Safety and Health at Work 8 (2017) 322–326

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.org

Short Communication

The Quality Control Program for Industrial Hygiene Laboratories in Korea

Hae Dong Park, Eun Kyo Chung, Kiwoong Kim*

Work Environmental Research Bureau, Occupational Safety and Health Research Institute, Korea Occupational Safety and Health Agency, Ulsan, Republic of Korea

ARTICLE INFO

Article history:
Received 28 June 2017
Received in revised form
1 August 2017
Accepted 2 August 2017
Available online 4 August 2017

Keywords:
proficiency analytical testing
quality control
work environmental monitoring

ABSTRACT

In 1992, the quality control program was introduced in Republic of Korea to improve the reliability of the work environment monitoring, which was introduced in the 1980s. The commission entrusted by the Ministry of Employment and Labor, the Occupational Safety and Health Research Institute has conducted the program for industrial hygiene laboratories including designated monitoring institutions and spontaneously participating agencies. The number of institutions that participated in the program has increased from 30 to 161. The initial conformance ratio in the participants was 43% (organic solvents) and 52% (metals). Thereafter, the conformance ratio increased rapidly and it has remained in a stable state at more than 89% since 1996. As subject materials, 13 kinds of organic solvents and 7 kinds of metals were used. To improve the capability of measurement and analysis of private institutions, educational courses were conducted annually. An assessment at the actual sites of participants was additionally introduced into the program in 2013. Thus, the program turned into a system that administrates the overall process of participants. For the future, the scope of target materials will be extended through additional items. Thus, the reliability of the results of the work environment monitoring is expected to increase accordingly.

1. Introduction

The concept of work environment monitoring (WEM) in Republic of Korea was initiated on the basis of the investigation of occupational diseases among coal miners in 1959, and thereafter, this measurement has been used spontaneously by private institutions [1]. Since then, along with the enactment of the Occupational Safety and Health Act in 1981, the enforcement decree (1982) and enforcement regulations (1983) were established. Thus, the measurement for the work environment found its legal ground [2–4]. In 1990, the Occupational Safety and Health Act was enacted wherein the provision specifying mandatory reporting of the results of the WEM to the Minister for Ministry of Employment and Labor (MoEL) was included. Furthermore, there were detailed stipulations that specified the number and method of measurements, the requirement to designate institutions dedicated for the measurement, and the procedure of designation (or cancellation) of such institutions [5].

However, during the mid and late 1980s, the incidents of intoxication by mercury and carbon disulfide and exposure to carcinogenic cokes oven emission occurred, and consequently, the reliability of the WEM became a social concern. To cope up with such problems, the quality control (QC) program was introduced in 1992, and thus, the institutions designated as those dedicated for the measurement of the work environment had to participate. From 1995, the institutions that intended to apply for an inclusion as a new one beyond existing institutions designated for WEM were obliged to make these applications with certified qualifications of QC program [6]. Thus, the QC program is the minimum legal ground to ensure the reliability and accuracy of the results of WEM.

The QC program was introduced in Republic of Korea by modifying the model of Industrial Hygiene Proficiency Analytical Testing Program developed in the United States of America. Since 2000, Occupational Safety and Health Research Institute (OSHRI) has been continuously conducting studies delving into the legal and institutional administration and technologies for technical application of the QC program [7–9].

Thus, this article was designed to introduce the QC program for industrial hygiene laboratories in Republic of Korea by reviewing

* Corresponding author. 400, Jongga-ro, Jung-gu, Ulsan 44429, Republic of Korea.
E-mail address: k0810@kosha.or.kr (K. Kim).

2093-7911/$ – see front matter
http://dx.doi.org/10.1016/j.shaw.2017.08.003

the following. The data of past 25 years included the topics on the background of introduction, operation system, consequences of the implementation, and educational courses and directions for the future QC program.

2. Introduction and stages of development of the QC program

In 1987, the workers of Wonjin Rayon factory were intoxicated with carbon disulfide, and this triggered the introduction of the QC program for work environment measurement in Republic of Korea in 1992. For introduction of the program in Republic of Korea, the OSHRI started bibliographic examinations of overseas cases and conducted basic preliminary studies since October 1991 to develop detailed plans. Based on the plans, the guidelines and regulations for QC over working environment measurement were notified to the public. Thereafter, through analyses of samples and reviews of the Operational Committee, final assessment result of the first QC program was officially announced on July 25, 1992 [10,11].

