

# Functional Requirement Specification (FRS)



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**PROJECT #:** xxxx

**Document Name:** Mahindra-ZHB-FD-FRS-MESTECH-V-1.4-2015-08-05

**Document Revision:** 2.0

05 August, 2015

## Summary of Revisions

A summary of revisions to this document are described below.

Revision	Date	Description	Revised By
<b>1.0</b>	01-07-2015	Document started.	MES Product Development COE
<b>1.2</b>	11-07-2015	FRS Sign Off Documents	MESTECH Services Pvt Ltd
<b>1.3</b>	14-07-2015	FRS Final Version	MESTECH Services Pvt Ltd
<b>1.4</b>	29-07-2015	FRS Publishing After the review by the Core team	MESTECH Services Pvt Ltd

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# 1. Introduction

This document defines the Functional Requirements Specification (FRS) for a Manufacturing Execution Solution (MES) system designed to control the information flow for the commercial manufacturing of M & M, Farm Division, facilities in Zaheerabad.

The detailed plan with completion dates are mentioned in the “Project Management plan” as a separate document. To avoid handling multiple documents the FRS may be divided in to separate sections representing the different plant shops Machining, Assembly & IMH

## 1.1. Purpose

The MES System project is significant to M & M FD in that the manufacturing of complex commercial Products requires detailed production execution, material management process traceability, component genealogy, and error proofing capability to meet specific customer requirements, and secure M & M's business globally.

M & M FD is a Tractor manufacturing company; the facility is planned for producing large variants of tractors Zaheerabad, India. This document details the Manufacturing Execution Solution (MES) requirements for the automotive facility classified by shop and by common patterns

This document will also serve as the basis for the development of a Functional Design Specification (FDS) document and eventually the System Acceptance Test Specification (SATS) for final system acceptance.

## 1.2. Scope and Key Objectives

The ultimate design of the MES system will be a template for global deployment within M & M, currently identified as production site at Zaheerabad, Telangana, India. This document, as defined by the current SOW, only includes a single deployment of the MES at M & M Commercial Vehicles Pvt. Ltd production site.

Key objectives of the MES project at M & M are:

- Reduce Paper work
- Reduce manual processing and increase efficiency
- Connect the enterprise to the plant for greater visibility and control

- Reduce lead time
- Reduce manufacturing costs
- Increase production throughput and product quality
- Reduce efforts involved in compliance and governance
- The MES system should be planned to be in service for the next 10 years
- Secure process stability

### 1.3. Documents Referenced

Document Name	Version / Date	Description
SOS MES 2	Version 2.0	Scope Of Supply Created for the Supplier (RFQ)
M&M-FRS-V-1.1	Version 1.0	Functional Requirement Document (FRS)

### 1.4. Meetings Referenced

Description and Location	Date	Attendees
Kick Of Meeting	22 <sup>nd</sup> June, 2015	All Core Team members
FRS Work Prep	2 <sup>nd</sup> July, 2015 to 4 <sup>th</sup> July, 2015	ZBH – Quality Team, Production & Maintenance Team
FRS Work Shop	8 <sup>th</sup> July, 2015 to 11 <sup>th</sup> July, 2015	All Core Team members

### 1.5. List of Participants for FRS Work Shop from Mahindra & Mahindra Team

Name	Plant Location
BINOD S	Zaheerabad
BHARAT PATIL	Kandivali

Name	Plant Location
EDPUPUGANTI UMASANKARARAO	Zaheerabad
RATH ASHUTOSH	Zaheerabad
KARVE KEDAR	Zaheerabad
M TARAK	Zaheerabad
KUMAR RAGHU	Zaheerabad
KUMAR VINAY	Zaheerabad
M HARIPRASAD	Rudrapur
LADHE DIGAMBAR	
PATRIKAR RACHANA	Nagpur
SAWANT MAHESH V	Nagpur
TRIVEDI D C	
TIWARI GANESHDUTT	Rudrapur
SHARMA PRAVEENKUMAR	
TENDULKAR SANTOSH	Kandivali
CHITLUNKAR SUNIL	
DOKE HEMANT	
SUHAS KUMBHAR	
HALDAR PARTHA	
SATAM MILIND	
VENKATAKRISHNAN B	Pune
PHADNIS LAXMIKANT	Kandivali
LIMAYE MADHAV	
VINAYAK	Pune
DIXIT NITIN	Pune
ADSAD NANDKUMAR	
PRAVEEN	Jaipur
BAJPAI RASHI	Jaipur

## 1.6. List of Participants for FRS Work Shop from MESTECH Services Pvt Ltd Team,

Name	Phone	Email
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## 2. Business Requirements

### 2.1. Business Requirements

M & M FD unit is currently running a tractor manufacturing plant in Zaheerabad, Telangana. As a part of IT set up, M&M is planning to have scalable and flexible Manufacturing Execution system in place which will help automate the Machining, Assembly, Internal Material Handling, Painting and Testing operations along with associated activities. The target of this MES will be to secure the quality of the machining, assembly, Painting & Testing. This MES will work in sub-assembly as well as Main lines and will guide the operator (for performing different operations on the line) and Machines (by sending the control parameters and capturing the measured values or End results). The MES system also needs to well integrate with the SAP system. The MES functionality applicable as per the Business requirement and which will be used in the Project has been categorized below.

### 2.2. Functional requirements

MES needs to have following key functionalities at different manufacturing stages.

1. Order Management
2. Vehicle Tracking and Genealogy
3. Error Proofing
4. Equipment integration & Data acquisition
5. Quality management
6. Operations management
7. Maintenance Management
8. Reporting
9. SAP interface

Below table explains the detailed list of MES functionalities required at different manufacturing areas-

Below table explains the detailed list of MES functionalities required at different manufacturing areas-

#	MES functionalities	Transmiss ion assembly & testing	VTU assembly & testing	C V assembly & Testing	Engine assembly & testing	Pre- Painting	Post painting and PDI	Chassis Painting
<b>A</b>	<b>Order Management</b>							
1	Broadcasting of Order	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
2	WIP of Components	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
3	Sequence Display	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
4	Serial Number Generation	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
5	Travel card/build sheet print	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
6	Barcode Printing	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
<b>B</b>	<b>Vehicle tracking &amp; Genealogy</b>							
1	WIP Tracking	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
2	Lot Genealogy	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
3	Pictorial view of assembly	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
<b>C</b>	<b>Error proofing</b>							
1	Correct program selection in DC nut runners, cleaning machines, paint specs etc.	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
2	Correct component selection (like sub assay) , paint selection (like sub assay)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
3	Poka yoke (automation) functioning	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
4	Operator manning as per skill confirmation	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
<b>D</b>	<b>Equipment integration &amp; Data Acquisition</b>							
1	Data Collection - Torque Tools (against each assembly)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
2	Data Collection - Test Data (against each assembly)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
3	Data Collection - Manual (against each assembly)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>

4	Interfacing with Number Punching Machine	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
5	Integration with paint shop Robot (Paint shop SCADA)	N/A	N/A	N/A	N/A	N/A	N/A	a
6	Equipment's/Process pressure, temp, Current, Voltage etc.(Historical/run time data)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✗ <input type="checkbox"/>	✗ <input type="checkbox"/>	✓ <input type="checkbox"/>
7	Paint process parameters data (control chart)	N/A	N/A	N/A	N/A	N/A	N/A	✓ <input type="checkbox"/>
8	DC nut runner torque	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	N/A
9	Air leak test result	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	N/A	N/A	N/A
10	Testing reading/data	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	N/A
11	Machine failure data	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
12	SPC tools	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
<b>E</b>	<b>Quality Management</b>							
1	Work Instruction Data display on LCD screens @ stations							
2	SOP & Manifest	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
3	Safety information, Skill required information	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
4	TAKT time display	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
5	Critical assembly/check points (Torque, pre-load etc.)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
6	Take In /Take Out	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
7	Specification like Backlash, float, pre-load etc. (Manual data entry)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	N/A
8	QP/Rework data and analysis(Manual entry with coding system)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
<b>F</b>	<b>Operations Management</b>							
1	Shift Manning data at start of each shift	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
2	Verification of operator login and manning for confirmation with skill matrix @ each station	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
3	Skill set management	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
<b>G</b>	<b>Maintenance</b>							
1	Machine PM schedule	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
2	Equipment's performance report	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>

3	Mail/ SMS alert for break down	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
4	Fault alarm *	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
5	MTTR & MTBF data	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
6	equipment's/torque wrench/gauges Calibration alert	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
7	Spare parts management. (communication for stock level)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
8	Energy Measurement, Monitoring	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
<b>H</b>	<b>Reporting</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>
1	Traceability and Genealogy report for each aggregate and critical components	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
2	Production report (day, shift, period, variant etc.)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
3	Time loss report	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
4	Model wise inventory	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	N//A
5	Build sheet at end of assembly (ok /Not ok)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	N//A
6	Machines failure data	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
7	QP/Rework data	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
8	Graphical presentation of analysis	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
9	Andon interface	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
<b>I</b>	<b>SAP interface</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>
1	BOM from SAP	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
2	Material Stock from SAP	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
3	SAP interface	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>
4	Production Booking (Confirm to ERP - Back Flushing)	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>	✓ <input type="checkbox"/>

### 3. MES Functionality Description

MES working approach for each function of Mahindra Farm division is described in detail below. MES also needs to be integrated with the SAP system. Integration will be for information coming from SAP and updates/reporting back to SAP.

The MES functionality applicable as per the Business requirement and which will be used in the Project has been categorized below.

Business Requirement	Explanation
SOP Display	<p>MES will display the Work operation steps to be performed by the operator on all required Stations. These operation steps will change based on the Model of vehicles produced on the Assembly Line. Also, the Parts applicable on each operation step have to be displayed along with the quantity required to be fitted.</p> <p>In case MES is capturing any value (from 3<sup>rd</sup> part device) related to the fitment of the part on the station, then the value should also be displayed on the SOP display screen.</p> <ul style="list-style-type: none"> <li>- Specific requirement for AOS screens <ul style="list-style-type: none"> <li>o SOP display for the identified areas</li> <li>o Display the name of operators for each group (Displayed at the start of each shift and will be confirmed by supervisor)</li> <li>o Planned sequence display</li> <li>o Display part , pictures and other attributes</li> <li>o WI display for multiple groups of operators on same screen</li> </ul> </li> </ul>
Order management	<p>The creation of orders will take place in MES. The orders available in MES may be required to be re-sequenced in MES. MES must dispatch these orders to the first station of the assembly after confirmation by PPC user. All the tracking data &amp; other essential data collected from the line will be saved against the respective order number. MES should display planned/confirmed order sequence.</p> <p>Orders can be divided in different categories listed below:</p> <ul style="list-style-type: none"> <li>o Open (Order downloaded from SAP will have Open Status)</li> <li>o WIP(Work In progress)</li> <li>o Closed (Information of production booking will not be sent to SAP). As soon as MES will get final quality OK signal, Order will be closed.</li> </ul>

Production sequence display	MES must be able to display the sequenced production orders which are coming from the SAP at the 1st station of Sub-assembly or Main line where the operator will start the manufacturing process. The operator needs to start the top most order in sequence. No re-sequencing provision is required to be done in MES.
Tracking	The MES must track orders as they are processed and on the line. It needs to track all actions performed on an order by changing the "state" or an order Tracking of bodies/orders are having following requirements: <ul style="list-style-type: none"> <li>○ Tracking in the MES system in only logical</li> <li>○ Where ever the system is receiving the Barcode scan system will display the same</li> </ul>
Quality management	The MES will capture important in-process quality inspection data and defect data and also track the quality summary of a particular job. Through Quality management following activity is required to be accomplished. <ul style="list-style-type: none"> <li>○ MES should be able to capture level 1 defect at every station. This can be done through defect capture screen. Link for this will be available on SOP screen.</li> <li>○ 2<sup>nd</sup> Level quality checks will be done at every quality gate (after every 5 stations). Audit screen will be provided for this requirement.</li> <li>○ Escalation for severe defects</li> <li>○ Quality gate screens should be available at required stations.</li> </ul>
Preventive Maintenance	The MES must be able to capture the Real time Equipment & Line status wherever required.
Performance Management	The MES must be able to capture the OEE (Overall Equipment Efficiency) for Mahindra identified equipment's. Equipment interface will be done with MES to capture MTTR & MTBF values.
Reports	The MES must be able to publish the Order, Quality and Line level data captured during the Production. This must include the Line status (downtime, Uptime, Maintenance, Quality etc.) The MES must be able to publish reports for planned Vs. actual data, Order history, Quality and equipment level measured values of orders during Production.
Operator Genealogy	Operator genealogy is to be captured for critical operations. Examples for the genealogy fields are: Operator Name, Group Name, Line Name, Station Name, Age, Training Attended, Skill matrix rating etc. Skill matrix to be defined for critical stations and Operator skills. A system for maintaining the skill matrix should be provided by MES system. Names to be defined and controlled in system.

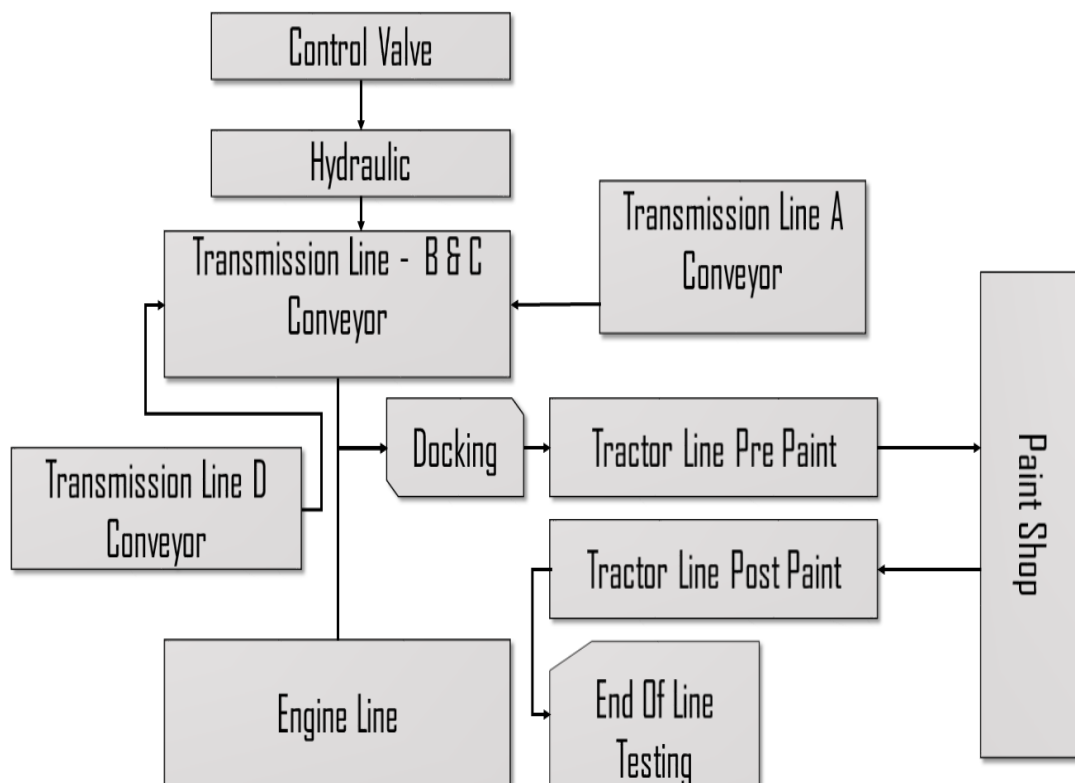
## 4. Plant Overview

This section briefly describes ZHB FD plant process flow including all 4 major shops production process. It is not intended to be an exhaustive description, but should be detailed enough to give a reader who might be unfamiliar with the project.

