New Training in Safety for Core Engineers in Sumitomo Chemical

Sumitomo Chemical Co., Ltd.
Process & production technology center
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FE (Fire & Explosion) Training has been carried out as a new practical training course for all core engineers at Sumitomo Chemical since January 2007. It aims to develop the engineers' knowledge of safety and disaster prevention, and sensitivity to danger in the chemical industry so that they can complete safe and stable operations in all factories and safe work in all laboratories. The training curriculum makes them safely experienced about the danger of fire and explosions. Every trainee will gain sure and practical knowledge supported by the experience.

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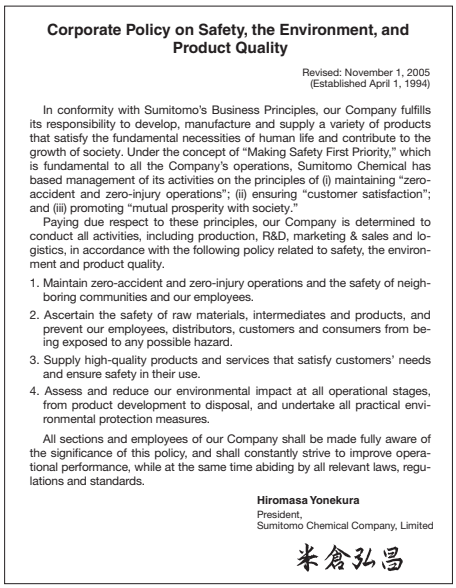
Introduction

At Sumitomo Chemical Co. Ltd., we have formulated a Corporate Policy on Safety, Environment and Product Quality which states that safety, the environment and product quality are factors which are to be given the highest priority in all aspects of our business activities. This policy is communicated to all departments and all of the employees in our company and to all companies in the Sumitomo Group both within Japan and overseas so that everyone in the Sumitomo Group can be aware of the policy without exception (**Fig. 1**).[1)] In addition, we have also formulated a Corporate Policy on Safety, Environment and Product Quality as part of the responsible care activities which are an essential part of fulfilling our corporate responsibilities and in ensuring that our business activities are carried out smoothly (**Fig. 2**)[1)]. Our company policies for safety and disaster prevention are directed at maintaining a safe working environment which is accident-free and disaster-free, and also at carrying out comprehensive risk management over the whole life cycle of products from development, manufacturing and distribution through to waste disposal in order to ensure the safety and health of our employees and the local region while also preserving the global environment.



Corporate Policy on Safety, the Environment, and Product Quality

Revised: November 1, 2005
(Established April 1, 1994)

In conformity with Sumitomo's Business Principles, our Company fulfills its responsibility to develop, manufacture and supply a variety of products that satisfy the fundamental necessities of human life and contribute to the growth of society. Under the concept of "Making Safety First Priority," which is fundamental to all the Company's operations, Sumitomo Chemical has based management of its activities on the principles of (i) maintaining "zero-accident and zero-injury operations"; (ii) ensuring "customer satisfaction"; and (iii) promoting "mutual prosperity with society."

Paying due respect to these principles, our Company is determined to conduct all activities, including production, R&D, marketing & sales and logistics, in accordance with the following policy related to safety, the environment and product quality.

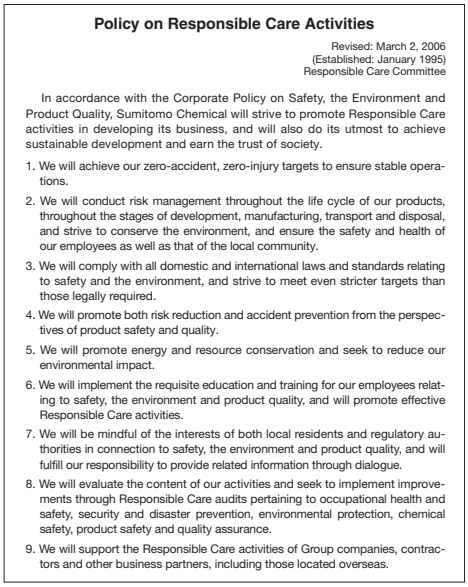
1. Maintain zero-accident and zero-injury operations and the safety of neighboring communities and our employees.
2. Ascertain the safety of raw materials, intermediates and products, and prevent our employees, distributors, customers and consumers from being exposed to any possible hazard.
3. Supply high-quality products and services that satisfy customers' needs and ensure safety in their use.
4. Assess and reduce our environmental impact at all operational stages, from product development to disposal, and undertake all practical environmental protection measures.

