Capacity Analysis Report (CAR)

User Guide

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INTRODUCTION

This manual is intended to assist in navigating the Plastic Omnium Lighting Company (POL) Capacity Analysis Report (CAR) for New Model Launch Capacity, as well as post launch capacity change, including capacity extensions. Significant updates are highlighted in blue italics. POL requires that supplier sites demonstrate their ability to satisfy POL volume requirements (CPV Capacity Planning Volume and Maximum Peak Volume) and report them as the deliverable of the PPAP.

POL utilizes Overall Equipment Effectiveness (OEE) to assess the risk associated with the supplier's plan to demonstrate capacity requirements, as it incorporates three key manufacturing performance elements (Equipment Availability, Performance Efficiency, and Quality Rate).

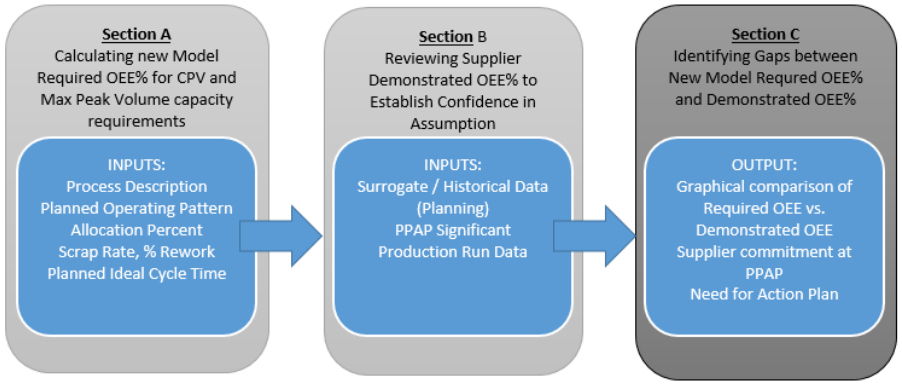
The CAR Form is a Microsoft Excel file containing the following 3 sheets:

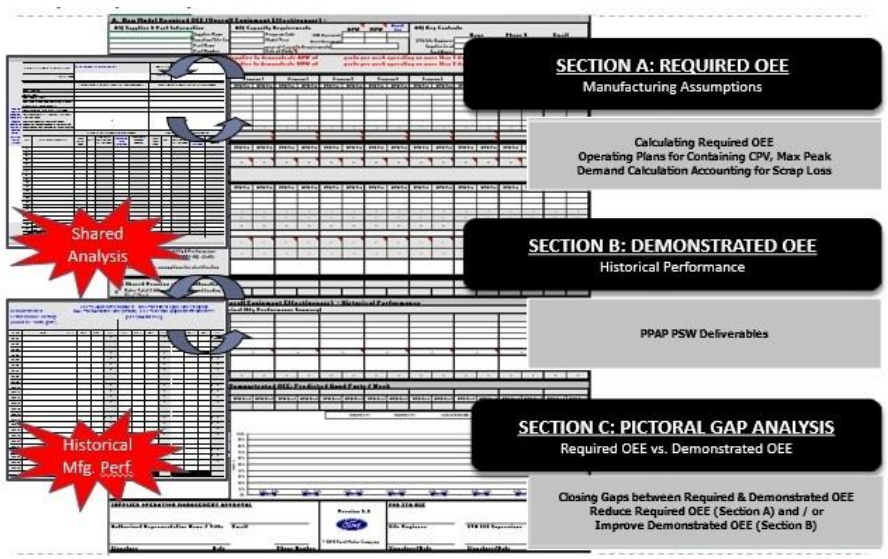
Sheet	Purpose
Shared Loading Plan	A sheet that must be completed for any shared processes – whether the process contains POL parts exclusively or a mix of POL and non-POL parts. Calculates minimum required allocation adjusted for Demonstrated OEE for new model part and total percent allocation for processes. The calculations within the sheet use historical/surrogate long term Demonstrated OEE to ensure that the total book of business within the specific process for sustainable OEE is not oversold and that the allocation percentage entered on Cap Ver sheet is valid. Note: for complex shared loading Detailed Shared Loading tool is used instead. Detailed Shared Loading is submitted in different files as it are not included in the CAR.
Historical Mfg Performance	A sheet for calculation of Demonstrated OEE for the intended or similar processes. The main output from the Historical Mfg Performance sheet is the calculation of Average OEE values for each process based on sustainable historical data. Additionally, to build confidence in the supplier's performance data, the sheet also charts the OEE values to identify trends. Suppliers may supplement the Historical Mfg Performance sheet with a comparable analysis using their own form, provided it is acceptable to POL SQD.
Cap Ver	Assesses capacity risk by comparing new model Required OEE to Demonstrated OEE from R@R.

Any CAR submission must include the following sheets:

1) *Cap Ver*
2) *Shared Loading Plan for shared processes*
3) *Historical Manufacturing Performance with updated OEE for all processes*

The objective is: *Demonstrated OEE must be greater than or equal to Required OEE.*





- Section A computes Required OEE.
- Section B computes the Demonstrated OEE.
- Section C compares the Required OEE (Section A) to the Demonstrated OEE (Section B) to determine if there is a capacity gap requiring an Action Plan.

Each of the main sheets includes three sections. **Section A** is for Required OEE. **Section B** is for Demonstrated OEE, and **Section C** is for Gap Analysis.

SETTING UP A CAR

- **Determining Single Value Streams for CAR Form:**

We need a CAR for each single Value Stream:

The CAR Form considers downstream in-process scrap losses to give the best available estimate of upstream volume requirements. As such, the processes must be entered in a single value-stream process flow.

For example, in the following process flow, we would need 2 CARs linked between them:

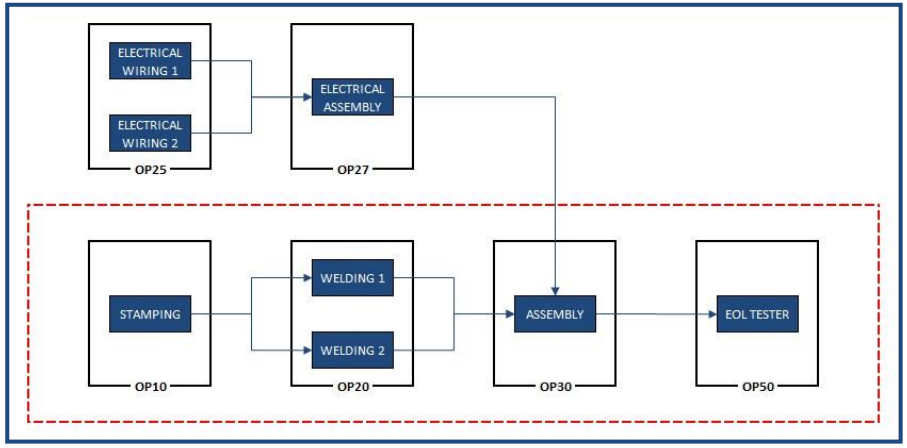
CAR 1)

A single Value Stream would consist of [OP10] Stamping, [OP20] Welding, [OP30] Assembly, and [OP50] End Of Line (EOL) Tester (Red dotted box).

