**Hybrid SUV Change Scenarios**

**November 26, 2015**

The following are the proposed updates to the Hybrid SUV change scenarios based on our discussion at our last telecon on November 23, 2015. Some background information and the change scenarios A, B, and C are included below.

During our telecon and in your email below, you note that the change board may request a group of changes to be evaluated that may include previously deferred changes from a change log. The scenarios below make minor reference to this, but this can be further accommodated in a future version if desired.

Regards,

Sandy

**BACKGROUND**

The following Hybrid SUV change scenarios are instantiations of the 'Process Change Request' scenario that you documented in the attached *Review Document For Process Change Request V6*. The scenarios are intended to align with the top level generic process, but the scenarios have not been compared with the lower level processes.

The scenarios are intended to provide a common basis for the Concept Leads to refine their concept and derive requirements for the System Modeling Environment (SME). It is not intended to be exhaustive, but sufficient to derive a representative set of requirements.

The System Modeling Environment includes the system modeling tool, and contains or integrates with the following kinds of tools to execute the change scenarios:

* Requirements management
* System modeling
* CAD
* CAE
* Software modeling
* Performance analysis (e.g., Simulink)
* Safety analysis
* Project management
* Problem reporting
* Configuration and change management

As we discussed, the Hybrid SUV in the SysML v1.4 Specification (Annex D) emphasizes a thread for fuel efficiency. In order for this change scenario to be more generally applicable, the scenario is initiated based on different issues that surface in different phases of the lifecycle as follows:

* During the pre-PDR phase, Contracts is notified of a change in the government regulation to improve fuel efficiency on selected models by 10 % within 3 years. Specifically, the fuel efficiency for this planned vehicle model must increase from 25 mpg to 27.5 mpg.
* During the I&T phase, Quality provides test data that shows the vehicle fails to meet its fuel efficiency requirement.
* During the operational and support phase, NHSTA issues a recall to the Automobile manufacturer to address a high rate of failure of the catalytic converter that results in both high emissions and poor fuel economy

**SCENARIOS**

The change scenarios A, B, and C for the Hybrid SUV are included below.

**Scenario A**

**Issue identification:**

During the pre-PDR phase, Contracts is notified of a change in the government regulation to improve fuel efficiency on selected models by 10 % within 3 years. Specifically, the fuel efficiency for this planned vehicle model must increase from 25 mpg to 27.5 mpg.

**Submit change request:**

Contracts prepares a change request and submits to the program change control board (CCB). The change request is submitted via an on line form that identifies the proposed requirement change, who submitted, when submitted, and rationale for the change by referring to the modified government regulation.

**Categorize change request:**

The CCB categorizes the change as class A (significant impact with high priority). This information gets added to the change request. This change is grouped with another previous change that relates to improved fuel efficiency.

**Evaluate business impact:**

The CCB determines that this will impact the production line of this new model beginning in January, 2018. The production schedule impact is added to the change request.

**Assess architecture impact/Assess preliminary design impact:**

The first attempt of this iteration is to determine whether software changes alone can achieve the fuel efficiency by modifying the fuel control algorithms. It is determined that approximately 5% can be accomplished via an algorithm change, and the other 5% must be accomplished through hardware changes. The assessment will include whether this can be accomplished through weight reduction to account for the other 5%, which may include a combination of material and design changes.

The preliminary assessment is performed by first identifying all affected elements across the system architecture that may be impacted. The hardware and software designers use their tools to conduct a preliminary feasibility assessment of what can be accomplished. The engine control team determines that they can achieve 5% efficiency through adjustments to the gear selection algorithm (e.g. switching gears at lower rpm). However, this reduces vehicle acceleration performance. As a result, the weight must be reduced sufficiently to achieve the additional fuel efficiency and to maintain acceleration performance. Preliminary weight reductions are identified by potential design and material changes to the engine, transmission, and battery (e.g., power train). In addition, consideration is given to adding a tire pressure control feature if the fuel efficiency cannot be achieved through the weight reductions.

Several analysis are performed as part of this initial proposed change, including fuel efficiency analysis, weight analysis, and acceleration analysis. A hazard assessment is also performed to confirm the changes do not adversely impact vehicle safety.

The above architecture and design impacts along with their rationale and traceability are captured in a preliminary change impact assessment, which is referenced in the change request.

**Review change request impact assessment:**

The CCB reviews the change impact assessment and approves the decision to proceed with the change, and adds the decision, rationale, and approvals to the change request.

**Plan release and effectivity:**

A preliminary project plan to implement this change is developed which includes tasks to update the hardware design and software design and implementation, updates to verification plans, manufacturing plans, and supplier plans.

**Update architecture and specifications /Assess detail design impact:**

A trade study is performed to assess the feasibility of adding a tire pressure control feature, but this is deemed as not cost effective for this vehicle design.