### 4.1. Plant over All Flow Chart

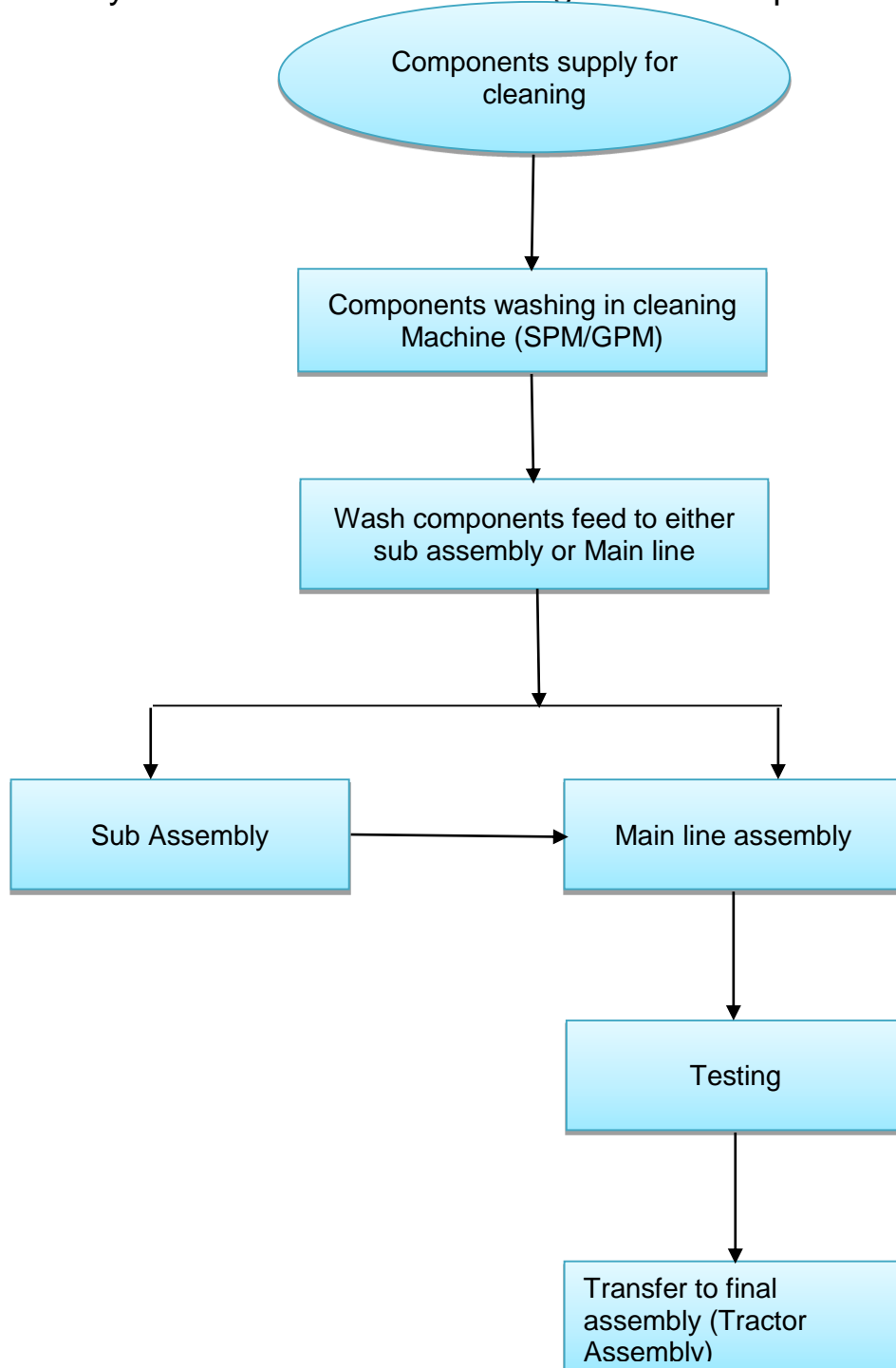
The MES requirements for integrating ZHB plant the below mentioned shops has to be covered and order flow is explained in the below layout.

1. Transmission assembly & testing area
2. VTU assembly & testing
3. C V assembly & Testing
4. Engine assembly & testing
5. Pre Painting & Paint Shop
6. Post painting and PDI



## 4.2. Engine, Transmission, Hydraulic and Control valve

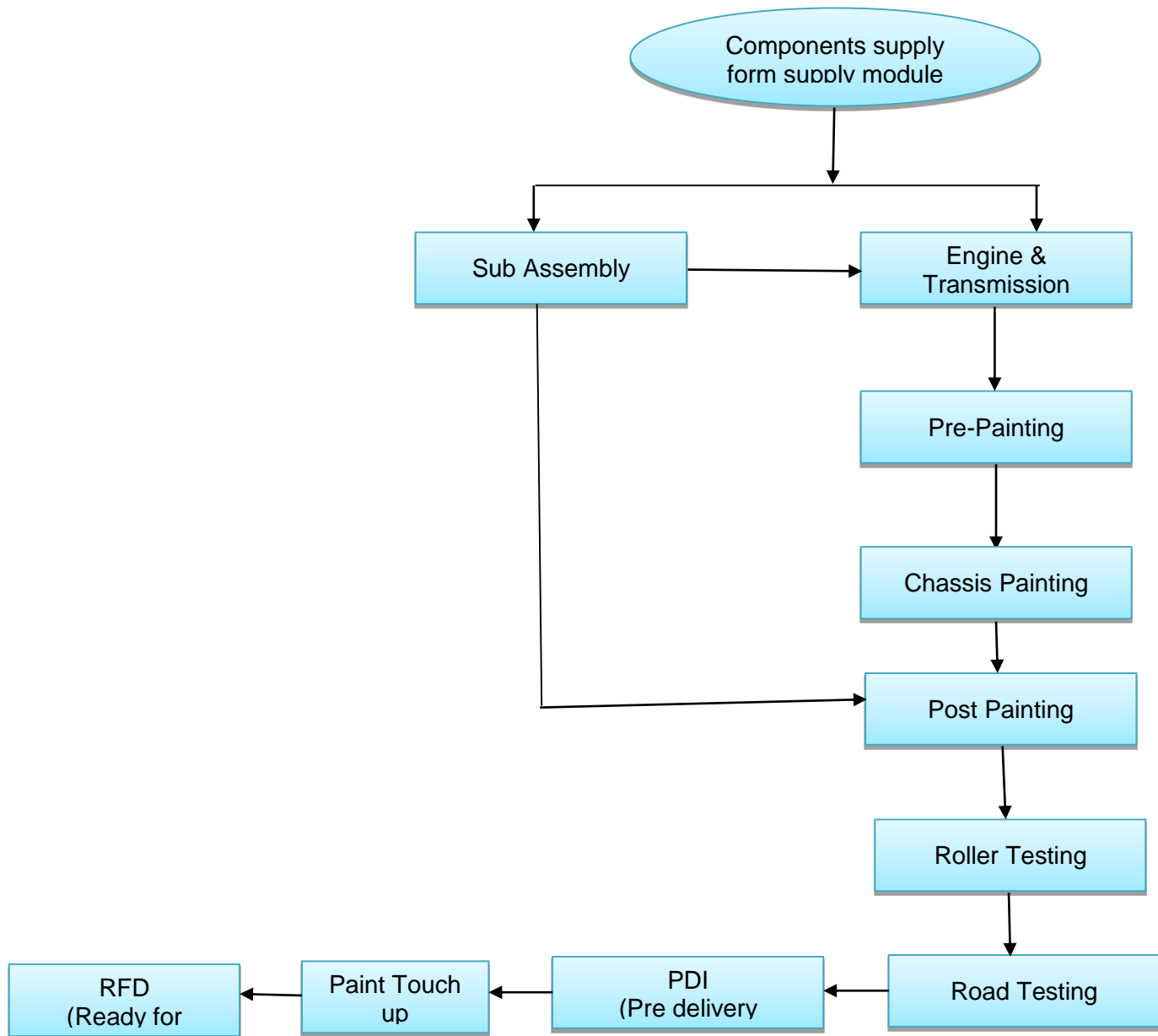
The flow chart explains the overall flow of production in the Engine shop, Transmission, Hydraulic and control valve shops. At the end of all the shops we have commonly have the test bed for testing the finished part.





## 4.3. Tractor Assembly

The tractor assembly shops consist of the Docking, Pre paint Line, Chassis Paint Shop, Post Pain Line. The Paint shop is operated by the well implemented SCADA solution form which MES has to take the data for reporting purpose. And in the End of Post paint line, PDI (Pre Delivery Inspection) and RFD storage.



## 5. System Overview (Use Case Flow Charts)

MES will be implemented in above mentioned shops of the M & M FD, ZHB manufacturing plant.

At a high level, the primary functionality to be implemented by the MES includes the following:

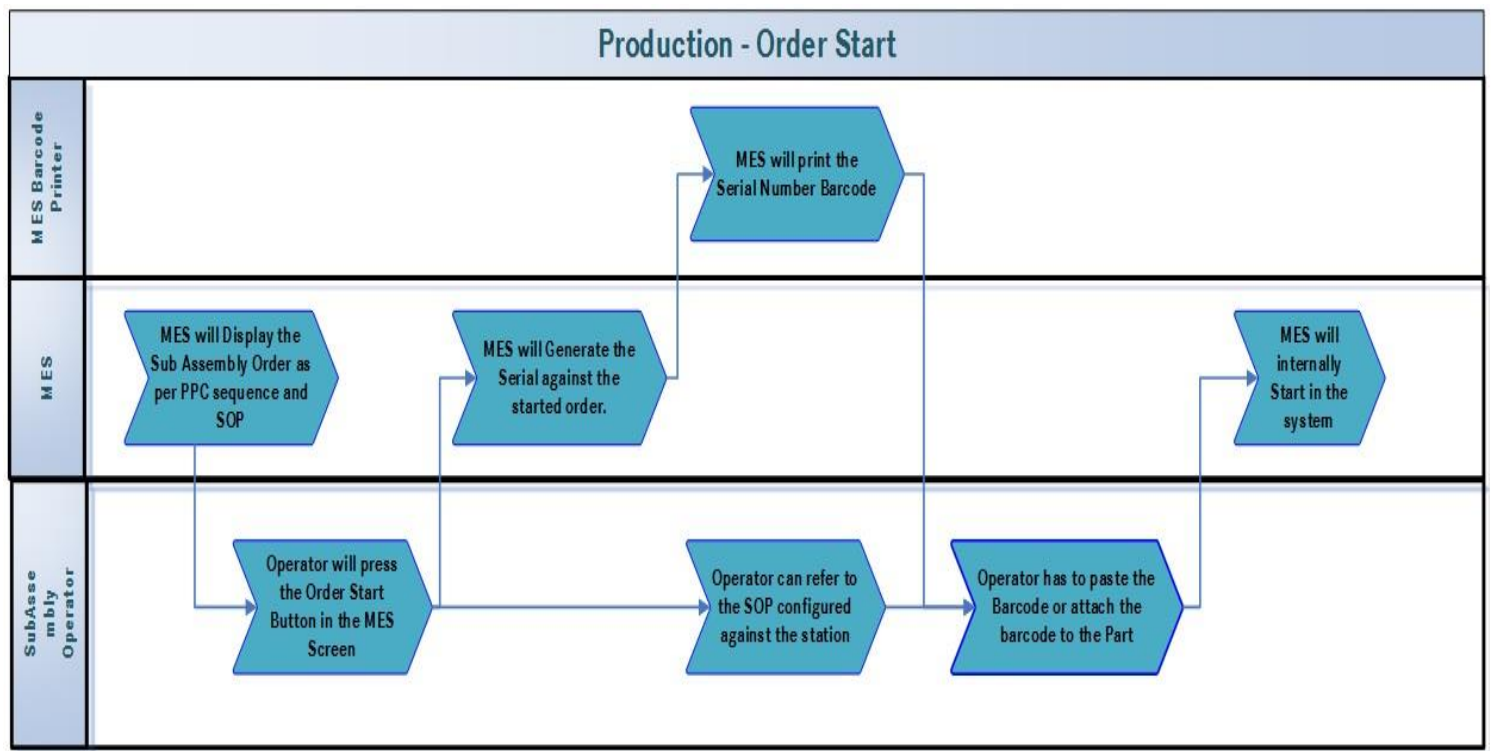
- Logical tracking of the plant through each process step and recording the date and time when the unit was processed for Genealogy purposes.
- Collection of major component information in the form of a serial number.
- Collection of any required process data associated with the manufacturing of an assembly (unit) for Genealogy purposes.
- Automatic machine setup (i.e. control system via PLC or OPC interface), as triggered by the MES sending to the Machine/Line, specific unit/order information such as the order number, unit part number and model variant, program to select etc.,
- Display of Production Sequence to ensure that units are properly manufactured, painted, assembled and tested.
- Execution of work orders and communication of confirmations, declarations to SAP (to enable Back Flushing of Materials and Order updates in SAP).
- Error Proofing - Component validation, Torque validation (OEM Interface) and Test equipment result validation.
- Serial Number Generation – Generation of serial numbers like Engine Serial Number (ESN), Transmission Serial Number (TSN), Paint Serial Number (PSN) etc.
- Barcode Printing for vehicle assembly etc.
- Generation of operational reports.
- Quality Management functionality.
- Order Management.

## 5.1. Production Process Flow Charts

Based on the FRS work Shop held during the 8<sup>th</sup> to 11<sup>th</sup> July, ZHB plant the below mentioned process has been finalized and same has been explained through swim lines,

### 5.1.1. Order Start

The creation of orders will take place in MES. The orders available in MES may be required to be re-sequenced in MES. MES must dispatch these orders to the first station of the assembly after confirmation by PPC user. All the tracking data & other essential data collected from the line will be saved against the respective order number. MES should display planned/confirmed order sequence.



The above swim line diagram explains the process for the order start functionality in MES and order start touch points in ZHB plant and listed below,

In ZHB plant we have the below mentioned place where the order start functionality is being used. The consists of Main order start at Engine, Transmission, VTU,CV & Tractor.

SR NO	Shop	Line Name	Station No	FRS ID
1	Engine	CC Line	Crank Case Washing Machine	PPE01
2	Engine	CC Line	Cylinder Head and GPM Washing Machine	PPE02
3	Engine	CC Line	Crank Shaft Washing Machine	PPE03
4	Engine	SA Crank shaft	Crank Shaft Sub assembly	PPE07
5	Engine	Main Line	CAM Shaft Sub Assembly	PPE11
6	Engine	Main Line	Cylinder Head Sub Assembly	PPE16
7	Engine	Main Line	EGR Sub Assembly	PPE19
8	Engine	Main Line	Turbo Sub Assembly	PPE20
9	Engine	Main Line	Piston & Connecting rod	PPE21
10	Engine	Clutch	Clutch Housing Assembly	PPE32
11	Tractor	Docking	Station No 1	PPTR01
12	Tractor	Post Paint Line	Scuttle Front , Hood , Front Grill Sub-Assemblies	PPTR45
13	Tractor	Front Axle Sub Assembly	Front Axle Sub Assembly	PPTR04
14	Tractor	Pre Paint Line	Fuel Tank SA	PPTR19
15	Tractor	Post Paint Line	Fender Sub Assembly	PPTR34
16	Tractor	Post Paint Line	Fuel Tank ,Compressor SA	PPTR36

17	Tractor	Post Paint Line	Tyre SA	PPTR38
18	Transmission	Conveyor B	RAC Sub Assembly	PPT18
19	Transmission	Conveyor D	Washing Machines	PPT39
20	Transmission	Conveyor B	Counter Shaft Sub Assembly	PPT06
21	Transmission	Conveyor B	Spline Shaft Sub Assembly	PPT08
22	Transmission	Conveyor B	Diffcase Sub Assembly	PPT09
23	Transmission	Conveyor B	Drive Shaft Sub Assembly	PPT13
24	Transmission	Conveyor B	Drop Box Sub assembly	PPT15
25	Transmission	Conveyor B	RAC Sub Assembly	PPT18
26	Transmission	Conveyor B	PTO Sub Assembly	PPT22
27	Transmission	Conveyor B	Brake Sub Assembly	PPT25
28	Transmission	Conveyor B	Gear Shifter Assembly	PPT28
29	Transmission	RFD Storage	RFD Storage	PPT38
30	Transmission	VTU	Washing Machines	PPT42
31	Transmission	VTU	Station 1	PPT43
32	Transmission	VTU	Station 4	PPT44
33	Transmission	VTU	Kitting Area	PPT46
34	Transmission	CV	Station 1	PPT52
35	Transmission	CV	Kitting Area	PPT53
36	Transmission	CV	Station 3	PPT54

### 5.1.2. Error Proofing

The process of validating the part to ensure the correct fitment is referred Component validation. The process of guiding torque tool for enabling the

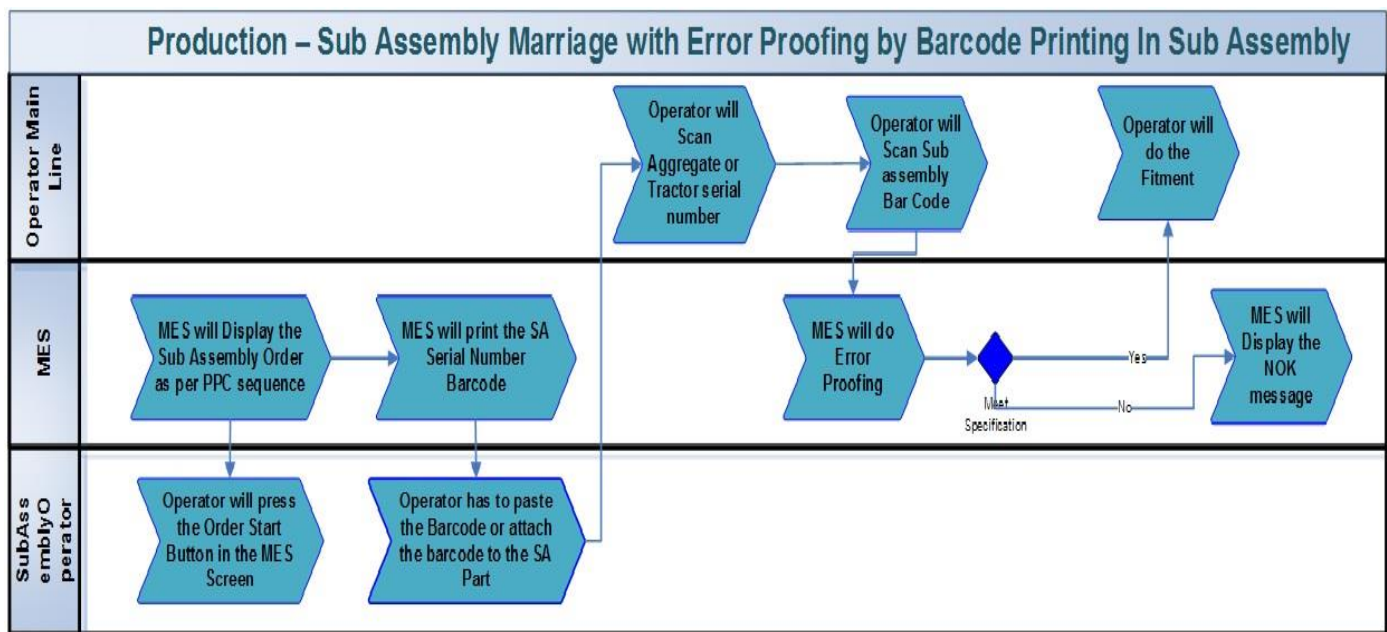
correct torque to the parts through barcode scanning is referred as DC tool error proofing.