CAR 2)

[OP25] Electrical Wiring, and [OP27] Electrical Assembly are introduced to the process at assembly, and require using another completed CAR file using appropriately adjusted capacity requirements values to link the CARs.

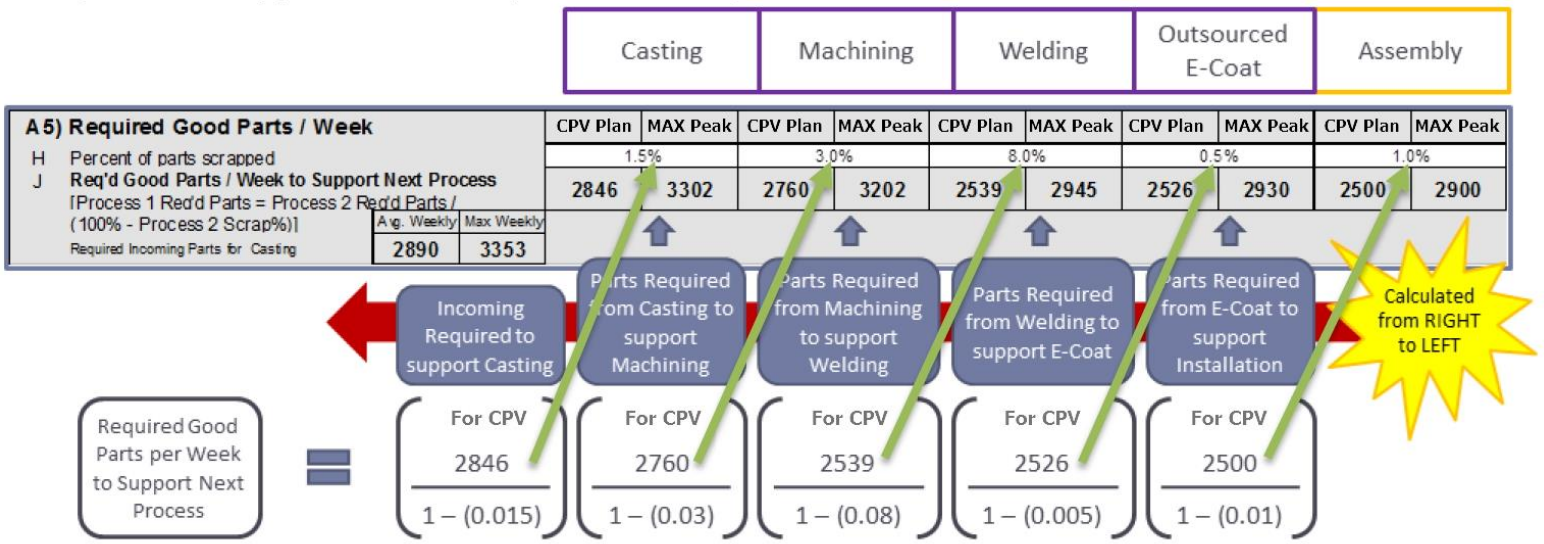
In this case, the **CPV/Max Peak used for CAR 2)** would be **the Required Good parts for OP20 from CAR 1)** *(Section A5- row J)*, to ensure we cover the scrap of the OP 30 and OP 50. (See following sections for more detailed explanation).



- **In-Process Scrap Loss Considerations**

Each process's scrap loss affects the subsequent process, compounding through the overall manufacturing value stream. The in-process scrap loss calculation is included and the individual process Required OEEs are calculated based on these unique value stream volume requirements. The only known good part requirement – POL's weekly demand CPV and Max Peak volume is the requirement of the final process in the analysis. As a result, the unique value stream volume requirements must be calculated in reverse (starting with the capacity requirements at the end of the line), as depicted in the graphic below (In-Process Scrap Loss Considerations).

In the example, the POL capacity requirement is 2,500 units per week at CPV. Considering the 1.0% scrap loss experienced in the final operation, "Assembly," the previous process, "Outsourced E-Coat," is required to produce 2,526 units per week at CPV [2,500 units ÷ (1-(0.01))], or 1% more than 2,500 to compensate for the 1% scrap loss during the final process. Each process's scrap loss increases the material required to support the subsequent process. The scrap loss values are shown with the arrows below.



- **Manual Linking of Multiple CARs:**

Manufacturing operations are typically grouped by similar cycle times and by types of manufacturing processes into a single process group on the CAR Form.

Manual Linking of Multiple CARs where there is more than one Value Stream

As described in "*Determining Single Value Streams for CAR Form*" section, same applies where we have parallel process flows converging in a process. In this case, the main value stream goes into a CAR and the other value streams need to be linked to it. The CPV/Max Peak Volume form these secondary value streams will be the Required Good Parts coming from the main CAR for the process previous to the converging process. With the way we cover the downstream scrap.

IMPORTANT: If a process step is outsourced, unless it is the first process that can be considered as incoming part, the process step needs to be placed in the CAR, it cannot be performed separately, to properly take into account all scrap losses for the previous processes.

GROUPING A FAMILY OF PATS INTO A CAR

We have the option to perform a single CAR for a family of parts when **all process steps and cycle times are the same**. In this case, the CAR CPV/Max Peak volumes need to consider all individuals references CPV/Max Peak volume.

We do not recommend to group parts when we have different changeover times as calculation can get complicated (weighted average needed) and CAR result may not reflect the reality.
The changeover time and frequency (G1 & G2) for each process needs to consider all individuals changes.
Even if the process is dedicated for the family of parts, the changeovers still needs to be considered.
In case that the process is shared with other parts, then the Shared loading plan is needed and the family of parts has to be grouped in one row.

In Notes section, it needs to be included the commitment for each part number, aligned with the PSW.

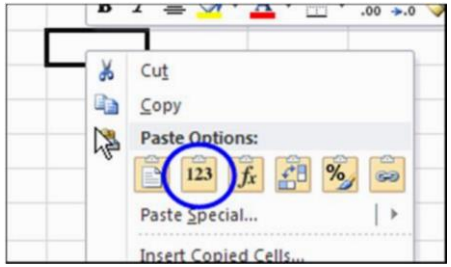
CAR COLOUR CODES OVERVIEW

Cells are highlighted in different colors to prevent many errors and advise user about data incongruences & risks to be analyzed:

WHITE & ORANGE: are the input cells. ORANGE indicates the cell needs data. **A CAR must not be approved with ORANGE**.
YELLOW: data to be reviewed. There is a potential capacity risk that **needs to be evaluated prior to CAR approval**.
RED: cells have no proper data or there is Capacity Issue. **A CAR must not be approved with any RED**.

