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MATERIAL COMPLIANCE MANAGE- MENT PROCESS

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TIIVISTELMÄ

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Opinnäytetyön tavoitteena oli tehdä prosessikuvaus materiaalien määräystenmukaisuuden hallinnasta ABB:n Distribution Solutions -yksikölle. ABB pyrkii noudattamaan EU RoHS- ja REACH -lainsäädäntöjä, jotka antavat tietyt vaatimukset datan keräämiselle. Tämä opinnäytetyö selvittää lainsäädäntöjen asettamia vaatimuksia ja rajoituksia, datan keräämisprosessia, vastuualueita sekä yhteyksiä muihin prosesseihin yksikössä.

Materiaalien data kerätään komponenteille niiden valmistajilta. Tällä hetkellä kerätään esimerkiksi RoHS- ja REACH -dataa vaatimusten täyttämiseksi. Dataa kerätään yhteistyössä ABB:n yhteistyökumppanin kanssa, joka tarjoaa tietokoneohjelmiston datan päivittämiseksi ja varastoimiselle. Materiaalien määräystenmukaisuuden hallinnointiprosessilla on yhteyksiä HW-prosessiin, toimitusketjun hallinnointiin, komponenttien valintaan ja HSE-projektiin.

Tämä opinnäytetyö antaa kokonaiskuvaa materiaalien määräystenmukaisuuden hallinnointiprosessista, jolloin vastuualueet voidaan jakaa osastoittain ja työntekijät saavat tietoa määräysten hallinnoinnista ja yhteyksistä muihin prosesseihin. Opinnäytetyö antaa ideoita uusiin prosessitoimenpiteisiin ja tehtäviin, jolloin määräykset voidaan ottaa huomioon aikaisemmin välttämällä ongelmia ja varmistaen tuotetason selvitysraportoinnin ABB:n asiakkaille. Haasteita datan keräämiselle tuovat esimerkiksi datan siirtäminen eri ohjelmistojen välillä.

ABSTRACT

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The purpose of the thesis was to do a process description of material compliance management for ABB Distribution Solutions unit. ABB follows the EU RoHS and REACH legislations, which give requirements for data collection. This thesis clarifies the requirements of the legislations, data collection process, responsibility parties and interfaces to other processes at ABB EPDS.

Material compliance data is collected for components from their manufacturers to get the RoHS and REACH compliances. Data is collected by material compliance engineers and ABB's cooperation partner, which provides also a software tool for maintaining and storing the data. The material compliance management process has interfaces to hardware milestone process, supply chain management process, component standardization process and HSE project.

This thesis gives an overall picture of the material compliance management process so that responsibilities can be shared, and employees will be more informed of compliance issues and process interfaces. It gives ideas of new process steps and tasks so that compliance issues could be noticed earlier to avoid problems and ensure the product level compliance reporting for ABB's customers. There are some challenges for the data collection, such as data importing between the software tools.

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GLOSSARY

EPDS	ABB Electrification Products, Distribution Solutions business unit
RoHS	Restriction of Hazardous Substances
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SVHC	Substance of Very High Concern
FMD	Full Material Declaration
BOM	Bill of Materials
EOL	End of Life
HSE	Health, Safety, Environment
SCM	Supply Chain Management
PM	Product Management
ESMA	Emirates Standards and Metrology Bureau
ECAS	Emirates Conformity Assessment Scheme
EQM	Emirates Quality Mark
Milestone	Shows how far a project has proceeded against defined criteria

1 INTRODUCTION

This thesis was done for ABB Distribution Solutions. The purpose of the thesis was to do process descriptions of material compliance management. ABB follows the EU RoHS and REACH regulations so there is on-going work to collect required documentation for all the components of the products to prove the compliance. The legislation is developing year after year, so this thesis describes how the legislation has developed, how everything has started, how it is now and how it seems in future. The material compliance management process is represented with a process picture. ABB Distribution Solutions has process descriptions of how different teams and departments are working, but not about material compliance management. In future, information of this thesis can be used for example in audits and trainings.

This thesis describes how and from whom the material data is collected, which the participants are and where the collected data is entered. For example, the REACH regulation is updated every half year, so collection is all the time on-going process. At the beginning of 2020, the new UAE RoHS regulation will come into effect, and this regulation is needed for products sold to the United Arab Emirates. The task is to determine which actions are needed from ABB Distribution Solutions and if different certificates are needed. Provisionally, the plan was to cooperate with SGS.

This thesis brings together these two concepts: how the material data is collected in a normal situation and what is done when regulations change, or new products or components are introduced by describing these matters with process pictures and finding interfaces with other processes. There is a function for the material compliance management process picture to identify in which phases of other processes the material compliances should be noticed and to share information with other parties at ABB Distribution Solutions.

2 ABB OY

ABB is a global leader in all time developing technology industry, which is getting more digitalized every day. ABB improves new products for developing demands and it is a big employer both in Finland and globally. /1/

2.1 About Company

ABB was started when Gottfrid Strömberg founded Strömbergin sähköliike in 1889 in Helsinki. The company manufactured electromechanical products. During the wartime in 1943 the production was moved to Vaasa and the factory was placed to its current location in Huutoniemi. /2/

ABB provides high quality products for utilities, industry and transport & infrastructure sectors, such as electrification and automation products and robotics. ABB operates in more than 100 countries with a personnel of about 147000 people. In Finland ABB has about 5300 employees. The production lines are situated in Helsinki, Hamina, Vaasa and Porvoo. ABB is one of the biggest employers in the technology industry in Finland. /1/

Environmental safety is important for ABB, so the company is focused on providing safety products pertaining to ecology and sustainable development. ABB offers energy-efficient systems and services so that the customers can decrease their use of energy and natural resources. ABB is developing products, which support the use of renewable energy sources. /3/

2.2 Distribution Solutions

ABB Distribution Solutions unit provides protection and control relays to help efficient use of electrical power globally while increasing industrial productivity and decreasing environmental impacts. Relays support smart grids technology and ensure reliable use of electricity. The Relion product family has products for protection, control, measurement and supervision for IEC and ANSI markets. The protection relay recognizes the faulty part or abnormal conditions of the grid, initiates

corrective actions and disconnects the faulted part from the grid and so protects people and devices and furthers safe electricity use without interruptions. /4-5/

3 MATERIAL COMPLIANCE REGULATIONS

ABB Distribution Solutions follows the EU RoHS and REACH regulations. There is an on-going collection process to meet all requirements. Environmental regulations are important to provide the safe use of products without hazardous substances for human health and the nature.

