

1.0 PURPOSE:

To define the required activities in the generation, processing and implementation of an Engineering Change Order (ECO).

2.0 SCOPE:

This document summarizes the activities involved in the Change Control Process.

3.0 RESPONSIBILITIES:

3.1 Components Engineering is responsible for verifying ECO technical content, cost evaluation, material disposition, effective date and incorporation into manufacturing operations.

3.2 Personnel responsibilities are as follows:

3.2.1 **Director of Engineering** - The primary contact for ECO initialization. Responsible for coordinating and processing ECOs through initial steps until ECO is released to Operations for implementation. Also responsible for organizing and overseeing ECO review meetings. (This varies from company to company)

3.2.2 **Development Engineer** - Responsible for technical content of ECOs relating to design and manufacturability of products affected by proposed change.

3.2.3 **Planning/Material/Program Manager** - Responsible for overall assessment of change impact on schedules, developing effective implementation plans (including material usage and procurement requirements) and verifying proposed effective dates entered on the ECO. They are also responsible for advising Purchasing and Sales of changes which will affect open purchase orders and open sales orders.

3.2.4 **Purchasing** - Responsible for notifying all suppliers of changes, cancelling purchase orders and RFQ's (Request for Quote).

3.2.5 **Operations Support** - Responsible for ensuring that technical aspects of changes are incorporated in the manufacturing process (on site and at supplier facilities) and no degradation of quality or reliability occurs as a result of the change.

3.2.6 **Components Engineer** - Responsible for all component level compliance with the ECO specifications, requirements, processes and material disposition. Component Engineering verifies the technical integrity of the change and ensures, along with the Process Engineer that proper methods and procedures are in place to incorporate the change in production.

3.2.7 **Mechanical/Printed Circuit Designers** - Responsible for updating assembly, fabrication and schematic drawings.

3.2.8 **Document Control** - Responsible for issuing approved ECOs, updating the MRP system, authorizing and monitoring the update of all Product documentation and the timely processing and distribution of related documentation (electronic and hardcopy).

4.0 DEFINITIONS:

4.1 **Initiator** Any TVS employee representing a technical function, with the assistance of their manager can initiate an ECO.

4.2 **Effective Date** - Based on type (urgency) of change, effective dates are defined with consideration to quantity on hand, work in process, and items on order.

4.3 **ECR** - Engineering Change Request , to be completed prior to ECO

4.4 **ECO** - Engineering Change Order, Document of final record of change

4.5 **ECO Review Team** - Participants representing impacted departments plus administrative leads

4.6 **MRP/PCMRP** - Materials Requirements Planning/ Part Master Data Base management system

4.7 **Red-lines** - Document change mark-ups including schematics, BOMs, and mechanical and assembly drawings

4.8 **R & R** - Repair and Return, associated with Customer Service

5.0 PROCESS FLOW:

Refer to **Appendix A** (Change Control Process Flow Chart). Paragraph numbers reflect process step numbers i.e. 5.1 = process step number 1.

5.1 **Need for an ECO is identified** - Change requests come from many sources both internal and external. Change requests can be verbal or in writing and should be directed to the engineer responsible for the particular design, product, or document which may require change.

5.2 **Engineer(s) evaluates requested change** - The Engineer or Component Engineer will isolate and identify the root cause(s) responsible for creating the need for a change. The Component Engineer along with the Responsible Engineer performs the initial research, modeling and any other background work required to justify the change, including cost benefit analysis. The evaluation process shall include review for impact to product performance in the following areas:

- Design Improvement
- Reliability
- Serviceability
- Installability
- Manufacturing Process Improvement
- Specifications/Documentation Impact
- Component Availability
- Cost Reduction

5.3 **Engineer red lines affected documents** - Engineer red lines affected documents in accordance with the procedures.

5.4 **Rework Required ?** - Dev/Component Engineer /Sustaining Engineering determine if proposed change is to be incorporated into work in process and at what levels of impact including suppliers and customers.

5.4a **R & R/Field Affected ?** - If installed field units would see this problem Dev/Component Engineer Engineer(s) work with Customer Service to outline R&R/Field rework requirements.

5.4b **Issue Customer Service Bulletin** - Customer Service issues a Customer Service Bulletin to alert customers of potential problems/hazards if necessary.

5.4c **Write Rework Instructions** - Dev/Component Engineer(s) writes factory rework instructions in accordance with standard red-lines; also writes R&R/Field rework instructions when required.

5.5 **Component Problem ?** - If proposed change highlights a technical problem with components or sub-assemblies manufactured by outside suppliers, then the Component Engineer(s), Development Engineer(s) and Purchasing will be notified of the problem.