All sections and employees of our Company shall be made fully aware of the significance of this policy, and shall constantly strive to improve operational performance, while at the same time abiding by all relevant laws, regulations and standards.

Hiromasa Yonekura
President,
Sumitomo Chemical Company, Limited

米倉弘昌

Fig. 1 Corporate Policy on Safety, Environment, and Product Quality



Policy on Responsible Care Activities

Revised: March 2, 2006
(Established: January 1995)
Responsible Care Committee

In accordance with the Corporate Policy on Safety, the Environment and Product Quality, Sumitomo Chemical will strive to promote Responsible Care activities in developing its business, and will also do its utmost to achieve sustainable development and earn the trust of society.

1. We will achieve our zero-accident, zero-injury targets to ensure stable operations.
2. We will conduct risk management throughout the life cycle of our products, throughout the stages of development, manufacturing, transport and disposal, and strive to conserve the environment, and ensure the safety and health of our employees as well as that of the local community.
3. We will comply with all domestic and international laws and standards relating to safety and the environment, and strive to meet even stricter targets than those legally required.
4. We will promote both risk reduction and accident prevention from the perspectives of product safety and quality.
5. We will promote energy and resource conservation and seek to reduce our environmental impact.
6. We will implement the requisite education and training for our employees relating to safety, the environment and product quality, and will promote effective Responsible Care activities.
7. We will be mindful of the interests of both local residents and regulatory authorities in connection to safety, the environment and product quality, and will fulfill our responsibility to provide related information through dialogue.
8. We will evaluate the content of our activities and seek to implement improvements through Responsible Care audits pertaining to occupational health and safety, security and disaster prevention, environmental protection, chemical safety, product safety and quality assurance.
9. We will support the Responsible Care activities of Group companies, contractors and other business partners, including those located overseas.

Fig. 2 Policy on Responsible Care Activities

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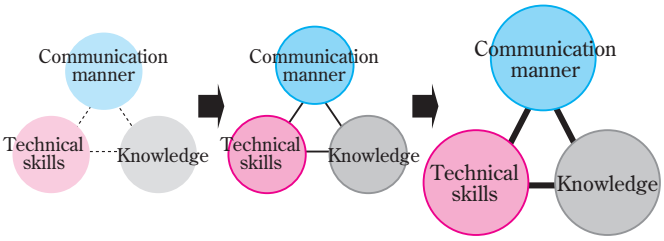
In order to ensure that safe and stable work practices are carried out in production departments and that the procedures followed in the research and development departments are safely followed, each and every one of our employees working in these departments receives thorough training in knowledge of safety and disaster prevention and sensitivity to hazards, otherwise if the employees do not have this knowledge and sensitivity to hazards, it would be very difficult to maintain safety in the workplace. In addition, as our company faces the modern-day prospect of large number of mandatory retirements of people born during the post-war baby boom, it is becoming necessary to nurture a new generation of engineers to provide them with practical knowledge in safety and disaster prevention[2]. Further to this, higher levels of control technology for ensuring safe work practices at chemical plants and stable results in safety management over long periods have meant that people are experiencing far fewer disasters and abnormal situations in the production workplace. In light of the present situation resulting from factors such as the above, it is not difficult to provide extensive safety education for new employees serving in production workplaces as well as engineers and researchers in production departments and research and development departments simply through classroom-based education, and it is becoming increasingly necessary to include experiential training in order to improve employees' sensitivity to an knowledge of hazardous situations. Sumitomo Chemical has implemented a practical experiential education and training system for hazardous situations which allows our employees to experience situations involving dangerous accidents in a safe environment in order to extend their knowledge of such situations.

Sumitomo Chemical's Experiential Education Systems

The main experiential education systems at Sumitomo Chemical include new worker training courses and experiential FE (Fire & Explosion) training courses. During any given training session, a specified number of trainees from different workplaces are selected for the course by the General Affairs departments (Ehime Factory and Oita factory) and by the Personnel Department's HR Development Center, and they participate in a group training session for a set length of time.

