enhanced by this performance. When data is defined as an abnormality, the data will be evaluated at three levels of caution, abnormality and emergency.

2.2.3 SITES DB Relational Module

This module relates to the module for the evaluation and automatic alarming after searching the data for such factors as a site characterization, or environmental and facility information, which includes the initial site survey data and measurement frequency. SEMS basically uses the data from the SITES database.

The SITES DB relational module performs its function when an analysis report and evaluation standards are produced monthly, quarterly and yearly for the real-time monitoring of data. This module also allows the users to search and print information from the DB freely.

The data in the SITES DB is controlled initially in the other DB server and renewed separately in a certain frequency.

2.2.4 Evaluation and Auto-Alarm Module

This module informs of an abnormality or an emergency to the staff and to relevant organizations. It sends this information automatically by e-mail or message service to their mobile phones after evaluation, analysis and prediction of the input data from the modules of the real-time monitoring and of the SITES DB relational. The most popular automatic informing system is the mobile phone message service using SMS (Short Message Service). SMS is an easier and more useful method for automatic alarming compared to using e-mail, which is limited in terms of place and time.

This auto alarm module stores the data defined for the alarming in the DB and performs the relevant procedure for the alarming. Initially, it connects rapidly with SMS and sends the data regarding the abnormality, as well as its occurrence time and the sender's name and details. It also sends an e-mail. The receiver can confirm the fact in the SEMS of SITES through the Internet.

2.2.5 Data Process Module

This module offers data processing when internal and external users perform a data search from SEMS via the web through a LAN or the Internet. It offers real-time data analysis, data evaluation, statistics and reporting, among other services. Data from SEMS includes weather data collected in real time, environmental radiation, ground-water, and site information from the SITES DB, as well as statistics and reporting information.

The data process module is based on Microsoft. Net. It offers a data rapidly wherever users connect to the web site using an internet browser. User authority is limited in terms of data service and access through user's certificates.

The information regarding environmental radiation and ground-water requires a trend that can show the time tendency. Accordingly, to show the results effectively, a list, chart, PDF and other formats can be offered. This variable format and standardized document system can offer flexibility to communicate with other systems or institutes.

2.2.6 GIS Relational Module

The site's safety information is achieved in a timely manner from SEMS and is made available to a Geological Information System. This module offers the results in a visual format for the users' convenience and makes it easy to understand the site information. The data in this module includes the site characterization, environmental and facility information from the SITES DB. Real-time information evaluated in the environmental monitoring module and the processed data in the data process module is also included.

The facility information and the location of monitoring sensors make it possible to access in three dimensions using geographic and spatial information. This system is effective in that it has the correct distance based on the scaling up and down of the site facility. GIS can show an accident region, its degree and its tendency with time changes.

3. CONCLUSIONS

The Safety Assessment System (SAS) in SITES is designed for an individual function of the assessment codes in the system mechanically related to the entire system's

function. Specifically, data analysis is performed using an analysis code, and an individual assessment is then performed on each constitutional factor. The result from this performance is used in the entire system. The individual codes and the system are mechanically correlated with each other and among each entity.

A method of composition and correlation between the codes is used under an integration concept. The characteristics of SAS are that it has flexibility to combine the codes in variation variety of ways, and to select a code combination based on what a user wants. It then determines an optimized method from among the variable code combinations.

SAS comprises a number of modeling codes for safety assessments, and is configured for the user's convenience. The codes are classified into three groups according to their use. Group I is comprised of the analysis programs for site environmental data whereas Group II is comprised of the safety assessment programs for the site operational period. Group III is comprised of codes for the performance assessment.

SAS has been developed with a 'project' concept, which is highly effective in applying it to a DB system. This concept generates assessment results in one process for one site.

The assessment codes have different PC operating systems, here this indicates that the environmental analysis operates under DOS and Windows systems whereas the codes of the performance assessment operate under a UNIX system (See Table 1). Two types of servers, Windows and UNIX, are required for the system configuration for SAS. For communications between the clients (users) and the codes needed for the UNIX system, a module using the TCP/IP protocol was developed.

The prominent function of SAS is that various safety assessment codes can be managed in the system instead of every modeler controlling one code through a single code.

Another system of the M&A Module is SEMS. The main purpose of SEMS is to enhance public confidence. The monitoring results with real-time data can be confirmed in this system on demand from the general public.

SEMS specifically functions to gain information regarding the weather, groundwater, and radioactive environment, among other factors, through various monitoring sensors placed around the site.

Six sub-modules, the data collection sub-module, the real time environmental monitoring sub-module, the SITES DB relational module, the evaluation and auto-alarm sub-module, the data processing sub-module, and the GIS relational module comprise the key functions in SEMS.

The M&A module composed of SAS and SEMS will be an important contributor for establishing the SITES system, which is able to thoroughly manage data obtained from a nuclear facility site.

ACKNOWLEDGEMENT

This project was carried out under the National Research Laboratory (NRL) Program supported by the Ministry of Science and Technology (MOST), Korea.

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