5.5a **Notify Supplier** - Components Engineering and Purchasing will take whatever advance steps are necessary to best serve the company interests in implementing the proposed change. This may include the introduction of a Suppliers Corrective Action Request, (SCAR), or the initiation of a root cause failure analysis effort.

5.6 **Generate ECR** - Engineer completes ECR and assembles the change package, including all attachments required for review to detail change for processing by Operations. The change package shall include all documentation (specifications, redlines, rework instructions, etc.) necessary to clearly define the change requirements.

5.7 **Transfer to ECO/Operations Coordinator** - Engineer reviews the technical aspects of the change with the ECO/Operations Coordinator after passing on the change package via email for earliest possible review. ECO Coordinator verifies that all necessary information to complete the ECR is included as part of the change package. The ECO Coordinator will then submit the ECR to the Engineering management for approval to proceed to the ECO stage.

5.8 **Will change affect Form, Fit, Function, or Reliability ?** - The Component Engineer determines if the change affects Form, Fit, Function, or Reliability in

accordance with Standard Operating Procedures; the information provided by the engineer is entered on the ECO form. If a change is determined to be a Record Change only, Cost Analysis and Material Disposition are not required and ECO is submitted for approval to the ECO review.

5.9 Cost Analysis, Material Disposition, Effective Date - ECO coordinator works with the Component Engineer and Material Planner to complete cost analysis, material disposition, and determine effective date.

5.10 ECO Coordinator completes ECO - ECO coordinator completes ECO and prepares change package for submission to the ECO review team. ECO must be complete prior to being submitted to the ECO review team for sign-off.

5.11 Distribute ECO to review team - ECO coordinator distributes advance copies to ECO review team via Email Notification prior to meeting for change validation and resolution of potential problems.

5.12 ECO Review team meeting - ECO coordinator arranges and chairs the ECO review team meeting. The ECO review team conducts a technical and logistical review of the proposed change and verifies that all issues relative to the change are properly addressed. Material disposition, rework instructions, and effective date(s) are agreed upon and verified with MRP.

5.13 Is ECO correct ? - Corrections which are minor in nature are made during the meeting in order to expedite the ECO. If corrections require additional analysis or input from other sources ECO is returned to the coordinator for resolution.

5.13a ECO Coordinator corrects and redistributes ECO - ECO coordinator acquires needed corrections and redistributes to team members for review if needed. If additional review is not needed coordinator presents ECO at next scheduled team meeting.

5.14 ECO Review Team Signs off ECO - Acceptance and sign-off must be unanimous. The preliminary and final "Approval" process will be performed via a routing procedure. All names required for "approval" will be included in the routing. An "advisory only" list may also be included in the email notification and routing. Only those signatures required for approval will be necessary before the ECO is released.

5.15 Class I or cost > \$?K - If proposed change is classified as **CLASS I** (Non-interchangeable) or cost of change exceeds **\$?K** CEO/VP/Director approval is obtained by ECO coordinator.

5.15a Is Field Upgrade required ? - If proposed change affects units in the field customers are to be notified and a field upgrade/rework plan is required.

5.15b VP/Director assigns Program Manager - If field upgrade/rework is required Product VP/Director assigns program manager and notes name of person assigned on rework instruction page of ECO.

5.15c ***VP/Director signs off ECO***

5.16 ***ECO handed-off to Document Control*** - ECO coordinator hands off ECO to Document Control for number assignment and incorporation.

5.17 ***Document Control assigns ECO #*** - Operations support will review the ECO for proper completion, all required routing signatures, all parts or BOMs effected, revisions are correct, cost sheet is completed, material disposition is addressed, red-lines and rework instructions are attached where required. After verifying the items listed the ECO coordinator or Documentation Control will log the ECO, assign an ECO # and begin processing.

5.18 ***Document Control updates MRP*** - Document Control updates PCMRP.

5.19 & 19a ***CAD Update required ?*** - If CAD files require updating Document Control sends ECO and redlines to CAD Services.

5.19b ***CAD Services updates files*** - CAD Services schedules work to be done and provides Document Control with updated documents.

