Integrating a Control Plan Methodology into an MES System to Enhance Ease of Process Control

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Key words: Control Plan, MES, Process Router, Process Control, OCAP, FMEA

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Abstract

Controlling a process is an important part of meeting customer requirements, maintaining good yields and obtaining excellent cycle times in high volume wafer manufacturing. Typically process control plans are developed and utilized by Quality Assurance groups to document and keep track of the status of all significant process characteristics. The use of a process control plan is an excellent way to ensure significant characteristics for a process are defined and understood. This paper will describe how TriQuint Florida has implemented a control plan methodology into its MES system to allow for ease in controlling a wafer fabrication manufacturing process.

INTRODUCTION

With a wafer fabrication manufacturing work force that consists of four shift coverage this provides challenges for process control in terms of prompt and consistent reaction to out of control process conditions as well as running a process the same shift to shift. The use of a router system integrated with a process control plan provides consistency by containing all the necessary information for process control. This web-based control plan contains links to other systems such as the controlled documents that contain procedures for running the process, defines the key parameters needed to control the process and provides easy access to out of control action plans to react to out of control process conditions.

CONTROL PLAN METHODOLOGY

Control plans are utilized as a tool to aid in the manufacturing of quality products according to customer requirements by defining key parameters needed to control a process. A control plan is typically maintained and used throughout the product manufacturing life cycle. Often times a control plan is developed by a multi-disciplined team to provide information to gain a better understanding of the process and what parameters are needed to control a process. This information is to be maintained as a living document to be changed when process changes/updates occur. Below is a control plan template that is used to understand the type of information that is needed to control a process. Different types of software are used to develop a control plan such as excel or web based templates. A control plan is typically filled out by cross functional teams and revised when changes occur in product or process characteristics, specifications, measurement systems, sampling, control methods, or the reaction plans. The usefulness of a control plan depends on how accessible it is or how often it is utilized to control a process. In some cases, a control plan is put together to define how well the process has been studied to identify key characteristics on how to control it. After a control plan this is completed, a process is released to production. If the control plan is not published as a living document, it is not as useful as it could be if it is utilized in everyday activities to run and control the process.

CONTROL PLAN

Prototype	Prelaunch	Production	Key Contact/Phone								Date(Orig)	Date (Rev.)	
Control Plan Number													
Part Number/Latest Change Level			Core Team								Customer Eng. Approval/Date		
Part Name/Description			Supplier/Plant Approval/Date								Customer Quality Approval/Date		
Supplier/Plant		Supplier Code	Other Approval/Date (If Req'd)								Other Approval/Date		
			Characteristics				Methods						
Part/ Process Number	Process Name/ Operation Description	Machine, Device, Jig, Tools, for Mfg.	No.	Product	Process	Special Char Class	Product/Process Specification/ Tolerance	Evaluation/ Measurement Technique	Size	Freq.	Control Method	Reaction Plan	

Figure 1: Control Plan Template

MANUFACTURING CONTOL PLAN

Using a control plan methodology the Manufacturing Control Plan (MCP) at TriQuint Florida involves the combination of a process control router and the significant characteristics needed to control the process. Each step of the process, from the first step (issuing wafers to a lot) to the last (shipping the wafers) has a defined control plan step. Below is an example of a single process step in the MCP. The blue indicates hyperlinks to live documents, current tool

status (facility UP/DOWN), and links to out of control action plans (OCAPs) for example.

When the MCP was first implemented, it consisted mostly of information defined in each block (no hyperlinks to external systems) and has evolved to an interactive webpage. This MCP web-page displays critical information as well as quick links to other systems to ease in manufacturing's ability to control the process, control processing equipment and the accessibility to OCAPs to ensure customer requirements are met; internal customers as well as external.

This paper will discuss further how the Manufacturing Control Plan is organized, trained against, updated, OCAP descriptions, live links to the FMEA system and how process control parameters are defined within.

Figure 2: Manufacturing Control Plan – Process: Automatic Inspection

1) Work Center is TriQuint Florida's version of a ***Control Plan Number***. This is a unique identifier for the combinations of tools, work instructions, control methods, etc. for a particular process router step.

2) The ***Process Name & Characteristics*** of the process is listed in Op Description and Op Instructions.
    a. Op Description is the name of the process that is to be performed.
    b. Op Instructions are special instructions that can be tied to a specific device in its manufacturing router. These instructions can also be left blank if the device process step combination is generic, i.e. no special instructions needed for this step.

3) ***Characteristics for the Product/Process*** are located in the work instructions and training procedures in the MCP. The documents that provide these work instructions and training requirements are controlled documents and are linked directly to the document control system.

4) The ***Machine for Manufacturing*** contains the equipment information assigned to the work center in the manufacturing control plan.
    a. *Equipment Status* – It states equipment identification and its current status such as Up/Down. This also provides a live hyperlink to the system that is used to maintain process equipment. Clicking this hyperlink opens software to allow for further investigation of a tools status, what department the equipment is down to, PM schedule, etc. Clicking this equipment hyperlink in the Manufacturing Control Plan is a fast and convenient way for anyone to put a tool down in the system.
    b. *Recipe availability* – This field is also used to state whether a particular process tool/equipment has the recipe needed to run a particular device.

See Figure 2 where it is indicated that only AIT1 and AIT2 are available for the lot in queue. AIT3 is down to production and AIT4 (Recipe UA) does not have the recipe needed for this lot to be processed.