Further detailed hardware and software design impact assessment is performed to determine changes to requirements to the system, element, and component level specifications. This includes changes to the system fuel efficiency requirement, the engine control software requirements, and the weight requirements for the engine, transmission, and battery. The battery is a long lead item that is acquired from a supplier, so the supplier specification must be modified along with changes to the supplier contract. Manufacturing determines that the manufacturing process and tooling will be impacted based on the hardware design and material impact assessment.

The results of this activity are proposed redlines to specifications and to updates to the architecture design which are captured in the preliminary change package. This impact is also referenced in the change request.

**Review final change estimate:**

The CCB reviews and approves the proposed preliminary change package. This approval is reflected in the updated change request.

**Update Project Plans, Cost and Schedule:**

The preliminary project plan is updated to reflect more detailed plans including cost and schedule estimates to support the detailed hardware and software design, implementation, and verification.

**Assess applicability of change to product family:** Per your comments below, this process will be treated as a separate use case, but is included here to give it visibility.

The change process described above is applied to the product family, where the change control board represents the institutional change control board responsible for managing the evolution of the product family.

**Scenario B**

**Issue identification:**

During the I&T phase, Quality provides test data that shows the vehicle fails to meet its fuel efficiency requirement. Quality generates a problem report. The corrective action process is performed, and identifies a design deficiency in the new fuel control algorithms. This information is added to the problem report.

**Submit change request:**

Quality prepares a change request and submits to the program change control board (CCB). The change request is submitted via an on line form that identifies the proposed design change, who submitted, when submitted, and rationale for the change by referring to the problem report.

**Categorize change request:**

The CCB categorizes the change as class A (significant impact with high priority). This information gets added to the change request.

**Evaluate business impact:**

The CCB determines that this has minimal business impact but must be fixed during the I&T phase.

**Assess architecture impact/Assess preliminary design impact:**

The preliminary architecture and design impact determines that this fix can be made through a software fix. The architecture and design impacts along with their rationale and traceability are captured in a preliminary change impact assessment, which is referenced in the change request.

**Review change request impact assessment:**

The CCB reviews the change impact assessment and approves the decision to proceed with the change, and adds the decision, rationale, and approvals to the change request.

**Plan release and effectivity:**

A preliminary project plan to implement this change is developed which includes tasks to update the software design and implementation and perform additional testing at the engine control software, engine, and system level.

**Update architecture and specifications /Assess detail design impact:**

The preliminary change package includes no change to the specifications.

**Review final change estimate:**

The CCB reviews and approves the proposed preliminary change package. This approval is reflected in the updated change request.

**Update Project Plans, Cost and Schedule:**

The preliminary project plan is updated to reflect more detailed plans including cost and schedule estimates to support the detailed software design, implementation, and verification.

**Scenario C**

**Issue identification:**

During the operational and support phase, NHSTA issues a recall to the Automobile manufacturer to address a high rate of failure of the catalytic converter that results in both high emissions and poor fuel economy.

**Submit change request:**

Contracts prepares a change request and submits to the institutional change control board (CCB). The change request is submitted via an on line form that identifies the defective unit, who submitted, when submitted, and rationale for the change by referring to the NHSTA recall.

**Categorize change request:**

The CCB categorizes the change as class A (significant impact with high priority). This information gets added to the change request.

**Evaluate business impact:**

The CCB determines that replacing the faulty catalytic converter will have a very significant business impact on the vehicle under question, but also will potentially impact other vehicles currently under development, since this same catalytic converter is used on the newer vehicles. The potential impact is added to the change request.

**Assess architecture impact/Assess preliminary design impact:**

The initial assessment identifies two alternative fixes, including replacing the part with another, or modified the current part. The two alternatives are identified, and analysis is performed to assess each alternative, including fuel efficiency analysis, emissions analysis, and reliability analysis. The results are captured in the preliminary change impact assessment, and referenced in the change request.

**Review change request impact assessment:**

The CCB reviews the preliminary change impact assessment and approves the decision to proceed with the part replacement, and adds the decision, rationale, and approvals to the change request.

**Plan release and effectivity:**

A preliminary project plan to implement this change is developed which includes tasks to perform the detailed design change with the replacement part, which involves some mechanical interface changes, and procurement of the replacement part. This change will impact multiple vehicle models.

**Update architecture and specifications /Assess detail design impact:**

The results of this activity are proposed redlines to the catalytic converter specification and a minor interface requirements change to the manifold. The updates are captured in the preliminary change package. This impact is also referenced in the change request.

**Review final change estimate:**

The CCB reviews and approves the proposed preliminary change package. This approval is reflected in the updated change request.

**Update Project Plans, Cost and Schedule:**

The preliminary project plan is updated to reflect more detailed plans including cost and schedule estimates to support the detailed design and implementation changes, procurement of the new part, and verification. The detailed design implementation and integration of this change, and the management of the change, will be the responsibility of each individual Vehicle program that is impacted.