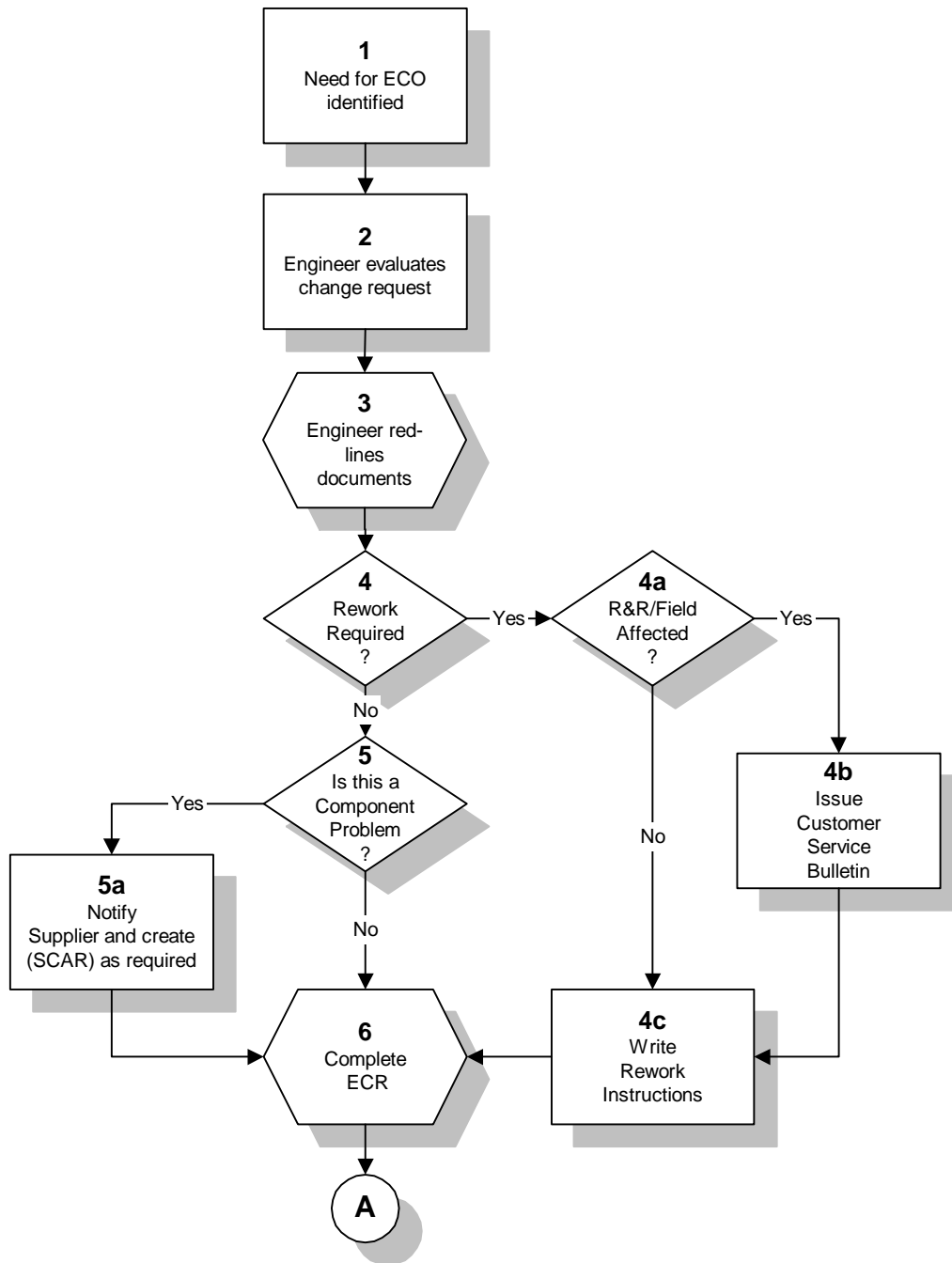
5.20 ***ECO Distribution*** - Document Control distributes copies of ECO and redlines to all for implementation.

5.21 ***Updated Documents assembled for sign-off*** - Upon receiving updated documents from CAD Services and/or other departments which may be charged with updating product documentation, Document Control assembles the ECO and all documentation affected by the ECO and notifies the initiator that the documentation package is ready for sign-off.

