Assessment and Control of Occupational Health Hazards in Japan: Success of Regulation and Problems Still Remained

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Assessment and Control of Occupational Health Hazards in Japan: Success of Regulation and Problems Still Remained

Norihiro KOHYAMA

Abstract

The working environment control system in Japan has been enforced since 1975. This system formulated by the Japanese Ministry of Labour (the present Ministry of Health, Labour and Welfare) employs a method of working environment measurement, and has greatly contributed to improve the condition of working environments of most facilities in Japanese enterprises. Consequently the occurrences of and occupational diseases by chemical substances including pneumoconiosis have been significantly decreased. However, some problems still remain to be solved, e.g. welders' pneumoconiosis and asbestos-related diseases exposed to asbestos in place. Firstly, this paper explains the working environment control system currently being enforced in Japan, and then refers some problems which could not be resolved by the control system, such as welding works and demolition and repair works of building using asbestos. Considering these merits and demerits of the working environment control system being performed in Japan, a new additional way which protects such workers' health should be established.

Key Words: working environment control, working environment measurement, pneumoconiosis, welding work, demolition and repair of building, asbestos exposure

Introduction

To protect the health and safety of workers, legal constraints are widely recognized as essential. Most regulations to protect workers' health and safety in Japan came into effect after World War II\(^1\). The Working Environment Measurement Law enacted in 1975 is especially important. This law involves using static sampling measurements of the working environment. In consequence the Working Environment Measurement Law has greatly enhanced the working environments of most facilities\(^2,3\). As an outcome the incidence of
occupational dust hazards has drastically decreased since the 1980s\textsuperscript{3}. The decrease is mainly a result of environmental controls.

On the other hand, some problems still remain. One is the currently high incidence of pneumoconiosis among welders, and another is worries about asbestos exposure of demolishing and repair workers of building in the future. This paper explains the working environment control system being enforced in Japan and confirms the improved environmental data collected in the workplace. It also mentions some remaining problems which the Japanese government is facing and considers the countermeasures.

**Regulations to prevent occupational diseases**

Most regulations to protect workers from industrial accidents and diseases were enforced in Japan after World War II. The Pneumoconiosis Law has been enforced since 1960 to prevent silicosis and pneumoconiosis among miners and other industrial workers and provide compensation for those with these diseases. In 1972, the Industrial Safety and Health Law was enacted to secure the safety and health of workers in the workplace by promoting systematic countermeasures to prevent industrial accidents and diseases. Under this law, some ordinances were established. Since 1972 many laws such as the Ordinance on Prevention of Organic Solvent Poisoning, the Ordinance on Prevention of Lead Poisoning, the Ordinance on Prevention of Hazards Due to Specified Chemical Substances, and so on have been established.

The 65th Article of the Industrial Safety and Health Law states that employers have to conduct specific regular working environment measurements with respect to the indoor workshops in facilities as prescribed by a Cabinet Order. In 1975, the Working Environment Measurement Law was enacted in conjunction with the Industrial Safety and Health Law.

The chronological history of these laws and ordinances is summarized in Table 1.

**Table 1.** The chronological history of industrial health regulations in Japan\textsuperscript{15}

<table>
<thead>
<tr>
<th>Law, Ordinance, or Order</th>
<th>Enactment Year</th>
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<tr>
<td>Pneumoconiosis Law (1960)</td>
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<tr>
<td>Enforcement Ordinance of Pneumoconiosis Law (1960)</td>
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<tr>
<td>Industrial Safety and Health Law (1972)</td>
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<tr>
<td>Enforcement Order of Industrial Safety and Health Law (1972)</td>
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<td>Working Environment Measurement Standards (1976)</td>
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<td>Ordinance on Industrial Safety and Health (1972)</td>
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<td>Ordinance on Prevention of Hazards Due to Specified Chemical Substances (1972)</td>
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<tr>
<td>Ordinance on Prevention of Organic Solvent Poisoning (1972)</td>
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<tr>
<td>Ordinance on Prevention of Hazards Due to Dust (1979)</td>
<td></td>
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<tr>
<td>Ordinance on Prevention of Asbestos Hazards (2005)</td>
<td></td>
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<tr>
<td>Others,</td>
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<tr>
<td>Working Environment Measurement Law (1975)</td>
<td></td>
</tr>
<tr>
<td>Enforcement Order of Working Environment Measurement (1976)</td>
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<tr>
<td>Enforcement Ordinance of Working Environment Measurement (1976)</td>
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By these laws, the working environment measurement system including static measurement and evaluation was established as mandatory for employers in Japanese enterprises. Since then many measurement experts who can measure and evaluate work environments among enterprises have been certified by a national examination administered by Ministry of Labour (now the Ministry of Health, Labour and Welfare). These experts who have passed the national examination have to receive some training conducted by the Japan Association of Working Environment (JAVE). The number of the measurement experts qualified and licensed by the government is now over ten thousand and they have work in large enterprises or small private companies which were established by each individual expert.