3.1 RoHS

RoHS, Restriction of Hazardous Substances, is a legislation for electrical and electronic equipment. The purpose is to restrict the use of hazardous substances in certain metals, plasticizing agents and fire retardants. The legislation is fighting for safer equipment, which protects human health and the environment. These restricted substances can be harmful during manufacturing and recycling, so the legislation reduces for example the harmfulness of waste. /6/

The original RoHS legislation, Directive 2002/95/EC, was published in the European Union in 2002. It restricts the use of six hazardous substances. RoHS compliance has been mandatory for all applicable products in the EU market since 2006. /7/

In 2011 came the new Directive 2011/65/EU which is called RoHS 2. After this legislation, the RoHS compliance is required for CE marking of products. ABB's relays belong to product category 9, which means that the legislation became mandatory in 2017 for industrial monitoring and control equipment /8/. /7/

In 2015 the latest change for RoHS regulation was published, which added four new restricted substances making the list of total 10 restricted substances. The regulation is called as RoHS 2 with New Substances or RoHS 3. For industrial monitoring and control equipment, RoHS 3 will become mandatory on July in 2021 /8/. /7/

The restrictions of RoHS concern substances below:

- cadmium, Cd

- lead, Pb
- mercury, Hg
- hexavalent chromium, Cr6+
- polybrominated biphenyls, PBB
- polybrominated diphenyl ethers, PBDE
- bis (2-ethylhexyl) phthalate, DEHP
- butyl benzyl phthalate, BBP
- dibutyl phthalate, DBP
- di-isobutyl phthalate, DIBP /6/

The maximum concentration of the hazardous substance can be 0.1 % of the homogeneous material, except cadmium and mercury, which have the limit of 0.01 %. Some exemptions can be granted, for example for the use of lead. /6/ Table 1 includes the RoHS restricted substances and where they can be generally used.

Table 1. RoHS substances generally used in. /9-11/

Substance	Generally used
Cadmium	In metal surface treatment products, paints, switches, connectors and recycling plastics
Lead	In metals, paints, welding and soldering products, metal surface treatment products and polymers
Mercury	In batteries and accumulators, paints and polyurethane materials
Hexavalent chromium	Surface treatment of metals, alloys and paints
PBB/PBDE	In plastics, PWBs and epoxy

Phthalates	As plasticizer in polymer products, mainly in PVC, materials to plastic, vinyl insulation, glue, filling medium and raw materials for paints
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Figure 1 below shows the RoHS timeline for category 9 products including protection and control relays. The next deadline is in 2021 when the RoHS 2 data with new substances should be collected. ABB's relays have been defined to a group category called large-scale fixed installations. The category has excluded for example from the RoHS 2 scope /12/. ABB is still trying to follow the directional timelines by collecting the data.

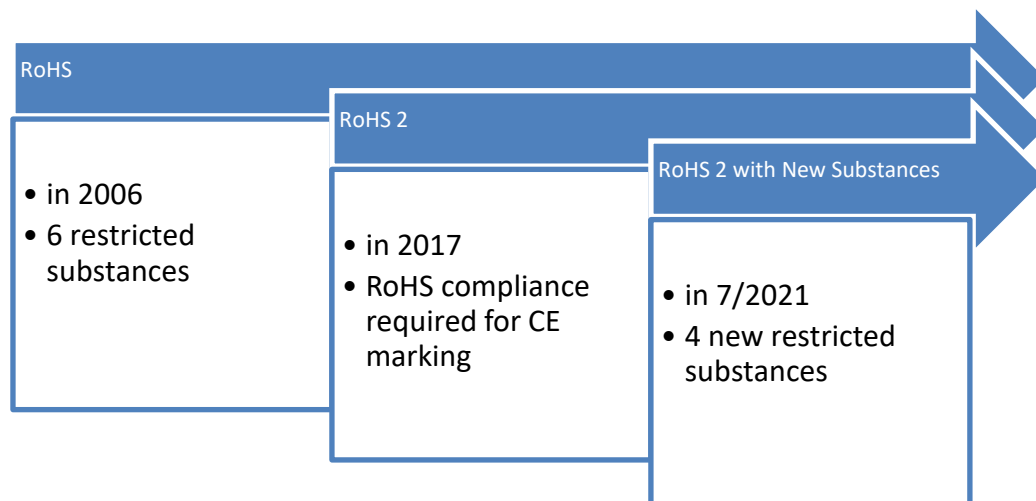


Figure 1. RoHS timeline for category 9 products.

3.2 REACH

The EU Regulation of EC 1907/2006 on REACH is a regulation which stands for Registration, Evaluation, Authorization and Restriction of Chemicals. The European Union published the regulation and it became into force on 1 June 2007. The purpose is to improve the protection of human health and the environment by avoiding the risks of hazardous substances. REACH affects both industrial processes and

daily used products, which means that REACH has impacts on the most companies in the EU. /13/

The idea of the regulation is that companies must identify and manage risks, which can be caused by the substances of their products in all parts of the supply chain. In the long run, the target is to substitute the most hazardous substances with less dangerous ones. /13/

There is a list of Substances of Very High Concern (SVHC) /14/, under REACH identified by the European of Chemical Agency, ECHA. The list is updated every six months adding new substances of very high concern. The latest update was on 15 January in 2019, making the list total of 197 substances. These substances are carcinogenic, mutagenic or toxic and they have an effect on either the environment or humans. The concentration limit for an SVHC is 0.1 % of the weight. /14/