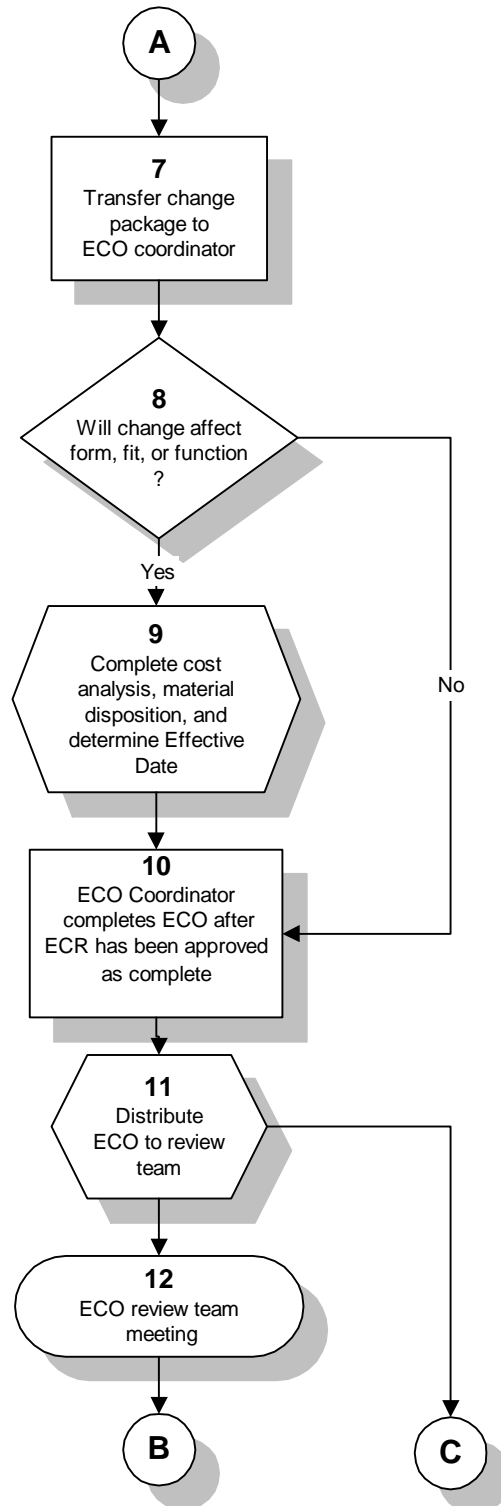
5.22 ***ECO Initiator signs off ECO*** - ECO Initiator verifies that changes were incorporated into the product documentation as specified by the ECO and any hard copy documentation or drawings are signed by responsible engineer. Initiator signs off ECO releasing updated documentation.

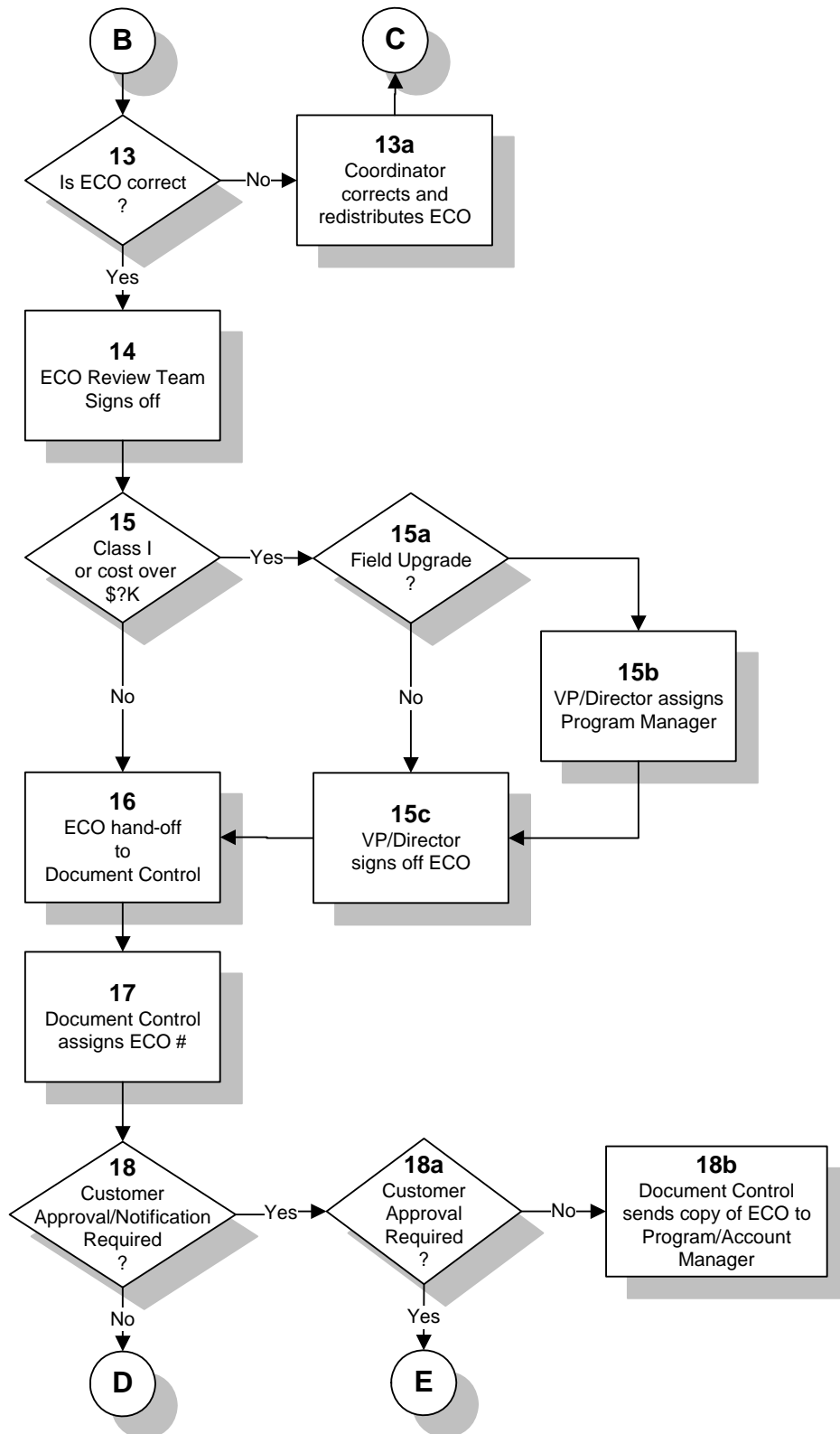
5.23 ***Master Files Updated*** - Document Control files original documents in master files, removes and archives obsolete documents, removes and replaces copies in computer files. ECO process is completed.