1. New worker training (carried out at Ehime and Oita factories)

The training curriculum for the new workers who are assigned to a particular workplace aims to train the workers to become operators who can faithfully carry out basic operations by understanding basic rules and principles. The previous training programs which centered around classroom learning have been revised to create a two-week program of training in basic operations and role recognition through training and practice include thorough repeat training centering on the basic factors for on-site job safety in the production workplace and by doing the same tasks that are carried out daily in the workplace. The curriculum is made up



Repeat training everyday
⇒ Thoroughly getting into three basic factors for on-site job safety

Fig. 3 New worker training course

Fig. 4 Experiential training how to handle piping trouble safely for inexperience operators

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of experience and sensitivity training exercises based on the three main factors involved in basic operations and role recognition in the workplace, namely are "Communication manner", "Technical skills" and "Knowledge" (**Fig. 3**). In addition, the basic operations used in technical training utilize methods of finding out (understanding) the hazards of doing something which should not be done (and what will happen if you do it). **Fig. 4** shows a simulation of a problem involving supply pipes which might occur in the workplace.

2. FE (Fire & Explosion) experiential training

This course was commenced in January 2007 as a means to provide training in safety and disaster prevention with respect to fires and explosions in chemical factories for supervisors, engineers and managers who are employed in core duties in production departments and research departments throughout the whole company. This course is conducted jointly by the Personnel Department's HR Development Center and the Safety Engineering Laboratory of the Process & Production Technology Center. In addition, this course follows a comprehensive curriculum which combines classroom learning sessions which are then linked into comprehensive practical experience in the workplace, so that the trainees can acquire thorough understanding of hazard prevention based on direct experience.

The course participants utilize the knowledge and the greater levels of sensitivity to hazards which have been acquired during this training to extract potential safety problems in their workplaces which may have been previously difficult to identify, and to propose improvements to both hardware and software aspects of disaster prevention in order to solve such problems. It also aims to provide means of carrying out preventative measures to eliminate accidents caused by explosions and other workplace problems by employees acting on instructions received from their departments and passing on their knowledge to their co-workers. The programs which are used in the course are developed by the Safety Engineering Laboratory of the Process & Production Center. Following is an outline of this FE experiential training.

Training Facilities for FE Experiential Education

A new FE Experiential Training Center which is equipped with all the materials and facilities which are required in our FE experiential training has been established at our Ehime factory as a special center for carrying out group training safely and effectively (**Fig. 5**). The FE Experiential Training Center includes a variety of special-purpose training facilities, including laboratories where experiential training can be carried out in the various categories in the curriculum which is described in more detail below, and also lecture rooms where trainees can undertake classroom training. In addition, the trainees can be divided up into small groups for rotation through different categories in the course, so that one group can receive practical training while the other receives classroom training. An upper limit is imposed on the number of trainees which make up these smaller groups, so that each trainee can gain a positive sense of participation in the activities. The practical training laboratories are also designed on a scale that allows the trainees to get closer to the action they are participating in so that they can gain a better understanding of it.

Fig. 5 The Experiential FE(Fire & Explosion) Training Center

Procedures for Experiential FE Education and Group Training

1. Training procedures

At Sumitomo Chemical, safety evaluations are carried out at each separate stage, from process research and development through to design and construction of the plant, operation and maintenance, and finally to disposal of waste materials, and all employees strive to finish the task to completion without any accidents or disasters occurring[3]. In order that evaluation of the hazards of various processes can be carried out correctly at each stage, internal company disaster-preven-

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tion guidelines have been formulated and put into book form, and these guidelines are distributed to all departments within the company (**Fig. 6**). During FE experiential training, (the most fundamental and important guidelines such as those for electrostatic hazards, incompatible hazards, chemical processes) and (safety book for accident-related problems) are selected from the internal disaster-prevention guidelines and used as learning materials.

Fig. 6 The Company's Internal Disaster-prevention Guidelines

The flow of training is organized so that firstly, the trainees need to study the company's internal disaster-prevention guidelines by themselves before the course takes place (for about two months), and then they give themselves a self-check test to ensure that they have reached a certain level of understanding. After this they proceed to group training (classroom-based and laboratory-based) at the Training Center.

Further to the above, once the group training is complete, the results of the training are evaluated in a follow-up report dealing with the safety aspects of the trainee's own workplace. This then completes the training course (**Fig. 7**).

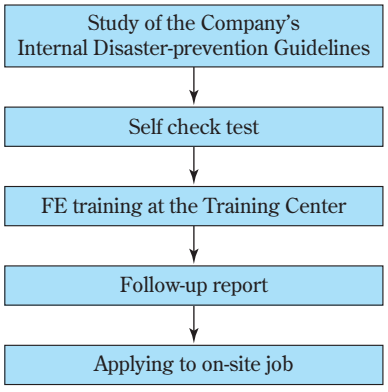

Fig. 7 Flow of the Experiential FE Training

2. Group training

Group training follows a curriculum which is made up of several categories (including "Incompatible hazards", "Ignitability and combustibility and dust explosions" and "Electrostatic hazards"), and it covers two days of combined classroom lectures and practical training.