3.3 Differences between RoHS and REACH

Both the RoHS and REACH legislations restrict the use of dangerous chemicals, although the basis for substance restrictions is different. The RoHS restrictions are based on hazards and potential substances, which should be banned, so it applies only to certain hazardous chemicals in electrical and electronic equipment. Substances can be decided without a full assessment of the impact based on potential risks. /15/

REACH affects all chemicals, their mixtures and the final products, while the RoHS applies only to electrical and electronic equipment. The REACH restricted substances are based on real risks to human health or the environment. The risks are measured on the whole lifecycle of the substance. /15/

3.4 ABB List of Prohibited and Restricted Substances

ABB has a list of prohibited and restricted substances, which includes the substances that must not be used or the use should be limited at ABB. The purpose is to achieve compliance with the legislation and to avoid chemicals harmful to the

environment or the health of workers, customers or other participants. The substances are based on either RoHS or REACH. The list shows which substances are prohibited and which are restricted and what the risks for the use of the substance are and where it can be generally used. The list is updated twice per year. /16/

4 MATERIAL AND SUBSTANCE DATA MANAGEMENT AT ABB DISTRIBUTION SOLUTIONS

ABB Distribution Solutions, EPDS, is collecting material and substance data to provide material compliance. The relays of EPDS include many electronic cards, printed wiring boards and other mechanical parts. Even if a card is purchased in one piece, it includes many components from different manufacturers. The material data management needs cooperation with manufacturers and other parties so that material compliance can be possible to provide.

4.1 Collected Data

ABB EPDS is collecting EU RoHS documentation including RoHS 2 with new substances, SVHC data, full material declarations and lifecycle statuses. The minimum data requirements at the moment are lifecycle status, RoHS 2, FMD-B or SVHC and component weight /17/. RoHS 2 with phthalates is planned to add as a mandatory requirement later on this year due to regulation changes.

RoHS and SVHC data reports collected from manufacturers will show if the part contains or does not contain the restricted substances. These documents include name of the manufacturer, component part number and signatures. The lifecycle status shows the product's stage of life. It can be active, not recommended for a new design, end of life or obsolete. The status helps to prioritize collection process and to know whether the part is still manufactured or in use.

The full material declarations can be used to assess the REACH SVHC and EU RoHS status. It helps the material data collection process if manufacturers can provide full material declarations for their parts. Actually, the declaration shows if the part includes some substance of very high concern so when the SVHC list is updated, the check can be done without contacting the manufacturer every six months. The RoHS documentation is needed to confirm exemption requirements if there are substances that exceed the compliance limit /18/. The full material declaration shows the chemical composition of a product or component. It is a document, which

provides the weight of the part, the percentage of weight of each material in the part and the percentage of weight of substances which the material contains.

4.2 Participants

ABB Distribution Solutions has a cooperation partner who provides data collection services and a software tool. Their team collects documents, helps with regulation issues and updates the software tool. Figure 2 shows the partnership between ABB Distribution Solutions and the cooperation partner. Basically, EPDS sends the bill of materials and component data to them and they maintain the data for the software tool. They provide monthly compliance reports of progression and inform of changing regulations.

The cooperation partner creates different rules of regulations, such as EU RoHS and REACH, and update them for the software tool when regulations change. The rules show statuses of the components according to the substances of the rule. Other rules, such as China or California RoHS can also be used, even if EPDS does not follow those regulations.

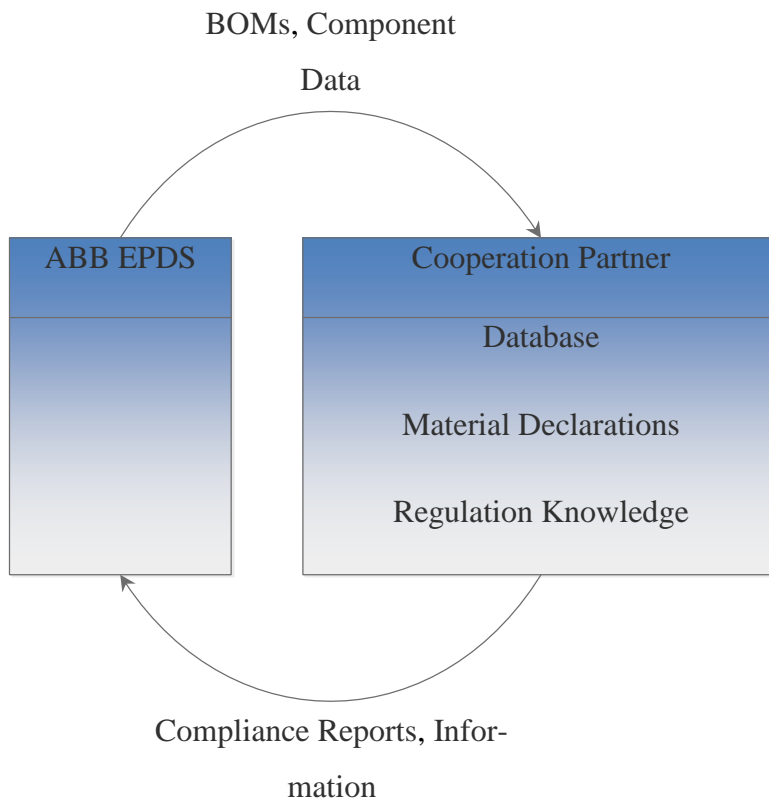


Figure 2. Partnership in material compliance management.

4.3 Collection Process

Every module has its own bill of material, BOM, which includes all components the module consists of. If the final product is RoHS and REACH compliant, it means that every component inside the BOM also needs to be compliant. The material data is collected for components from their manufacturers or distributors. ABB EPDS send a request for compliance data and the manufacturer or distributor provides the required documents.

Figure 3 describes the data collection process between EPDS and previously called cooperation partner. Responsibilities are shared between EPDS and the cooperation partner. The cooperation partner processes the components EPDS have sent them and first gets the data from their database. If they don't have the data, they will contact the manufacturer or escalate the components they don't get the data so that EPDS can help to solve the issues. EPDS contacts also manufacturers and works with escalations. The collection process is prioritized for new products and critical

parts at EPDS. At the moment, the collection process is prioritized for products which have the highest selling volume and for new products supposed to have high selling volume in future.