GREY: cells are generally protected in the CAR Form, because those cells contain calculations and text which are not to be overwritten by the Capacity Planner unless otherwise noted. Conversely, the non-grey-shaded cells in the body of each worksheet remain unprotected and are to be populated as appropriate.

As White & Orange cells are not protected, conditional format can be removed with copy-paste option, in this case the title of the row or column will still show the warning color.
To ensure the conditional formats are working properly is highly recommended to paste only the values.



HISTORICAL MANUFACTURING PERFORMANCE

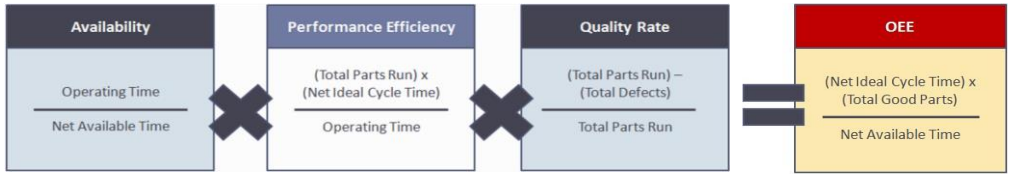
The **Historical Mfg Performance** sheet calculates the **Average OEE** of each process, **considering ALL parts produced in the process from all customers**.

It needs to be updated to check OEE evolution and sustainability

For the Cap Ver, the average OEE from Historical Mfg Performance is used to compare it with the Demonstrated OEE from the runs (Section B4), to check sustainability of OEE and Demonstrated Capacity (Section C)

For **shared processes**, it is used in the "Shared loading Plan" sheet to calculate the minimum allocation for each part and the total process allocation.

The calculation for OEE is based on Availability, Performance Efficiency, and Quality Rate, as follows:



The above formula can be simplified to require only **three inputs**:

GPP: **Total Good Parts *Produced*** *(number of good parts produced through a process in a week, considering all products (POL & non-POL) produced in the process)*

***NICT**: **Net Ideal Cycle Time** (seconds / part of the specific surrogate process – consider the number of tools or machines in parallel and the number of identical parts produced per cycle).*

*When we have parts with different cycle times in the same process, to properly calculate the weekly OEE, it is needed to calculate the weighted cycle time for each week (an "average" cycle time taking into consideration the volumes produced for each part). To help the calculation, please refer to the "**Weighted Cycle Time**" excel file.*

NAT: **Net Available Time** (hrs/week). NAT needs to consider the complete operating pattern (includes all POL and other customer part numbers produced at the process), and only deduct the contractual planned downtime and the unscheduled time because lack of demand.

NAT needs to include all stoppages (unplanned and planned) during the working time: breakdowns, downtimes due to internal & external factors, changeovers, maintenance performed during the working pattern, etc.

YELLOW: NAT > 144 hours (24 hours x 6 days)

The "Historical Mfg Performance" sheet requires the input of the above three characteristics for each process for 25 data points, which, will generate OEE data. The 25 data points should be 25 weeks. The resultant OEE for each data point is then averaged to be used for Capacity calculations.

When using surrogate performance data for capacity planning analysis of **new manufacturing sites, processes and technology**, an assessment of data integrity must be completed based on:

1. Part and process design complexity
2. Manufacturing value stream impact
3. Potential confounding variables such as: manpower allocation, historical ramp up lead time, technical resources, etc.

Surrogate data should be replaced with actual manufacturing run data, as they become available during the industrialization process from tool tryouts, tooling buyoff, and prove out runs to reassess to validity of the capacity plan

In the case where the supplier calculates Average OEE with a different method, not allowing to place the requested 25 sets of data in the Historical Mfg Performance sheet, then the supplier is required to include supporting documentation to demonstrate the calculation method used.

The data used to populate the "Historical Mfg Performance" sheet should be actual production data, obtained from production logs or production boards. The integrity of the data is of paramount importance for the successful analysis of sustainable Surrogate OEE.

OEE is automatically calculated.

Remember that for shared process OEE calculation, Net Available Time must include changeovers and production of all parts manufactured in the process.

YELLOW: Weekly OEE lower than Required OEE. Sustainability of Average OEE needs to be evaluated.

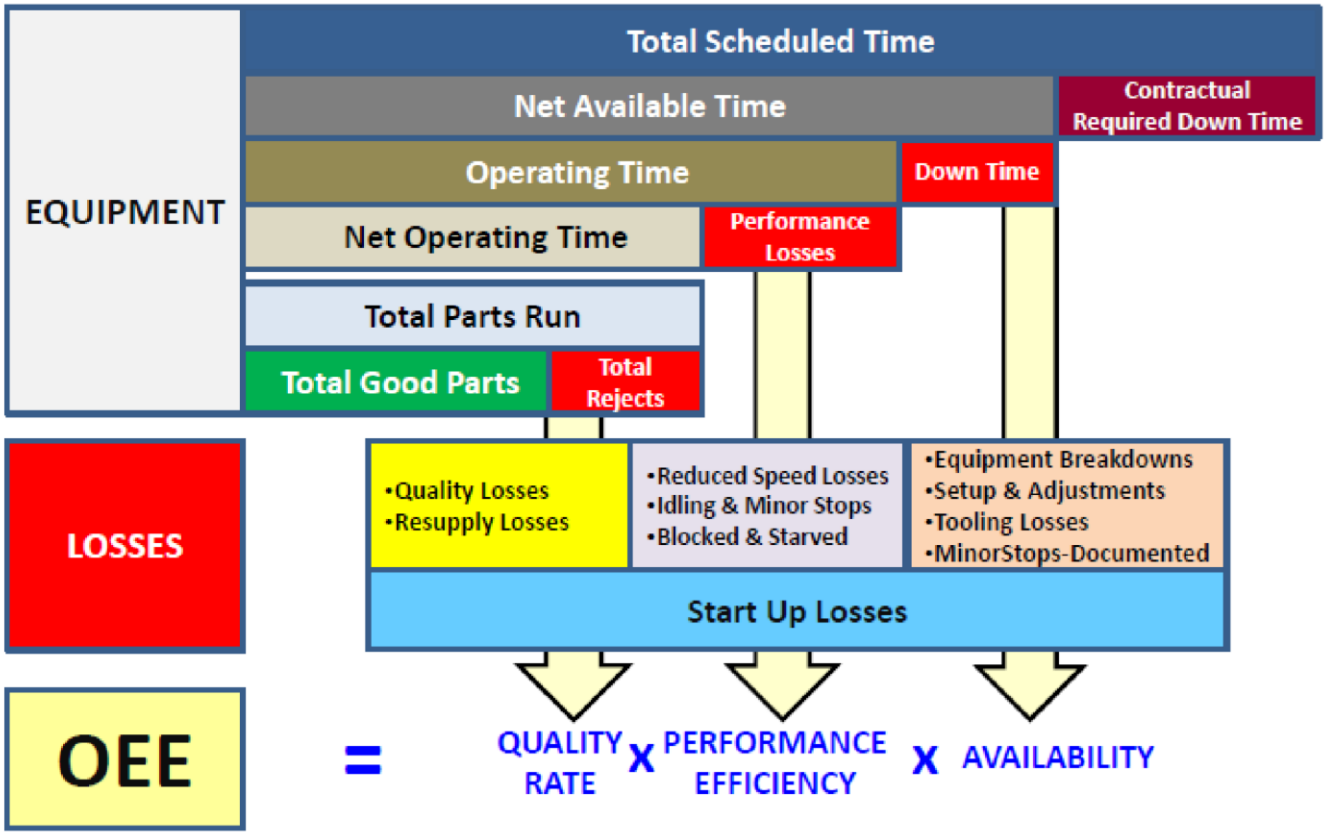
RED: OEE> 100%. A calculated OEE value for a single data point cannot be greater than 100%, as an actual OEE over 100% is physically impossible. Should a data point reflect such error, there is likely confusion about the NICT for the process, or the NAT is understated. Inputs should be raw data, rather than data adjusted for supplier's efficiency loss expectations.