(1) Classroom lectures

During classroom lectures, several examples of accidents which can occur in each category classification and the methods of evaluating their hazards, safety measures and learning exercises are presented. During this time, a teaching format involving discussion and quizzes between the lecturer and the trainees is adopted, so that the trainees do not become passive during the lecture.

By using this type of lecture format, an active exchange of opinions can occur and important information can be shared between the trainees and the lecturers and among the trainees themselves (**Fig. 8**). In addition, the lecturers are taken from members of the Safety Engineering Laboratory of the Process & Production Center, in case the trainees have any questions about safety in their own individual workplaces, or if they have questions about safety in anything they have observed during the training. Trainees themselves have given the following opinions about these types of classroom lectures, and from these opinions it is clear that the adoption of a discussion format is an effective way to gain knowledge.

Fig. 8 A scene of the lecture

- Because the classes make progress with the discussion format, concentration improves, the classes become more interesting, and retention of information becomes stronger, so it is a good format.

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- Discussion involving the giving of examples and explanations allows us to think about things while learning, and I feel this makes learning smoother and deepens our understanding.
- During classroom lectures, the lecture asks questions for the trainees, so that the trainees can keep the tension.
- The trainees learn by grouping together and thinking about what they are hearing.
- It's good that we can receive answers to our questions straight away. We can use the answers as a reference to consider safety measures.

(2) Practical training

1) Aims

For FE experiential training, learning materials are prepared based on the several aims contained in the curriculum so that trainees can experience safety according to the following themes.

- Incompatible hazards: To gain an understanding of evaluation methods for incompatible hazards. To experience incompatible hazards for substances being handled.
- Electrostatic hazards and gas explosions: To gain an understanding of different static electric phenomena. To nurture the ability to discover potential electrostatic accidents before they happen and to be able to take suitable safety measures by directly experiencing static charges and sparks.
- Ignitability and combustability: To gain a practical understanding of ignition and combustion phenomena when handling combustible materials in the workplace and nurture the ability to take suitable safety measures by directly experiencing the hazards relating to handling temperatures and flash points.
- Dust explosions: To gain an understanding of dust explosions. To nurture the ability to improve sensitivity to hazards involved with the handling of powders and to be able to take suitable safety measures by directly experiencing dust explosions.
- Thermal stability: To gain an understanding of the importance of and safety measures for cooling systems. To nurture the ability to take suitable safety measures by experiencing thermal runaway.

2) Details of practical experiential training

Some of the main training aspects are explained in more detail below. As a general rule, actual work procedures, actual tools and actual equipment and materials used within a chemical factory are employed during training.

(i) Hazards of static electric charge buildup when transferring flammable liquids

As an example, trainees experience a practical situation whereby a non-grounded stainless steel funnel is used to transfer a highly-flammable solvent (18L or less) from a pail into an insulated plastic container, and the electrical potential of the funnel increases and a spark is discharged, causing flammable gases to ignite (**Fig. 9**). This practical training gives the trainees an understanding of the crucial importance of grounding the funnel (conductor) for reasons of safety. In addition, they can calculate the amount of accumulated energy from the results of voltage measurement at the funnel and the level of electrostatic capacity, and compare this to the minimum ignition energy required to ignite the flammable gas, so that the reasons for the ignition can easily be explained quantitatively.

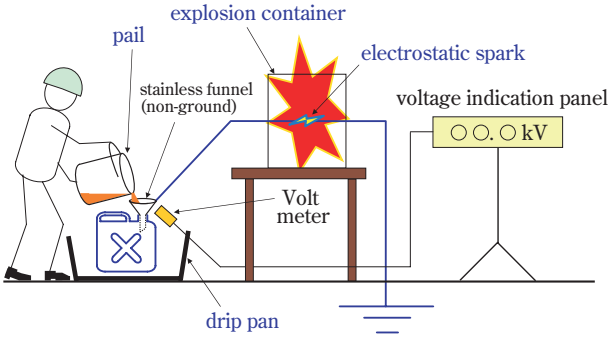

Fig. 9 An example of explosion training by static electricity

(ii) Hazards of dust explosions

In recent years there has been an increase in the diversity of processes within chemical factories that utilize powders as raw materials, intermediate products and final products, and there have also been increases in the amounts of such powders used, and this has given rise to greater level of anxiety about the increase in potential hazards from dust explosions[4]. But even despite this, workers still have almost no chances to gain experience of dust explosions. Therefore, by observing the circumstances whereby dust explosions can occur, trainees can gain direct experience of the instances where dust explosions are generated and the

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magnitude of the force of such explosions (**Fig. 10**). In addition, the trainees also have an opportunity to use samples of the powders which they handle in their own workplaces, so that they can receive a direct re-appreciation of the potential hazards of the powdered materials around them.