If the required data has been received, the documents are put to the software tool by the cooperation partner. After data analysis, the type of documents defines the future for the collection process of each component. If the manufacturer provides full material declarations, the collection process is practically ready. The percentage of new hazardous substances published can be calculated from FMDs, so updated SVHC data can be calculated straight for the declaration without contacting the manufacturer. Otherwise, new SVHC statuses are needed to solve if FMD is not available. The maintenance project is ongoing by the cooperation partner, and the process cycle starts again every six months, and EPDS helps to figure out the problems.

The most challenging situations are if not all manufacturers are responsible to provide data, or they provide only partial data. In these cases, is the importance of the component, replacement opportunities and the available second sources are considered, and the best option is tried to find depending on the case.

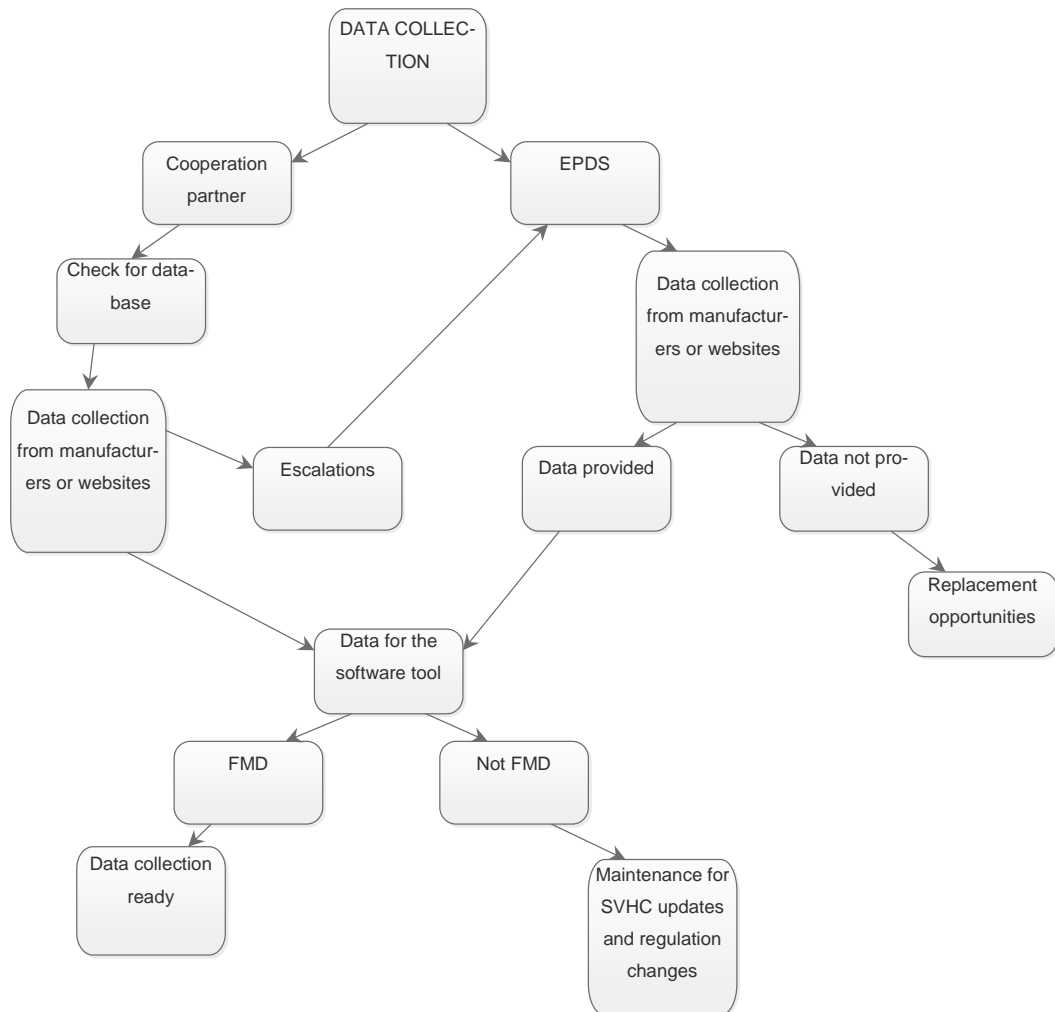


Figure 3. Data collection process.

4.4 Purpose of the Collection Process

The most important reason for the data collection is the opportunity to provide the proof of compliance for ABB's customers. If ABB's products are RoHS and REACH compliant, it means that ABB needs to be ready to prove it. Data collecting enables to create reports of compliance. By following the substance data, the exceeding substance and material limits can be reported. In addition, ABB wants to supply environmental friendly products, which are safe to use for humans and the environment and to support sustainable development. Environmental safety is important nowadays and it is getting even more important in future.

ABB's product compliance requires that manufacturers need to follow the same standards and to provide the required material data. If the manufacturer does not provide the needed data, it is worth to think if the cooperation will be continued or not. Thus, collecting material data shows which manufacturers are ready to provide it, and in the long run it helps choosing the best suitable manufacturers.

4.5 Product Level Management

The purpose of the material compliance management is to support the supply chain so that the final products can be delivered for the customers on time with needed requirements. The product level data is managed via BOMs. New BOM revisions are released if needed to change the structure of the BOM. All statuses of the BOMs can be found in the software tool. Material quality and other technical requirements are monitored, and if there are problems or issues in availability, the component can be changed to other. New components are also tested before they can be used in the production. One challenge for the product level data management is that EPDS relays are built with customer requirements so there are many variable products. Sometimes it is hard to work with only one BOM without getting a general view of the product statuses.

4.6 Software Tool

The cooperation partner provides the software tool, where the collected data is entered. The collected documents are sent to the cooperation team so that they can update new documents and statuses for the software tool. It includes all electronic components from ABB's component base system. ABB EPDS enters BOMs into the tool and it automatically collects the components and second sources which the BOM includes and shows the statuses. Typically, the collection work is done by choosing a BOM with rules and collecting missing documents for components inside it.

