Introduction

Company-Wide Standardization Activities Regarding ISO 26262 at KYB

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1 Introduction

An international standard on functional safety of electrical and/or electronic (E/E) systems for road vehicles was published as ISO 26262 in November 2011. KYB first applied the standard to automotive electronic power steering [1] and currently promotes the application to other automotive components.

In 2013, a new organizational function was established in Engineering Planning Dept., Engineering Div. for the purpose of promoting activities related to functional safety across the departments involved in functional safety.

This report introduces ISO 26262 and KYB's company-wide standardization activities for related development.

2 Overview of ISO 26262 and Related Standards

Before describing the main topic, this chapter will introduce ISO 26262 and related standards.

2.1 Overview of ISO 26262

This standard aims to address functional safety. The term "functional safety" is defined as "absence of unreasonable risk due to hazards [Note 2)] caused by malfunctioning behavior of E/E systems [Note 1)]". In other words, this standard requires a reduction in the risk caused by malfunction in E/E systems to a permissible level. It also requires an evaluation of the safety of the systems through confirmation measure, including functional safety assessment.

ISO 26262 defines the matters required to achieve the requirements above and the number of work products as large as 100. The standard consists of the 10 parts as listed in Table 1. Parts 3 to 6 contain development processes for safety design based on ASIL [Note 3)], as well as for ensuring traceability from requirement analysis, design to testing. Part 2 provides a scheme and management methods to maintain a safe culture. Part 8 indicates various measures to support development.

Note 1) Electrical and/or Electronic systems. An E/E system consists of electronic control units (ECUs), input devices such as sensors, and output devices such as actuators (Fig. 1).

Note 2) Potential source of harm caused by malfunctioning behaviour of the item.

Note 3) Automotive Safety Integrity Level. There are four ASILs from ASIL A to ASIL D, with ASIL D representing the highest level. ASIL level decides what should action should be taken.

Table 1 Structure of ISO 26262

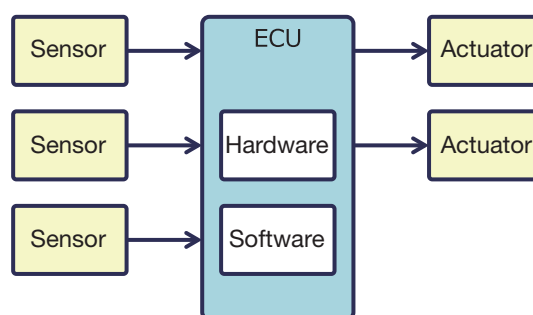| Part1	Vocabulary
Part2	Management of functional safety
Part3	Concept phase
Part4	Product development at the sysytem level
Part5	Product development at the hardware level
Part6	Product development at the software level
Part7	Production and operation
Part8	Supporting processes
Part9	Automotive Safety Integrity Level (ASIL)-oriented and safety-oriented analyses
Part10	Guideline on ISO 26262

Fig. 1 Example of E/E system configuration

2.2 Overview of Automotive SPICE [Note 4)]

Automotive SPICE (Software Process Improvement and Capability dEtermination) is the industry standard process model of on-vehicle software established by European automotive manufacturers. The first edition was published in 2005. The standard aims to improve the software processes and consists of the three process

categories and eight process groups shown in Table 2. Under each process group, carrying out an assessment using detailed process models will allow determination of the organization's capability.

The aforementioned ISO 26262 standard requires the establishment of a process infrastructure. As the best practice of the establishment, Automotive SPICE has been introduced by a number of companies.

On the contrary to the scope of ISO 26262, Automotive SPICE includes no description about hardware development, but places an importance on software development as well as development of ECU systems that are the source of the software development. However, Automotive SPICE describes the process consisting of ECU system development and software development being aware of the "V model" Note 5), which is shared by ISO 26262.

Note 4) Automotive SPICE is a registered trademark of the German Association of the Automotive Industry (VDA).

Note 5) A kind of development process model. The left part of the letter "V" represents requirement analysis and design processes while the right part a testing process. If the requirement analysis/design process is located at a height in the letter "V" that is the same as that of the testing process, this means that these two processes share the same level.