Average OEE will not be calculated if any of the OEEs is higher than 100%, as it indicates that OEEs are not properly calculated

"**Required OEE**" will be automatically displayed from the corresponding sheet.

Historical Mfg Performance sheet performs an evaluation of each process' data to generate the following:

1) **Average OEE**, which is used for comparisons with Required OEE and with the Demonstrated OEE from the runs; also it is used for the Shared processes to calculate the corresponding allocation.
2) **Trends in the OEE**, graphed by process, to identify the stability of the production data and potentially identify inconsistencies.



Demonstrated Performance History (could be surrogate)

GPP = Good Parts Produced NICT = Net Ideal Cycle Time (sec/part) NAT = Net Available Time (hrs/wk) OEE = Overall Equipment Effectiveness [GPP/(NAT/NICT)]

WK#	Date	GPP	NICT	NAT	OEE	GPP	NICT	NAT	OEE	GPP	NICT	NAT	OEE	GPP	NICT	NAT	OEE	GPP	NICT	NAT	OEE	GPP	NICT	NAT	OEE
WK1					-				-				-				-				-				-
WK2					-				-				-				-				-				-
WK3					-				-				-				-				-				-
WK4					-				-				-				-				-				-
WK5					-				-				-				-				-				-
WK6					-				-				-				-				-				-
WK7					-				-				-				-				-				-
WK8					-				-				-				-				-				-
WK9					-				-				-				-				-				-
WK10					-				-				-				-				-				-
WK11					-				-				-				-				-				-
WK12					-				-				-				-				-				-
WK13					-				-				-				-				-				-
WK14					-				-				-				-				-				-
WK15					-				-				-				-				-				-
WK16					-				-				-				-				-				-
WK17					-				-				-				-				-				-
WK18					-				-				-				-				-				-
WK19					-				-				-				-				-				-
WK20					-				-				-				-				-				-
WK21					-				-				-				-				-				-
WK22					-				-				-				-				-				-
WK23					-				-				-				-				-				-
WK24					-				-				-				-				-				-
WK25					-				-				-				-				-				-
	AVERAGE OEE				-				-				-				-				-				-
	REQUIRED OEE																								

Data has to be updated for each Phase: from most recent production runs.

There must be enough data available to be representative (25 sets)

To include only Good parts (from all products produced in the process)

For shared process with parts with different cycle times, Weighted Cycle Time has to be calculated for each week.

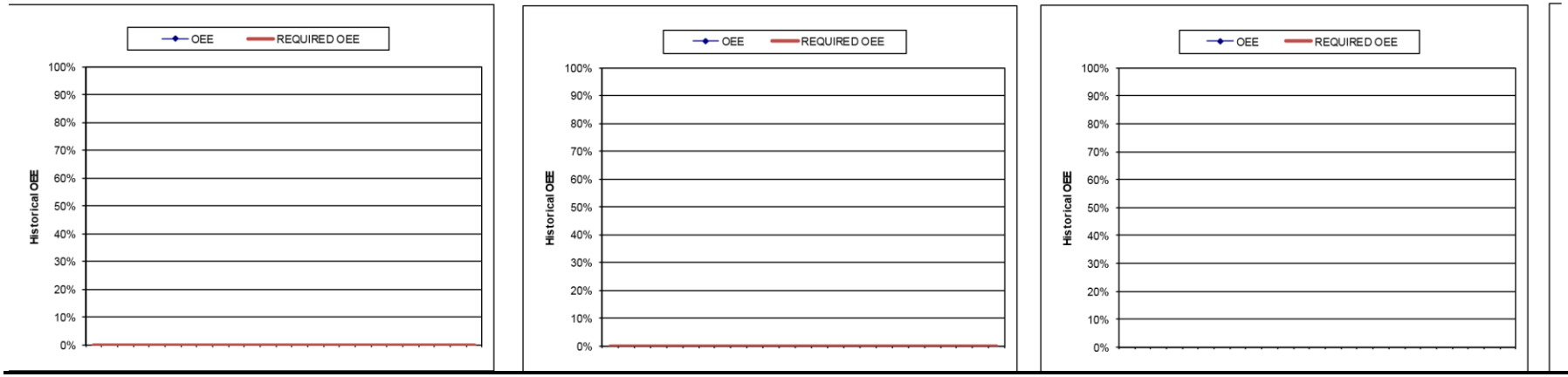
For shared process OEE calculation, Net Available Time must include changeovers and production of all parts manufactured in the process.

YELLOW colour: OEE lower than Required OEE
RED colour: OEE> 100%

NAT needs to consider the complete operating pattern (includes all Ford and other OEM part numbers produced at the process), and only deduct the contractual planned downtime and the unscheduled time because lack of demand.
NAT needs to include all stoppages: breakdowns, downtimes due to internal & external factors, changeovers, maintenance performed during the working pattern, etc.

YELLOW colour: NAT > 144 hours (24 hours x 6 days)

Average OEE will not be calculated if any of the OEEs is higher than 100%, as it indicates that OEEs are not properly calculated



SHARED LOADING PLAN

A Shared Loading Plan is needed for each process when in addition to the analyzed part, more parts are or will be manufacturing in the process. It calculates the minimum allocation required for each part and total process allocation, to ensure process is not oversold.