**Measurement and evaluation for working environments**

The purpose of working environment measurements is to recognize the working conditions by the measurement of hazardous materials and factors and to judge what countermeasures are needed to be installed to improve the work environment. For this purpose, the Working Environment Measurement Standards and the Working Environment Evaluation Standards were regulated by the order of the former Ministry of Labour in 1976 and 1988, respectively.

**Figure 1** shows the structure of working environment controls which currently exist in Japan. Firstly an employer or administrator should adhere to the basic actions indicated in the boxes of Figure 1, which is general control and isolating hazardous materials or factors. Then, environmental measurement of the workplace should be done to check if the environment is suitable for workers. Measured values should be evaluated and if the levels

![Diagram](image_url)
are not suitable, some further countermeasures should be taken. After the countermeasures
are enacted, the working environment should be measured again and the results of working
environment measures should be evaluated. This cyclic process is performed regularly
among larger businesses in enterprises in Japan now.

The working environment measurement system consists of three steps: design, sampling
and analysis, and evaluation.

The design includes the following actions:

![Diagram of working environment measurement system]

- **Design**
  - Determination of substances to be measured
  - Setting 'Unit Work Area'

- **Sampling**
  - Setting Sampling Points of Measurement A & B in each UWA
  - Sampling by Measurement A and/or Measurement B
  - Sample Analysis

- **Evaluation**
  - Calculation of M, σ
  - Does M/E exceed X? Yes
    - Does C_B exceed the ACL? Yes
      - Does C_B exceed 1.5 times the ACL? Yes
        - Control Class I
      - Does C_B exceed 1.5 times the ACL? No
        - Control Class II
    - Does M/E exceed X? No
      - Control Class III

\[ M: \text{geometric mean} \quad \sigma: \text{geometric SD} \quad E: \text{Evaluation value} \quad X = 10^{-1.151 \log_{10} \delta} \quad Y = 10^{-1.654 \log_{10} \delta} \]

C_B: measured value by Measurement B  \quad ACL: Administrative Control Level

**Figure 2.** Schematic flow of working environment measurement
(1) Define what constitutes a unit work area and set the area
(2) Determine what must be measured
(3) Decide the timing and duration of measurements
(4) Decide what measurement and analyses are appropriate

The whole schematic flow including “design”, “sampling” and “evaluation” is shown in Figure 2.

The measurement of hazardous materials or factors is performed two ways: Measurement A and Measurement B. In the design, the setting of sampling points of Measurement A and B is included. In Measurement A, sampling points are randomly set at a number of points (5 points or more) in a unit work area, and in Measurement B a point where the exposure level is considered to be a maximum is additionally set in a particular case systematically selected in each unit work area. Therefore, the measured value of Measurement B is one for each unit work area. Static sampling is performed for 10 minutes or more at each sampling point. The sampling is basically done for two continuous days. If sampling is done for only one day, the mean geometric standard deviation is given a handicap value in the calculation.

In the evaluation, the geometric mean and geometric standard deviation are calculated from the measured values of Measurement A and compared with the Administrative Control Levels (ACL*) according to a statistical method mentioned later. Then the unit work area is tentatively evaluated into one of three classes: Control Class I’, II’ and III’. These classes are divided by two control levels: the First Control Level and the Second Control Level. The unit work area is finally evaluated into the one of three classes of Control Class I, II and III taking the result of the comparison of Measurement B and ACL. The Control Class I indicates green light that the working environment is well controlled, whereas Control Class III represents red light that the working environment needs significant improvement right away. Control Class II represents a yellow light in which the working environment needs careful monitoring on regular works until the next measurement.

