The development of practice manual for LSC based on job analysis in radiation measurement and analysis

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Abstract. Radiation technology is closely related to the industrial growth and the creation of employment in Korea. The techniques as radiation or/and radioactivity measurement, and the practical skills achieving a higher level analysis are required. In this study, practice manual for liquid scintillation counter were developed by job analysis. Raw data applied in job analysis are collected by on/off line survey by 420 workers employed in KOREA. Importance-priority analysis was performed to make duties and competency unit that consists of knowledge, skills as each task. Refined data was reviewed by expert who experienced actual duties on site. Classification was conducted by focus group interview to deduce duties and competency unit. From the radiation devices in measurement and analysis, liquid scintillation counter was preferentially selected because of the high demands for training. Investigation of build-up status to liquid scintillation counter in KOREA was conducted. Then technical specification and operating procedure of 2 main devices were analyzed and integrated by practice manual. Duties and competency unit were applied to integrated materials respectively. To validate effectiveness, test curriculum was designed by the advanced course to workers who engaged in radiation measurement and analysis. The developed manual is structured to take advantage of test training. This manual will be a practical handbook that can improve the knowledge, skills of radiation workers in Korea.

1. Introduction
Job analysis is a crucial process to identify and determine in definite the particular job duties and requirements and relative importance of these practical duties for a given job. An important concept of Job analysis is that the analysis process is conducted to job, not the person. The purpose of job analysis is to establish guideline and procedure such as training, selection, compensation, and performance appraisal. Through the process of job analysis, more practical curriculum and training program can develop for workers to reflect industrial demands. Additionally, job analysis can be used in development of training contents, assessment tests to measure effectiveness of training, equipment to be used in delivering the training, and methods of training [1, 2].

Hence, variety methodologies are suggested and developed to reflect industrial demands such as national competency standards in Korea. National competency standards are currently operating in more than 130 countries worldwide. A successful country is typically British. It has a history of 60-70. Australia's vocational education and basic skills are based on the NCS. These educational methods are based on the job analysis because there are good resources for curriculum development and operations corresponding to the practical industrial demands. In particular, the techniques explained as radiation or/and radioactivity measurement, and the highly practical skills/knowledge achieving a higher level analysis are required. The tasks of radiation measurement and analysis have specialty related industrial
characteristic on site. It is necessary to compensate for the gap between the operated curriculum and job on site consistently [3, 4].

But now, systematic job analysis in radiation measurement and analysis are not conducted so the difference between the theoretical training and field training was more going on. This gap has had a negative impact in industrial development and reducing job competency of related workers on site. The study, reflects the recent social interest in job analysis including standard practice manual of liquid scintillation counter, presents ad detailed practice manual that is a reference for work sites concerning troublesome that may occur in radiation fields.

2. Materials and method

2.1 Demand survey on workers

The training needs survey was conducted targeting 420 professionals engaged in the field to perform a job analysis of the radiation industry. The purpose of the survey was to determine training status and labor supply and demand realities and needs of radiation-related industries. Convenience Sampling was extracted to radiation technology-related institutions from total population. The research was conducted online survey by 420 samples. The survey was used to a structured questionnaire. Survey results were utilized for statistical analysis SPSS 21.0 program. To validate and design radiation measurement training curriculum, in-depth interviews were conducted by 15 experts. Table 1 indicated the procedure and method of demand survey step by step.

| Procedure         | Method                                                                 |
|-------------------|------------------------------------------------------------------------|
| Step 1 Setting objective | Identifying radiation-related industrial labor supply and demand situation |
|                   | Identify your needs and radiation-related industries Education Status |
| Step 2 Survey design | Population: convenience sampling (radiation technology-related agencies and academia, and industry workers) |
|                   | Sample size: online (370 sample), offline (50 sample) |
|                   | Survey type: on / off-line survey |
|                   | Questionnaire type: structured questionnaire (closed, open, etc.) |
|                   | Items array: Similar question the purpose community form |
| Step 3 Survey conducted | Survey period: on-line('15.2~'15.3) |
|                   | Off-line('15.3) |
| Step 4 Result analysis | Analysis Method(Frequency Analysis, Ratio Analysis, reliability analysis, analysis IPA) |
|                   | Statistical analysis program : SPSS 21.0 |

2.2 Job analysis of radiation measurement and analysis

Through the Human Resource Development Council, 8 technical fields are suggested in radiation industry. Hence, validation of organization was conducted by demand survey. Importance-priority analysis was performed to make duties and competency unit that consists of knowledge, skills and attitude about total radiation measurement and analysis. Refined data was reviewed by 15 experts who experienced duties about radiation measurement and analysis. Classification procedure was conducted by focus group interview to integrate various opinions. Duties and competency unit were deducted by
regular expert verification [5, 6, 7]. Radiation measurement and analysis field was selected for the rank three. Since the equipment education is suitable for radiation measurement and analysis training, we analyzed detailed job analysis of radiation measurement and analysis. Various measuring devices have been derived to develop practice manual. Then, additional demand survey is conducted. It established the equipment deployment plan.