It needs to be updated for each phase.

All parts that will be produced in the shared process, during the production period of the model year analyzed, need to be included in the Shared loading.

If there is more than one process that is shared, the corresponding process on the "Shared Loading Plan" sheet must be completed for each shared process. Eight shared loading processes are available in the worksheet.

In the top of the "Shared Loading Plan" sheet, data should match the **operating patterns** detailed in Section A of the Cap Ver analysis sheet (including Days / Week, Shifts / Day, and Contractual Planned Downtime).

To complete a "Shared Loading Plan" in the CAR for a process, the following information is required:

- **Required Good Parts per Week** volume information for the specific process, along with the **NICT** (Net Ideal Cycle Time), for all parts (POL and non-POL) that are planned for production on the specific process (accounting for downstream scrap losses)

- **Average Demonstrated OEE** from most recent sustainable production performance data (including all parts produced in the process).

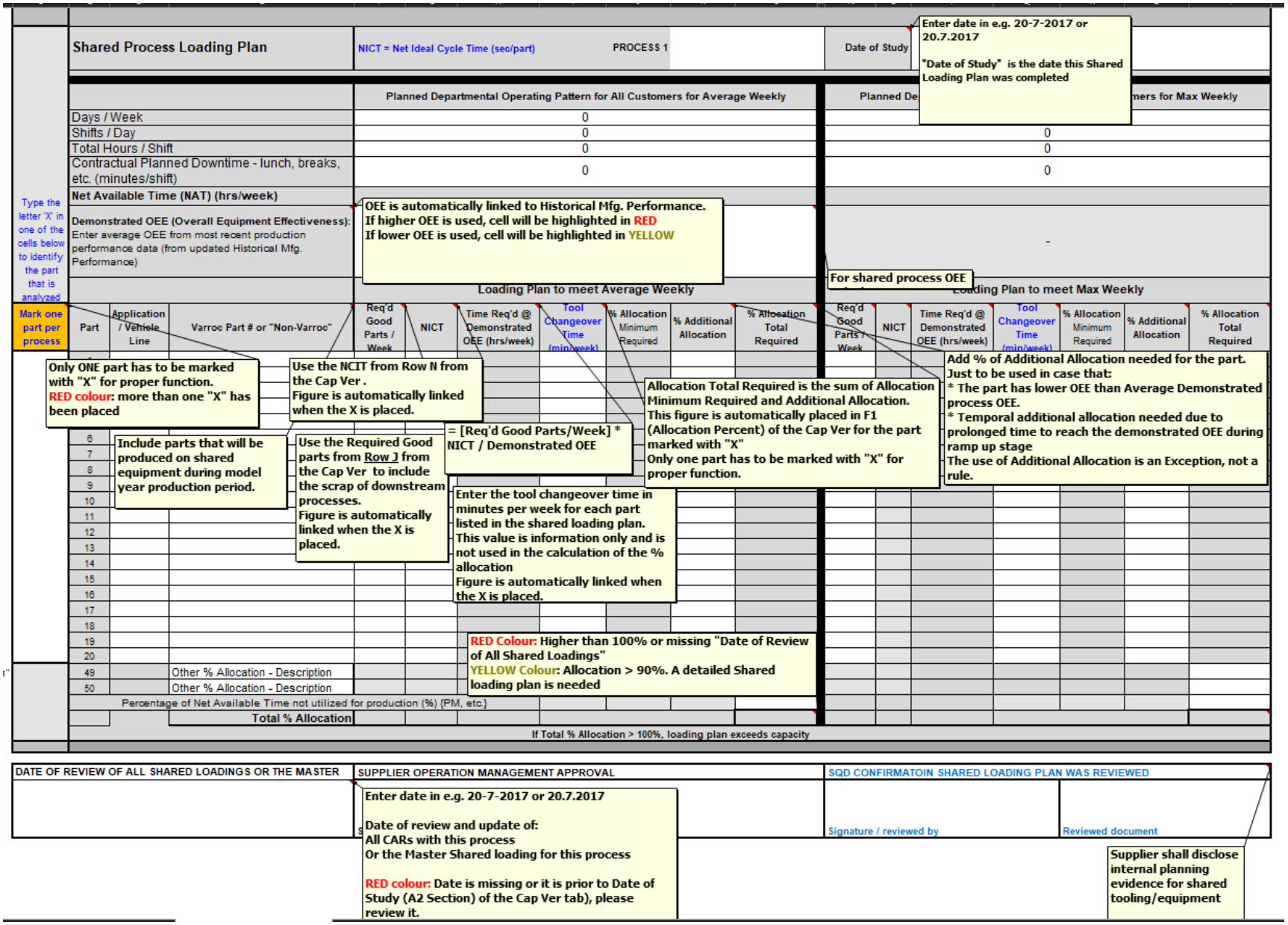
For **Required Good Parts / Week**, the same methodology used for calculating Row J on the Cap Ver analysis sheet should be used, incorporating in-process scrap loss. (See *Section A5* for more details)

Likewise, the **NICT** should be transferred from Row N of the Cap Ver analysis sheet. When transferring NICT information, the number of tools or machines in parallel and the number of identical parts produced per cycle must be considered (Rows L and M from the analysis sheets). (See *Section A6* for more details)

The **Average Demonstrated OEE** is automatically transferred from *Historical Manufacturing Performance*, but can be overwritten. It should be only overwritten when we expect the process to have lower OEE than the Historical / Surrogate OEE (for example due to complexity of new part or process). When the OEE is overwritten, the cell will be automatically highlighted:

YELLOW: OEE lower figure than in the Historical Manufacturing Performance

RED: OEE higher figure than in the Historical Manufacturing Performance


Shared Process Loading Plan
NICT = Net Ideal Cycle Time (sec/part)
PROCESS 1
Date of Study
Enter date in e.g. 20-7-2017 or 20.7.2017
"Date of Study" is the date this Shared Loading Plan was completed
Planned Departmental Operating Pattern for All Customers for Average Weekly
Days / Week
Shifts / Day
Total Hours / Shift
Contractual Planned Downtime - lunch, breaks, etc. (minutes/shift)
Net Available Time (NAT) (hrs/week)
Demonstrated OEE (Overall Equipment Effectiveness): Enter average OEE from most recent production performance data (from updated Historical Mfg. Performance)
OEE is automatically linked to Historical Mfg. Performance.
If higher OEE is used, cell will be highlighted in RED
If lower OEE is used, cell will be highlighted in YELLOW
For shared process OEE
Type the letter 'X' in one of the cells below to identify the part that is analyzed
Loading Plan to meet Average Weekly
Loading Plan to meet Max Weekly
Mark one part per process
Part
Application / Vehicle Line
Varroc Part # or "Non-Varroc"
Req'd Good Parts / Week
NICT
Time Req'd @ Demonstrated OEE (hrs/week)
Tool Changeover Time (min/week)
% Allocation Minimum Required
% Additional Allocation
% Allocation Total Required
Only ONE part has to be marked with "X" for proper function.
RED colour: more than one "X" has been placed
Use the NCIT from Row N from the Cap Ver .
Figure is automatically linked when the X is placed.
= [Req'd Good Parts/Week] * NICT / Demonstrated OEE
Allocation Total Required is the sum of Allocation Minimum Required and Additional Allocation.
This figure is automatically placed in F1 (Allocation Percent) of the Cap Ver for the part marked with "X"
Only one part has to be marked with "X" for proper function.
Add % of Additional Allocation needed for the part.
Just to be used in case that:
* The part has lower OEE than Average Demonstrated process OEE.
* Temporal additional allocation needed due to prolonged time to reach the demonstrated OEE during ramp up stage
The use of Additional Allocation is an Exception, not a rule.
Include parts that will be produced on shared equipment during model year production period.
Use the Required Good parts from Row J from the Cap Ver to include the scrap of downstream processes.
Figure is automatically linked when the X is placed.
Enter the tool changeover time in minutes per week for each part listed in the shared loading plan.
This value is information only and is not used in the calculation of the % allocation
Figure is automatically linked when the X is placed.
RED Colour: Higher than 100% or missing "Date of Review of All Shared Loadings"
YELLOW Colour: Allocation > 90%. A detailed Shared loading plan is needed
Other % Allocation - Description
Other % Allocation - Description
Percentage of Net Available Time not utilized for production (%) {PM, etc.}
Total % Allocation
If Total % Allocation > 100%, loading plan exceeds capacity
DATE OF REVIEW OF ALL SHARED LOADINGS OR THE MASTER
SUPPLIER OPERATION MANAGEMENT APPROVAL
SQD CONFIRMATOIN SHARED LOADING PLAN WAS REVIEWED
Signature / reviewed by
Reviewed document
Enter date in e.g. 20-7-2017 or 20.7.2017
Date of review and update of:
All CARs with this process
Or the Master Shared loading for this process
RED colour: Date is missing or it is prior to Date of Study (A2 Section) of the Cap Ver tab), please review it.
Supplier shall disclose internal planning evidence for shared tooling/equipment

The Shared Loading Plan sheet contains 8 tables, which align with 8 process groups. These 8 tables are linked by formulas to Section A of the Cap Ver sheet. **The formulas transfer "Total % Allocation" figures from tables of the Shared Loading Plan into Section A7 of the corresponding processes**. Note that the CAR Form is designed to reflect a single point in time. Therefore the previously recorded shared loading percentages will not be retained.

The capacity requirements entered into the Shared Loading Plan for each process must account for the planned downstream scrap losses.

Another feature of the *Shared Loading Plan* sheet is the **requirement to enter a letter "x"** into the leftmost column of any of the 8 tables that align with processes that requires shared loading analysis. The letter "x" is used to identify which of the parts (or part families) in the shared loading list is the POL part that is being analyzed in the CAR. Only one "x" is allowed for proper function.

Once the "x" is in place, the "Required Good Parts/Week", "NICT" and "Tool Changeover Time" will be automatically placed from Cap Ver sheet. The formulas are in unblocked cells; therefore user must be carefully to avoid deleting the formulas.

In addition, **"Allocation Total Required" for the part selected with the "x" will be automatically transferred to the corresponding phase into Section A4 (F1 – Allocation Percent)**

Additional rows to include more parts (up to 50) are available. Select rows 34 & 63, "right" click on mouse and select "Unhide"

Any other known allocation percentages (i.e., planned downtime for maintenance or other usage making the equipment unavailable for manufacturing, etc.) can be included in the "**Percentage of Net Available Time not utilized for production (%) {PM, etc.}**"cells.

Additionally, Tool Changeover Time should be entered to validate that all changeover times between parts in the same process are similar. Note that the input of tool changeover time on the Shared Loading Plan sheet does not impact the % allocation minimum required calculation.

The intention of the "Shared Loading Plan" is two-fold:

- First, it validates the allocation percentage for the process, adjusted for the Demonstrated OEE.
- Second, it validates that the equipment / process is not oversold considering the total book of business on each process.

If the "Shared Loading Plan" indicates that the supplier's plan does not have enough allocation provided to the POL part number of the analysis, an action plan should be developed to resolve the discrepancy. Opportunities to resolve the gap, in no particular order, may include:

- [Preferred] Improve the Demonstrated OEE for the -shared process, since the Demonstrated OEE performance data is used to adjust the "% Allocation, Minimum Required" value;
- Reduce the Net Ideal Cycle Time required (also must be adjusted in Section A);
- Increase the Allocation Percent for the corresponding part, adding allocation in the column **"% Additional Allocation"** .

  The use of Additional Allocation is an Exception, not a rule. Just to be used in case that:
  - Due to specific characteristics/ complexity, the part has lower OEE than Average Demonstrated process OEE
  - Temporal additional allocation needed due to prolonged time to reach the demonstrated OEE during ramp up stage

  It is undesirable to have a "% Allocation, Minimum Required" that is significantly less than the Allocation Percent (F1) from Section A. Essentially, such a condition indicates that the supplier's plan is giving too much allocation to this POL part – which could have potential commercial implications.

When the "**Total % Allocation**" from a shared process is **higher than 90**%, a **Detailed Shared Loading Tool is needed** to further evaluate the potential risk and ensure robustness of the capacity plan.

YELLOW: Allocation > 90%. A detailed Shared loading plan is needed.

RED: Higher than 100% or missing "Date of Review of All Shared Loadings"

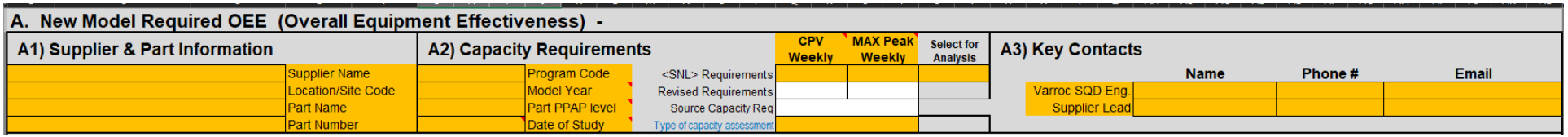
The "**Date of review of All Shared loadings or Master**" is mandatory to ensure all shared loadings are up to date. If it is missing or prior to the date of the Cap Ver, the *Section A2* from the corresponding phase will be highlighted in RED.

When we have many parts in a Shared process, it is highly recommended to have a "Master Shared loading" that will be maintained up to date and will be the reference every time a CAR update is done for any part included in the process.