As mentioned above, these three tentative control classes are produced by two control levels: the First Control Level is the border of Control Class I’ and II’, and the Second Control Level is the border of Control Class II’ and III’. The First Control Level and the Second Control Level are expressed by the following equations, respectively:

$$\log E_{A1} = \log M + 1.645 \log \delta \quad \text{(the First Control Level)}$$

$$\log E_{A2} = \log M + 1.151 \log^2 \delta \quad \text{(the Second Control Level)}$$

Footnote: The Administrative Control Level (ACL) represents the concentration of an airborne hazardous substance providing a standard to judge workplace conditions. The ACL differs in concept from exposure limit, whose values are set by the ACL Committee of the Japanese Ministry of Health, Labour and Welfare referencing various exposure limits and the technical feasibility of securing those values in the workplace. The ACL assumes the implementation of engineering control measures. Evaluating the values, the work environment is evaluated into one of the three categories: Control Class I (safe zone), Control Class II (gray zone) and Control Class III (unsafe or hazardous zone), by statistical comparison of the measured concentration of an airborne substance with its ACL.
$E_{A1}$ and $E_{A2}$ are the Evaluation values of unit work areas to classify into the three classes. $M$ and $\sigma$ mean geometric mean and geometric standard deviation, respectively, of the measured values of Measurement A for two continuous days.

The First Control Level means the upper significant level of 5% of measured values of Measurement A, i.e. 95% of measured values are smaller than the ACL when $\log E_{A1} > \log M + 1.645 \log \delta$. The Second Control Level is the geometric expression of arithmetic mean. Therefore, if calculated as $\log E_{A2} > \log M + 1.151 \log^2 \delta$, 50% of measured values of Measurement A do not exceed the ACL.

**Control Class I** means that 95% of the measured values of Measurement A do not exceed the ACL, i.e. $\log E_{A1} > \log M + 1.645 \log \delta$, as well as the measured value of Measurement B does not exceed the ACL. **Control Class III** is that the arithmetic mean of the measured values of Measurement A exceeds the ACL, i.e. $\log E_{A1} < \log M + 1.151 \log^2 \delta$, and/or the measured value of Measurement B exceeds 1.5 times of ACL. **Control Class II** is that the measured values of Measurement A is $\log E_{A2} < \log M + 1.645 \log \delta$ but the arithmetic mean of the measured values of Measurement A does not exceed the ACL and the measured value of Measurement B exceed the ACL but does not exceed the 1.5 times.

**Improvement of working environments in Japan**

Figure 3 shows the occurrence of occupational diseases due to the exposure of chemical substances during work. Since the various regulations mentioned above were enforced, the occurrence of occupational diseases has been gradually decreased owing to the improvement of working environments in most of enterprises and industries.

Figure 4 shows the development of dusty work environments from 1983-2000. The number of Control Class I sites has increased, while the II and III have gradually decreased.

![Figure 3. Occurrence of occupational diseases due to the exposure of chemical substances](Data from Ministry of Health, Labour and Welfare, 2004)
This is a concrete example of legal action resulting in the improvement of working environments.

Following the development of dusty working environment in the 1970s and early 80s, new cases of pneumoconiosis have remarkably decreased in the late of 1980s and early 1990s as shown in Figure 5.

However, the incidence of newly diagnosed pneumoconiosis has been still higher among tunnel construction workers than workers in other industries in recent years as shown the right side of Figure 5. The Ministry of Labour in Japan, published the guidelines for dust control among tunnel construction workers in 2000.
The guideline recommends that the owner and/or employer of construction enterprise should conduct to do control measure against dust emission by setting ventilation system in tunnel, to decrease into a target dust level at worksites in tunnels and measuring dust levels in tunnels. The guideline also requires workers to wear protective dust masks all times during construction work.