Fig. 10 An experiment of dust explosion

(iii) Incompatible hazards

Incompatible hazards occur when two or more substances, principally liquids, are mixed together, and heat is generated from the mixing, or sometimes a chemical reaction occurs leading to the hazard of fire or an explosion, thereby resulting in greater hazard than from the original substances by themselves[5]. Of the 88 outbreaks of fire which occurred during the Great Kanto Earthquake, 69 of them are believed to have been caused by incompatible hazards, and recently 23 people including drivers and passers-by were injured when a tanker carrying hydrogen peroxide exploded on the Shuto Expressway in Tokyo. As such incidents demonstrate, there are important problems which cannot be neglected in the handling of chemical materials, including storage and transportation[6]. During experiential training, the trainees mix hydrogen peroxide with a catalyst in an environment where safety is maintained, in order to reproduce the chemical reaction which occurred during the tanker accident. By using the experimental equipment for this experiential training, trainees can safely experience a wide variety of incompatible hazards not limited to this single example.

Educational Results of Experiential FE Training

The educational results of experiential training are analyzed by means of surveys of the trainees which are taken after the group training sessions are complete, as well as by the contents of follow-up reports. Following is a summary of the types of results.

1. Questionnaire results

Questionnaires show the changes in the trainees' levels of understanding before and after the training course and record their opinions of the training. Evaluating the levels of understanding are done by assigning one of five levels to the trainees before and after the training, starting from 1 (before training: absolutely no knowledge; after training: did not understand the course at all) through to 5 (before training: already had a good understanding; after training: understands thoroughly and can help in training others), and these levels can be used by the trainees to evaluate how they think their levels of understanding changed. The average values for the changes in the levels of understanding before and after training are shown in **Table 1**.

These results show that the average improvement in the levels of understanding for managers and specialists was from 1.7 to 1.9 in the areas of electrostatic hazards and gas explosions, incompatibility hazards and thermal stability, and ignitability, combustibility and dust explosions, and shows that the trainees felt that they had progressed in their acquiring of knowledge dealing with such hazards. In addition, some of the

Table 1 Mean value of each categories' knowledge step-up by self estimation after the FE Training

	Managers	Specialists
Electrostatic hazard Gas explosion	1.7	1.8
Incompatible hazard Thermal stability	1.7	1.9
Ignitability and combustibility Dust explosion	1.7	1.8

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opinions of the trainees regarding their training are also given here, and these showed that their understanding of safety aspects had improved after the training, and that experiential learning during the training fitted together well with the classroom-based learning and enabled them to learn smoothly.

- Normally "Hazard" is something you only learn in a classroom, and you can't get a clear image of it, so being able to see and experience the effects of reactions directly is a very good way to get a clear image of what happens.
- Experiential training lets us experience things visually and directly, so it makes the training very easy to understand.
- I feel very strongly that the parts of this training which were learnt by experiencing contained extremely important knowledge and experience for carrying out work safely. I intend to use the knowledge and experience I have gained from this training to help make my workplace a safer and more stable environment.
- The classroom training and experiential training went very well together and made the course extremely easy to understand.

2. Follow-up reports

Follow-up reports are used to analyze the hazardous categories that require particular attention in order to maintain safety in the trainees' own workplaces based on the knowledge and experience they have gained from the training (**Fig. 11**). The results show that for managers and specialists alike, the hazards of static electricity are the ones that require the greatest deal of attention. Static electricity is a phenomenon which is difficult to ascertain visually, but through the training which provides thorough experience and knowledge, the trainees can take more positive steps to deal with the hazards than they could previously, and they feel that they are much better able to maintain safety in their workplaces because of this.

