Designing a Data Storage System for Environmental Compliance (Focusing on RoHS-type Legislation)

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Abstract
As more governments pass, implement, and enforce environmental compliance initiatives covering electronics, small to medium sized businesses continue to struggle with what data should be tracked, how to track it, and keeping current on legislative changes. This paper will focus on how to store and organize compliance data as well as what a company should look for in a data tracking system.

Background & Introduction
In 2003 when the European Union (EU) passed the *Restriction on the use of certain Hazardous Substances Directive* (RoHS) companies began scrambling to gather compliance data for electronics parts and components. The EU's RoHS Directive restricts the use of six substances in electronic and electrical equipment: lead (Pb), mercury (Hg), hexavalent chromium (Cr6), cadmium (Cd), polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDE). Even though there were no specifics on what data was needed to prove compliance with the Directive, most companies began gathering certificates of compliance. Some companies went a step further and began requesting materials declaration data from the supply chain.

The industry began documenting compliance with the EU's RoHS Directive by obtaining certificates of compliance (CoC): a simple form stating the part or component purchased met the EU's RoHS Directive. Some CoCs were acceptable to meet the burden of proof for compliance; some were worthless. Since the EU's RoHS Directive focused on the amount of restricted substance at the homogeneous material level, companies also began requesting information on the level of restricted substance contained in each material of a component or part. In response to this request, the supply chain returned CoC's stating that restricted substances were below the expected restriction levels specified by legislation. A typical CoC or materials declaration response only included the six restricted substances listed in the EU's RoHS Directive.

Eventually, guidance on how to comply with the RoHS Directive emerged from various sources. The United Kingdom was the most vocal of these sources. It published a non-binding government guidance document on the RoHS Directive. The EU Commission also published a "Frequently Asked Questions" document, which assisted in clarifying many of the definitions used in the RoHS Directive. In 2006, the EU Commission published an enforcement guidance document to assist member states with evaluating and enforcing compliance with the RoHS Directive.

In response to the guidance from the EU Commission and other sources, several companies began implementing a more systematic approach to collection and storage of data supporting compliance with the RoHS Directive. Companies also began working on a strategy to protect themselves from implications of potentially false data. Product lifecycle management software suppliers began offering add-on modules to assist companies in documenting compliance.

Companies created custom questionnaires and sent them to suppliers for completion. Most questionnaires were in a spreadsheet format so suppliers were not required to obtain specialized software. These data files were created manually by entering data into the spreadsheet or a database which transferred the data to the spreadsheet for distribution. The flood of unique questionnaires created a significant need for standardization of the format in order to facilitate data exchange.

Without a global standard available, the supply chain was overwhelmed by requests for data. In response to the need for a global standard, IPC released the IPC-175x series of materials declaration standards. The IPC standard is

designed to gather materials composition data and to provide the ability to create a certificate of compliance. Currently under review by the IPC 2-18 committee, the 175x-series standard provides a basic format for gathering, maintaining, tracking, distributing and reviewing materials declaration information.

The Data

What to Collect

In an ideal situation, a company would send a material data request and the supplier would complete it with all materials listed at the homogeneous material level. Also, a supplier would provide a certificate of compliance with each shipment either in hard-copy or electronic format. In reality, a generic certificate of compliance or a generic materials declaration is returned. Rarely are both documents returned in one request response.

With companies beginning to approach environmental compliance in a more proactive manner, it is recommended to not only gather data on the "toxic six" from current RoHS-type legislation, but begin requesting full materials declaration. This means that companies should collect data on every substance used in the manufacture of the part or component which remains with the part. A compromise between full materials declaration and the current RoHS "toxic six" materials is to gather data to the Joint Industry Guide Materials Composition Declaration for Electronic Products – Annexes A and B (aka JIG-101 or JIG A&B). This standard (co-authored by EIA, JEDEC, and JGPSSI) lists substances which are restricted, reportable, or prohibited by existing legislation. It also lists substances "of concern" to industry and/or government.

In addition to the materials declaration data and certificates of compliance, companies should also gather data on the supplier's environmental activities. This would include information such as the supplier's environmental policy, internal or external audits regarding eco-compliance, qualifications or certifications in regards to eco-compliance, and any documents pertaining to overall environmental efforts such as consumables recycling. The data could also include any quality certifications, such as ISO-900x. It is recommended that companies also have an internal policy stating their own efforts towards environmental compliance. This internal policy may include roadmaps, team member names and job descriptions, and compliance procedures. All of these documents, in addition to the data storage system, are part of an overall eco-compliance strategy.

How to Collect

Compliance data can be collected in a variety of ways from manual to semi-automatic collection methods. Manual data collection means gathering data via direct contact with the supply chain. Data is gathered through e-mails, phone calls, fax communications, and web searches, and placed in a central depository. If the data is available in a machine readable format, it can be automatically uploaded to the central system.

Today, most data is collected via semi-automated methods. This includes the use of forms or custom questionnaires. For example, the IPC-175x Materials Declaration standard can be used to gather data semi-automatically. The form requires initial, manual input but some companies have developed internal operations to automatically return a completed form. Regardless of the how companies gather data, the storage method needs not only to be organized, but also have the ability to be searched and distributed.