A problem in welding work environments

Most of work environments in Japan have improved as a result of tightened regulations. On the other hand, welding work environments have still not improved. Figure 6 shows the number of pneumoconiosis patients engaged in dusty work in 1994.

Why haven’t welding environment improved in spite of many regulations have enacted such as the Working Environment Measurement Law? The main reason is because welding was not specifically designated as a form of "specific dusty work" in the Ordinance on Prevention of Hazards Due to Dust which was set in 1979. In the ordinance, "dusty work" and "specific dusty work" were defined and listed work names one by one, respectively. "Dusty work" referred to general dusty work which did not require any local ventilation devices and working environment measurement if the facility has a general ventilation system, whereas the "specific dusty work" needs them as it is seen to be more dangerous than a dusty work. At that time welding work was designated as a type of "dusty work". Therefore, local ventilation devices have scarcely been settled in welding workplaces because the company owners employing welders have no legal obligation to settle them.

![Figure 6. Number of patients diagnosed with pneumoconiosis engaged in dusty work in 1994](image)
Working environment measurements have scarcely been conducted as well. Why was not welding work categorized as "specific dusty work" at that time? It has been said that the reason is due to the problem of blowholes which occur when welding shielding gas is dispersed by a local ventilation system applied to exhaust the welding fume. Therefore, worried occurrence of blowholes in products has avoided engineers and welders to use a local ventilation system in welding works in Japan until now.

However, a recent study revealed that blowholes do not occur at an appropriate speed of ventilation air flow\(^6\). According to the study, an optimum capture velocity of ventilation air flow which exhausts the welding fume enough and does not break the shielding gas is about

![Welding work using a local ventilation device in a shipyard in Denmark.](image)

**Figure 7.** Welding work using a local ventilation device in a shipyard in Denmark\(^7\). Upper: manual welding, lower: robot machine welding. Welding fumes are exhausted by local ventilation devices and no plume can be seen by the naked eye.
0.6m/sec when CO₂ shielding gas flow rate is 20 L/min. This means that we can use a local exhaust ventilation system for welding effectively. Actually the author experienced recently that obviously well welding environment has achieved by introducing a sophisticated local ventilation system in each welding work area in a shipyard in Denmark²⁷(Figure 7). There the working environment is so clean that we can not see any plumes of welding fume at least by the naked eye.

There may be still many difficulties associated with this problem, but the author believes that only way to get well welding environment is to categorize welding work as "specific dusty work" by regulation. Consequently the owners of company employing welders have to introduce local ventilation devices for welding work and have to do the working environment measurement regularly. As the result, it will decrease the occurrence of welder's pneumoconiosis.

**Current and future problems concerning asbestos in Japan**

The amount of asbestos consumption, which is almost equal to that of import in Japan, recorded highest plateau between 1970 and 1990 at about 250-350 thousand tons per year. Then it gradually decreased and it became smaller than a ten thousand ton in 2004. The amount of asbestos consumption in Japan was totally just ten million tons for about 80 years since 1926.

Asbestos related diseases such as lung cancer and mesothelioma are on the increase every year now. The occurrence of mesothelioma was 500 persons in 1995 and 953 in 2004. These diseases occur after a long incubation period of about 20-50 years since the first exposure to asbestos. Considering the long incubation period and the highest plateau time of asbestos consumption in Japan, the peak is projected to occur in 2020-30. The peak number of these diseases will get 1500-3000 persons per year. Most cases of such mesothelioma are considered due to so-called "occupational exposure" to asbestos. The asbestos workers, who had worked in asbestos company and produced asbestos products, know themselves asbestos and their chances of asbestos exposure during their works, however most of the other workers exposed to asbestos in place do not know the chance of their asbestos exposure: these workers had not recognized asbestos and asbestos products being used in place. For compensation for workmen's accidents, it does not succeed even if the medical doctor or officers of supervision tries to hear about the chance of asbestos exposure from these general workers, or from their relatives and/or families when unfortunately the worker had died.