"SQD Confirmation Shared Loading Plan was reviewed" Supplier shall disclose internal planning of toll/equipment as an evidence for sharing of toll/equipment.

SECTION A: New Model Required OEE

Cap Ver (Capacity Verification)



A. New Model Required OEE (Overall Equipment Effectiveness) -										
A1) Supplier & Part Information		A2) Capacity Requirements			CPV Weekly	MAX Peak Weekly	Select for Analysis	A3) Key Contacts		
									Name	Phone #	Email
	Supplier Name		Program Code	<SNL> Requirements							
	Location/Site Code		Model Year	Revised Requirements				Varroc SQD Eng.			
	Part Name		Part PPAP level	Source Capacity Req				Supplier Lead			
	Part Number		Date of Study	Type of capacity assessment							

A1 Supplier and Part Information

Enter supplier information and part information.

A2 Program and Customer Information

Enter program code / model year.

Enter the PPAP level for the part analysed from PPAP checklist

Enter the study date (date of the capacity analysis).

Enter weekly Capacity Planning Volume (CPV) demand. Number of weeks to calculate weekly CPV from annual CPV shall be stated in SNL, typically 47 weeks has to be used.

Enter Maximum Peak Weekly demand. 47 weeks has to be used to calculate weekly MAX Peak from annual Max Peak

Use the dropdown menu to identify which CPV and Max Peak values are to be used for analysis (mandatory selection).

For Revised requirements, enter the Source of Capacity Requirements

For capacity requirements info supplier should contact the POL Buyer to obtain the capacity requirements appropriate to the part.

For locating part number capacity requirements refer to Sourcing Nomination Letter or Capacity Studies.

Use the dropdown menu to select the Type of capacity assessment POL SQD on-side R@R or Self-assessment

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A3 Key Contacts

Enter key contact information.

A4 Planned Departmental Operating Pattern Net Available Time for All Customers

A4) Planned Departmental Operating Pattern & Net Available Time for All Customers		Process 1		Process 2	
		CPV Plan	MAX Peak	CPV Plan	MAX Peak
A	Process description/tool identification (in value stream order)				
B	Days / Week				
C	Shifts / Day				
D	Total Hours / Shift				
E	Contractual Downtime - lunch, breaks, etc. (min/shift)				
F	Dedicated or Shared Process				
F1	Allocation Percent (automatically displayed)				
G	Net Available Time (hours / week) [B*C*(D-(E/60))*F1]	-	-	-	-
G1	Planned Minutes per Changeover (into this part #)				
G2	Planned Changeover Frequency / Week (into this part #)				

This is to ensure that the Capacity Planner reconsiders the latest operating pattern assumptions.

A Process Descriptions/tool identification (in value stream order)

Enter process descriptions and tool identification in value stream order (sequential; in series).

B Days / Week

Enter planned number of days per week (departmental) for each process.

CPV must be contained within a 5-day operating pattern, otherwise, an acceptable deviation is required. If a value is entered greater than 5-days / week in the CPV column, the cell will turn **YELLOW**. If a value is entered greater than 6-days / week in the Max Peak column, the cell will turn **YELLOW**. Operating patterns outside of the 5-day CPV or 6-day Max Peak patterns signify the need for additional alignment between POL & the supplier.

C Shifts / Day

Enter planned number of shifts per day (departmental) for each process.

D Total Hours / Shift

Enter total hours per shift (departmental hours calculated from shift start to shift end) for each process.

E Contractual Planned Downtime – lunch, breaks, etc. (minutes / shift).

Enter contractually planned downtime minutes for lunch, breaks, etc. for each process.

F Dedicated of Shared Process

Select from Drop Box: "Dedicated" or "Shared"

"Dedicated:" process will be used exclusively for the part analyzed in this CAR. The Allocation % will be automatically placed in F1 as 100%

"Shared": more parts are or will be manufactured in the process during the production period of the model year analyzed. For shared processes, Allocation % includes changeover time into this part number

For each shared process (out of a maximum of 8 processes per CAR) a "Shared Loading Plan" must be completed. The Shared Loading Plan has a separate area for each of the 8 processes on the CAR main sheet. Note that when the value stream includes more than eight major defined processes, a 2nd CAR is required.

The Allocation % will be automatically placed in F1 once the Shared loading plan is done.

F1 AUTO-LOAD. Allocation Percent (automatically displayed) F1 figure is automatically displayed based on selection made in F:

Dedicated = 100%

Shared = Once the Shared Loading Plan is done and the **corresponding part is marked with "X"**; it will display the "% Allocation Total Required" for the selected part, from the Shared Loading Plan.

For proper function, only one "X" can be placed in the Shared Loading Plan. If the CAR is done for a family of parts, they need to be grouped in one row.

YELLOW: Selection in F row done as "Dedicated" but the Shared Loading Plan shows more parts manufactured in this process. Please check it and clarify it in the comment box.

RED: More than one "X" placed in the Shared Loading Plan. Please correct.

G **CALCULATED. Net Available Time** (hours / week)

RED: The working pattern (B, C, D or E) does not match with working pattern in the "SHARED LOADING" tab. Please check data and correct.

G1 **Planned Minutes per Changeover (into this part #)**

If the CAR document is being used for part families instead of specific, individual part numbers, changeover time must still be considered if applicable. During Capacity Planning, such changeover times may not be included in OEE calculations (as Historical/Surrogate OEE may have different changeover times), so the input of changeover in Rows G1 and G2 is used to consider the available time for changeover and other losses in section A6..

G2 **Planned Changeover Frequency / Week (into this part #)**

Enter the planned number of changeovers per week (this does not need to be a whole number).

Note: Changeover is considered unplanned (not contractual) downtime, consistent with OEE calculations.

A5 Required Good Parts / Week

A5) Required Good Parts / Week			CPV Plan	Max Peak	CPV Plan	Max Peak
H	Percent of parts scrapped					
J	**Req'd Good Parts / Week to Support Next Process** (Accounts for the scrap loss of each process)		-	-	-	-
		Avg. Weekly	Max Weekly			
	Required Incoming Parts for	-	-			

H **Percent of parts scrapped.**

Enter the percent of parts that would be expected to be scrapped through the specific process. This figure must be based on sustained, long term historical / surrogate performance, it is not a best case theoretical scrap rate

J **CALCULATED. Required Good Parts / Week to Support Next Process**.

For shared processed, Required Good parts for each process has to be used for Shared Loading Plan, as it contains the scrap of downstream processes.

For example, for Shared Loading of Process 1, we need to take the Required Good parts of Process1.

RED*: the Required Good parts in "SHARED LOADING" tab do not match with this row. Please check data and correct.*

Required Good Parts is automatically transferred into Shared Loading, but as the formulas are in unblocked cells, user must be carefully to avoid deleting them.