The software tool shows the statuses of RoHS and REACH compliance, full material declarations, lifecycle statuses, technical datasheets and weight of the components. In addition, collected documents can be shown. The full material declarations

can be used for reporting when the tool calculates from the weight and other data how much substance is included in the BOM or in component and shows the percentages. All in all, the software tool is used for both managing and storing the data.

4.7 New Parts and Maintenance

ABB's product base is changing and developing continually, and it means that new products, new modules and new components are introduced. The availability of the component can change, or manufacturing of the component has stopped so it might need replacement. New components are updated to the component base system by component engineers. After that, the changes are updated to the software tool.

For new parts, the statuses and documents are first checked by using quick turnaround option, which prioritize the added new parts. The cooperation partner's team checks their database and if they do not have required data, they contact manufacturers or check the manufacturer's websites and provide the data for EPDS. When ABB has a new design, BOMs of the modules are entered to the software tool and after that it can be checked which components are missing statuses.

The maintenance project is proceeding all the time. REACH SVHC is updating every six months and if the manufacturer does not provide full material declarations, the maintenance need to be done every six months. In addition, lifecycle statuses can be changed. The cooperation partner works with the maintenance project and goes through all component data about twice a year.

4.8 Reporting

If the component data is available in the software tool, it allows creating reports of compliance or reports of substance composition. Either a specific BOM or all components of the component base can be chosen. The reports show if the components are compliant or not.

4.8.1 Substance Reports

For substance reports an individual substance can be chosen, and the report shows which components include the substance and how much. There are two types of reports, Item Substance Analysis Report and BOM Substance Analysis Report. The Item Substance Analysis Report includes all components of the component base and the BOM report only one BOM which has been chosen. The reports show if the substance is present or not and weight of the presented substance. The maximum concentration value is shown at the component level, article level and homogeneous level.

An article can be of homogeneous material or a combination of homogeneous materials or other articles. If there is not assignment of articles in FMD, the software tool will assign articles at the homogeneous material level. The tool assumes the worst case by taking the homogenous materials as the articles. /19/

Aggregate mass is the mass of the substance and it is calculated from FMD. The percentage of the substance in the article is multiplied by the article mass, which includes the substance. The component level concentration is obtained by dividing the aggregate the component mass, and the article level concentration is obtained by dividing the aggregate mass the article mass.

Figure 4 shows the substance analysis for a part number. Figure 5 is a partial copy of the FMD of the part. This inductor includes a solder wire, magnet core, printing ink and wire, which are all defined as articles. The solder wire is the article, which includes cadmium 0,002 %, which is the same number as the homogeneous level concentration 20,0 ppm.

The percentage of the substance in article is multiplied by the article mass and it gives an aggregate mass of:

$$0,002 \% * 0,00391 \text{ g} = 0,0000000782 \text{ g.}$$

The component level concentration is the aggregate mass divided by the product mass:

0,0000000782 g / 0,13501 g = 0,579 ppm.

Report Type:	Item Substance Analysis Report
Date of Report:	3/12/2019 9:42:30 AM
Substance Name:	Cadmium
CAS Number:	7440-43-9
EC Number:	231-152-8

Internal PN	Manufacturer Name	Substance Present?	Component Level ppm	MCV (ppm) Article Level	MCV (ppm) Homogeneous Level	Aggregate Mass (g)
PAA 100UHOA3		Present	0,579	20,000	20,000	0,000000078200

Figure 4. Picture of Item Substance Analysis Report.

Part Description	Weight (g)	Substance Description	Substance	CAS Number	Substance %
SOLDER WIRE	0,00391	Solder Alloy	Tin	7440-31-5	96,184
			Silver	7440-22-4	3
			Copper	7440-50-8	0,5
			Pb	7439-92-1	0,1
			Arsenic	7440-38-2	0,03
			Bismuth	7440-69-9	0,05
			Iron	7439-89-6	0,02
			Aluminum	7429-90-5	0,001
			Cadmium	7440-43-9	0,002
			Zinc (metal)	7440-66-6	0,001
			Antimony	7440-36-0	0,1
			Gold	7440-57-5	0,005
			Nickel	7440-02-0	0,007
MAGNET CORE	0,1				
PRINTING INK	0,0021				
WIRE	0,029				
Product	0,13501				

Figure 5. Partial FMD for the inductor.

4.8.2 Compliance Reports

The compliance reports show RoHS or REACH SVHC compliances. There is an option for the substance analysis so that it can be used also to get RoHS or REACH compliance report by selecting a defined rule. Either RoHS, RoHS 2 with new substances or REACH SVHC number can be chosen. After that, it creates a report which shows for example the six RoHS substances and if the parts are compliant and if the concentrations are below threshold. Either one BOM or all components of the component base can be granted. The Substance Matrix Report gives the same

kind of report of RoHS, RoHS 2 with new substances or REACH SVHC compliance but it cannot be used for BOMs.

4.8.3 Required Reporting

The legislation requires that ABB needs to list all components, which exceeds the RoHS or REACH SVHC limits. EPDS will create a declaration, which defines the components exceeding the limits so that the declaration can be given to the customers. One challenge for reporting is that it is not possible to export reports, which includes many BOMs to get a product level reporting. In addition, reports are sometimes hard to handle because there are many thousands of components. The list needs to be updated many times in a year because of the SVHC list updates and component changes, so the situation might need to be consider in future how it is easiest to do.

5 PROCESS DESCRIPTIONS

This chapter describes the material compliance management process at ABB Distribution Solutions. There are many parties, which have some responsibility for the process. The process starts from defining the requirements and product designing and advances to maintenance projects.

5.1 Participants and Responsibilities

Figure 6 shows the main participants and responsibilities of the material compliance management process at EPDS. There are some main departments, which have the responsibility of the material management. Firstly, the Research & Development department designs new products and BOMs. The component engineers check the selected components used in the designs so that the components have correct technical requirements, add new components to the component base system and maintain the component base. The supply chain management team purchases the needed materials from suitable suppliers and the materials go to the production. HSE takes care of health, safety and environmental issues and defines the regulations ABB needs to follow. The material compliance engineers collect the material and substance compliance data with the cooperation partner, which also updates the software tool and informs of regulation changes.