Under these circumstances, Ministry of Health, Labour and Welfare of Japan banned asbestos use except for some limited products in October, 2004. And, in July 1, 2005, the "Ordinance on Prevention of Hazards Due to Asbestos" was issued in the first time since Industrial Safety and Health Law was issued in 1981. The purpose of the new ordinance is to prevent new asbestos exposure among workers engaged in demolition and repair of asbestos-
used-buildings and asbestos waste disposal in the future. This ordinance mainly focuses that
the owner or contractor of asbestos-used-buildings should severely prevent workers from
asbestos exposure during demolishing and repairing works. This shall be the center of
attention on asbestos problem in future of Japan.

The use of asbestos was totally banned in this September 1, 2006, except a few materials,
such as joint sheet, gasket or grand packing, which can not be substituted by other materials
at the present. At the same time, the definition of asbestos products was altered for
constructing materials or natural minerals containing asbestos as impurities, which are "the
materials containing asbestos of 0.1 weight % or more". Before that asbestos products had
been defined as the materials containing asbestos of 1 weight % or more. Therefore, the
measurement method is urgently required to judge if asbestos is at the level of 0.1 weight %
or more. The methods were issued in August 26, 2006\textsuperscript{9-10}. At the present, a XRD method and
phase contrast microscopy using dispersion staining objective lens are employed for the
certification method for constructing materials and other industrial products\textsuperscript{8}. For natural
minerals only XRD method is employed for the judgment\textsuperscript{9,10}.

Two days before the issue of the Ordinance of asbestos (June 29, 2005), an asbestos
disaster was disclosed to media by a company, which was an ex-asbestos company in
Amagasaki, Hyogo Prefecture, Japan. The disaster was that some residents who have or had
lived in surrounding area of the ex-asbestos factory were found as mesothelioma in addition
to some workers and their families in the company. The ex-asbestos factory had produced
cement water pipes using crocidolite asbestos for 20 years from 1955 to 1975. As those days
there were not severe regulations to control asbestos use, the working environments using
asbestos would be very poor. These mesotheliomas of general residents were obviously due
to the exposure of the crocidolite asbestos being dispersed from the factory in the company
in olden days of about 30-50 year ago. After a long incubation of 30 to 50 years, the asbestos
related disease, mesothelioma, has become obvious in these days. Lung cancers due to
asbestos exposure should also be occurring in the residents near the factory. Following the
press conference by the company in June 29, 2006, the asbestos disaster quickly became a
social problem and the counter-measures of asbestos problems have taken into action in
every government and organization now. For example, the Ministry of Environment issued a
new law 'Asbestos Health Damage Relief' in February 10, 2006. The law aims to provide swift
relief to those who suffer from health damage caused by asbestos exposure, such as asbestos
lung cancer and mesothelioma\textsuperscript{11}.

We can see realities of companies from the facts mentioned above, i.e. if there are no
severe regulations to control working environments, the owners and/or persons in charge
do not pay money for improvement or reform of the conditions of working environments, and
the workers in such companies have to work under a poor and hazardous condition. Consequently the companies produce occupational diseases in the workers who exposed to
some hazardous substances and/or factors during works.
Fortunately, a regulation to control working environments, "The Working Environment Measurement Law", has been enacted since 1975 and we would not see like the disaster mentioned above due to the effect of the regulation after this. A new regulation was issued in 2006, i.e. "Ordinance on Prevention of Hazards Due to Asbestos", for asbestos problem in future to prevent new asbestos exposure of construction workers. We should watch and care the actual state under the rule hereafter.

Conclusion

The current control system of working environment employing static sampling and statistical evaluation method has clearly improved the working environment and decreased occupational disease in Japan. However, it has also been insufficient for some workplaces such as welding and demolition works as well as works in buildings in which asbestos had been used in place. We should study to improve the ways to recover these deficits. An ordinance to prevent hazards due to asbestos was enacted in 2005.

In conclusion, the control system of working environment being conducted in Japan is very effective as the first step to improve working environment. After working environment adequately improved, the control system which monitors the exposure level of individual workers would become more important to prevent further occupational diseases in the workers who engage in welding works and in demolishing and repairing of buildings.

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References

1. Japan International Center for Occupational Safety and Health (JICOSH):
2. Koshi S: A basic framework of working environment control for occupational health in Japan, Industrial Health 34, 149-165 (1996)