Table 2 Structure of Automotive SPICE

[Primary Life Cycle Process Category]
Acquisition Process Group (ACQ)
Supply Process Group (SPL)
System Engineering Process Group (SYS)
Software Engineering Process Group (SWE)
[Supporting Life Cycle Process Category]
Supporting Process Group (SUP)
[Organizational Life Cycle Process Category]
Management Process Group (MAN)
Process Improvement Process Group (PIM)
Reuse Process Group (REU)

3 Industrial Trend Related to KYB's Products

As mentioned above, the automotive functional safety standard ISO 26262 was published in 2011. As of 2017, it is said that domestic and foreign automotive manufacturers and major suppliers have completed conformance to the standard. To win contracts for on-vehicle E/E products, it is a must to have development activities conforming to the standard. ISO 26262 is scheduled to be revised as a second edition in 2018, in which the scope is expected to cover motorcycles and large vehicles as well.

KYB manufactures many different products for a wide variety of applications, including not only automotive and motorcycles, but also railway, aircraft, construction equipment, industrial machinery, agricultural machinery and special purpose vehicles. These individual products are increasingly electronified. [2]

With the trends in the automotive industry including the compliance to ISO 26262, other industries are also raising their awareness of functional safety. Base machine manufacturers will probably accelerate their demands for functional safety to their suppliers, such as KYB.

For your reference, the hierarchy of international safety standards is shown in Fig. 2. ISO 26262 falls under Type C standards that specify detailed safety requirements for particular machines. This layer of the standard hierarchy includes the standards on railways or construction machinery that many KYB products are subject to. Note that the aircraft industry has another scheme of international safety standards that is different from the one shown in Fig. 2.
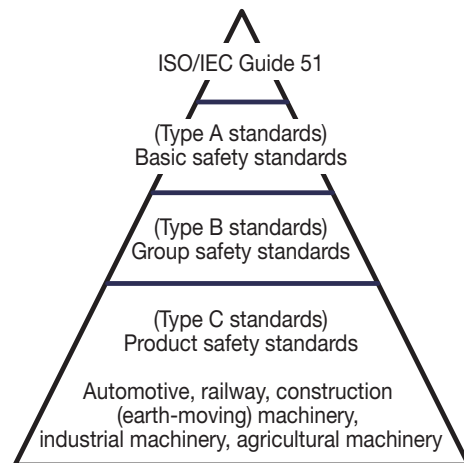

Fig. 2 Hierarchy of international safety standards

4 Aim of Company-Wide ISO 26262 Standardization Activities

The company-wide standardization activities on ISO 26262 and its related development aim to:
① Define not only functional safety, but also a standard development process that will be the base to realize functional safety for development of E/E products;
② Define "common words" and "a common way of doing" which work at an international level in the form of a company-wide manual, not leaving it up to individual developer competence, and;
③ Use the manual to achieve the quality of E/E products to meet the customer and market demands.

These standardization activities are expected to bring the following effects:
① "Product quality assurance" by reducing omissions in the development process
② "Better mutual understanding and higher company confidence" by strengthening the liaison between personnel, departments and companies
③ "Improved development expertise" by sharing and

accumulating knowhow and design/evaluation techniques

④ "Improved development process and higher improvement efficiency" by creating opportunities in improving the development process.

5 Overview of Standardization Activities

Under the slogan "Support activities to develop E/E products which meet customer/market demands", the Engineering Planning Dept. has promoted company-wide standardization activities with the following three pillars:

① To establish, disseminate and improve company-wide standard processes

② To create and apply the development environment

③ To support actual projects of related departments

Fig. 3 gives a conceptual image of activities. In phase 1 to kick off activities, Engineering Planning discussed the standardization of development processes with Engineering that had already addressed ISO 26262 compliance, established "E/E company-wide standards" defining company-wide processes and created a KYB base of E/E product development. The Phase 1 also included establishment of rules to access development activities, development of human resources for assessment, and selection and introduction of software to support the development activities.

Engineering Planning is currently in Phase 2, where company-wide standard processes are being also applied to E/E products for applications other than automotive, leading to more departments involved. Phase 3 aims to strengthen the application of company-wide standard processes to individual departments and finally achieve constant use of the processes throughout the company.