Based on the FRS work Shop held during the 8<sup>th</sup> to 11<sup>th</sup> July, ZHB plant the below mentioned process has been finalized,

- Error Proofing by Barcode printing in the Sub assembly
- Error Proofing by Scanning Kitting Barcode
- Error Proofing by Scanning Pre-Fabricated Tag

The individual process explanation of the above mentioned methods are explained below through swim lines,

### 5.1.3. Sub Assembly Marriage with Error Proofing by Barcode Printing in Sub Assembly



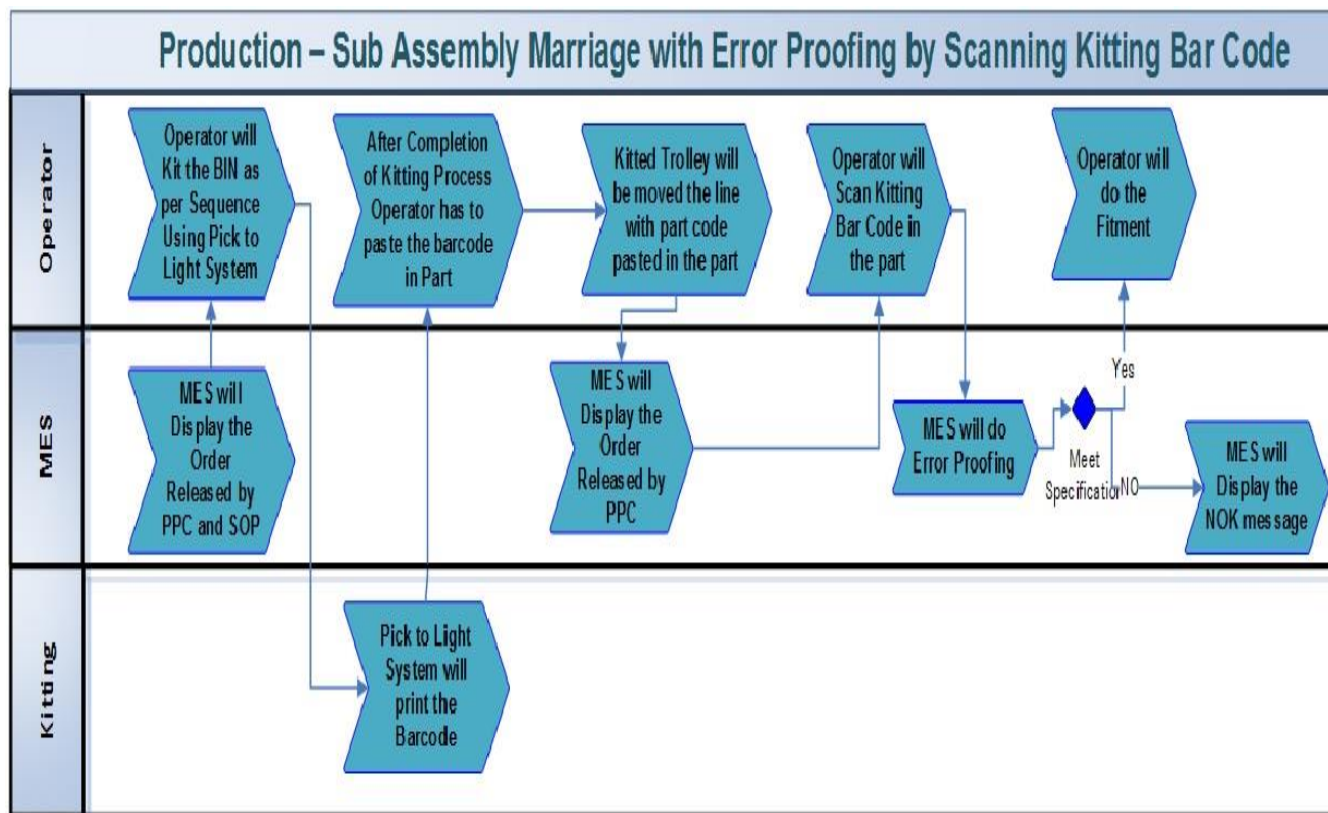
The above swim line diagram explains the process for the Error Proofing functionality in MES and order start touch points in ZHB plant and listed below,

List of touch points in ZHB plant for Error Proofing through Sub assembly Barcode Printing,

SR NO	Shop	Line Name	Station No	FRS ID	MES Functionality
1	Engine	Main Line	ML1	PPE06	Error Proofing for Crank Shaft Marriage
2	Engine	Main Line	ML3	PPE09	Error Proofing for Fuel Injector Pump
3	Engine	Main Line	ML9	PPE15	Error Proofing for Cylinder head
4	Engine	Main Line	ML11	PPE18	Error Proofing for EGR sub assembly



### 5.1.4. Error Proofing by Scanning Kitting Barcode



The above swim line diagram explains the process for the Error Proofing by Scanning kitting Barcode in MES and order start touch points in ZHB plant and listed below,

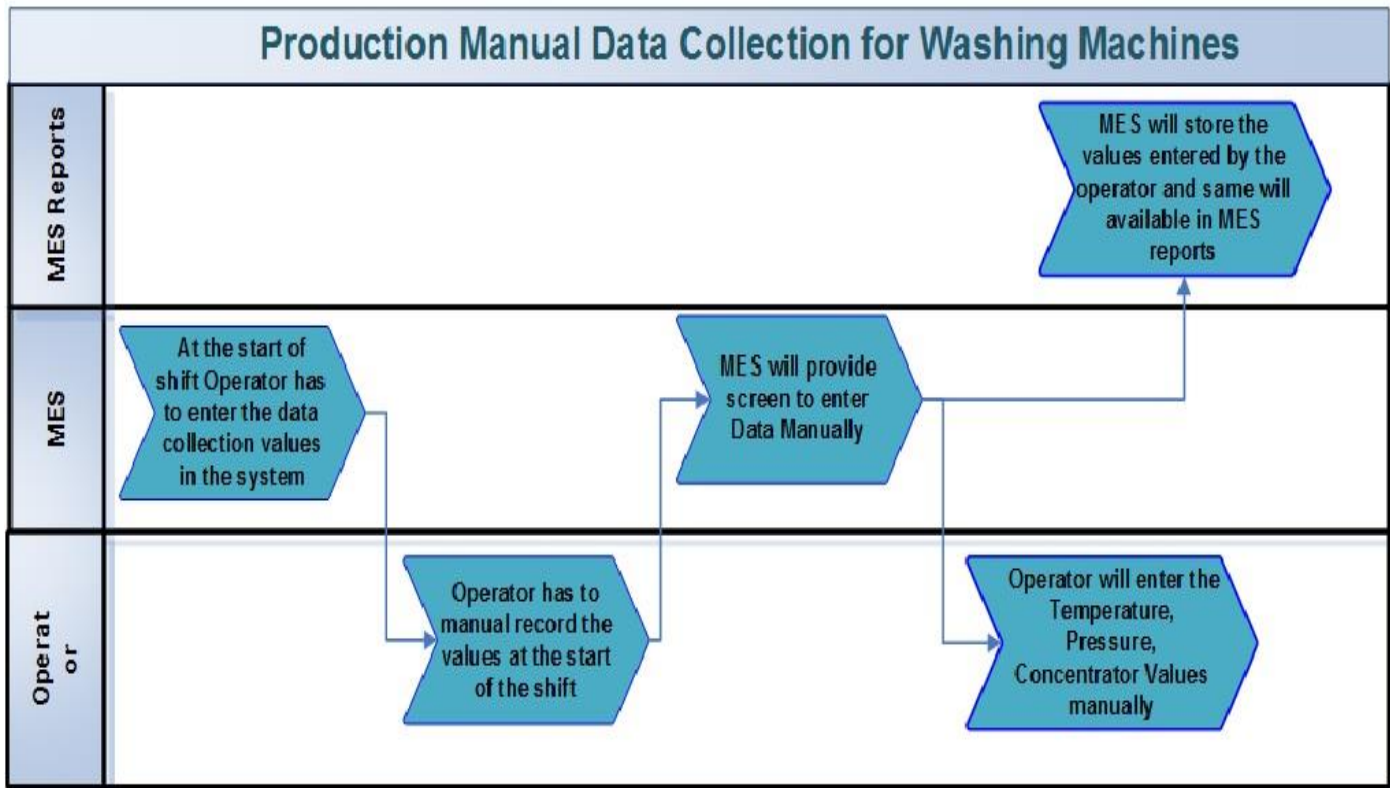


List of touch points in ZHB plant for Error Proofing by scanning Kitting Barcode,

SR NO	Shop	Line Name	Station No	FRS ID	MES Functionality
1	Tractor	Docking	Station No 2	PPTR02	Error Proofing for engine & Transmission
2	Tractor	Docking	Station No 4	PPTR03	Error Proofing for Front Axle
3	Tractor	Pre Paint Line	Station 3	PPTR08	Error Proofing by Mounting Bracket, Steering Gear Box, Hydraulic
4	Tractor	Pre Paint Line	Station 6	PPTR12	Error Proofing for direction control calve
5	Tractor	Pre Paint Line	Station 11	PPTR18	Error Proofing for Fuel Tank
6	Tractor	Post Paint Line	Station 2	PPTR33	Error Proofing for Fender
7	Tractor	Post Paint Line	Station 4	PPTR37	Error Proofing for Tyre barcode
8	Tractor	Post Paint Line	Station 12	PPTR47	Error Proofing for front grill
9	Tractor	Post Paint Line	Station 14	PPTR49	Error Proofing for Hood

## 5.2. Manual Data Collection for Washing Machines

Based on the FRS work shop it has been finalized that the MES has to collect the data from the operator entry for the washing machine,



Note:-

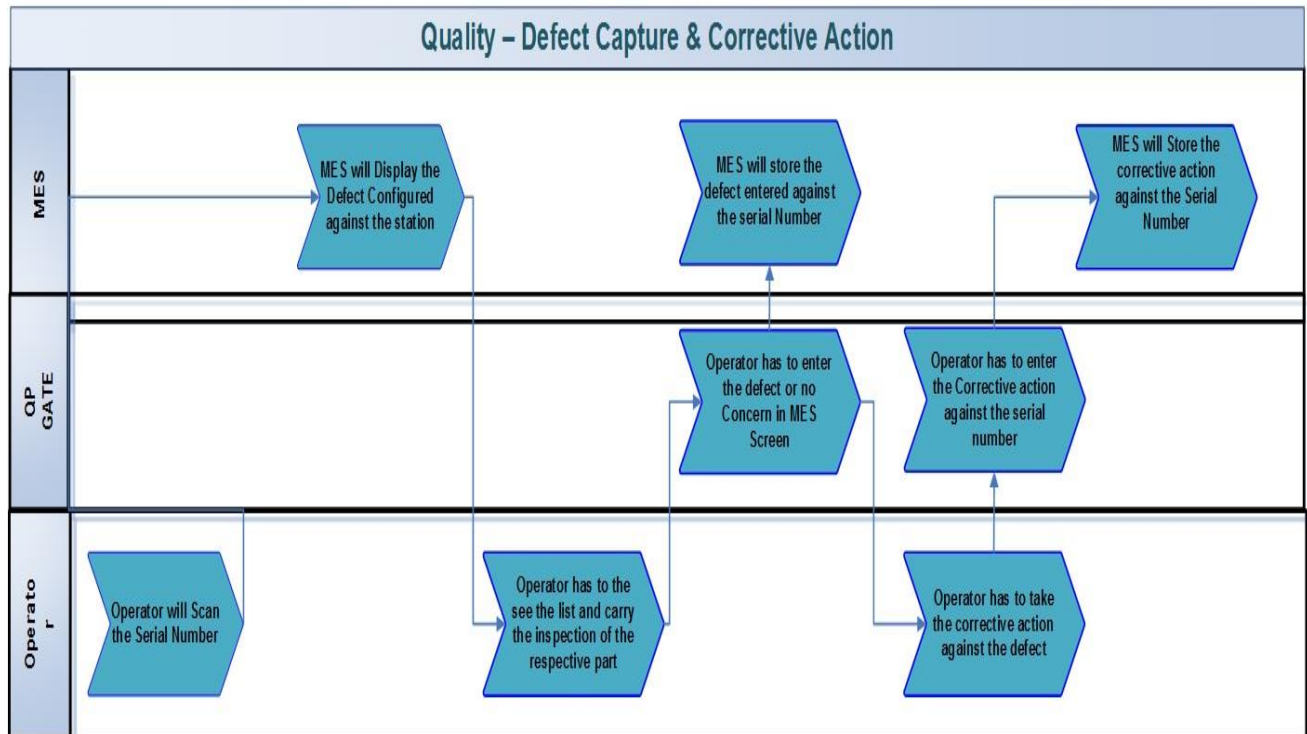
- System will provide the option to enter the values and same will be stored for the reports
- Every day at the start of the shift within half an hour operator has to enter the values else system will give information pop up.

