Management of Chemical Substances Contained in Products

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The Fujitsu Group has promoted such progressive activities as the new development of lead-free solder for managing restrictions on hazardous substances contained in products ever since the EU's RoHS Directive was enacted in 2003. In recent years, RoHS-like regulations have been enforced also in Japan, China, and South Korea, along with a trend toward new regulations being enacted in various countries and regions such as in North America. As a result, a growing number of restrictions are being imposed worldwide on hazardous substances in products. The scheme to systematically ensure and promote the non-containment of restricted chemical substances is very important in order to properly comply with worldwide regulations governing the chemical substances contained in products. This paper introduces Fujitsu Group's internal organization, management method, and other specific measures that have been established to address restrictions on hazardous substances in products, with regard to the management of chemical substances contained in products that we have been implementing.

1. Introduction

In the conventional system, the mainstream regulations concerning chemical substances have been the laws controlling the chemical substances themselves such as the "Chemical Substances Control Law" and "Law concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management" and the regulations controlling pollution to prevent it from directly harming people and the environment such as the "Air Pollution Control Law" and "Water Pollution Control Law".

In recent years, hazardous substances contained in waste products that are disposed in an illegal manner or processed in an inappropriate manner have attracted public attention as a source of environmental pollutants. Therefore, the EU started to integrate the concept of a "precautionary principle" in regulations related to chemical substances. This precautionary principle is a concept that requests the establishment and/or revision of regulations when there is a risk of chemical substances having a serious effect on people. Namely, it is a concept to control the chemical substances contained in equipment in advance so as to prevent leakage of hazardous substances even if they are illegally disposed of. Based on this concept, regulations such as the RoHS Directive[note 1)] and the ELV Directive[note 2)] were established. The RoHS Directive restricts the use of four heavy metals (lead, mercury, cad-

note 1) Abbreviation of Restriction of the use of certain hazardous substances in electrical and electronic equipment. An EU directive regulating the specific hazardous materials contained in electric and electronic equipment.

note 2) Abbreviation of End of Life Vehicles. An EU directive regulating the specific hazardous materials contained in materials and components of vehicles as well as the recycling rate of the end of life vehicles.

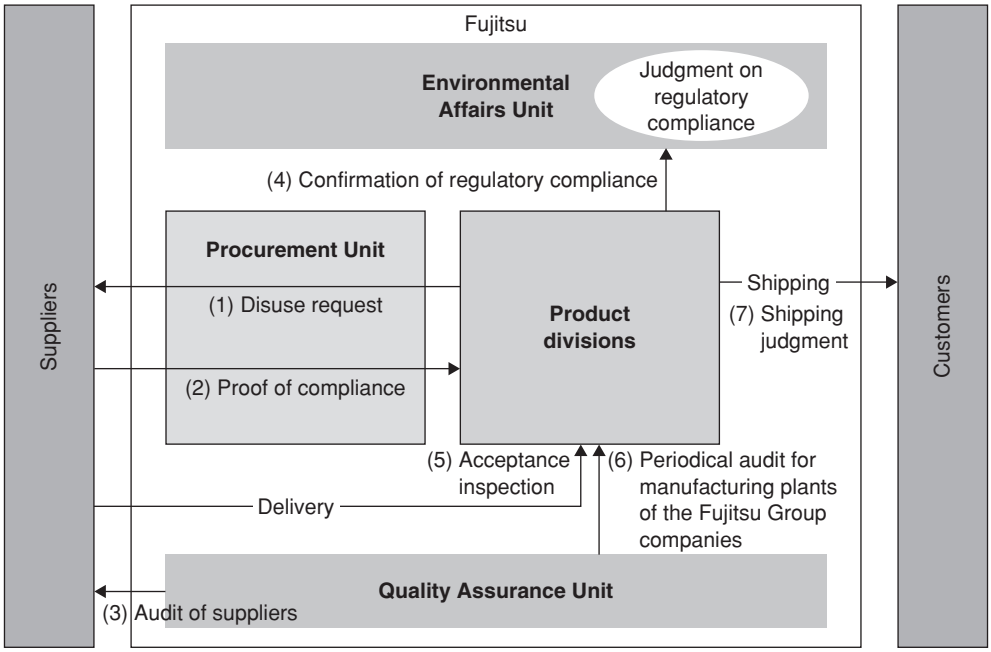

Figure 1
Framework of management of chemical substances contained in products.