Manufacturers cooperate with ABB, provide the requested material data, produce and test their components to be manufactured of safe substances. Regulatory agencies, such as the European Union or ECHA, update the regulations and publish new regulations or new restricted substances. They also inform other parties of changes. ABB's customers can require the proof of material compliance and ABB needs to be ready to provide it and to inform their customers of regulations, which they comply with and of which substances and materials their relays contain.

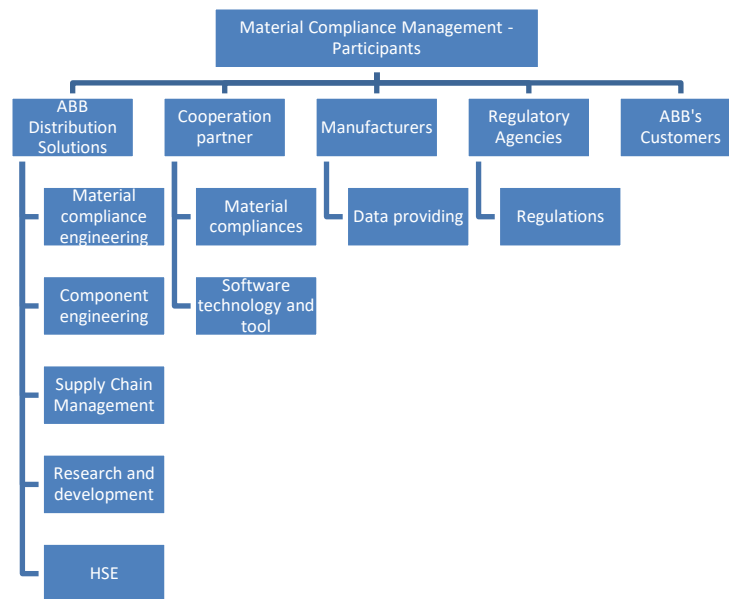


Figure 6. Material compliance management participants.

5.2 Process Interfaces

EPDS has other processes, which have interfaces to the material compliance management process. The purpose was to identify which processes have interfaces and in which process steps the material compliance management is noticed and should be noticed in future. The process interfaces for the material compliance management process are Hardware Milestone Process, Component Standardization Process, Supply Chain Management Process and HSE project checklist. The interfaces are described in Figure 7.

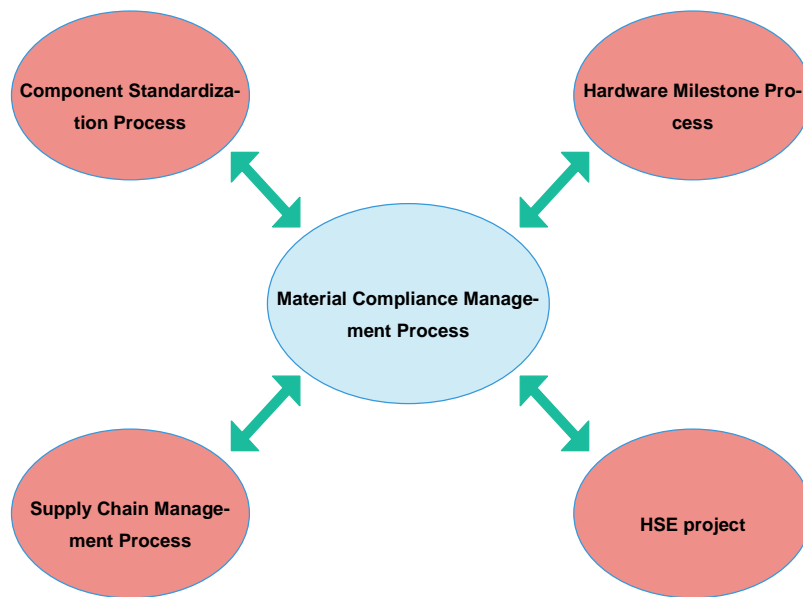


Figure 7. Material compliance management process interfaces.

The hardware milestone process includes the electronic module development and the mechanics development ending for the module release and production. The process input is market requirement specifications and the output the module in the operational mode. The component standardization process is for checking selected component requirements, adding new components to the component base and handling the EOL-process to offer components for production and R&D with correct technical requirements for a design. The supply chain management process is to support the supply chain by selecting suitable suppliers, delivering the manufacturing documentation to the manufacturer, ordering the prototypes, negotiating prices of components and requesting offers. /20/

The HSE project includes a checklist for the ABB Gate Model, which helps the product and technology development process by identifying key sustainability aspects /21/. It gives requirements for starting the material management process and checking the needed requirements:

1. Which laws (health, safety, environment) are likely to be applicable for your product /21/?
2. Are any of the hazardous substances on "ABB's list of restricted and prohibited substances" list /21/?

3. Are measures in place to ensure that restricted and prohibited substance limits are not exceeded due to parts obtained from suppliers /21/?
4. Does the product contain potential conflict materials and therefore requires special sourcing considerations /21/?

5.3 Material Compliance Management in Product Creation Process

The created picture of the material compliance management in the product creation process at ABB Distribution Solutions is described in Appendix 1. It shows responsibilities in every part of the process. Material compliance management should be taken notice in the early beginning of the processes, and therefore the process picture is started from defining the laws and other requirements and designing. Actions, which should be added to the process in future, are marked with green color.

5.3.1 Pre-Study

The process picture is divided into pre-study, design, verification, finalization and product phases according to the hardware milestone process. The process starts from the HSE project step by defining the laws to follow. The HSE manager has the responsibility to identify the laws and to inform other parties of the laws. For material compliance management, the laws currently are RoHS and REACH. The task is to add compliance items for requirements of the projects even before designing by sharing information of material compliance management to avoid non-compliance. The product management team will inform other parties of it.