List of touch points in ZHB plant for manual data collection,

SR NO	Shop	Line Name	Station No	FRS ID	MES Functionality
1	Engine	CC Line	Crank Case Washing Machine	PPE01	Order Display & Manual Data Collection
2	Engine	CC Line	Cylinder Head and GPM Washing Machine	PPE02	Order Display & Manual Data Collection
3	Engine	CC Line	Crank Shaft Washing Machine	PPE03	Order Display & Manual Data Collection
4	Tractor	Post Paint Line	Station 3	PPTR35	Order Start & Manual Data Collection
5	Transmission	Conveyor A	Station No 1 & 2	PPT01	Order Display & Manual Data Collection
6	Transmission	Conveyor A	Station 3	PPT02	Order Display & Manual Data Collection & Serial Number Generataion
7	Transmission	Conveyor D	Washing Machines	PPT39	Order Display & Manual Data Collection
8	Transmission	Conveyor D	Station 1	PPT40	Order Display & Manual Data Collection
9	Transmission	Conveyor D	Station 2	PPT41	Order Display & Manual Data Collection
10	Transmission	CV	Washing Machines	PPT51	Order Display & Manual Data Collection

## 5.3. Quality Process Flow Charts

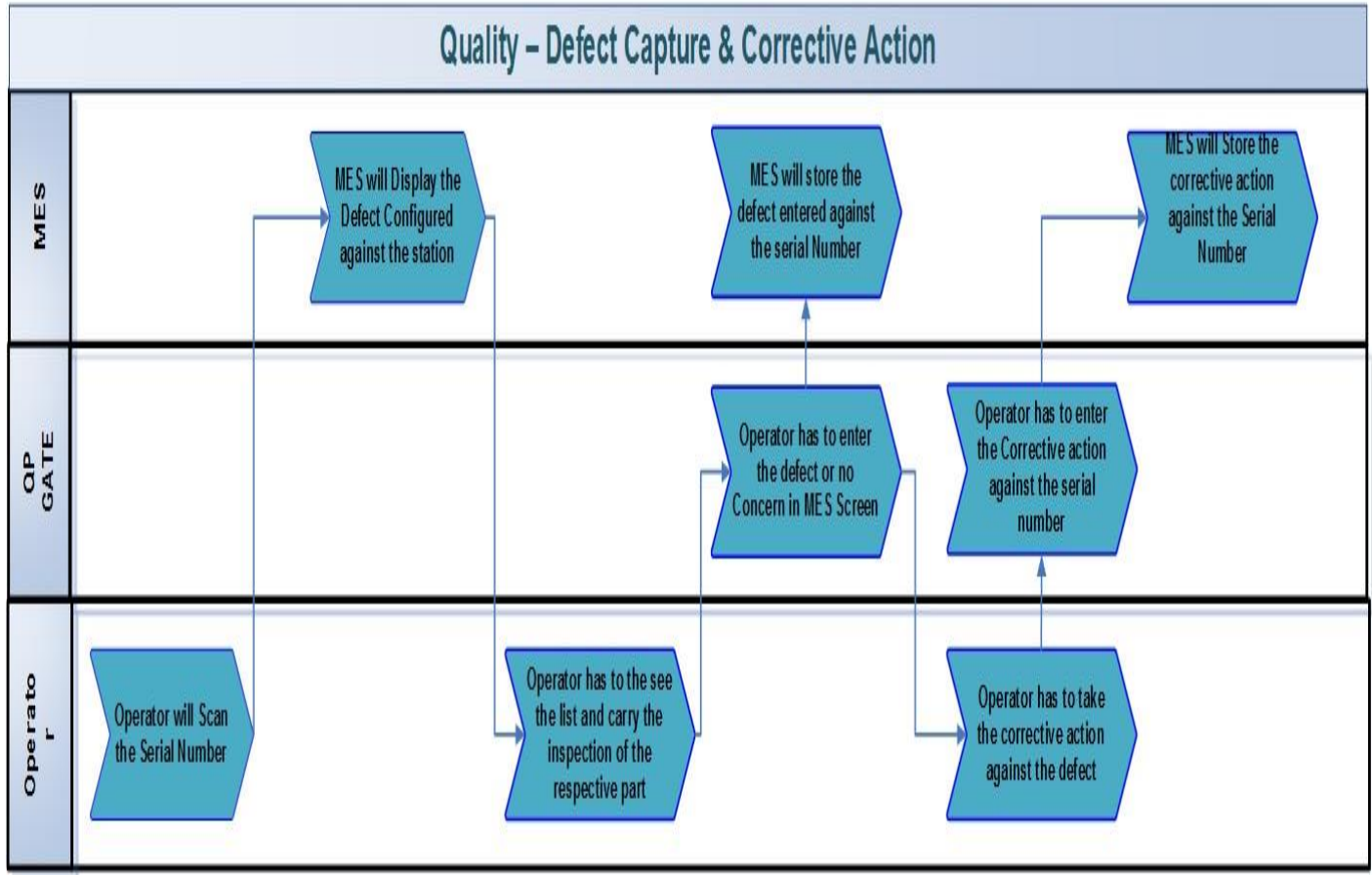
Standardized inspection process is defined at a defined interval for capturing defects on the shops. All the shops- Engine, Transmission Tractor & Paint will be following the same working philosophy for inspection.



The MES requirements for defect capture & Corrective action capture in all shop are as follow-

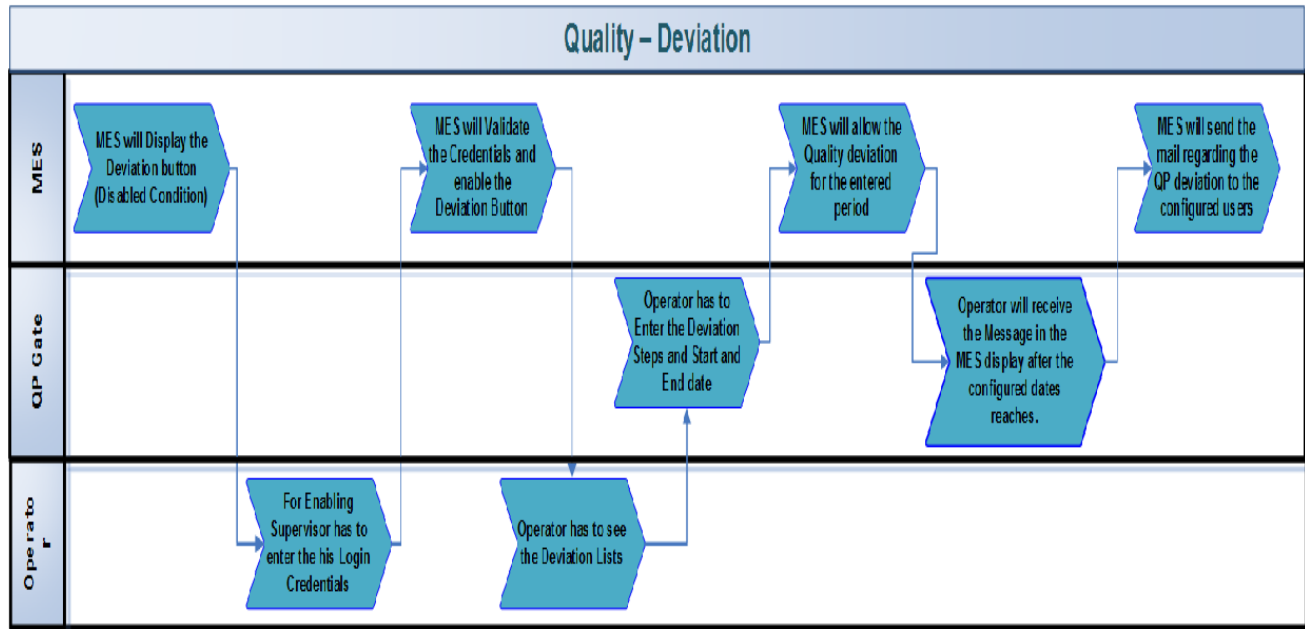
1. Operator will scan the Barcode sticker pasted on part / History card at the quality station through Barcode reader provided by MES for capturing the defect into MES.
2. MES will display defect check list configured against station based on scan.

### 5.3.1. Defect Capture and corrective action capture



Inspection will be completed by operators working at different stations. Operator will visually check the quality of the parts at working station and take corrective action if any defects are found. In case, operator is unable to correct any defect then he will inform to the Quality Supervisor responsible for that Sub-assembly or line. This process is also called self-certification by operator. The defects are recorded on the history card against the station number and operator Id. If any defect captured on the history card is corrected by any operator, it will be recorded on the history card against the captured defect.

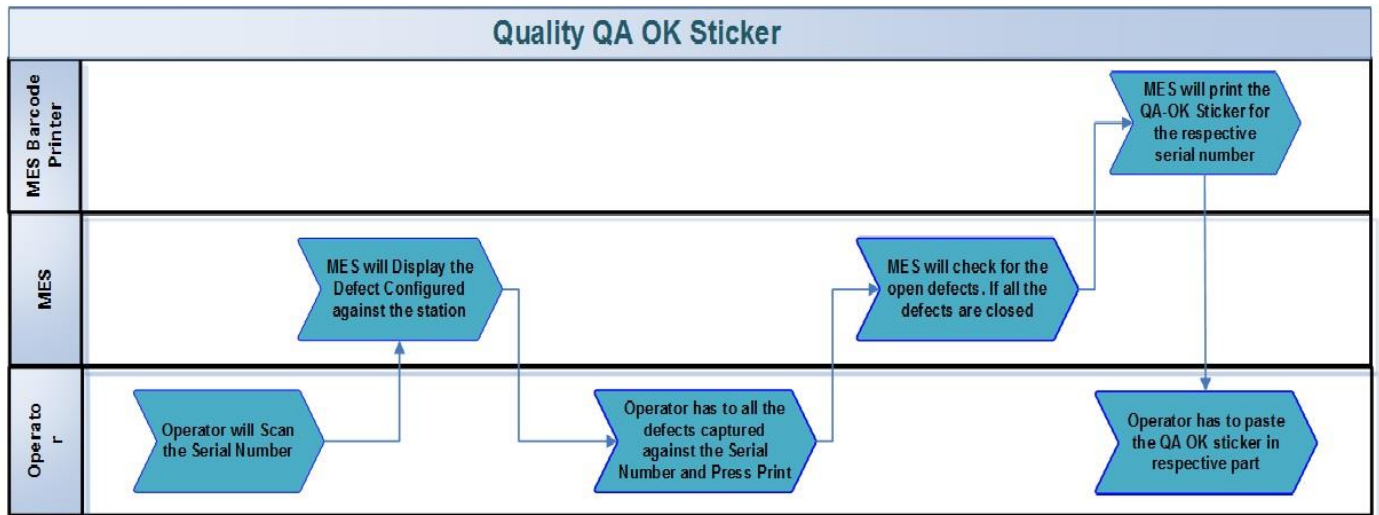
### 5.3.2. Quality Deviation Process (Open)



The above swim line diagram explains the process for Quality Deviation using MES Quality Gates.

- Step 1 : MES will Display the Deviation button (Disabled Condition)
- Step 2 : For Enabling Supervisor has to enter the his Login Credentials
- Step 3 : MES will Validate the Credentials and enable the Deviation Button
- Step 4 : User has to see the Deviation List and select for the same
- Step 5 : Operator has to Enter the Deviation Steps and Start and End date
- Step 6 : MES will allow the Quality deviation for the entered period
- Step 7 : Operator will receive the Message in the MES display after the configured dates reaches.
- Step 7 : MES will send the mail regarding the QP deviation to the configured users

### 5.3.3. Final Quality OK Sticker Printing



The above swim line diagram explains the QA ok barcode printing process using MES Quality Gates

The MES requirements for printing the Final Quality Ok sticker in the below mentioned areas of the ZHB plant,

7. Transmission assembly & testing area
8. VTU assembly & testing
9. C V assembly & Testing
10. Engine assembly & testing
11. Post painting and PDI

List of touch points in ZHB plant for Final Quality Ok sticker printing

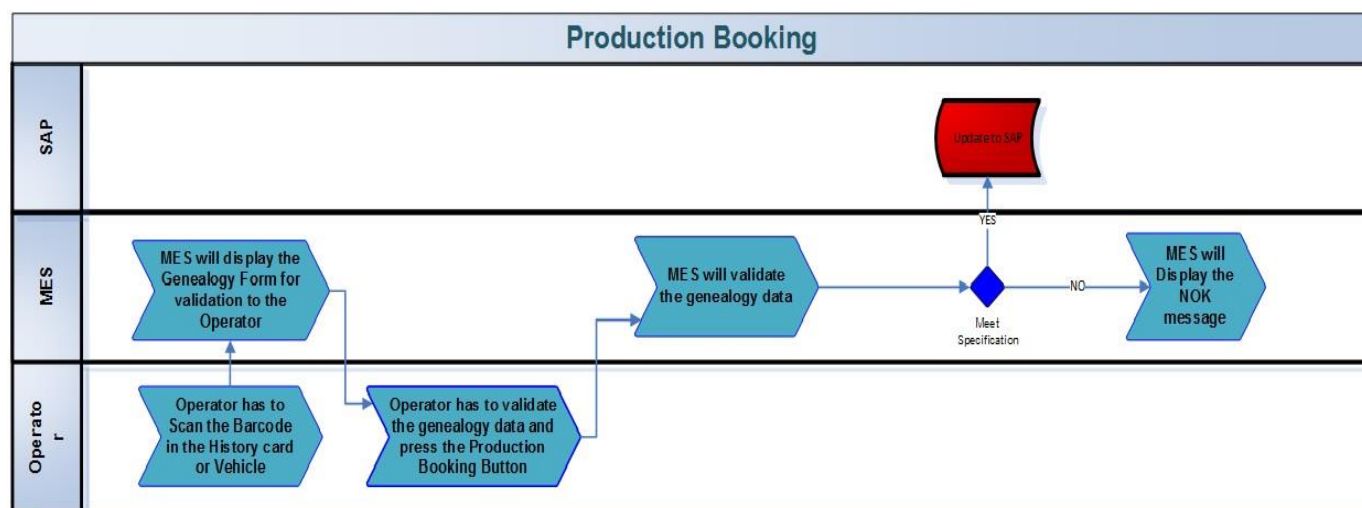
SR NO	Shop	Line Name	Station No	FRS ID	MES Functionality
1	Engine	Test Bed QP	Behind Test Bed	PPE30	Final QA OK Sticker Printing
2	Tractor	Post Paint Line	Paint Touch UP QP	PPTR59	Final QA OK Sticker Printing



3	Tractor	Post Paint Line	Export Shell QP	PPTR60	Final QA OK Sticker Printing
4	Transmission	Test Bed	Test Bed QP	PPT36	Final QA OK Sticker Printing
5	Transmission	VTU	Test Bed Quality Gate	PPT49	Final QA OK Sticker Printing

### 5.3.4. Production Booking (Open)

The MES requirements for production booking are MES will do the validation and recording of Tractor in MES and send the information to SAP.



The above swim line diagram explains the Production Booking process using MES Quality Gates



## 5.4. Associate Management

MES functionality that needs to be used for addressing the requirements mentioned above are-

1. **Associate Allocation:** MES will help the supervisor to allocate the appropriate Associate to the respective station. Based on the skill set level of the Associate, MES will suggest the station which must be allocated to the Associate. This will help and save the time of supervisor in allotting the stations to the Associates.
2. **Associate tracking:** MES will keep track of the Associate with respect to their training, attendance, punctuality, incidents. MES will keep the track of the skill set level of the Associate. The training which the Associate has undergone and completed successfully, the trainings which he needs to undergo further to achieve the next skill set level.
3. **Associate Genealogy:** Associate Genealogy is one of the important aspects of MES. MES will trace the genealogy of an Associate with respect to the orders he/ she produced. The name of the Associate the Associate ID who worked on a particular VIN or Order number can be maintained and generated in the form of reports, if required. It can be kept in both ways, i.e. Associate against the serial number or the VIN against the Associate or station to Associate.
4. **Associate Evaluation:** The supervisor needs to be provided with UI in MES through which he will be able to use and evaluate the effectiveness of the Associate and provide ratings.
5. **Training Allocation:** The user will have to pre specified the training which the Associate has to undergo to full-fill the desired skill set level. The supervisor or the manager can define this limit in the MES well in advance, and thus the MES will cross check against the set list, every time the Associate is undergoing training or at the time of skill set level up-gradation.



6. **Station Intergradation**: Based on the availability of the MES client in the station and OEM machine / Line MES will provide the Machine start stop signal for the respective operator allotment against the Skill Set.

### 5.4.1. Use case for MES requirement:

FRS ID	Use Case	Business Requirements	MES Functionality
AM 01	- Operator skill matrix in MES	Business logic for upgrading operators from 1 skill level to other skill level needs to be incorporated in MES	Operator skill management
AM 02	Operator training to be assigned and allocated through MES	MES needs to also capture which operator has worked on which Job	Training Master and tracking
AM 03	Attendance	MES needs to capture the attendance of operators	Employee registration & Attendance tracking
		MES should capture the In-time, Out-time and Lunch time & Tea time of the operator	
		System should run the business logic and should be able to provide the absenteeism at start of the day and the affected areas due to absenteeism	
		System should also suggest which operator can work on the affected areas depending on the skill sets	
AM 04	Daily Line up sheet through the system	MES needs to have the provision for configuration of work allocation by operator and publish daily report of work allocation.	Operator work allocation
AM 05	MES should give the work allocation report of different lines	System should run the business logic and should be able to provide the absenteeism at start of the day and the affected areas due to absenteeism.	
		System should also suggest which operator can work on the affected areas depending on the skill sets	

## 5.5. EWT computation

### 5.5.1. EWT

Effective Working Time describes utilization of Direct Manpower deployed on the job against the NEPT (Net Effective Production Time) e.g. 465 min. EWT is a measure of Operator utilization.