2.3 Analysis of installed equipment on site
From the radiation devices for use in measurement and analysis, a practical manual for liquid scintillation counter was preferentially selected because of the high demands for training. Construction status of liquid scintillation counter in KOREA was investigated to develop standard manual for applicable in radiation field. After examining the equipment that is most often distributed in the domestic priority, we performed a comparison and analysis of the technical specifications of the equipment survey. Figure 1, 2 indicated the composition of liquid scintillation counter about each manufacturer.

2.4 Development of practice manual
Liquid scintillation counter is utilized after dissolving the sample to a detector using a liquid scintillator dissolved fluorescent substance in a solution, and equipment for measuring the radiation emitted by the sample, it can be measured by dissolving a sample in a scintillator better the efficiency tritium (H-3), C-14, Ra-226, such as that often used in low-energy beta nuclide analysis [8]. Therefore, beta nuclide analysis training using liquid scintillation counter should provide essential incumbent to radiation, this liquid scintillation counter equipment practice should also be established. Equipment preliminary research was carried out and expert validation, evaluation and selection of suitable devices for training. Through Findings demonstrated to be the PerkinElmer and HIDEX showed that delivery of liquid scintillation counter from two manufacturers, two of PerkinElmer's Quantulus HIDEX's 300SL models and liquid scintillation counting two types of equipment most often distributed in Korea.
Examining the technical specifications of the two devices, and do the comparison and analysis on the educational aspects. To design test education curriculum, we established 1 liquid scintillation counter through technical comparison. However, the development has been reflected in the equipment manuals and the operating procedures of the two companies. Detailed manual contents are consists of results that based on job analysis of radiation measurement and analysis.

3. Results and discussion

3.1 Reliability analysis of the demand survey

Utilizing SPSS 21.0 in order to ensure the reliability of the survey data about the demand investigation was carried out reliability analysis. Confidence coefficient for radiation-related manpower supply and demands are 0.786 and the confidence coefficient value about the radiation educational status and needs for appeared to .750. We conducted validation of reliability to the survey questionnaire and reliable factor for this result is shown below in Table 2.

3.2 Survey analysis and implications

It was performed to investigate the training needs of workers and their job demand survey showed 28% of response rate. Table 3 shows response results of the demand survey to worker in radiation field. As you can see from the survey results, most of the workers are hoping for specialized courses. Workers are engaged in routine task so prefer the short-term course. Education time in 1 day is preferred 6 to 8 hour for education efficiency. Also, curriculum is the best considerations to participate actively. Other areas of highest needs in radiation technology is "safe use and handling" sector ranked first, "Operation" field position 2, "Measurement Analysis" appears as the field is a priority 3. It was investigated to primarily educational technology sector that appears to be the "Measurement Analysis" field and "equipment maintenance" areas. In this results are reflected test education curriculum

3.3 Determination of definition

A job definition for the radiation measurement and analysis was defined as follows :
“Professionals to the measurement and analysis of radioactive materials through the practical verification of radiation measuring and understanding the principles and operating procedures and systems, sample preparation process and the results analysis by the radiation source is required”

The job definition and the knowledge, skills, were obtained through the expert focus group interview. Job descriptions are applied practice manual development in liquid scintillation counter. Table 4 shows that essential competency results as definition of job in Radiation measurement and analysis.

| Survey results | Confidence coefficient (α) | Target people | Number of respondents | Response rate |
|----------------|---------------------------|---------------|-----------------------|--------------|
| Radiation workforce supply and demand status | 78.6% | 1,500 | 420 | 28% |
| Radiation Education Status and Requirements | 75.0% | 1,500 | 420 | 28% |
Table 3. Response results of the demand survey.