Format

The storage format depends on the type of data. Human-readable formats are commonly used for documents which support the methods of compliance or a general statement regarding compliance; e.g. certificates of compliance, environmental policy statements, certificates from external audits, etc. A common file type is the portable document file, such as Adobe Acrobat®.

Machine readable documents are commonly used for hard data, such as material content data. A common format is extensible mark-up language (XML). XML allows for machine readability, as well as offers formatting capabilities for a human readable format. For materials declaration data, it is recommended to be in a machine readable format with capabilities for human interaction; such as with XML. The IPC-175x material declaration standard version 1.x does have XML capabilities allowing for machine readability of the underlying data within the Adobe Acrobat® form.

Regardless of the type, all data should be stored in a non-editable format. If this is not possible, the document should have the ability to track changes.

The Data System

Levels of Data Storage Systems

There are three basic levels of data storage systems: simple, intermediate, and complex. A simple system is like a file hierarchy within an operating system. This is a simple and economical solution for many companies. Company level documents are kept in a folder, data specific to a bill of materials is kept in a folder, and an enhanced bill of materials spreadsheet has a link to all data in support of the compliance of the product. The spreadsheet also lists whether the part is fully compliant or compliant by exemption, as in the case of meeting the EU's RoHS Directive. This detail allows companies to determine if the part is compliant with additional laws such as China's *Administration on the Control of pollution Caused by Electronics Information Products* (China RoHS) legislation, which does not include any exemptions.

An intermediate system is commonly found as an add-on module for an existing inventory management system or product lifecycle management system. It gives the ability to run reports manually to group the data necessary to prove a product or product line is compliant.

A complex system has fully-integrated checks and balances. It is an algorithm which checks the relationships between data, exiting legislation, proposed legislation, and human review sign-offs that the data is legitimate. In some cases, multiple algorithms are necessary for maintaining checks and balances.

Basic Functions and Capabilities

Data systems have two major functions: storage and distribution. Storing the data depends on company size. As the size of the company increases, the data system typically increases. It will likely be associated with a bill of materials structure or approved vendor listing. Distributing or reporting usually occurs at the request of an enforcement agency and pertains to a given law or directive. Reports should be available not only on a part basis, but also on a finished product basis.

In addition to storage and distribution, a data system should include a good search feature and compliance tracking capabilities. The system should have the ability to search data points such as given levels of material content and special circumstances (e.g. exemptions for EU RoHS).

A data system should have the ability to track compliance at the part level, sub-assembly level, and the completed assembly level. It should also be able to track compliance with active and proposed legislation; including deviations from specific legislations, as in the case of the EU's RoHS Directive, which has exemptions which will change over time. The system should also be expandable in order to follow a proactive approach to meet future requirements. Attachment storage capability is a must for any data storage system working with eco-compliance data.

Going Forward: Determining Needs

A data storage system is part of an overall compliance strategy. The following questions can help a company to find or design an appropriate data system.

Where is the company within the supply chain?

The answer to this question will point to how accessible/searchable the data needs to be and how is it organized. For a company within the supply chain, data will need to be easily accessed for customer requests. All points in the supply chain will need the ability to search on specific materials, especially on compliant parts covered by exemptions; particularly in the case of the EU's RoHS Directive.

How will the data be collected?

Will it be manual? This is someone sitting in front of a computer, or on the phone, requesting the information from the supply chain. Semi-Automated or fully-automated requires manual input and review of basic information, but some data exchange is done automatically between computers. A web site which takes a customer's input of a part number and returns a certificate of compliance or a materials information sheet based on the part number input is an example of semi-automated collection system. In fully automated systems a data file is sent to a machine and a series of forms is automatically created.

Is it possible to track a part or component via exemption or other special circumstance?
This is a must-have for any data system focused on environmental compliance and is specifically used for tracing the level of restricted materials. As more RoHS-type legislation is passed, requirements change, making the tracking process more involved. By allowing for tracking based on special circumstances such as exemptions, a company can immediately determine which parts are affected when the special circumstances change.

Conclusion
A data storage system is part of an overall compliance strategy. Like many parts of a business strategy, it will evolve over time. Having a system framework and an understanding of how RoHS-type legislations around the world are evolving will allow for the creation of a basic system which is also flexible.

A part simply listed as "compliant" does not give enough information to make the determination that it truly complies with multiple laws. By using a data storage system capable of having specific fields for restricted substances, as well as applicable exemptions, compliance data is more easily accessible. This capability allows companies to adjust procedure, rather than start from scratch, to prove compliance with a new law. By gathering materials beyond the RoHS "toxic six", such as the materials listed in Annex A&B of the JIG, companies are better prepared for the next RoHS-type law, regardless of the governing body implementing such legislation.

A system capable of reporting the compliance status of individual parts, as well as sub-assemblies and final assemblies, makes the eventual report to an enforcement agency less stressful and a more productive. In the design process, companies use existing parts. By having full materials declaration data on parts already used in existing designs, the ease of reporting use of restricted substances allows for improved utilization of resources.

With regulations expanding into new territories, as well as the potential of additional substances being restricted, companies have a continual, growing need for the ability to trace not only the current restricted materials, but also materials which have the future potential for being restricted. By following the recommendations for collection and storage of compliance data put forth in this paper, companies can continue to proactively approach environmental compliance.

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