### 5.5.2. Monitoring

EWT is monitored for – Plant, PU, PG, Department, Cell. On Shiftwise, Daywise, Monthwise & Yearwise basis.

### 5.5.3. Calculation\_formula

$$\text{EWT (min)} = \frac{\sum_{p=1}^{p=n} [(\text{Work content}) \times (\text{Production})]}{\sum_{d=1}^{d=n} [(\text{Manpower present for production})]}$$

Where p = product  
d = department

### 5.5.4. EWT calculations in system

1. Work Content : To be taken from Latest SAP Routings / Equivalent Tractor calculations
2. Production : To be taken from online production declaration
3. Manpower : Deployed Direct manpower for the shift

### 5.5.5. Considerations

1. Manpower considerations:

- a. Manpower present and deployed for production is to be considered (excludes indirect manpower, manpower deployed for training, improvements.).
- b. All manpower deployed for activities included in the work content of the part/model have to be considered irrespective of category (Permanent, FTE, EPP, APP, NEEMS, ITI, DET, etc.)
- c. Each person is to be considered as full manpower and no factor is to be applied for different categories of manpower. Eg.: each Government Apprentices is to be considered as 1 and not as 0.6, etc.
- d. In Cells where 3<sup>rd</sup> shift working is carried out, a factor equal to  $(\text{working time in 3}^{\text{rd}} \text{ shift}) \div (\text{general working time as per settlement})$  is to be applied to 3<sup>rd</sup> shift manpower. This will help to make the actual EWT comparable to general working time as per settlement. Eg.: If 100 operators are deployed in 3<sup>rd</sup> shift, 3<sup>rd</sup> shift working time is 375min and general working time is 465min, then manpower to be considered for EWT is 81 (ie.  $100 \times 375 \div 465$ )
- e. For declared reduction in working time due to Dussehra pooja, Ganesh immersion, voting on election day, low demand, etc. a factor equal to  $(\text{declared working time}) \div (\text{general working time as per settlement})$  is to be applied to enable comparison of actual EWT with general working time as per settlement. Eg.: If 100 operators are deployed where declared working time is 405min against a general working time is 465min, then manpower to be considered for EWT is 87 (ie.  $100 \times 405 \div 465$ ).
- f. Only normal working days/shifts are to be considered for EWT. Hence, partial working on holidays are to be excluded since they give a misleading representation while computing average EWT. The production made on these days will not be reflected in the system. However, normal working on holiday in lieu of an off during preceding/succeeding week is to be considered for EWT.

2. Production considerations:

- a. All products/models manufactured are to be declared. Production should not be booked against the highest work content model, although the line may be balanced against that work content.
- b. Multiple declaration of the same part due to rework should not be done.

### **5.5.6. Calculation Process**

- a. Work content picked up from SAP routings corresponding to the declared part for that Cell –
- b. Work content is multiplied by production of the part to give work content produced
- c. Total work content produced is summed up for all products declared in the Cell/ Department/ Plant
- d. Total work content produced is divided by manpower present to give EWT of the Cell/ Department/ Plant

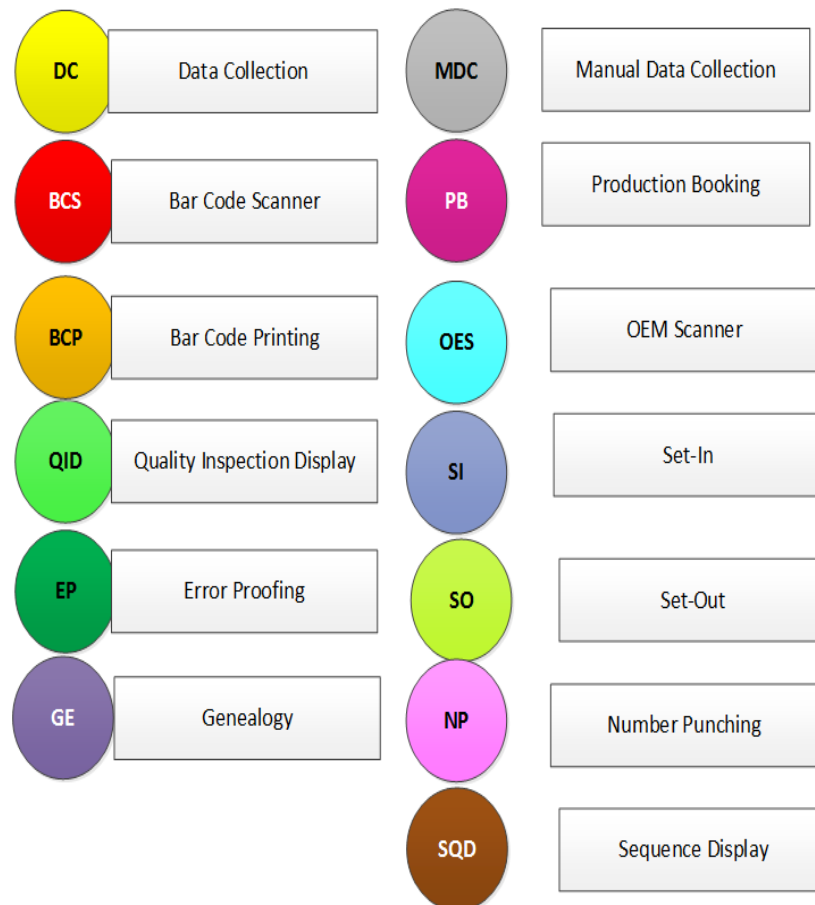
### **5.5.7. Report Requirements**

- a. Daily/ weekly/ Monthly / yearly - Cell / Module/ PU / Plantwise EWT report,
- b. Loss Analysis report
- c. Man-days report for – manpower deployed on Training & Improvement

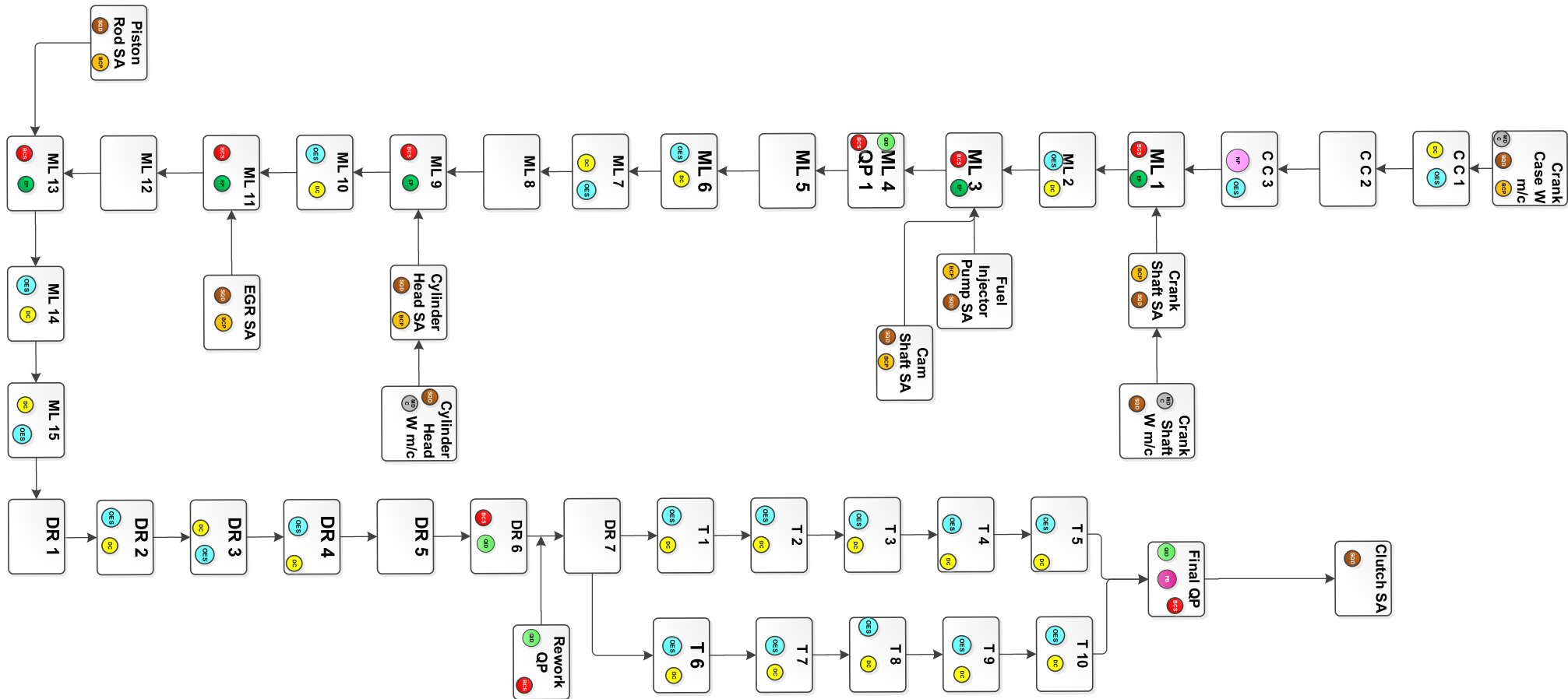
## 6. ZHB Requirements and MES Functionality Mapping

The MES requirements are mentioned in the below table. Each requirement has been mapped against an operator / equipment activity from the shop floor and the required MES functionality to enable the requirement.

### Legends for the Shop layouts,



## 6.1. Production – Engine Station wise MES Functionality Mapping



Layout of MES Touch Points in Engine Shop



The MES requirements are mentioned in the below table. Each requirement has been mapped against an operator / equipment activity from the shop floor and the required MES functionality to enable the requirement.

SR NO	Shop	Line Name	Station No	FRS ID	User Requirements	MES Functionality
1	Engine	CC Line	Crank Case Washing Machine	PPE01	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to feed parts in Washing m/c by acknowledging sequence on panel. 3. Operator to Enter Pressure, Temperature & Concentration values. 4. Operator to accept order then barcode will be printed	Order Display & Manual Data Collection
2	Engine	CC Line	Cylinder Head and GPM Washing Machine	PPE02	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to feed parts in Washing m/c by acknowledging sequence on panel. 3. Operator to Enter Pressure , Temperature & Concentration values	Order Display & Manual Data Collection
3	Engine	CC Line	Crank Shaft Washing Machine	PPE03	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to feed parts in Washing m/c by acknowledging sequence on panel. 3. Operator to Enter Pressure , Temperature & Concentration values.	Order Display & Manual Data Collection
4	Engine	SA Crank Case line	CC1	PPE04	Torque data capturing from DC nut runner 1. DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection

5	Engine	SA Crank Case line	CC3	PPE05	<p>1. Operator to scan ESN barcode same number will be Punched on Engine</p> <p>2. The scanner will connected to MES Client and in-turn the MES client will send the serial number to punching machine through serial port and programming of the number punching machine will be in maintenance scope</p> <p>3. MES will track the engine unit</p>	VIN Generation
6	Engine	Main Line	ML1	PPE06	<p>1. Operator will scan Engine serial numbers in the travel card and Crank shaft subassembly barcode</p> <p>2. MES will do the error proofing and capture the Crank shaft number for traceability</p>	Error Proofing
7	Engine	SA Crank shaft	Crank Shaft Sub assembly	PPE07	<p>1. Display available for showing order start sequence based on PPC orders + SOP Display</p> <p>2. As per this sequence operator has to enter the Crank Shaft serial number and MES will generate the barcode (Running serial Number + Crank Shaft Serial Number + Part Number)</p>	Order Start
8	Engine	Main Line	ML2	PPE08	<p>Torque data capturing from DC nut runner</p> <p>1.DC nut runner is connected with M &amp; M network and same will transferred to MES against the engine serial Number.</p>	Data Collection
9	Engine	Main Line	ML3	PPE09	<p>1. Operator will scan Engine serial numbers in the travel card and Fuel injector pump &amp; Cam Shaft sub assembly barcode</p> <p>2. MES will do the error proofing.</p>	Error Proofing
10	Engine	Main Line	Fuel Injector Pump Sub Assembly	PPE10	<p>1. Display required for showing order start sequence based on PPC orders + SOP Display</p> <p>2. As per this sequence operator has to start the fuel injector pumps sub assembly order</p> <p>3. Operator has to scan the Fuel Injector "Serial Number" and</p>	Error Proofing

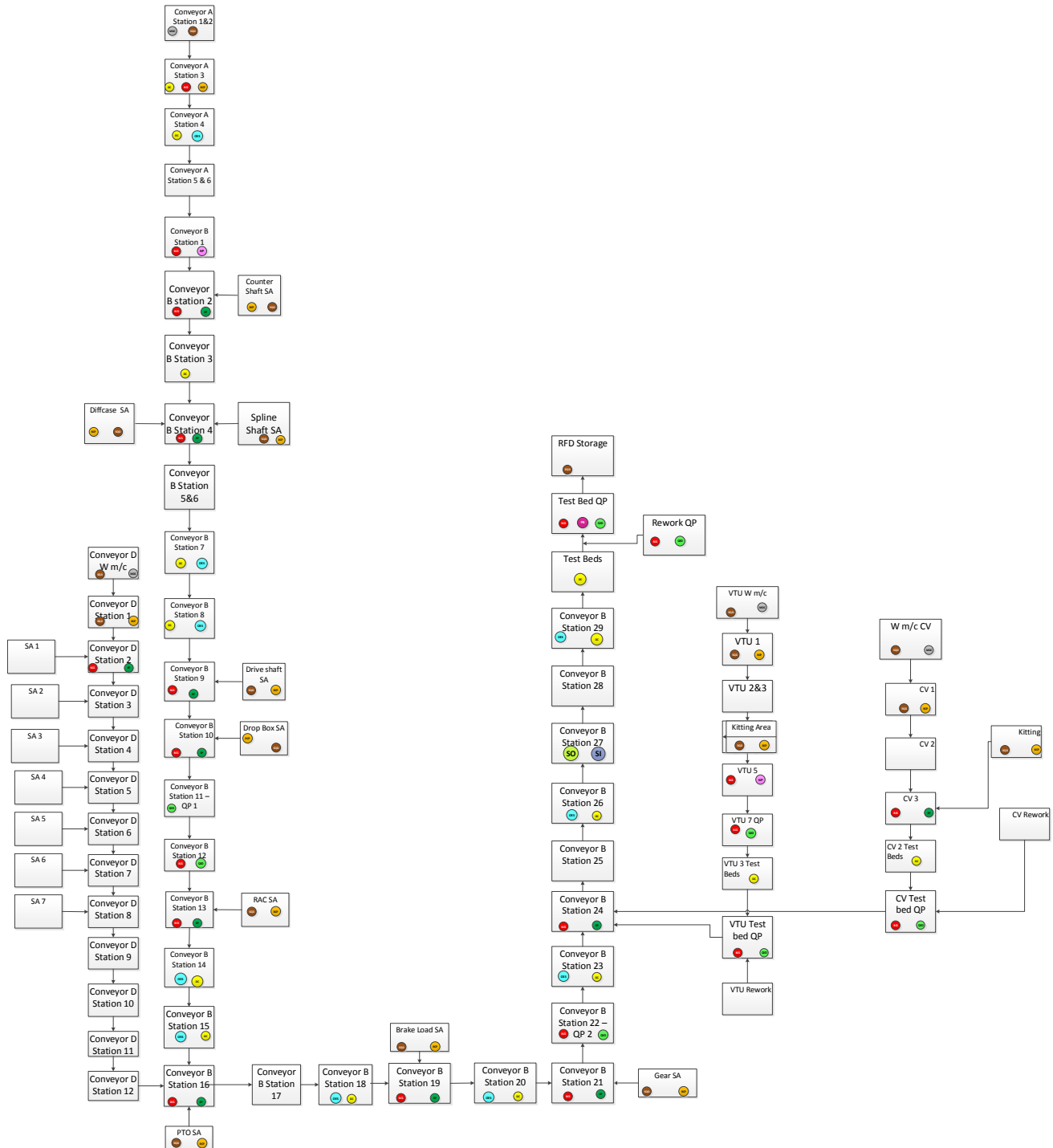
					error proof for the scanned part. 4. MES will print the barcode	
11	Engine	Main Line	CAM Shaft Sub Assembly	PPE11	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to start the Cam Shaft sub assembly orders 3. MES will generate the barcode and same has to be attached with part	Order Start
12	Engine	Main Line	ML4	PPE12	1. Operator will scan Engine serial numbers in the travel card 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality Station
13	Engine	Main Line	ML6	PPE13	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
14	Engine	Main Line	ML7	PPE14	Engine OIL filling data Collection from OEM '- OEM will send the Engine oil filling data to MES against the engine serial number	Data Collection
15	Engine	Main Line	ML9	PPE15	1. Operator will scan Engine serial numbers in the travel card and Cylinder head subassembly barcode 2. MES will do the error proofing and capture the Crank shaft number for traceability	Error Proofing
16	Engine	Main Line	Cylinder Head Sub Assembly	PPE16	1. Display available for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to enter the Cylinder Head serial number and MES will generate the barcode (Running serial Number + Crank Shaft Serial Number + Part Number)	Order Start