| Question                                                                 | Response material          |
|-------------------------------------------------------------------------|----------------------------|
| Do you think you need a specialized educational institution with facilities and equipment acquired for radiation technologies? | YES (90.5%)                |
|                                                                         | NO (9.5%)                  |
| What you want in a place where education and training?                   | Company (21.4%)            |
|                                                                         | Outside experts (78.6%)    |
|                                                                         | ETC (0%)                   |
| How long take Job training for the workers?                              | 3Days (52.4%)              |
|                                                                         | 5Days (8.3%)               |
|                                                                         | 2Weels (8.3%)              |
|                                                                         | 1Month~2Month (131%)       |
|                                                                         | ETC (17.9%)                |
| What is appropriate time for training in one day?                        | Under 2 Hours (15.5%)      |
|                                                                         | Under 2~4 Hours (13.1%)    |
|                                                                         | Under 4~6 Hours (29.8%)    |
|                                                                         | Under 6~8 Hours (40.5%)    |
|                                                                         | Above 8 Hours (1.2%)       |
| What are the considerations to select education institution?             | Curriculum (50.0%)         |
|                                                                         | Quality of instructor (7.1%)|
|                                                                         | Period (6.0%)              |
|                                                                         | Famous (1.2%)              |
|                                                                         | COST (6.0%)                |
|                                                                         | Location (29.8%)           |

Table 4. Essential competency results as definition of job (Radiation measurement and analysis).

| Knowledge                                                                 | Radiation measurement system |
|                                                                         | Understanding of devices for radiation measurement and analysis |
| skills                                                                  | Pretreatment of the sample  |
|                                                                         | Radiation devices and operating systems |
|                                                                         | Radionuclide factor and spectral analysis capabilities |
|                                                                         | Environmental radiation analysis capabilities |
|                                                                         | Analytical measuring sword / calibration capabilities |

3.4 Development of liquid scintillation counter practice manual

Derived job description and definition can improve the job skills. On the basis of the outputs were designed training manuals and content. To enhanced practical education contents, standardized operating manual of the latest equipment being used in the country. Table 5 shows the contents of the standard configuration of the operating manual for practical training liquid scintillation counter. Figure 3 shows the outputs of the handbook type for developed manual. Based on the demand survey and job analysis results, liquid scintillation counter test curriculum was designed a short-term education program. Table 6 shows that organized main contents of liquid scintillation counter practice manual.
### Table 5. Organized main contents of liquid Scintillation counter practice manual

| Chapter | Subject | Num. of page |
|---------|---------|--------------|
| 1       | Outline of LSC | 1            |
| 1-1     | Principle of measurement | 1            |
| 1-2     | Objective | 2            |
| 2       | Organization of LSC system | 2            |
| 2-1     | Hidex 300SL LSC | 2            |
| 2-2     | Quantulus 1220 LSC | 3            |
| 3       | Procedure of pretreatment as nuclide | 4            |
| 3-1     | H-3(Water, air sample) | 4            |
| 3-2     | C-14(Water, air sample) | 12           |
| 4       | Procedure of operation | 21           |
| 4-1     | Hidex 300SL LSC  
(Operation, Program performing, turn off) | 21           |
| 4-2     | Quantulus 1220 LSC  
(Operation, Program performing, turn off) | 35           |
| Reference | - | 42            |

*Figure 3. The Handbook of developed liquid scintillation counter practice manual*
Table 6. Organized main contents of liquid Scintillation counter practice manual

| Schedule | Main contents                                                      | Time(h) |
|----------|--------------------------------------------------------------------|---------|
| 1st Day  | LSC principles and basic theories Commentary                        | 6       |
|          | Understanding the radioactivity measured using LSC                  |         |
|          | LSC measurement definitions and descriptions                        |         |
|          | Beta nuclide analysis of new technologies                           |         |
| 2nd Day  | Sample preparation & LSC Tips                                       | 6       |
|          | Radioactivity measured using LSC Working                            |         |
|          | Questions and Answers and Discussion                                |         |
| 3rd Day  | Using the LSC analysis of urine samples                              | 3       |

4. Conclusion

Radiation measurement and analysis are need to essential education through a systematic analysis of the actual duties performed in the field due to the peculiarity that has its own duties. Many developed countries have changed the job training courses focused field training in the curriculum of the existing theories centered. It is necessary to develop job analysis-based training manual on radiation measurement and analysis because there are conducted the role of the primary jobs in the radiation industry. Among them, practical manual for liquid scintillation counter that can measure low-energy beta radiation effectively was selected and developed preferentially. Integrated manual for liquid scintillation counter are based on job analysis in radiation measurement and analysis. There are continuous necessity to the practical manual to encourage the activation of professional education and employment. It needs to additional onsite check continuously because developed competencies are reified to meet on-site demands. This manual will be utilized as practical handbook that can improve the knowledge, skills of radiation workers in Korea.

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