5.3.2 Design

The next phase is designing. It includes mechanics and electronic components selection and preliminary supplier selection. The responsibility party is R&D and the supply chain management. Electronic components selection starts the component standardization process. When the mechanics and electronic components have been chosen, the material compliance data collection process can be started by the material compliance engineers. The material compliance engineers or R&D will do the preliminary check for the components and mechanics by finding critical non-com-

pliances. The HSE project states to check components against “ABB List of Prohibited and Restricted Substances”. There is also a plan to do material checks against the material standards for the mechanics. If the components or materials seem to be non-compliant, the component or material can be replaced to other, or other actions can be done depending on the case. Otherwise, the process can be continued. The Milestone M2 checklist includes other tasks, which should be done before the verification phase.

5.3.3 Verification

The Milestone M3 checklists include the final BOM checks for the electronic components and status check for the mechanics. These final BOM checks are held to avoid non-compliant components and to ensure technical requirements. At the latest this phase, non-compliances should be noticed and ensured that documents will be got. It is done in cooperation with the component engineers, supply chain management and material compliance engineers. The task is to check components against the ABB list of prohibited and restricted substances. The second next task is to check replacement opportunities for critical non-compliant parts. All parts cannot be compliant at this phase, but the situation is needed to clarify by finding the critical parts. Actions are done depending on the case, and the process can get back to the mechanics or electronic components selection or continue to the finalization phase.

5.3.4 Finalization and Product

At the finalization phase, 0-Series orderings are done by the SCM team. The task is to ensure and send the final compliance data request for the suppliers during the final supplier selection process. The material compliance engineers send the needed templates for the SCM team. After the 0-Series, compliance data should have been collected including the customized mechanics parts. The HSE project states compliance engineers to calculate material limits for restricted and prohibited substances and to identify the exceeding limits. Compliance requirements would be added for requirements before the milestone M4 can be achieved. The process ends for the product phase when the required documentation has been received and the

material limits calculated so that the product management team can send the document of product level compliance to the customers or other parties. The process goes on with maintenance.

The purpose is to share information of the material compliance management and to add it as mandatory for process steps to ensure that components and mechanics are compliant and if they are not, there is still time to change the part if the checks are done early before orderings and production. Sometimes projects are long, so new restricted substances can be added to the candidate lists before the projects have ended which cause challenges. New tasks were added to the HW milestone checklist template and the mechanics milestone checklist template. Material compliance templates were added for requirements when selecting new suppliers.

5.4 Inputs and Outputs

When considering the process inputs and outputs in Figure 8, the most important party to notice is the customer. Every action taken is to ensure the customer satisfaction. Inputs are to verify the right materials and components with needed requirements. Regulations are the main rule to follow and they define which actions need to be done now and in future. As for new regulations, EPDS takes actions to ensure legality and safety of their products. Manufacturers and suppliers are also responsible to comply with the same rules.

Processing includes collecting material compliances and managing other material issues. New parts can be added and outdated, or non-compliant parts removed. By controlling for example quality, new development ideas can arise, and the faults can be noticed.

The outputs of the process are compliant components and products, minimal environmental impacts and customer satisfaction so that the customers want to buy products again. Feedback from the customers give new ideas and information and it helps to develop the products. Process is ongoing with maintenance of the parts by updating the statuses.

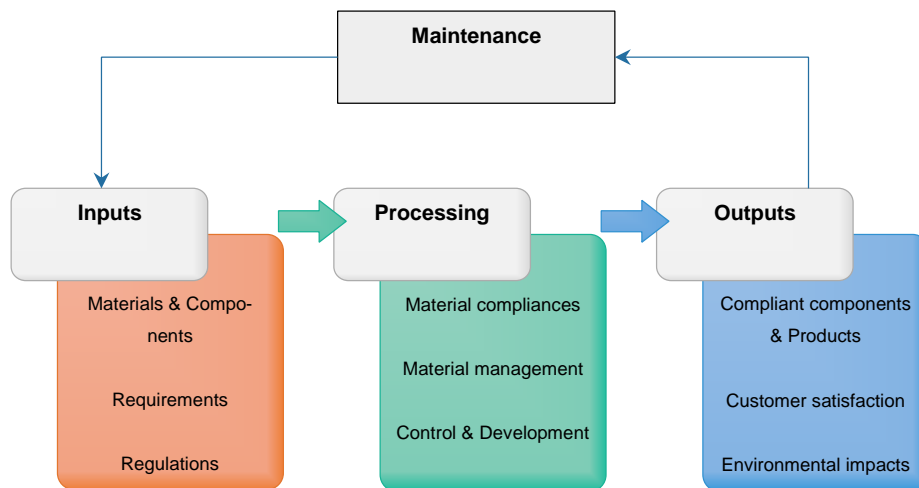


Figure 8. Inputs and outputs.

Entry criteria: Process starts when new BOM designs, new components come or regulation changes

Exit criteria: Product has required material data documentation

Inputs: Regulations and requirements for materials and components

Outputs: Compliant components and products with required material data documentation, customer satisfaction and minimal environmental impacts

6 UAE ROHS LEGISLATION

UAE RoHS is a new regulation, which comes into effect in January 2020. EPDS's marketing area extends for the United Arab Emirates, so it is needed to consider if EPDS needs the compliance for this regulation. The plan is to cooperate with SGS to get required certificates and more information of the regulation.

6.1 Description of Legislation

UAE RoHS is a legislation for the United Arab Emirates. The country published it on 27 April 2017. UAE RoHS is similar to the EU RoHS 2 legislation, but it also has some differences. UAE RoHS includes the same 10 restricted substances as RoHS 2. Companies need to register products, to have declarations of conformity and to follow restricted substances requirements. ESMA, Emirates Standards and Metrology Bureau, issues the certificate of compliance when requirements are passed. Companies can follow the ECAS Registration System or the EQM Product Certification System to get the compliance. /22/

6.2 Requirements

The UAE RoHS legislation requires a notified body certification. In this case, SGS would be the notified body. Requirements for the ECAS Registration System were identified with SGS, and actions would be:

1. Risk assessment to be submitted in case the full product compliance is not completed.
2. The applicant issues a Declaration of Conformity including only critical components.
3. The applicant submits a full RoHS test report of the complete product (if available). Otherwise 3 test reports of the critical component to be submitted once requested by the UAE authority.
4. ESMA verifies compliance to the set limits.
5. ESMA issues the certificate.
6. Valid for one year only. /22/

The EQM Product Certification System is the second option, which includes the following actions:

1. The applicant must provide a self-conformity statement.
2. The applicant submits risk assessment documents in accordance to IEC 63000 and IEC 62476.
3. Technical audit and verification through site visit.
4. Verification of compliance requirements and issuance of certificates and license to use EQM.
5. Valid for 3 years. /22/

The UAE RoHS includes the same exemption for large-scale fixed installations such as the EU RoHS /23/. EPDS can decide either to follow the regulation or not to follow it based on the granted exemption.