When the first QC program was introduced, the degree of conformance was 43% and 52% for organic solvents and metals, respectively. With the introduction of QC, the conformance ratios for organic solvents and metals started improving gradually year by year and reached a level of approximately 90% commonly from 1996; it subsequently entered into the stage of stable consolidation. At the initial stage of the QC program, it focused on the competence of analysts. By accomplishing the analytical competence of analysts, it was found that the existing standards of QC program needed further modifications. The site assessment system was introduced in 2013 and was thus integrated into the QC program located in the stage of further improvement.

3. Operation of the QC program for WEM

3.1. Administrative Organization

The OSHRI was designated as an agency responsible for the QC program for WEM by the official notification of MoEL. There are two committees for the operation and practical execution of the program that run under the institute. The committee for practical execution consists of experienced analysts who are responsible for the establishment and detailed scheduling for the implementation, preparation of reference specimens, evaluation of the results, and actual implementation of decisions made by the operational committee. The committee for operation consists of the head of the OSHRI, four mandatory members, and six specialists; additionally, it is accountable for final determination of the concentration of sample, methods of preparation and evaluation of reference materials, providing feedback on final results, and education on QC.

The OSHRI joined the Proficiency Analytical Testing (PAT) program directed by the American Industrial Hygiene Association in 1992. Through this, the reliability of QC with respect to the agency is verified and its proficiency is maintained by participating in the quarterly PAT program over the four materials, such as organic solvents, metals, silica, and asbestos, every year.

3.2. Subjects of QC

Institutions that are responsible for the measurement of work environment are obliged to participate in the QC program. Otherwise, the institutions will be deemed as institutions showing inconformity. Non-profit-oriented university laboratories or other industrial hygiene research institutions are not obliged but are encouraged to participate in the QC program spontaneously.

3.3. Procedure

Types of QC program are divided into regular, occasional, spontaneous, and temporary types. Regular and spontaneous QC programs are carried out twice a year; therefore, the plans for each type of QC are notified 30 days in advance to receive respective applications during the period of 30 days. On completion of the period of application for the programs, the prepared samples are sent to each applicant within 2 weeks and the applicants are given an average period of 20 days to complete the analyses of the samples sent. The results of analyses reported by applicants are then aggregated and put into statistical analyses to determine the range of conformance. Thereafter, the results are forwarded to the two committees for operation and practical execution to finalize the conformance of the statistically analyzed results to be reported to the applicants who participated.

In the case of applicants who participated for the first time, a member of the committee of operation and one of the staff members of the OSHRI visited the new applicants and checked analyst responsible for participation and equipment used for the analyses. The occasional QC program was introduced from the site assessment system, and it is usually conducted on the occasion of expiry of the certified period due to unavoidable reasons such as the absence or retirement of analysts qualified in each institution. The temporary QC program is realized in the case of occurrence of civil petitions that resulted from or are related to inappropriate measurement of the work environment of respective institutions or in case where the need for temporary QC is determined by the operational committee.

3.4. Samples and range of conformance

The materials to be subjected are selected by considering materials frequently used in Republic of Korea and the subject materials in overseas countries. The materials for each session are determined by the operational committee. For the sample of organic solvents, a fixed amount of 1–3 kinds of organic solvents is injected into a charcoal tube and sealed. For the metal sample, a fixed amount of standard solution of 1–3 metals is injected on the mixed cellulose ester filter and dried thereafter. The samples are made in the concentrations of 10 stages. And 10% of samples selected randomly were analyzed. When the coefficient of variation thereof is less than 5%, the samples are used as QC samples. Among the samples, four samples are randomly selected in each field and are distributed to each institution.

At the initial implementation stage of the QC program, the reference values were mean values obtained by solely using the values analyzed in the standard laboratories. Thereafter, all of the values obtained from the standard laboratories and respective institutions were used to determine the reference values through the statistical test (Grubbs' test) conducted to exclude values of the outliers. For the range of conformance, the range of the reference value $\pm$ 3 times of the value of standard deviation thereof is normally taken. When the coefficient of variation of standard deviation is less than 3%, the value is adjusted to 3% to determine the range of conformance.

3.5. Judgment on conformance

When more than 75% of the analyzed values of samples fell in the range of conformance, it was judged to be commonly suitable for two kinds of subject materials, namely organic solvents and metals. The criterion was set in such a way so as to allow for non-hierarchical errors as far as possible within the extent avoiding the deviation from the range of conformance of samples due to