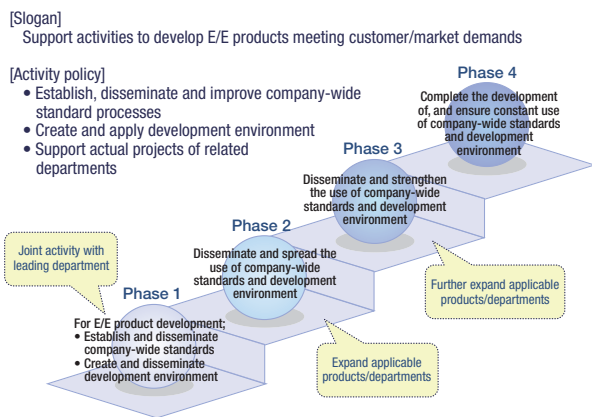The following sections describe details of the activities.

sites. Since the majority of KYB products are mechanical products, QMS used at production sites is not sufficient from the viewpoint of the electric/electronic industry.

With the aim of establishing a company-wide standard development process for E/E products, Engineering Planning has established company-wide E/E standards: "Electronics Development Manual" based on Automotive SPICE with an additional scope of ECU hardware, and "Functional Safety Manual" that defines what should be conductor to ensure compliance to the automotive functional safety required by ISO 26262. These manuals were prepared with due care to avoid any discrepancy between the manuals and the processes defined in the existing QMS (development events and gates).

Based on these manuals, Engineering Planning has established, as part of the E/E company-wide standards, a "Guideline for establishing department standards on electronics development" and a "Guideline for establishing department standards on functional safety," both of which allow individual development departments to draw up their own standards. Both guidelines include a collection of templates to which relevant development departments can actually refer in creating their department standards. The collection has several templates for corresponding typical development processes (for example, software development and change control processes) so that development personnel can select a template suitable for the development range or features of the development department.

Fig. 4 shows the relationship between company-wide E/E standards and department standards at production sites. The figure only covers the standards of products for automotive. It is under discussion to promote compliance to the standards on products for other industrial fields. Engineering Planning continues its routine survey activity to keep track of any amendments to related national/international standards.
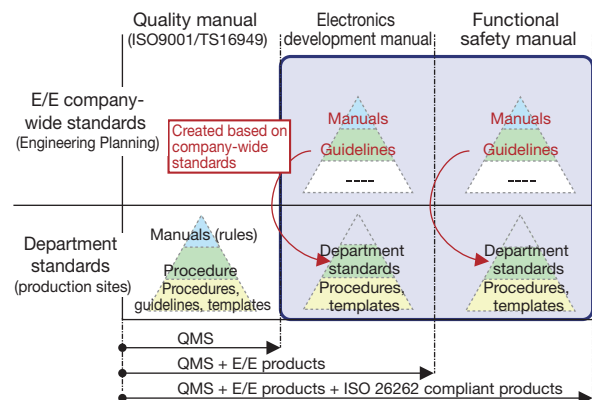

Fig. 3 Conceptual Image of Company-Wide Standardization Activities

5.1 Establish, Disseminate and Improve Company-Wide Standard Processes
5.1.1 Establishing Company-Wide Standard Processes

KYB uses a quality management system (QMS) conforming to ISO 9001 or ISO/TS 16949 at its production

Fig. 4 Relationship between E/E company-wide standards and department standards

5.1.2 Disseminating Company-Wide Standard Processes

The company-wide E/E standards indicated above are stored in the KYB general database so that Development can access them whenever necessary. In the

standardization activities, however, not only defining rules but also disseminating them and encouraging the related departments to actually put them into use are important. To this end, an education and training course on the Electronics Development and Functional Safety Manuals has been developed and is used as part of dissemination activities.

As well as this, some other education and training courses are available, which will be described in section 5.2.3.

5.1.3 Improving Company-Wide Standard Processes

Engineering Planning Dept. continues to review the improvement of the existing E/E company-wide standards that are still being disseminated. Specifically, department checks whether the standards are easily readable and usable, and written with an appropriate degree of detail. In addition to this text expression aspect, it also reviews from the aspect of documentation structure, namely, whether there is no overlap or discrepancy between the company-wide standards and the department standards, or how the company-wide standards should be if the number of applicable products or standards increases.