3. Identifying potential hazards in the workplace and sharing disaster-prevention information

There has been discussion from the trainees who have participated in the training courses about where there are any hazards from fire caused by static electric discharges from the tools used for cleaning away powder residues in their workplace. This question arose as a result of the increased sensitivity to hazards resulting from having undergone experiential training, and is a good example of the attention being paid to potential hazards that exist in the workplace. Safety Engineering Laboratory's members who received this question considered the problem individually and decided that an evaluation (experiment) would be the best way to determine whether the hazard was real, and so together with the trainees, they conducted an experiment to evaluate the static electricity in this situation. In ways such as this, the knowledge which the trainees have acquired by means of their FE training can be utilized to take another look at the conditions in the production sites and laboratories where they work and to discuss their opinions with us, so that any necessary countermeasures can be proposed and information can be shared with other areas of the company and with related companies more effectively (**Fig. 12**). In addition, experiential training is further strengthened by links between factories, research departments and the safety

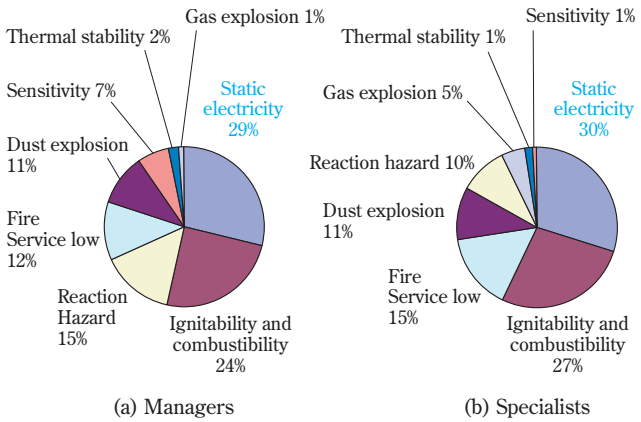

Fig. 11 Percentage of the follow-up report categories by managers and specialists

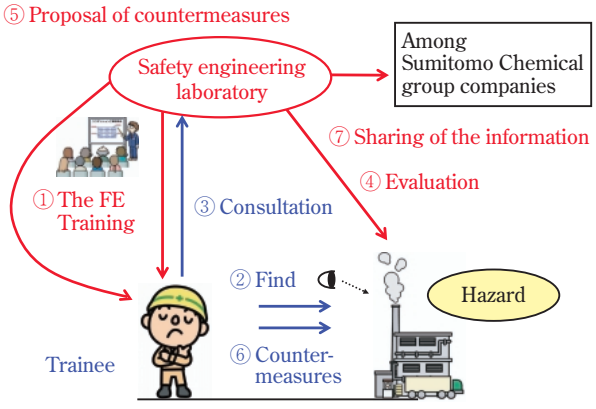

Fig. 12 The effect acquired from the FE Training

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engineering laboratory to make the identification of potential hazards and the formulation of disaster-prevention countermeasures more effective and to allow the company to carry out its duties of responsible care to the fullest.

Future Topics and Directions

Experiential FE training started in January 2007, and by the end of 2007 a total of 341 company employees had undergone training. However, as Ebbinghaus mentions, human beings are living creatures who easily forget, and their memories fade as time progresses[7]. This is also true for trainees who have undergone experiential FE training, that the sensitivity and knowledge which they have gained through the experiential training will tend to fade over time. Accordingly, in order to address this and also to maintain their sensitivity and knowledge at high levels, we are planning to repeat the experiential FE training at a frequency of once every five years (**Fig. 13**). In addition, in order to make the training more effective, it is important to create a much fuller body of educational materials for allowing trainees to safely experience the hazards which can occur in the workplace. To help achieve this, we are also intending to revise and improve existing experiential training materials.

Finally, in order to maintain safety in the workplace at Sumitomo Chemical and related companies, our employees and the employees of related companies will continue to undertake experiential FE training regularly and without delay so that they can maintain high levels of knowledge of and sensitivity to disaster-prevention measures in the future.

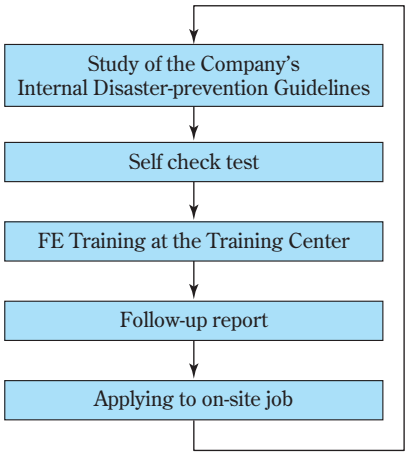

Fig. 13 The Cyclic Experiential FE Training for the training plan

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