mium, hexavalent chromium) and two brominated flame retardants (polybrominated biphenyl [PBB] and polybrominated diphenyl ether [PBDE]). To comply with the RoHS Directive and other regulations applicable to electrical and electronic equipment, conducting source control to check for regulated substances contained in the purchased components and materials plays an important role.

This paper introduces the unique approaches for management of chemical substances contained in products made by the Fujitsu Group.

2. Framework of management of chemical substances contained in products

As indicated in **Figure 1**, the Fujitsu Group has established a system appropriate for organizational activities comprised of the Quality Assurance Unit, Procurement Unit and Environmental Affairs Unit while centering on Product divisions responsible for product-related matters. The Group's environmental efforts have been promoted based on this system since December 2005.

Details of the framework are described below:

1) Disuse request

Product divisions request suppliers to control the regulated substances in components and materials to be used for products so that the composition of each of these chemical substances is lower than the predetermined level. To be specific, all the design drawings for components and materials comprising the products have descriptions on the requirements regarding the applicable regulated substances.

2) Acquisition of proof of compliance

Product divisions obtain proof of compliance from suppliers to address the disuse request for non-containment of regulated substances.

3) Audit of suppliers

Quality Assurance Unit performs audits on suppliers. Audits are conducted on a company basis, because the Fujitsu Group considers it essential that a supplier, as a company, should have

a mechanism or system that allows submission of proof of compliance in an appropriate manner. The details of the audits are based on the "Guidelines for the Management of Chemical Substances in Products"[1] established by JGPSSI.[2),note 3] To identify a management system for controlling regulated substances, audits are carried out on the management policy, standards and on-site system for addressing the requirements, and the suppliers are encouraged to make improvements, if necessary.

4) Confirmation of regulatory compliance

Environmental Affairs Unit obtains proof of compliance for all the components and materials used for the products concerned from the product divisions to confirm that audits on all the suppliers concerned have been duly completed.

5) Acceptance inspection

Product divisions inspect actual components and materials delivered by suppliers in sampling inspections.

6) Periodical audit for manufacturing plants of the Fujitsu Group companies

Quality Assurance Unit performs audits to determine if there is any system to prevent mixing of regulated substances during the suppliers' production process.

7) Shipping judgment

Product divisions confirm that all the factors mentioned in 1) to 6) are appropriately implemented as a part of shipping judgment to decide whether shipping can be conducted.

The main characteristic of this framework is the integration of a procedure to ensure compliance with RoHS Directives into the conventional product development procedures, so that the designers can develop and/or design products while giving sufficient consideration to compliance with RoHS Directives.

note 3) Abbreviation of Japanese Green Procurement Supply Survey Initiative. It is a consortium comprised of leading manufacturers of electric and electronic equipment, organized to promote harmonized approaches to green procurement.

Another characteristic is the judgment and evaluation made from multiple aspects such as components, materials and companies when judging and evaluating components and materials that the suppliers deliver in accordance with the requirements of the Fujitsu Group.

From the next section, several topics on specific activities carried out by the Fujitsu Group are described.

3. Efficient verification based on Containment Probability Chart

The RoHS Directive stipulates the maximum concentration values of a homogeneous material. Therefore, control of applicable substances should be conducted for each part of a component. To cite an example of a part-wise breakdown of a component, a cable is considered to have elements such as a coating, copper wire, shield and plating part. Thinking of a unit using these elements, an enormous number of positions should be verified. To carry out such a verification efficiently, the Fujitsu Group has developed a "Containment Probability Chart"[3] (**Figure 2**) that allows part-wise as well as regulated substance-wise determination of the containment probability for each regulated substance.