Another improvement activity is to create standard templates for work products. A number of work products to be created through development activities are defined in ISO 26262 and Automotive SPICE. Then, a set of templates for these work products was prepared to build an environment in which employees can share the templates within the company. Many of the templates were supplied by different departments actually involved in development, although some were original templates from Engineering Planning. Each template consists of a template body, a fill-in guide and fill-in samples, and is arranged to help the actual user easily fill in the form. The templates are planned to have more and more fill-in samples so as to be used for various development activities in the future.

5.2 Create and Apply Development Environment

To ensure that departments involved in functional safety properly carry out development activities, not only to establish rules but also to create an associated environment, are important. This section describes the following three items:
① Assessment
② Development support tool
③ Education and training

5.2.1 Assessment

As mentioned above, ISO 26262 requires safety evaluation through functional safety assessments for each product to be developed. The process assessment according to Automotive SPICE extracts development activity challenges, which can result in improvement. Those who carry out these assessments are accessors.

KYB has promoted development of human resources for internal accessors. For this purpose, the company defined the role and required capability of assessors, and has promoted obtainment of the official qualification by applicable certifying bodies. The number of qualified

assessors is increasing not only in Engineering Planning, but also in Development.

An assessment implementation manual was prepared for standardized operation and is shared by assessors. Furthermore, activities by accessors themselves to establish an evaluation policy is being continued to suppress variations in evaluation results and improve quality. These activities are helpful for deeper understanding of the standards and improving assessor skills.

In actual assessment, an internal assessment is conducted two or more times depending on the progress of the product development project. The result is input to the relevant development department as feedback. KYB can support assessment of KYB by its customers or assessment of its partner company.

5.2.2 Development Support Tool

Development of E/E products deals with an enormous volume of data. Manual efforts to ensure traceability of the information is limited. ISO 26262 and Automotive SPICE require configuration management, change management and problem resolution management of work products. For efficient management, several dedicated software products called development support tools are commercially available and introduced by KYB too.

Engineering Planning has prepared an operating procedure for the development support tool to be used by Development and provides education and training on the introduction. Engineering Planning also responds to regular inquiries from users, and periodically updates information obtained through such inquiries to be available in the form of FAQs [Note 6)] as feedback to users.

In addition, Engineering Planning established a dedicated server for the development support tool, and also provides daily maintenance service on the server to ensure reliable use of the infrastructure.

Note 6) Frequently Asked Questions.

5.2.3 Education and Training

To facilitate the dissemination of the company-wide standard processes (section 5.1.2), the development of human resources for assessors (section 5.2.1) and the introduction of the development support tool (section 5.2.2) for E/E product development, KYB held the education and training courses listed in Table 3. All the courses are provided by instructors from Engineering Planning and irregularly held upon request by Development. The results of taking these courses are maintained as evidence of employee competence.

Table 3 Education/training courses on E/E development

Electronics development
General functional safety
Specific functional safety
Assessor training
Development support tool training

5.3 Support Actual Projects of Related Departments

Besides the activities related to the company-wide processes and development environment as described above, support to actual product development projects is also one of the priority activities. This activity mainly implements the assessment stated above and supports the development support tool users. In addition, Engineering Planning sets up regular opportunities to meet together to provide advice on the introduction or implementation of the standard processes.

Engineering Planning also holds regular meetings of two or more departments involved in functional safety so that they can share information about the trend and details of related domestic/international standards, and the progress and challenges of various projects.

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<tr><td>**6**</td><td>**In Closing**</td></tr>
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It's been a long time since people started to say that the wave of applying electronic control to many different general products and technology was accelerated. The same trend has been seen with the KYB's products. Probably the opportunities and necessity of conforming to the specified processes and standards related to functional safety are increasingly rising.

I can easily imagine that Development requires more and more man-hours every time another rule is established. Although it may be somewhat contradictory, I could say I want Development personnel to smartly use the standard processes and various domestic/international standards as a tool to provide "evidence of proper design".

References

1) ISHIZUE: Toward Adopting ISO 26262 in EPS development, KYB Technical Review No.50 (April 2015).
2) MATSUDA: Electronic Device Product Development and Future Outlook in a KYB group, KYB Technical Review No.50 (April 2015).

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