APPENDIX A - CHANGE ORDER PROCESS FLOW

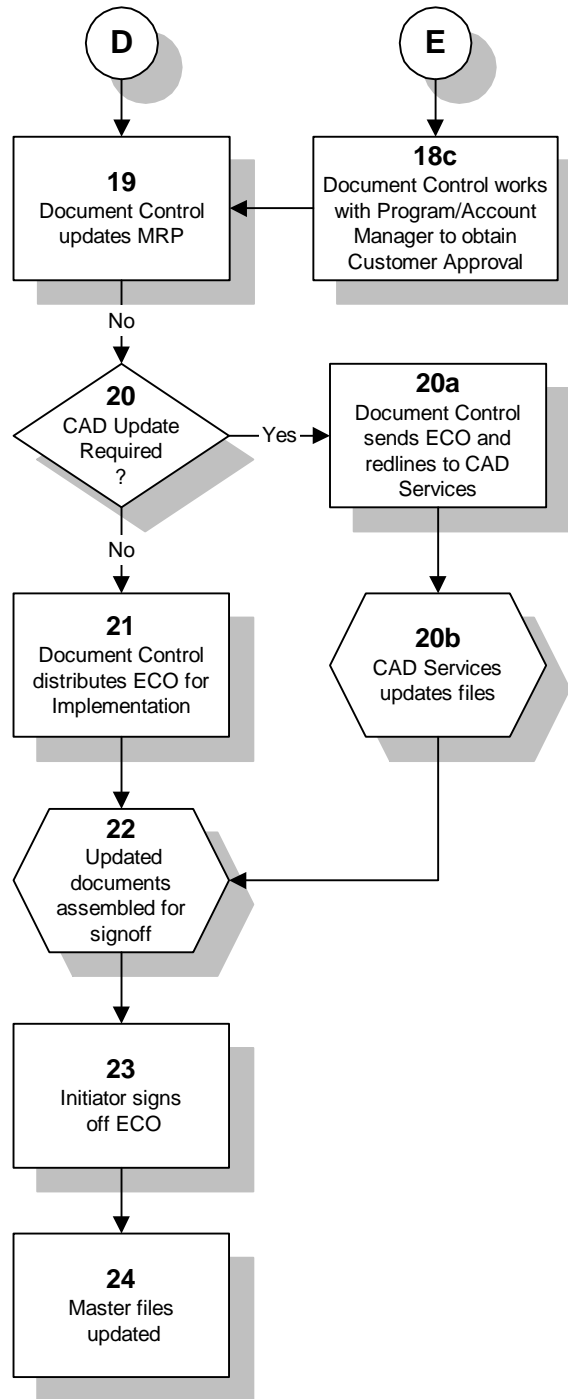


APPENDIX A - CHANGE ORDER PROCESS FLOW (cont'd)





APPENDIX A - CHANGE ORDER PROCESS FLOW (cont'd)



The routing path and signatories. (This is where you would put in your organizations names that match the titles for your ECO routing and approval signature processes.)

CEO/VP Engineering
Director of Engineering
Development Engineer
Software Engineer
Planning/Materials/Program Manager
Manufacturing Manager
Purchasing
Operations Support
Component Engineer
Printed Circuit Designer
Mechanical Designer
Documentation Control
ECO Coordinator
PCMRP Administrator
Cad Services
Customer Service/Support -R/R