Figure 3: Equipment Block specifies equipment available as well as status of each piece of equipment

5) The Recipe ID field is not specifically called out in the AIAG Control Plan Methodology but it is considered a ***Special Characteristic*** to the process. The MCP has the ability to display the recipe in different ways:

    a. A static recipe name is one that is filled in for the process and does not change, for example a spin rinse dryer may have 1 or 2 recipes. This recipe field is hard coded in the process router.
    b. A dynamic recipe name is one that changes with each device; an inspection recipe is specific to a device. In this case, the Manufacturing Control Plan pulls the device name from the device drawing to auto populate a recipe and is concatenated with the hard coded layered recipe description in the process router.
    c. Lastly the recipe name is populated from the use of a look up table that is maintained by the process engineer that owns the process equipment.

6) The ***Control Method*** is specific to the equipment set and process that is contained in this work center. In

some cases a hyperlink is set in this field and can open a webpage in which data is located or is to be entered for a particular operation. In the example in Figure 2, the control method for the product is defined as well as the process equipment.

7) Sample ***Size and Frequency*** is specified in their respective fields. Due to the nature of updating the MCP, changing the frequency to more or less depending on how the process is running can be done quickly. Both product and process size and frequency are defined.

8) The ***Reaction Plan*** is one of the most important aspects of the MCP and contains the Out of Control Action Plan (OCAP) for the process step. The OCAP is lined to the Reaction Plan in the MCP. These OCAP's can be process specific and/or equipment specific. 2 different OCAP's exist for each step of the router/MCP. An operator OCAP and an Engineering OCAP. The engineering OCAP are OCAP's specific to what a process technician or engineer would do to react to excursions in the process. The speed in which one reacts to an excursion is directly linked to how well the process is controlled. An example of an OCAP that is connected to the MCP is located in Figure 3. Operations and engineering OCAPs are connected to the MCP.

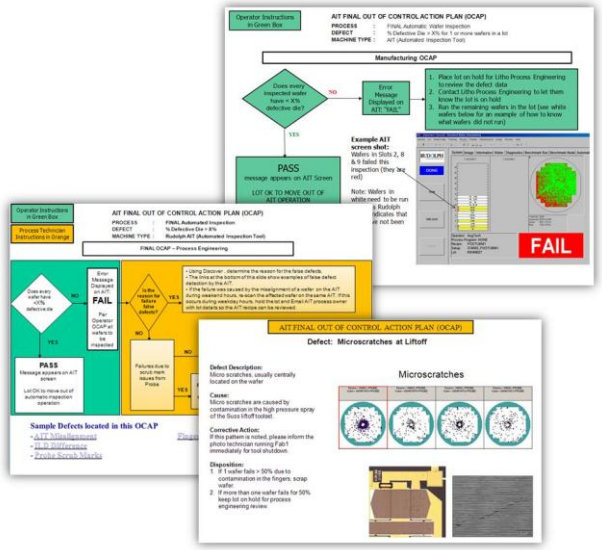

Figure 4: Out of Control Action Plan Example

ENGINEERING CONTROL PLAN

The Manufacturing Control Plan (MCP) can also be toggled to view the Engineering Control Plan. This view of the MCP displays items that pertain to process engineering such as technician operating instructions, training plans, engineering OCAPs and a hyperlink to the FMEA for this process. The owner of the control plan is also defined in the engineering control plan.

Training Plans	Control Method	Sample (Size/Frequency)	OCAP	FMEA	Owner
136803-Training Program for final closing for PTSI	Review Fab Lot Data Check Screen	*Size*: All wafers *Freq*: Each Lot	Lot Close Out Data Check Maverick & PQL Lot system.pdf	FMEA	PTSI Process Engineering

Figure 5: Engineering Control Plan – Process: Lot Closeout

BENEFITS TO THE MANUFACTURING CONTROL PLAN

- One stop location for pertinent information to perform a process consistently by multiple process groups and areas.
- Consistent layout for work instructions for operations, makes training a process easier when the operator sees consistency in setup's, documentation and reaction plans no matter which area they are in the fab.
- Sample plans and OCAPs are easily accessible to react to changes that occur in sample plans and how to respond to out of control conditions promptly.
- When performing audits on the process, it is much easier for an outside auditor understand the process flow, the work instructions for performing a step in the process.
- Quick links exist for engineering to access FMEA system

CONCLUSIONS

The Manufacturing Control Plan was integrated into our process router MES system to become a part of how we run manufacturing at TriQuint Florida. This living control plan is extremely useful to ensure the process is executed in a consistent manner in order to meet internal and external customer requirements. It is updated when new processes come about and when new systems are implemented into our manufacturing process.

ACKNOWLEDGEMENTS

The authors would like to thank the cross function team that developed the Control Plan Methods into the existing router system. Those people include Nitzia Jimenez-Drack and William Payne. Additionally, we appreciate the support from the Quality Department in understanding that though implementing a control plan is important and useful to understand a process, it is even better to put this control plan to use in daily activities to run a wafer fab.

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ACRONYMS

AIAG: Automotive Industry Action Group
AIT: Automatic Inspection Tool
FMEA: Failure Modes and Effects Analysis
MCP: Manufacturing Control Plan
MES: Manufacturing Execution System
OCAP: Out of Control Action Plan
SAW: Surface Acoustic Wave