6.3 Differences between UAE RoHS and EU RoHS

The EU RoHS is for products in the EU markets, and the UAE RoHS extends only for the United Arab Emirates. The EU RoHS does not need the third-party certificate. Table 2 shows the differences between the UAE RoHS and EU RoHS. Both legislations include the same 10 restricted substances and the same product categories. The UAE RoHS will come into effect one year earlier than the EU RoHS 2. The UAE RoHS needs the ESMA certificate and possibly the EQM label for marking, and the EU RoHS needs the CE marking for products. Testing may be required only for the ECAS Registration System. /24/

Table 2. UAE RoHS and EU RoHS 2. /24/

	UAE RoHS	EU RoHS 2
Substances	10	10
Timeline for Category 9	2020	2021

Marking	ESMA Certificate and possibly EQM label	CE Marking
Documentation	Declaration of Conformance and technical documentation (provided to ESMA)	Declaration of Conformance and technical documentation
Testing Required	May be required for ECAS Registration	Not required, but can be used to show compliance

7 CHALLENGES AND IMPROVEMENTS

There are some challenges in material compliance management. The main difficulties are data updating so that it does not lag behind, different legislations and requirements, suitable management tool and some substances, which can cause problems.

7.1 Data Updating

It is not easy for companies to comply with all environmental regulations, which change all the time. For example, the SVHC list which is updated every six months, which means that the SVHC collection will always be behind. It is also a problem for manufacturers because they should have time to follow restricted substances, to check if their components or products include some of them and to update their certificates twice a year. Full material declarations would be the answer, but not all manufacturers are willing to provide them. It is also challenging for ABB to collect and check data issues many times in a year.

7.2 Different Legislations and Requirements in Different Countries

Some countries have their own legislations or requirements, which complicates the collection process. For example, China and California have their own RoHS legislation. Additionally, UAE RoHS comes into effect in 2020. ABB is a global company and products are sold to many countries so there are many legislations, which should be complied with or determined if there is a need to comply.

ABB's customers can require or ask different specifications of some substances or legislations and ABB should be ready to provide them. Long lists of different substances are challenging and slow to work with because a lot of manual work is required. Usually only one substance report can be exported at a time. The cooperation partner's software tool does not always include all asked information, so it can be hard to find the answer.

7.3 Information

Information flows between all participants are important. At ABB the cooperation with the material management should be between the departments. For example, the supply chain management and R&D could be informed more of environmental regulations to comply with to avoid difficulties later on. The SCM team could inform the suppliers of the environmental regulations ABB requires already when choosing new suppliers and ordering items so that ABB can avoid unresponsive suppliers, which do not provide material data. Furthermore, suppliers could provide material data before orderings so that there is time to change the supplier if they do not provide the required data.

7.4 Tools and Other

Because the component data is not shared automatically between the component base system and the cooperation partner's software tool, data can be outdated because component changes can occur daily. It would be easier if all data and documents were in the same tool. In addition, the software tool is updated only monthly so that new documents and statuses will become shown to other users, and when there are many employees, someone can do the same work, which someone else has already done. It could be good that all participants could see the interfaces also.

It is not always clear if some components are in use or not. Some can be used only for old products. Even if the lifecycle status is obsolete or at the end of life, the parts can be for example in storages, or a bigger quantity is purchased to ensure the availability in future. These parts give difficulties for data collection because manufacturers do not typically provide data for obsolete parts and they might still be in use, so the data should be obtained.

7.5 Lead

Some challenges may appear in the future, for example in the use of lead. The use of lead has been restricted by the RoHS legislation, but RoHS has exemptions, so the use is allowed for example in high melting temperature solders. In June 2018, lead was added to the SVHC list, which means that there are no exemptions for use,

and this causes difficulties to the manufacturers and other parties. Unfortunately, lead has many different uses, and it is hard to find alternatives for it.

8 CONCLUSION

This thesis gives an overall picture of the material compliance management at ABB Distribution Solutions. It describes which regulations ABB is complying with and what requirements the regulations have for ABB. The RoHS and REACH regulations includes substances, which should not be used in products and components. EPDS is collecting RoHS and REACH documentation for components from their manufacturers to accumulate the situation of the component base and to solve the issues to get the compliances for RoHS and REACH.

Material data collection is a long process and needs many responsible parties. This thesis gives some ideas how the collection process could be managed in future by sharing the knowledge of compliance issues and avoiding problems by holding BOM and material checks early enough at ABB. Furthermore, when informing suppliers of the requirements before orderings, only suitable suppliers can be chosen, which can provide the required documentation and avoided unresponsive suppliers. Collected material data ensures the opportunity to send the product level compliance reports to ABB's customers.

The process picture created of the material compliance management in the product creation process gives a description of interfaces of the other processes so that the picture shows in which process steps the compliance issues should be noticed. It helps to see an overall description of the material compliance management. There are shared responsibilities so all parties know their tasks and can help to achieve the product level material compliance in future. New tasks were added to the hardware milestone checklist template and mechanics milestone checklist template, and material compliance templates were added for requirements when selecting new suppliers.

Challenges for the material data collection can be for example changing regulations and new regulations or requirements. One new regulation is the UAE RoHS for the United Arab Emirates. Requirements for the UAE RoHS were identified and needed actions clarified with SGS. In future, EPDS can decide either to follow the

regulation or not to follow it based on the exemption granted for large-scale fixed installations.

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APPENDIX 1