					3. MES has to capture the Leak test values	
17	Engine	Main Line	ML10	PPE17	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
18	Engine	Main Line	ML11	PPE18	1. Operator will scan Engine serial numbers in the travel card and EGR sub assembly barcode before the marriage 2. MES will do the error proofing	Error Proofing
19	Engine	Main Line	EGR Sub Assembly	PPE19	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to start the fuel EGR sub assembly orders	Order Start
20	Engine	Main Line	Turbo Sub Assembly	PPE20	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to start the fuel EGR sub assembly orders	Order Start
21	Engine	Main Line	Piston & Connecting rod	PPE21	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to start the order and assign the Pre-fabricated tag	Order Start
22	Engine	Main Line	ML13	PPE22	1. Operator has to scan the Piston & Connecting rod before the assembly 2. MES will do the error proofing	Error Proofing
23	Engine	Main Line	ML14	PPE23	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
24	Engine	Main Line	ML15	PPE24	Torque data capturing from DC nut runner 1.DC nut runner is connected	Data Collection

					with OEM PLC and MES will collect the data from there.	
25	Engine	Dressing	DR2	PPE25	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
26	Engine	Dressing	DR3	PPE26	Leak test value Capture from OEM - OEM will send the leak test values to MES against the serial number	Data Collection
27	Engine	Dressing	DR4	PPE27	Engine Oil Filling Capture from OEM - OEM will send the leak test values to MES against the serial number	Data Collection
28	Engine	Dressing	DR6	PPE28	1. Operator will scan Engine serial numbers in the travel card 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality Station
29	Engine	Test Bed - 10	T1 – T10	PPE29	Data capturing from Engine Test bed 1.OEM will provide the data to MES 2. Mode of communication between MES and OEM has to discuss with the OEM. 3. MES will store the OK /NOK signal from the OEM against the ESN	Data Collection
30	Engine	Engine Final QP	Behind Test Bed	PPE30	1. After the testing is completed the operator has to enter the final QAOK in the system and barcode will be generated 2. Operator has to paste the QAOK sticker in the Engine	Final QA OK
31	Engine	Rework Area QP		PPE31	After the rework is completed the operator has to enter the quality in the QP	Quality Station

32	Tractor	Clutch	Clutch Sub Assembly	PPE32	<ol style="list-style-type: none"><li>1. Display required for showing order start sequence based on PPC orders + SOP Display</li><li>2. As per this sequence operator has to start the Clutch Sub Assembly and ACK the same in the screen</li><li>3. If engine has to send back to engine rework operator has to send the same using the screen</li><li>4. Based on the Call from Docking the operator has to load the engine in the EMS</li></ol>	Order Start
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## 6.2. VTU & CV Station wise MES Functionality



The MES requirements are mentioned in the below table. Each requirement has been mapped against an operator / equipment activity from the shop floor and the required MES functionality to enable the requirement. The Remaining points are already covered in the other sections of the FRS document. Where ever there is display is available MES can Enable Manual Data Collection Functionality.

SR NO	Shop Name	Line Name	Station No	FRS ID	User Requirements	MES Functionality
1	Transmission	Conveyor A	Station No 1	PPT01	<ol style="list-style-type: none"> <li>1. One Display required for showing order start sequence based on PPC orders + SOP Display for two washing machines</li> <li>2. As per this sequence operator has to feed parts in Washing m/c by acknowledging sequence on panel.</li> <li>3. Operator to Enter Pressure, Temperature &amp; Concentration values.</li> </ol>	Order Display & Manual Data Collection
2	Transmission	Conveyor A	Station 2		<ol style="list-style-type: none"> <li>1. As per this sequence operator has to feed parts in Washing m/c by acknowledging sequence on panel.</li> <li>2. Operator to Enter Pressure, Temperature &amp; Concentration values.</li> </ol>	Order Display & Manual Data Collection
3	Transmission	Conveyor A	Station 3	PPT02	<ol style="list-style-type: none"> <li>1. Display is already available for Transmission barcode printing.</li> <li>2. Sequence will be provided based on PPC orders + SOP Display by MES</li> <li>3. Operator has to Accept the order to start the order and bar code will be printed</li> <li>4. Based on the operator input system will start the Transmission order.</li> </ol>	Order Display & Serial Number Generation



					3. Operator to Enter Pressure, Temperature & Concentration values.	
4	Transmission	Conveyor A	Station 4	PPT03	Torque data capturing from DC nut runner 1.DC nut runner is connected with M & M network and same will transferred to MES against the Transmission serial Number.	Data Collection
5	Transmission	Conveyor B	Station 10	PPT14	1. Operator will scan Transmission serial numbers in the travel card and drop Box kitting barcode 2. MES will do the error proofing.	Error Proofing
6	Transmission	Conveyor B	Station 1	PPT04	1. Operator to scan TSN barcode same number will be Punched on transmission unit 2. The scanner will connected to MES Client and in turn the MES client will send the serial number to punching machine through serial port and programming of the number punching machine will be in maintenance scope 3. MES will track the transmission unit	Number Punching
7	Transmission	Conveyor B	Station 2	PPT05	1. Operator will scan Transmission serial numbers in the travel card and Counter shaft kitting barcode 2. MES will do the error proofing.	Error Proofing
8	Transmission	Conveyor B	Counter Shaft Sub Assembly	PPT06	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the Counter shaft Sub assembly kitting barcode	Order Start

9	Trans mission	Conv eyor B	Station 4	PPT0 7	1. Operator will scan Transmission serial numbers in the travel card and Splinr Shaft kitting barcode 2. MES will do the error proofing.	Error Proofing
10	Trans mission	Conv eyor B	Spline Shaft Sub Assembly	PPT0 8	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the Counter shaft Sub assembly kitting barcode	Order Start
11	Trans mission	Conv eyor B	Diffcase Sub Assembly	PPT0 9	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the Counter shaft Sub assembly kitting barcode	Order Start
12	Trans mission	Conv eyor B	Station 7	PPT1 0	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
13	Trans mission	Conv eyor B	Station 8	PPT1 1	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
14	Trans mission	Conv eyor B	Station 9	PPT1 2	1. Operator will scan Transmission serial numbers in the travel card and dirve Shaft kitting barcode 2. MES will do the error proofing. .	Error Proofing
15	Trans mission	Conv eyor B	Drive Shaft Sub Assembly	PPT1 3	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the Drive shaft Sub assembly kitting barcode	Order Start
16	Trans mission	Conv eyor B	Drop Box Sub assembly	PPT1 5	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the Drop Box Sub assembly kitting barcode	Order Start

17	Trans mission	Conv eyor B	Station 11		1.Operator to Take Out & Take In the transmission unit 2.Operator to declare Taken Out & Take In QP 1	Take Out/ Take In
18	Trans mission	Conv eyor B	Station 12 QP 1	PPT1 6	1. Operator will scan Transmission serial numbers in the travel card 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality
19	Trans mission	Conv eyor B	Station 13	PPT1 7	1. Operator will scan Transmission serial numbers in the travel card and RAC Sub Assembly kitting barcode 2. MES will do the error proofing	Error Proofing
20	Trans mission	Conv eyor B	RAC Sub Assembly	PPT1 8	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the RAC Sub assembly kitting barcode	Order Start
21	Trans mission	Conv eyor B	Station 14	PPT1 9	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
22	Trans mission	Conv eyor B	Station 15	PPT2 0	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
23	Trans mission	Conv eyor B	Station 16	PPT2 1	1. Operator will scan Transmission serial numbers in the travel card and clutch house Sub Assembly kitting barcode 2. MES will do the error proofing.	Error Proofing
24	Trans mission	Conv eyor B	PTO Sub Assembly	PPT2 2	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the PTO Sub assembly kitting barcode	Order Start

25	Trans mission	Conv veyor B	Station 18	PPT2 3	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
26	Trans mission	Conv veyor B	Station 19	PPT2 4	1. Operator will scan Transmission serial numbers in the travel card and Brake Load Sub Assembly kitting barcode 2. MES will do the error proofing.	Error Proofing
27	Trans mission	Conv veyor B	Brake Sub Assembly	PPT2 5	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the Brake Sub assembly kitting barcode	Order Start
28	Trans mission	Conv veyor B	Station 20	PPT2 6	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection
29	Trans mission	Conv veyor B	Station 21	PPT2 7	1. Operator will scan Transmission serial numbers in the travel card and Gear Sub Assembly kitting barcode 2. MES will do the error proofing	Error Proofing
30	Trans mission	Conv veyor B	Gear Sub Assembly	PPT2 8	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to scan the Gear Sub assembly kitting barcode	Order Start
31	Trans mission	Conv veyor B	Station 22 QP 2	PPT2 9	1. Operator will scan Transmission serial numbers in the travel card 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality
32	Trans mission	Conv veyor B	Station 23	PPT3 0	Torque data capturing from DC nut runner 1.DC nut runner is connected with OEM PLC and MES will collect the data from there.	Data Collection

33	Trans mission	Conv eyor B	Station 24	PPT3 1	1. Operator will scan Transmission serial numbers in the travel card and VTU subassembly barcode 2. MES will do the error proofing	Error Proofing
34	Trans mission	Conv eyor B	Station 26	PPT3 2	Data capturing from Machine 1.OEM will provide Leak Testing data to be discussed with OEM	Data Collection
35	Trans mission	Conv eyor B	Station 27 QP 3	PPT3 3	1. Standard SET IN & SET OUT functionality will be provided to Set In or Set Out transmission from line.	Quality
36	Trans mission	Conv eyor B	Station 29	PPT3 4	Data capturing from Machine 1.OEM will provide Oil filling data to be discussed with OEM	Data Collection
37	Trans mission	Test Bed	Station 1	PPT3 5	Data capturing from Machine 1.OEM will provide Testing data (6 - Transmission Test Bed)	Data Collection
38	Trans mission	Test Bed	Test Bed QP	PPT3 6	1. After the testing is completed the operator has to enter the final OK in the system and barcode will be generated 2. Operator has to paste the OK sticker in the transmission	Quality
39	Trans mission	Rew ork	Rework	PPT3 7	1. After the rework is completed the operator has to enter the status in the system and take back the transmission to test bed for QP	Quality
40	Trans mission	RFD Stora ge	RFD Storage	PPT3 8	1. Display required for showing order start sequence based on PPC orders 2. Based on the Call from Docking the operator has to load the transmission in the EMS	Order Start

41	Trans missi on	Conv eyor D	Washing Machines	PPT3 9	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to feed parts in Washing m/c by acknowledging sequence on panel. 3. Operator to Enter Pressure, Temperature & Concentration values.	Order Display & Manual Data Collection
42	Trans missi on	Conv eyor D	Station 1	PPT4 0	1. Display is required for order start 2. Sequence will be provided based on PPC orders + SOP Display by MES 3. Operator has to Accept the order to start the order and bar code will be printed	Order Display & Manual Data Collection
43	Trans missi on	Conv eyor D	Station 2	PPT4 1	1. Operator will scan Transmission serial numbers in the travel card and subassembly pre - fabricated tag before assembly 2. MES will do the error proofing.	Order Display & Manual Data Collection
44	Trans missi on	VTU	Washing Machines & General Washing Machines	PPT4 2	1. Display required for showing order start sequence based on PPC orders + SOP Display 2. As per this sequence operator has to feed parts in Washing m/c by acknowledging sequence on panel. 3. Operator to Enter Pressure, Temperature & Concentration values.	Order Start / Display
45	Trans missi on	VTU	Station 1	PPT4 3	1. Sequence will be provided based on PPC orders + SOP Display by MES 2. Operator has to Accept the order to start the order and bar code will be printed 3. Based on the operator input system will start the VTU order.	Order Start, Serial Number generation & Barcode Printing

46	Trans mission	VTU	Station 4	PPT4 4	1. Operator will Scan the serial - number and Kitting tag before assembly 2. MES will do the Kitting validation	Order Start
47	Trans mission	VTU	Station 5	PPT4 5	1. Operator to scan serial number barcode same number will be Punched on VTU2. The scanner will connected to MES Client and in-turn the MES client will send the serial number to punching machine through serial port and programming of the number punching machine will be in maintenance scope3. MES will track the transmission unit	Number Punching
48	Trans mission	VTU	Kitting Area	PPT4 6	1. Operator will collect the parts from Washing Machine and Kit it as per the Sequence 2. MES will generate the barcode as per the sequence	Order Start
49	Trans mission	VTU	Station 7	PPT4 7	1. Operator will scan serial numbers in the travel card 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality
50	Trans mission	VTU	Test Bed 1, 2 & 3	PPT4 8	Data capturing from VTU Test bed Machine 1.OEM will provide Testing data	Data Collection
51	Trans mission	VTU	Test Bed Quality Gate	PPT4 9	1. After the testing is completed the operator has to enter the final QAOK in the system and barcode will be generated 2. Operator has to paste the QAOK sticker in the VTU	Quality
52	Trans mission	VTU	Rework	PPT5 0	1. After the rework is completed the operator has to enter the status in the system and take back the transmission to test bed for QP	Quality