By using this Containment Probability Chart, parts with higher containment probability are identified during the specification process in which components and materials used for the product are examined. This method is an efficient way of verifying whether or not a product contains any regulated substances, and helps to minimize the probability that it does.

4. Information collection from supply chain and data management

Most electrical and electronic equipment manufacturers make products by using components and materials purchased from their suppliers. Accordingly, to understand the status of regulated substances contained in their products,

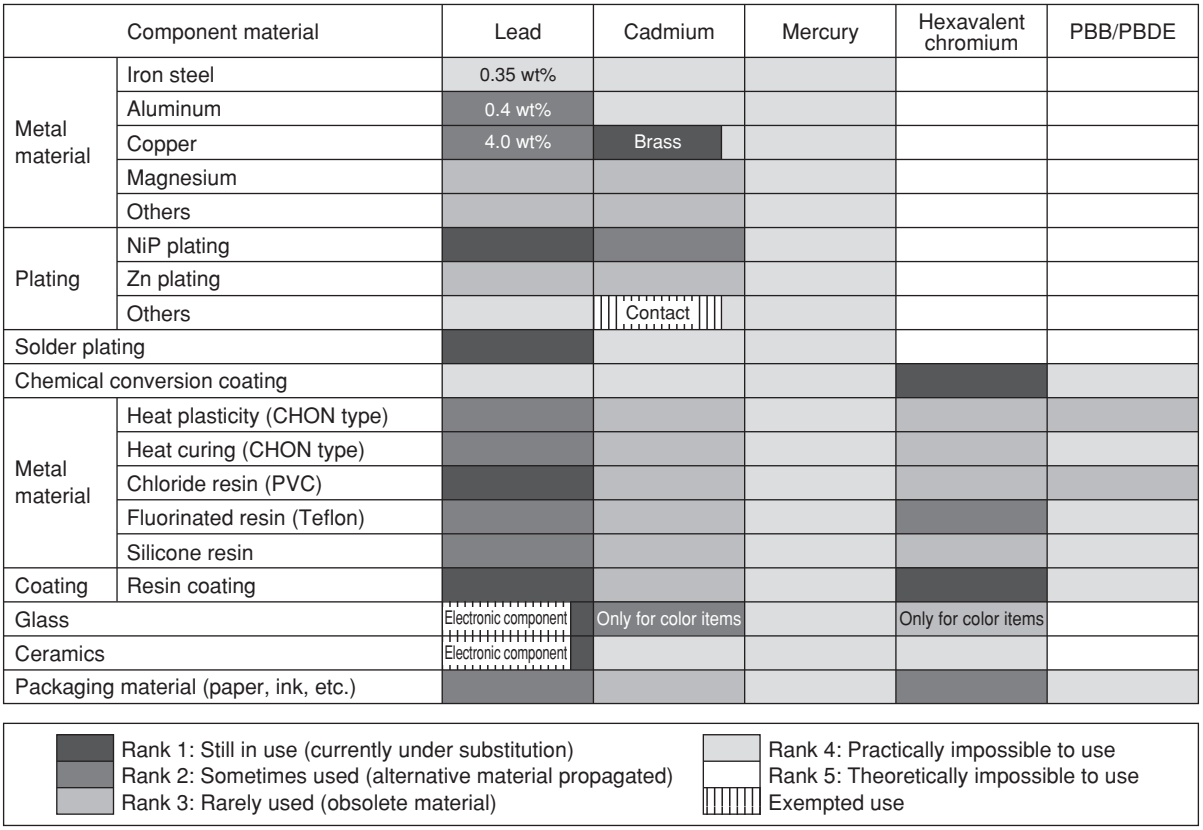

Figure 2
Containment Probability Chart for RoHS-prohibited substances in various materials.

it is essential to collect information through the supply chain. The Fujitsu Group also actively uses a JGPSSI survey format, which is a common survey format in the electrical and electronic equipment industry.

