OBD-II and HD OBD require extensive documentation from manufacturers for approval of new vehicle models by certification authorities. Creating it requires precise knowledge of the legal requirements, details of the implementation of the monitoring functions in the ECU, knowledge of extensive responsibilities, insight into the calibration parameters of the ECU, and much more. Besides the complexity of these tasks, correctness (of form and content) is extremely important, since there is a threat of fines for each approved vehicle. A structured process for creating On-Board Diagnostics documentation supports manufacturers and suppliers in meeting these challenges and makes it possible to build up a knowledge base.

Environmental protection legislation sets emissions standards for vehicles with combustion engines. With growing environmental consciousness in recent years, these regulations have been extended to more and more vehicle classes, and the limits have been lowered again and again. These rules differ depending on the approval country, approval year, and vehicle type. The regulations not only govern the upper limits for pollution emissions, but also require monitoring of all emission-related components during operation. If an assembly fails and produces more emissions than stipulated, the ECU must detect this, store the information, and inform the driver. Furthermore, the legislation requires that standardized scan tools can query these monitoring functions and fault memories in order to allow checks by authorities, repair shops, and users.

The effort to implement and comply with the legal requirements represents a significant part of ECU software development work. In order to verify implementation of the legal requirements, the vehicle manufacturers must submit extensive documentation for approval of each vehicle variant. The so-called OBD documentation describes a list of emissions-related faults and their effect, monitoring, and detection (figure 1). All information needed for this documentation is produced automatically in the course of the development process, but often in an unsuitable form. For example, the fault detection strategy is implemented in the software and must be described in plain text. Limit values for sensors that trig-
ger an error when exceeded are calibrated as parameter values in the HEX file of the ECU and must be identified as a monitoring range. Or diagnostic trouble codes are listed in the diagnostic description and must be assigned to a standardized SAE code.

Above all, creating the OBD documentation is an organizational challenge. It is necessary to ensure that all information is collected in the appropriate form and correct version and can be processed by technical experts according to the legal requirements.

Typically, this task is performed largely by hand without special tool support. The person responsible for the OBD documentation collects this information in text or tabular documents and processes it. This involves significant effort, since, besides the initial data gathering, it is necessary to ensure that everything is up to date for the approval:

> Has the detection algorithm been modified during development?
> Does the calibration data correspond to the current vehicle variant?
> What information can be reused for derivatives?
> Who is the contact person for inquiries about a diagnostic function?

It is very important that all information is correct at the time of submission. The authorities set fines based on the number of approved vehicles. The regulations of the CARB (California Air Resource Board) set penalties between 25 and 50 US dollars per fault and approved vehicle. Depending on the number of units sold, this can quickly add up to significant amounts.
Integrated Complete Solution
A dedicated data management solution can offer significant added value and support error-free creation and maintenance of OBD documentation. Such an integrated approach is described below with the example of vCDM, the calibration data management solution from Vector. This database-supported platform allows ECU parameters to be managed reliably. All functions are available to calibration engineers as a multi-user solution in order to manage the data supply of various vehicle variants during development and series maintenance. Project approvals control access to the data. Furthermore, all calibration data is subject to version control, which allows all changes to be tracked consistently.

Defined functions and data are available to each developer according to his or her role and the project approvals. This allows an OBD calibration engineer to run the diagnostic application for an ECU with the “Function Inhibition Editor”. The diagnostic fault codes and ECU functions are represented in a clearly organized matrix, and the blocking conditions can be set directly (figure 2). Additional information such as the SAE code is displayed directly.

A Comprehensive Knowledge Repository
For the purpose of data management, it makes sense for developers to store additional text for every entry (software, parameter, diagnostic fault code). Arbitrary text categories can be defined and assigned, for example the “Application Tip” knowledge block for calibration parameters, or the “Enable Condition” and “Threshold Value” knowledge blocks for a diagnostic fault code. The current forms of these knowledge blocks are displayed there or modified. The knowledge management system exports and imports these from/to standard Office formats via standard functions for processing or reuse of the information. This makes it easy to load information that already exists into the knowledge repository and reuse it. Each knowledge block has a scope which controls which software versions or variants these texts can be reused for.

A report generator can be helpful for defining and printing templates for individual reports. In the generator layout, users can access all elements (parameters, diagnostic fault codes, knowledge blocks) and position them in the layout accordingly. It should also be possible to use formulas and variables within a knowledge block which can be “calculated” accordingly when it is output:

Threshold Value knowledge block for fault code P0401:
Content: “=ECU_Parameter1 to ECU_Parameter2”
Output: “12.0 to 20.0”

This ensures that the values of the vehicle variant are always used when creating a report. In this way vCDM allows the company to build up comprehensive knowledge management in addition to the actual calibration data (figure 3).

Figure 3: Linking knowledge content to calibration data allows reuse and ensures that documents always show current content
Efficient OBD Documentation

The OBD documentation in vCDM takes advantage of the versatile data management functions and provides a configuration that makes it possible to start documenting content immediately. The necessary vehicle variants can be created, and calibration data can be imported or applied. For the OBD domains, the relevant knowledge types are pre-configured, and lists of diagnostic fault codes can be imported. For certain engine ECUs, the fault codes can be read out automatically from the ECU description file (A2L). The report generator provides some templates with the required format for the European and US OBD documentation requirements. The base system offers extensive options for independent and customized extension. For example, users can define and populate their own knowledge blocks. Adaptable templates allow them to create their own reports or insert additional columns representing this knowledge so they can be used to represent project management requirements, for example. This provides a software tool to which all the technical experts involved contribute in order to provide and reuse information efficiently (figure 4).

Conclusion

It is to be expected that the regulated requirements that On-Board Diagnostics places on ECU development will continue to increase constantly in coming years. These tasks are currently performed “by hand” in the development process with significant effort. An integrated tool can support all the engineers involved according to their tasks and makes it possible to reuse existing knowledge in a sensible way. This leads to significant time savings and helps to reduce errors and the associated costs.