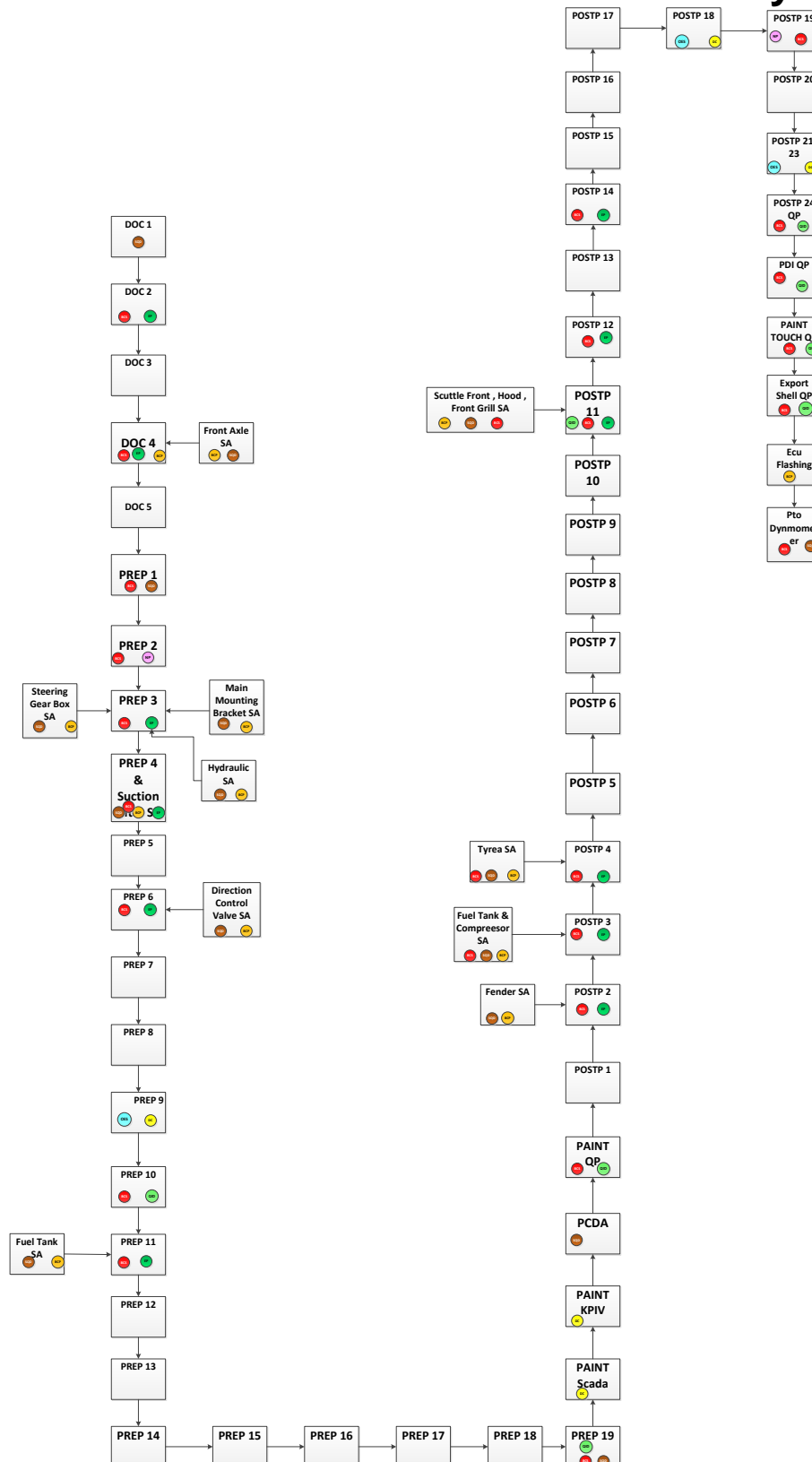


53	<b>Trans missi on</b>	<b>CV</b>	<b>Washing Machines</b>	<b>PPT5 1</b>	<p>1. Display required for showing order start sequence based on PPC orders + SOP Display</p> <p>2. As per this sequence operator has to feed parts in Washing m/c by acknowledging sequence on panel.</p> <p>3. Operator to Enter Pressure, Temperature &amp; Concentration values.</p>	Order Display & Manual Data Collection
54	<b>Trans missi on</b>	<b>CV</b>	<b>Station 1</b>	<b>PPT5 2</b>	<p>1. Display required for barcode printing.</p> <p>2. Sequence will be provided based on PPC orders by MES + SOP Display</p> <p>3. Operator has to Accept the order to start the order and bar code will be printed</p> <p>4. Based on the operator input system will start the CV order.</p>	Order Start, Serial Number generation & Barcode Printing
55	<b>Trans missi on</b>	<b>CV</b>	<b>Kitting Area</b>	<b>PPT5 3</b>	<p>1. Operator will collect the parts from Washing Machine and Kit it as per the Sequence</p> <p>2. MES will generate the barcode as per the sequence</p>	Order Start
56	<b>Trans missi on</b>	<b>CV</b>	<b>Station 3</b>	<b>PPT5 4</b>	<p>1. Operator will Scan the serial number and Kitting tag before assembly</p> <p>2. MES will do the Kitting validation</p>	Order Start
57	<b>Trans missi on</b>	<b>CV</b>	<b>Test Bed 1 &amp; 2</b>	<b>PPT5 5</b>	<p>Data capturing from CV test bed</p> <p>1.OEM will provide Testing data</p>	Data Collection
58	<b>Trans missi on</b>	<b>CV</b>	<b>Test Bed Quality Gate</b>	<b>PPT5 6</b>	<p>1. After the testing is completed the operator has to enter the final QAOK in the system and barcode will be generated</p> <p>2. Operator has to paste the QAOK sticker in the CV</p>	Data Collection
59	<b>Trans missi on</b>	<b>CV</b>	<b>Rework</b>	<b>PPT5 7</b>	<p>1. After the rework is completed the operator has to enter the status in the system and take back the transmission to test bed for QP</p>	Quality



60	<b>Trans missi on</b>	<b>Store s</b>	<b>Pick to Light Stations</b>	<b>PPT5 8</b>	1. Displays required for displaying the PPC order 2. Barcode printers will be connected with the pick to light system 3. After the completion of the kitting process and pick to light system will print the barcode	Order Display
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## 6.3. Tractor Station wise MES Functionality Mapping



The MES requirements are mentioned in the below table. Each requirement has been mapped against an operator / equipment activity from the shop floor and the required MES functionality to enable the requirement.

#	Shop Name	Line Name	Station No	FRS ID	User Requirements	MES Functionality
1	Tractor	Docking	Station No 1	PPTR 01	1.Display required to see the PPC orders + SOP Display 2.Operator to request Engine and Transmission as per sequence and Ok status of the same	Order Start
2	Tractor	Docking	Station No 2	PPTR 02	1.Engine and Transmission marriage operator to scan both serial numbers MES will do the Error proofing	Error Proofing
3	Tractor	Docking	Station No 4	PPTR 03	1.Docking and Front Axle marriage operator to scan both serial numbers MES will do the Error proofing 2.After Error proofing ok Tractor serial number will generated and barcode will be printed.	Error Proofing
4	Tractor	Docking	Front Axle Sub Assembly	PPTR 04	1.Display required to see the PPC orders + SOP Display 2. Operator to start the order as per sequence barcode will be printed and same has to be pasted on the axle	Order Start
6	Tractor	Pre Paint Line	Station 1	PPTR 06	1.Display is required to show the PPC orders as per sequence + SOP Display 2.Operator to scan the Bar code before loading in the line	Order Start
7	Tractor	Pre Paint Line	Station 2	PPTR 07	1.Operator to scan Tractor serial number same number will be Punched on tractor 2. The scanner will be connected to the VIN punching machine. 3. MES will track the tractor	Number Punching

8	Tractor	Pre Paint Line	Station 3	PPTR 08	1. Operator will scan Tractor serial numbers and Main mounting bracket , Steering gear box ,Hydraulic subassemblies barcodes before assembly 2. MES will do the error proofing .	Error Proofing
9	Tractor	Pre Paint Line	Main mounting bracket , Steering gear box ,Hydraulic sub-assemblies	PPTR 09	1.Display is required to show the PPC orders as per sequence + SOP Display 2.Operator to start the orders by pressing accept button Bar codes will be printed	Order Start & Barcode Printing
10	Tractor	Pre Paint Line	Station 4 & suction filter sub Assembly	PPTR 10	1.Display required to show the ppc orders for tractor and suction filter subassemblies 2.Operator will start the suction filter orders by pressing Accept button barcode will be printed 3. Operator will scan Tractor serial numbers and suction filter subassemblies barcodes before assembly 4. MES will do the error proofing .	Error Proofing
11	Tractor	Pre Paint Line	Station 5	PPTR 11	Oil filling data to be captured from OEM PLC in MES	Data Collection
12	Tractor	Pre Paint Line	Station 6	PPTR 12	1. Operator will scan Tractor serial numbers and Direction control valve subassembly barcodes before assembly 2. MES will do the error proofing .	Error Proofing
13	Tractor	Pre Paint Line	Direction Control Valve Sub Assembly	PPTR 13	1.Display is required to show the PPC orders as per sequence + SOP Display 2. Operator to start the orders as per sequence by pressing Accept button and Barcode will be generated. Operator has to paste the same in the part	Order Start & Barcode Printing

16	Tractor	Pre Paint Line	Station 9	PPTR 16	DC Torque machine data to be captured from OEM PLC 1.DC Torque machine is connected with OEM PLC and MES will collect the data from there.	Data Collection
17	Tractor	Pre Paint Line	Station 10	PPTR 17	1. Operator will scan Tractor barcode 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality
18	Tractor	Pre Paint Line	Station 11	PPTR 18	1. Operator will scan Tractor serial numbers and Fuel Tank subassembly barcodes before assembly 2. MES will do the error proofing .	Error Proofing
19	Tractor after 36	Pre Paint Line	QP4B	PPTR 17	1. Operator will scan Tractor barcode 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality
20	Tractor	Pre Paint Line	Fuel Tank SA	PPTR 19	1.Display is required to show the PPC orders as per sequence + SOP Display 2. Operator to start the orders as per sequence by pressing Accept button and Barcode will be generated. Operator has to paste the same in the part	Order Start & Barcode Printing
21	Tractor	Pre Paint Line	QP 2	PPTR 27	1. Operator will scan Tractor barcode 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen. 4. Scan data sequence will be given to Paint shop pre robot booth (MST)	Quality
22	Tractor	Paint Line	Paint Line	PPTR 28	Required data will be collected from SCADA	Data Collection
23	Tractor	Paint Line	Paint Line	PPTR 29	Display is required to enter KPV (LAB Testing Values)	Data Collection
24	Tractor	Paint Line	PCDA	PPTR 30	Display is required for displaying the paint shop IN and Paint Shop out data	Quality

25	Tractor	Paint Line	QP3	PPTR 31	1. Operator will enter the tractor serial number 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality
26	Tractor	Post Paint Line	Station 2	PPTR 33	1. Operator will scan Tractor serial numbers and Fender subassembly barcodes before assembly 2. MES will do the error proofing .	Error Proofing
27	Tractor	Post Paint Line	Fender Sub Assembly	PPTR 34	1. Display is required to show the PPC orders as per sequence + SOP Display 2. Operator to start the orders as per sequence by pressing Accept button and Barcode will be printed and same will be pasted in the part	Order Start
28	Tractor	Post Paint Line	Station 3	PPTR 35	1. Operator will scan Tractor serial numbers and Fuel Tank, Compressor subassemblies barcodes before assembly 2. MES will do the error proofing.	Order Start & Manual Data Collection
29	Tractor	Post Paint Line	Fuel Tank, Compressor SA	PPTR 36	1. Display is required to show the PPC orders as per sequence + SOP Display 2. Operator to start the orders as per sequence by pressing Accept button and Barcode will be printed	Order Start & Barcode Printing
30	Tractor	Post Paint Line	Station 4	PPTR 37	1. Operator will scan Tractor serial numbers and Tyre barcodes (LH & RH) before assembly 2. MES will do the error proofing. 3. MES will collect DC nut runner data values from OEM PLC	Error Proofing
31	Tractor	Post Paint Line	Tyre SA	PPTR 38	1. Display is required to show the PPC orders as per sequence + SOP Display 2. Operator to start the orders as per sequence by pressing Accept button and Barcode will be printed	Order Start & Barcode Printing

32	Tractor	Post Paint Line	Scuttle Front , Hood , Front Grill Sub-Assemblies	PPTR 45	1. Display is required to show the PPC orders as per sequence + SOP Display 2. Operator to start the orders as per sequence by pressing Accept button and Barcodes will be printed for respective sub-assemblies	Order Start & Barcode Printing
33	Tractor	Post Paint Line	Station 11	PPTR 46	1. Operator will scan Tractor serial numbers and Scuttle Front subassemblies barcodes before assembly 2. MES will do the error proofing. 3. Operator will scan Tractor barcode 4. MES will display the quality check list configured by the user 5. Operator will enter the defect / no defects in the MES screen.	Quality
34	Tractor	Post Paint Line	Station 12	PPTR 47	1. Operator will scan Tractor serial numbers and Front Grill subassemblies barcodes before assembly 2. MES will do the error proofing.	Error Proofing
35	Tractor	Post Paint Line	Station 14	PPTR 49	1. Operator will scan Tractor serial numbers and Hood subassemblies barcodes before assembly 2. MES will do the error proofing.	Error Proofing
36	Tractor	Post Paint Line	Station 18	PPTR 53	DC Torque machine data to be captured from OEM PLC 1. DC Torque machine is connected with OEM PLC and MES will collect the data from there.	Data Collection
37	Tractor	Post Paint Line	Station 19	PPTR 54	1. Operator to scan Tractor barcode same number will be Punched on name plate 2. MES will validate the Serial number punched on transmission	VIN Punching
38	Tractor	Post Paint Line	Station 21 -23	PPTR 56	Oil dispensing data to be captured from OEM PLC (Coolant, Transmission, VTU, Etc.)	Data Collection
39	Tractor	Post Paint Line	Station QP 5B	PPTR 57	1. Operator will scan Tractor barcode 2. MES will display the quality check list configured by the user	Quality

					3. Operator will enter the defect / no defects in the MES screen.	
40	Tractor	Post Paint Line	PDI QP	PPTR 58	1. Operator will scan Tractor barcode 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen.	Quality
41	Tractor	Post Paint Line	Paint Touch UP QP	PPTR 59	1. Operator will scan Tractor barcode 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen. 4. Operator will stick the Quality Ok sticker for domestic variants	Quality
42	Tractor	Post Paint Line	Export Shell QP	PPTR 60	1. Operator will scan Tractor barcode 2. MES will display the quality check list configured by the user 3. Operator will enter the defect / no defects in the MES screen. 4. Operator will do the quality audit. 4. Operator will stick the Quality Ok sticker for export variants	Quality
43	Tractor	Post Paint Line	ECU Flashing Station	PPTR 61	- Barcode Printer has to be considered for ECU flashing	Barcode Printing
44	Tractor	PDI	PTO Dynometer	PPTR 62	- Barcode scanner and display for displaying the PPC orders - OEM will send the data against the serial number	Data Collection

## 6.4. Detailed MES Functionality Matrix Quality

Inspection will be completed by operators working at different stations. Operator will visually check the quality of the parts at working station and take corrective action if any defects are found. In case, operator is unable to correct any defect then he will inform to the Quality Supervisor responsible for that Sub-assembly



or line. This process is also called self-certification by operator. The defects are recorded on the history card against the station number and operator Id. If any defect captured on the history card is corrected by any operator, it will be recorded on the history card against the captured defect.

FRS ID	Use case	Business Requirement	MES Functionality	Master Configuration Requirement (Defect Library)	Remarks
QMF 01	Configurable parameters for defect capturing	The MES needs to provide the designated quality system to administrator to maintain the quality gate specific information like defect code, defect part, responsibility, rework code, inspector code, and station code.	Quality Administration	Quality Master data Configuration	
QMF 02	Image templates for defect capturing	MES needs to display on the quality display an appropriate picture of the assembly unit produced at that line for entering the defects per location on the unit.	Inspection Data Entry	Quality Image data Configuration	
QMF 03	Vehicle information on Quality display	When the vehicle / body reaches QP, Quality operator scans the barcode label pasted on the Manifest or on the body. As per the scanned value, MES needs to display the production number, vehicle details and the relevant check list based on the variant of the unit being inspected.	Inspection Display	Stage Wise Quality Master Data Configuration	

QMF 04	Escalation based on Severity of defects	The MES will monitor the frequency of defect Alert notifications. If a particular defect Alert notifications repeats for configurable number of times, the MES will send an e-mail message to a list of recipients, per a configurable hierarchy rules for escalation purposes, defined by the M & M Quality team.- e.g. 1 Alert - Quality Supervisor, 2 Alert repeats - Quality Manager and 3 Alert repeats Quality Head	Quality Alert Notification	Quality Alert Notification Configuration	
QMF 05	Tool Gauge calibration system	MES has to provide provision for the user to configure and maintain the tool gauge data across the plant	Tool Gauge calibration system	Tool Gauge Maintenance Configuration details	Its is available in SAP. So has to be carried out in SAP
QMF 06	QAOK Declaration	MES has to provide provision for the user to print QAOK sticker and declare stage wise QAOK status to the users	QAOK Declaration	Station wise list for QAOK declaration	

## 6.5. Detailed MES Functionality Matrix Maintenance

Maintenance Management in MES: MES needs to guide the shop floor for the Maintenance of equipment's which are monitored through it [Ex- Conveyor, Skids, Hangers, and Dies etc.]. The planned maintenance (PM) schedule needs to be maintained in MES for such equipment's and alerts needs to be provided on plant floor when the PM will be due. The Maintenance activity will be done and the update will be given in MES.