For regulations such as the RoHS Directive that stipulates the maximum concentration values of substances, we need to control the containment level of each product. Namely, we must understand the level of each regulated substance contained in a purchased product within the framework of the above-mentioned management of chemical substances contained in products.

If such a survey of contained chemical substances is carried out by each company without agreeing on any unified format or surveyed substances, there will be serious confusion among suppliers, which will make it difficult to collect information. Therefore, industry-wide tie-ups are indispensable.

The Fujitsu Group uses a unique database system called GIDB[note 4)] with the following advantages to centrally control the information on contained regulated substances obtained from suppliers.

1) Unilateral control of data ranging from a request for a component and material survey to the suppliers' response can be conducted.
2) Regulated substances contained in Fujitsu's products are tabulated, which allows easy evaluation of the status of compliance with laws and regulations such as the RoHS

note 4) Abbreviation of Green Information Data Base. The database for chemical substances contained in items purchased by the Fujitsu Group.

Directive and allows us to meet the customers' requests for green procurement.

3) Because Fujitsu collects data on contained substances other than those regulated by the RoHS Directive by using the JGPSSI survey format, when a new chemical substance is regulated, it is easy to understand which components of products contain that substance. Accordingly, this database can be used as a convenient tool for examining alternative materials.

Such intra-company know-how is summarized in a software package called "PLEMIA/ECODUCE".[4] This environmental information control system PLEMIA/ECODUCE not only allows the input and output of data files based on the JGPSSI survey format but also provides linkage to IMDS,[note 5] which is a data collection system for the component materials and contained substances used in the automobile industries. PLEMIA/ECODUCE is used as a tool for controlling contained chemical substances in many companies in various industries.

5. Development of analysis technology

Analysis is performed as a tool to verify reliability of the information obtained from suppliers or a procedure performed by suppliers themselves to guarantee the non-containment of certain substances. The Fujitsu Group has established and published an efficient method of analysis as "Guidelines Regarding Non-containment Management on Hazardous Substances Specified by Fujitsu Group"[5] while giving consideration to the regulatory requirements and the latest trends of international standards. Besides, Fujitsu has developed some new analysis technologies in the fields where highly accurate analysis was impossible with conventional analysis methods. These new technologies are described below.

5.1 Highly accurate analysis technology for hexavalent chromium

In the conventional method, the presence of chromium element is determined, first of all, by conducting screening analysis based on energy dispersive X-ray fluorescence spectrometry. If chromium element is detected, elution is carried out by using official methods such as the boiling-water extraction method (based on JIS H8625 Annex 2), or the alkaline extraction method (based on EPA 3060A) in most cases, followed by quantitative procedures such as absorptionmetry or ion chromatography. However, because this method involves some challenges as shown below, a method to detect hexavalent chromium in the state of a chromate film was necessary:

1) Complete extraction of hexavalent chromium contained in chromium film
2) Prevention of valency in hexavalent chromium during extraction process (hexavalent chromium⇔trivalent chromium)
3) Countermeasure against interference by coexisting substances

In September 2005, Fujitsu established an analysis method[note 6] with highly accurate reproducibility by using radiation analysis (XANES stands for X-ray Absorption Near Edge Structure).[6] By using this method as a quantitative standard and calibrating quantitative values obtained by general chemical analysis, the abovementioned challenges can be overcome and highly accurate measurements of hexavalent chromium based on chemical analysis can be achieved. Besides, some other methods of analyzing hexava-

note 5) Abbreviation of International Material Data System. The system to collect data on about 30 000 components for vehicles and the chemical substances included in those components.

note 6) Nondestructive measurement using peak of X-ray absorption spectrum for the wavelength characteristic specifically to hexavalent chromium by using electromagnetic waves (X-rays) which are generated when the moving direction of an electron moving in a straight line at the speed of light is changed with a magnet or in some other way.

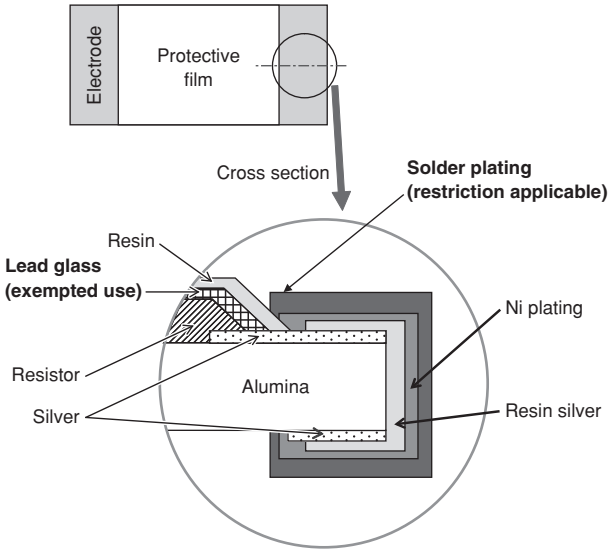

Figure 3
Example of cross section of electrode in chip resistors.

lent chromium such as Raman spectroscopy[note 7)] were reviewed. In any case, to achieve efficient and highly accurate analysis, it is essential to choose the most suitable method and conditions for analysis depending on the object, purpose and situation of the each analysis.

5.2 Highly accurate and easy analysis technology for electrode solder plating

With the chip resistor indicated in **Figure 3**, the lead contained in lead glass used for protective films and film resistors has been approved for use as an exempted use based on the RoHS Directive in the conventional provisions. On the other hand, a restriction is applied for lead used in the electrode solder plating adjacent to the film. In the conventional method, however, highly accurate and efficient analysis for electrode solder plating has been difficult, because a chip resistor is comprised of multiple materials and the structure of electrode solder plating is particularly complicated because there are many thin layers.

In September 2007, Fujitsu developed a method to efficiently analyze the lead in solder plating by using some X-ray fluorescent spectrometry equipment.[7)] In this method, the solder plating section of the component is polished with a plastic lapping film and solder plating in powder form attached to the film is used as the measurement specimen together with the film. This method allows a component to be analyzed without such analysis being affected by the lead in the scope of exempted use.

Further, because this method can be used with widely-used X-ray fluorescent spectrometry equipment and inexpensive films without using any special tools, it is an economical, speedy and highly accurate analysis method in production sites as well as in places where purchased items are accepted.

6. Conclusion

In this paper, the commitments and unique activities concerning management of chemical substances contained in products by the Fujitsu Group were introduced. These activities have been initiated and promoted by the Fujitsu Group to meet the EU RoHS Directive. In recent years, RoHS-like regulations have been enforced also in Japan, China, and South Korea, along with a trend toward new regulations being enacted in various countries and regions. Further, in 2007, REACH[note 8)] was enacted in Europe as a new policy for chemical substances. Unlike the RoHS Directive, the REACH regulation does not ban certain chemical substances that are known to be used in products. Instead, it asks manufactur-

note 7) Analysis method using Raman spectrum. When a substance is irradiated with visible rays of a short-wavelength or ultraviolet rays, the incident beam will scatter, being influenced by a change of wavelength attributable to the molecular vibration that results in a change of polarizability. This analysis method is based on the fact that each substance has its own scattering intensity.

note 8) Abbreviation of Registration, Evaluation, Authorization and Restriction of Chemicals. An EU regulation on mandatory registration and evaluation by manufacturers and importers concerning the chemical substances.

ers to understand the level of harmful substances contained in their products, and, based on the evaluation of the chemical substances concerned, it asks them to stop using chemical substances in their products if those substances are judged to be hazardous based on the evaluation, in the same way as the RoHS Directive.

The trend for management of chemical substances contained in products is changing into management of the contained level of regulated substances in products. To address such a change in trends, the Fujitsu Group is committed to continue making efforts so that the Group can in a timely way review its system for management of chemical substances contained in products and promptly respond to market needs including the increased control of supply chains.

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