#	FRS ID	Use case	Business Requirement	MES Functionality	Remarks
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1	MM 01	Breakdown Maintenance Process & Down Time Tracking	An alarm from the equipment's which leads to stoppage of equipment need to be captured in MES for all the shops. Down time Tracking should be based on the below mentioned points, -Material Shortage - Supervisor Call - Quality Issue	Performance Management	Selected list of machines A & B (critical only) Class machines. OEM PLC Program will out of Scope for MES team
2	MM 02	Alarm from equipment	- When an alarm is captured, MES needs to trigger SMS to the Maintenance team as per the defined Business logic for the downtime. Ex: Downtime more than 5 mins should be triggered for SMS. - MES needs to capture the reason for the alarm. This will be captured from the alarm / fault codes configured in the equipment.	Alarm Management	- Alarm List Configuration in MES - Mailing list has to be configured by user
3	MM 03	Preventive Maintenance (PM)	- The PM schedule for all the AUTOMATIC equipment's needs to be maintained in MES. The PM schedule needs to maintain manually in MES by the Maintenance supervisor. - MES needs to provide the list of Equipment's whose PM is due with a time period. [Ex: Daily, Weekly or Monthly]	Planned Maintenance	Selected list of machines A & B (critical only) Class machines. OEM PLC Program will out of Scope for MES team
4	MM 04	Equipment running and alert on MES display (TBM)	- If the Maintenance set point has reached, MES needs to alert the maintenance dept for Preventive Maintenance of the equipment. - Maintenance user needs to update the state of the equipment when TBM is performed on it.	Time Based Maintenance	Selected list of machines A & B (critical only) Class machines. OEM PLC Program will out of Scope for MES team
5	MM 05	CLITA - Cleaning - Lubrication - Inspection - Retightening	- Operator has manually enter the values in MES. - Order display screen will used by the operator to enter the values	Maintenance Management	Selected list of machines A & B (critical only) Class machines. OEM PLC Program will out of Scope for MES team

6	MM 06	CBM Condition Based Maintenance (CBM) is a maintenance strategy that uses the actual condition of the asset to decide what maintenance needs to be done. - Air Management - Water Management - Fuel	<ul style="list-style-type: none"> <li>- Required devices to be planned and installed for collecting the data in MES</li> <li>- Budget to be planned and Installed</li> <li>- Interface with MES to be done after availability of devices</li> <li>- Provision for storing the data and reports to be made available in MES</li> </ul>	Maintenance Management	Selected list of machines A & B (critical only) Class machines. OEM PLC Program will out of Scope for MES team
7	MM 07	ANDON Display	Andon data has to come to MES from OEM PLC for MES reports	ANDON Display	ANDON data has to come to MES for records
9	MM 08	Energy Management (Open)	Energy consumption details required for aggregate wise	Energy Management	Possibility for collecting data from RS485 ports to MES needs to be checked.
10	MM 09	Spare Parts Management (Open)	Needs to done in SAP Notifications from SAP for Min/Max level of spare parts. Auto mail from SAP.	Machine Spare Parts Management	Needs to done in SAP with notifications to user and buyer
11	MM 10	MTTR/MTBF data	<ul style="list-style-type: none"> <li>- Operator has manually enter the values in MES.</li> <li>- Order display screen will used by the operator to enter the values</li> </ul>	Maintenance Management	Selected list of machines A & B (critical only) Class machines. OEM PLC Program will out of Scope for MES team
12	MM 11	Minor Stoppages	<p>Included in machine downtime analysis</p> <ul style="list-style-type: none"> <li>- Stoppages less than a defined duration will fall under downtime stoppage</li> </ul>	Performance Management	

## 6.6. Detailed MES Functionality Matrix PPC

#	Category	MES Functionality	FRS ID	FD Requirement
1	Order planning	Tractor Order upload	PPC01	<p>1. PPC needs to upload tractor orders in MES/SAP using excel file. Upload will be done on tractor finished part # at lot level.</p> <ul style="list-style-type: none"> <li>- PPC Plan can also be created in MES using dropdowns for mode/part# selection and entering the qty.</li> <li>- PPC planner needs to freeze the Day-1 plan after which MES will create the MES detailed plan (orders) for Tractor, PTCED &amp; other aggregates</li> <li>- MES needs to provide functionality for entering Day-2, 3 &amp; 4 plan. Day-2, 3,4 plan will be tentative and can be modified before the day of production / freezing.</li> </ul> <p>2. MES needs to split the batch to unit orders without changing the lot sequence</p> <p>3. WIP &amp; Stock / Lead time consideration of aggregates &amp; PTCED to be taken into account for order planning of Tractors</p> <p>4. MES needs to have configurable lead time / WIP &amp; Stock consideration to have provision for aggregate &amp; PTCED</p> <ul style="list-style-type: none"> <li>planning of other plant working in different shift</li> <li>- Aggregate plan / Sequence needs to be shown to PPC planner for confirmation &amp; freezing separately</li> <li>- Functionality for Manual re-sequencing / modification needs to be provided for aggregate &amp; PTCED plan</li> </ul> <p>5. MES needs to have the functionality to address the Aggregate rejection scenario</p> <p>EX: If Engine is dead (Scrap). MES needs to have provision to create Engine orders which can be used at Docking with the existing Tractor &amp; Transmission orders.</p>

2	Order Planning	Aggregate Planning	Daily	<p>1. MES Should generate Aggregate planning automatically from the tractor plan.</p> <p>2. Procedure – For generating Engine docking plan from tractor plan, Engine RFD stock and WIP stock to be considered.</p> <p>3. Procedure – For generating Transmission docking plan from tractor plan, Transmission RFD stock and WIP stock to be considered.</p> <p>4. Procedure – For generating VTU plan same as Transmission plan only corresponding VTU plan should be shown.</p>
3	Order planning	Spare order upload-Aggregate level	PPC02	<p>1. PPC needs to upload or ENTER the plan for spare / Special orders at aggregate level</p> <p>2. MES needs to display the special order requirement on the sequence display screen of aggregates as a separate category and after click on a button</p> <p>3. Production team to decide the time of execution of special orders and start them based on that</p>
4	Order planning	Manual order re-sequence with reason	PPC03	<p>1. PPC will take the decision of changing the sequence / Plan of orders.</p> <p>2. PPC needs to re-upload the changed plan or manually re-sequence the orders in MES</p> <p>3. PPC needs to assign a justification / reason for change in plan</p> <ul style="list-style-type: none"> <li>- Freezed plan can be changed only by authorized personnel based on escalation</li> <li>- Tentative plan: Plan change can be done by PPC personnel</li> </ul>
5	Order planning	Order release	PPC04	<p>1. After resequencing, PPC needs to release the orders in MES for execution</p>
6	Sequence broadcast	Sequence broadcast-Aggregate wise	PPC05	<p>1. MES needs to display the sequence of freezed plan of Tractor &amp; Aggregates &amp; PTCED at the start stations on the respective lines and Docking station of the tractor line</p>

7	Order Start	Serial No. generation-Aggregate wise - Equipment creation trigger to SAP	PPC06	<p>1. MES needs to generate the serial number for following aggregates as per the business logic defined by ZHB plant (Process team)</p> <ul style="list-style-type: none"> <li>- Engine</li> <li>- Transmission</li> <li>- CV</li> <li>- VTU</li> <li>- Fr Axle (Domestic)</li> <li>- Fr Axle (Export)</li> <li>- Tractor</li> </ul> <p>2. MES needs to send the equipment creation trigger to SAP after serial no. is generated in SAP</p>
8	Order Start	Advance serial no. Generation - Equipment creation trigger to SAP	PPC07	<p>MES needs to have the functionality to generate advance serial no for the next year</p> <p>Ex: In Dec- 2015, serial no. of January-2016 needs to get generated</p> <ul style="list-style-type: none"> <li>- This functionality can be activated only after approval from senior personnel and cut-off date is decided.</li> </ul>
9	Order completion	Production booking-(online declaration) Aggregate wise	PPC08	<p>1. MES needs to book the orders (Online declaration) at end of the line for following aggregates</p> <ul style="list-style-type: none"> <li>- Engine</li> <li>- Transmission</li> <li>- CV</li> <li>- VTU</li> <li>- Tractor</li> </ul> <p>2. Online declaration trigger from MES to SAP will be sent after rollout.</p>
10	Order Hold	Automatic order Hold	PPC09	<p>1. For Tractor order start at Docking line, MES needs to check the availability of Transmission &amp; Engine in MES system Buffer.</p> <p>2. In case relevant transmission or Engine is not available in MES System Buffer, MES needs to automatically HOLD the tractor order at Docking line and sequence will change automatically.</p> <p>3. MES will automatically assign the reason as Transmission / Engine shortage after HOLDING the order</p> <p>4. PPC needs to manually re-introduce the AUTO HOLD orders</p>
11	Order Hold	Manual order hold with reasons	PPC10	<p>1. Due to any other plant constraints, if the tractor plan / order sequence needs to be changed, PPC will manually HOLD the tractor order and assign a reason / Justification</p> <p>2. PPC needs to manually re-introduce the manual HOLD orders</p>



12	Report	Plan Vs Actual Report	PPC11	MES needs to consider the spill over quantity of previous day in calculating Plan of the current day for generating plan Vs Actual report
13	Report	Equipment Creation report-Aggregate wise	PPC12	Report template to be defined at the time of development and current report is required
14	Report	Online declaration report-Aggregate wise	PPC13	Report template to be defined at the time of development and current report is required
15	Report	Sequential schedule adherence report	PPC14	Report template to be defined at the time of development and current report is required
16	Report	Volume adherence report	PPC15	Report template to be defined at the time of development and current report is required

## 6.7. Detailed MES Functionality Matrix SAP (Open)

Interaction between MES and SAP is expected to be at a real time for all the MES to SAP reporting updates Order related data will be downloaded from SAP to MES at a defined frequency, which will be mutually discussed and agreed between SAP and MES during design phase.

S.no	Points	FRS ID	Requirements	Action required by
1	SAP equipment Creation Tractor	SAP01	<ul style="list-style-type: none"> <li>- Equipment Creation at docking stage (Engine &amp; Transmission nos. available)</li> <li>- SAP Status will be - AVLB</li> <li>- Equipment updation at EOL for Genealogy data</li> </ul>	SAP RFC to be developed 1. Equipment Creation 2. Equipment Updation
2	Production Booking Tractor	SAP02	MES to send Prodn Booking data to SAP auto (If QP is OK)	Available and are in use. Need to check compatibility for FD.



3	SAP equipment Creation for aggregates i.e. Engine, Transmission, VTU (Hydraulic Assy), PTCED	SAP03	Equipment Creation - Not required Prodn Booking - MES TO SAP Auto (if QP OK)	Action not required as - 1. Equipment creation not required 2. Production Booking as per S.No.2
4	BOM Download From SAP to MES	SAP04	Station level configuration to be done in MES by mfg team for further usage e.g. SOP, Error Proofing, Genealogy	Mapping of Part & station to be done in MES and owner to be identified

## 7. Reports Requirements

This section describes the reporting requirements needed to support the everyday use of the MES and to allow the MES to provide expected benefits to the user community.

Reporting capabilities can be divided into three main categories, defined as:

- **Operational Reports** - based on “near real-time” data from the live Production database, or from an offline historical database. This style of report’s time frame is kept to current day information.
- **Business Intelligence (BI) Reports** - based on data stored in the historical database. These reports typically span a longer, historical time period and draw their data using decision style analysis. Not in the scope of this project.
- **Dashboards** - reports are graphical views of near real-time, live production data to indicate overall work center, line, or plant status. These reports are usually tied to “key performance indicators” (KPIs) that allow direct assessment of the condition of the shop floor via a web browser.

MES needs to provide reports which can be selected based on the below mentioned criteria (wherever applicable)

- Quality gate
- Date
- Shift
- Part
- Model
- Line
- Station

List Of reports against the respective team of user is mentioned list,

Sr No	Functionality	FRS ID	Reports Required
1	Maintenance Management	MMRP 01	Down time report
		MMRP 02	Preventive maintenance status
		MMRP 03	Maintenance spear consume data
		MMRP 04	Andon interface
2	Production Process	MMPP 01	Traceability and Genealogy
		MMPP 02	Line plant display. Which will provide real time WIP information.
		MMPP 03	Production schedule adherence Plan Vs. Actual
		MMPP 04	Real time visibility to WIP for sub assembly and Aggregates
		MMPP 05	Real time Work in Process & Tracking of Sequence.
		MMPP 06	Vehicle details on schematic Dashboard like serial number, quality status, POKA YOKE adherence, Tightening & torqueing information,
		MMPP 07	Real time RPH/LPH
		MMPP 08	Model wise inventory (RFD,WIP)
		MMPP 09	History card at the end of assembly
3	Quality management	MMQP 01	QP & Rework data
		MMQP 02	Buy Off WIP Status

## 8. Master Data Requirements

For the above mentioned requirements mentioned in various sections system requires inputs form the users which is termed as Master data configuration.

The list of master data configuration is required by the system against the respective team is mentioned in the below table.

Sr No	Functionality	Master Data Required
1	Associate Management	1. Employee Registration:
		2. Training Master
		3. Training Master
		4. Critical Station Configuration:
		5. Operator skill set association
		6. Station Allocation
		7. Shift configuration will provide the ability to configure timings of the shift by shop
2	Maintenance Management	1. Critical Machines list
		2. Critical Machines to line mapping
		3. Critical Machines configuration
		4. Critical Machines alarms configuration
		5. PM schedule maintenance
		6. CLITA schedule
		7. TBM schedule
		8. CBM schedule
3	Quality Management	1. Quality Poka Matrix
		2. Station wise defect list and checklist configuration
		3. Common Deviation Directory
		4. Station wise defect corrective action configuration
4	Production Process	1. SOP for all required stations
		2. Build sheet configuration data
		3. Serial number generation logic for all shops
		4. Station wise BOM & new Variant configuration

Note: Kindly note that there may be addition or deletion in the above mentioned list based on the system requirements during the design face.

## 9. Open Points and Required Actions

During the FRS Work Shop 8<sup>th</sup> July 2015 to 11<sup>th</sup> July 2015 the below mentioned points were not concluded.

Discussion Date	Points	Target Date	Responsible	Remarks
02-Jul-15	- Process for calculating the down time report has to be confirmed (OEM PLC IP Details,	27-07-2015	Mr.Uma	
02-Jul-15	- Control cabling for all the OEM PLC and data collection protocol has to be confirmed	01-12-2015	Mr.Venugopal	During Installation phase
02-Jul-15	- ANDON data requirement has to be discussed		Maintenance	Data to come from OEM plc to MES for reporting only
02-Jul-15	- Order upload and child order creation in MES process has to be discussed		PPC	
02-Jul-15	- Spare order creation and spare manufacturing process has to be discussed		PPC	
02-Jul-15	- BOM / MBOM creation process in the MES has to be discussed		PPC	
02-Jul-15	- As a requirement from the PPC team the part quantity with the SAP has to be discussed.		PPC	
02-Jul-15	- SAP back flush shop wise or plant wise has to be discussed		PPC	
03-Jul-15	- Process to collect the data from the VTU & CV test bed has to be confirmed - Currently the OEM Machine is storing the data locally in the PC (MS ACCESS)	NA	Mr.Uma	OK/NOK to be taken from PLC
04-Jul-15	- Production booking points for transmission and engine has to be discussed.		Production	Before loading the aggregate for docking
04-Jul-15	- Engine test bed data collection has to be finalised (Data base to Data base transfer)	NA	Mr.Uma	- OK/NOK to be taken from Engine Test bed and all DC tools - For DC tools MES will collect the data from Line PLC
08-Jul-15	-Poka matrix working to be discussed (Station wise defect list)	25-07-2015	Mr. Sharad	Data to be collected from quality
08-Jul-15	-Master data configurations and ownerships to be discussed - SOP for all required stations - Build sheet configuration data - Serial Number generation for all shops	27-07-2015	Mr. Binod	List of all the required master data has to be prepared by Venu and sent the user by 14-07-2015

09-Jul-15	Tractor group parent parts to be discussed		Mr. Bharat	To be
09-Jul-15	Barcode printing full proof to be done by M&M			
09-Jul-15	All the barcodes coming from vendors as subassembly parts to be validated			Completed
09-Jul-15	2D barcodes for Piston Assembly to be checked			
09-Jul-15	Common deviation directory		Binod	To be addressed in Master data list
09-Jul-15	Network availability for export shed for final QP station		M&M	Available
09-Jul-15	Serial number generation to be done in SAP - Confirmation from Senior management has to be taken regarding the risk involved in this process. - Risk involved Network Link between plants will becomes very critical as SAP becomes real time system - If network link between plants are slow or down - Line will stop	17-07-2015	Mr. Laxmikant	
09-	Integration with attendance system	17-07-2015	Mr. Laxmikant	Will be addressed after the skill matrix management point
09-Jul-15	PPC procedure for Kanadvali to be confirmed		PPC	To be discussed during the Kandhvali implementation
09-Jul-15	List of critical machine to be collected for ZHD plant (A and B Critical)	15-07-2015	Mr. Uma	Only A type and B criticals are included in MES, List to be collected
09-Jul-15	CBM/TBM alarms communication to be established with MES		M&M	
09-Jul-15	Hardware for CBM/TBM/CLITA is open point this is to be planned in different budget		M&M	
10-Jul-15	Energy meter data to be collected from meters to be checked		Mr.Venugopal	Auto or Manual data entry to be confirmed by M&M
10-Jul-15	Air management, water management, fuel management , oil management meters list to be provided by M&M	10-07-2015	Mr. Uma	All the data will entered manually in the system
10-Jul-15	GRI 11 parameters day wise to be collected form M&M	27-07-2015	Mr. Santosh	Work flow to be collected from Mr.Santosh
10-Jul-15	Skill matrix management system, Scope is in MES or IT has to finalized	17-07-2015	Mr. Laxmikant	- Line stop interlock required for wrong operator remarks from Mr. Krishnan - Operator has to scan the ID card in the station for

confirming.

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