Similar applies to incoming parts: For sub-tiers, we should not use CPV/Max Peak volumes; we need to take into consideration the downstream scrap and consider the Required Good parts of the previous process of the incoming part usage.

For example, for incoming parts of Process 1, we need to take the "Required Incoming Parts". For incoming parts of Process 3, we need to take the Required Good parts of Process 2.

A6 Required OEE

A6) Required OEE (Overall Equipment Effectiveness)		CPV Plan	Max Peak	CPV Plan	Max Peak
K	Ideal Cycle Time per Tool or Machine (sec/cycle)				
L	# of Tools or Machines in parallel				
M	# of identical parts produced per Tool or Machine Cycle				
N	Net Ideal Cycle Time (sec/part) [K / (L*M)]	-		-	
P	Theoretical Parts per week at 100% OEE [G x 3600 / N]	-	-	-	-
Q	**Required OEE** [J / P]	**-**	**-**	**-**	**-**
R	Percent of parts reworked (re-run through process)				
S	Can process contain its changeover, scrap & rework assumptions? [Is J/(100%-H) + (JxR) + (G1x60xG2/N) <= P]	-	-	-	-
T	% Remaining for Availability & Performance Efficiency losses {P - [(J/(100%-H)) + (JxR) + (G1x60xG2/N)]} / P	-	-	-	-
	Enter any other assumptions for clarification (Process details and further clarifications)				

K Ideal Cycle Time per Tool or Machine (sec / cycle).

For processes with multiple stations / operations, use the ideal cycle time of the constraint operation. Further, the ideal cycle time is not the "engineering standard" including elements such as personal fatigue and delay, or other OEE losses. Ideal cycle times are the best times that are achieved and sustainable. Ask the question 'if the process ran perfectly and consistently, what is the time from the start of one cycle to the start of the next cycle?'

Ideally, the best way to represent each process is having each manufacturing operation separately represented as a "process" in the Capacity Analysis Report. However, in many cases, there are many more than 8 operations in a manufacturing line, therefore where operations are combined under one capacity analysis "process", it would be necessary to choose the constraint operation for combined operations under one "process".

L # of Tools or Machines in parallel.

Enter the number of tools, lines, or machines that are planned to produce parts concurrently for the specific process.

M # of identical parts produced per Tool or Machine Cycle.

Enter the number of identical parts that are produced per cycle (i.e., for a molding operation, does the mold have multiple cavities?)

N CALCULATED. Net Ideal Cycle Time (sec / part).

RED: the NICT in Shared Loading Plan sheet does not match with this row. Please check data and correct

P CALCULATED. Maximum Possible Parts / Week.

This cell calculates the maximum number of parts that are possible for production, given the Net Available Time (G) and the Net Ideal Cycle Time (N), all operating perfectly at the theoretical 100% OEE.

Q CALCULATED. Required OEE.

Specific to the individual process, the Required OEE is the OEE that must be achieved by the process to support the capacity requirements. The Required OEE is the minimum level of efficiency that is required to support the demand.

By definition, a Required OEE > 100% is not possible.

RED: Required OEE>100% or the NICT in Shared Loading Plan sheet does not match with N in the Cap Ver. Please check and correct

R **Percent of parts reworked (re-run through process).**

Only count in-line rework that is re-run through the process, since that rework is using manufacturing time that could have been used to make good parts the first time through. Do not count off-line rework. If off-line rework is significant, consider adding an additional process – elimination of all rework, insomuch as practical, must always be a manufacturing goal.

S **CALCULATED. Can process contain its own scrap, rework, and changeover loss assumptions?**

RED: Required # of Good Parts + Scrap + Changeover + Rework > Maximum Possible Parts, as will the cell below (T).

T **CALCULATED. % of Net Available Time (NAT) remaining for other availability and performance efficiency losses** (i.e., unplanned downtime). See further explanations in next page (Max. Possible Parts & Loss Considerations)

YELLOW: Remaining % for Availability and Efficiency losses is less than 10%. Please check OEE feasibility.

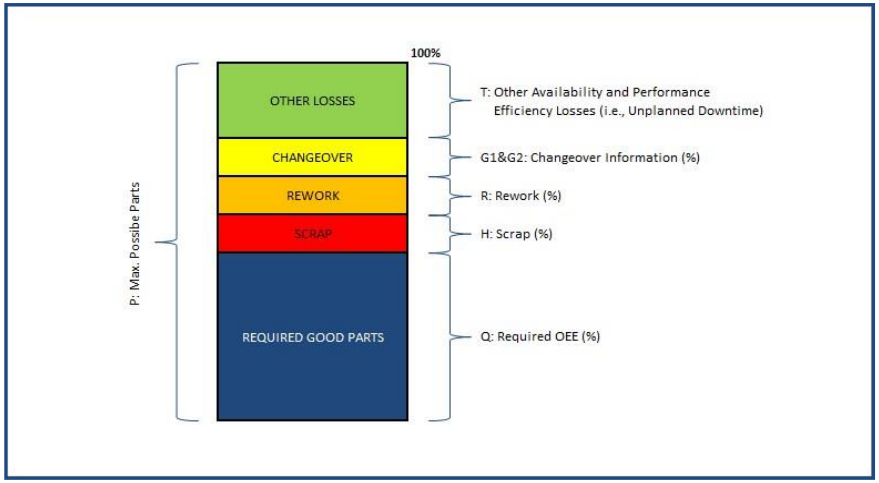
RED: OEE is not feasible, it cannot contain the changeover, scrap & rework.

***** **Enter any other assumptions for clarification.**

This cell is intended for text input that may clarify the information input in Section A. For example, if the process is utilizing tag-relief to avoid downtime, specify the bottleneck operation if we have a group of operations, the kind of machine, process details, etc. It can be documented here for clarification.

Note: Tag relief is where manufacturing is continuous without break due to operators taking over immediately a without stopping the manufacturing process.

Max. Possible Parts & Loss Considerations



NOTE: Maximum Possible Parts & Loss Considerations

The maximum possible parts (P), is the maximum parts possible given the operating pattern, allocation percentages, and cycle times assumed in Section A of the Capacity Planning document. The maximum possible parts value is based on 100% OEE – the value does not account for any losses. The capacity demand for a specific operation is the required good parts (J), which has a direct correlation to the Required OEE (Q). The relationship between the required good parts and maximum possible parts is the Required OEE.

Required OEE (Q) = Required Good Parts (J) ÷ Maximum Possible Parts (P).

A process may not be feasible if it cannot contain the Required OEE plus all loss assumptions. For example, if a process has a Required OEE of 82%, and it is known that the process is expected to have significant scrap and rework losses, the process may not be capable of containing the loss assumptions within the defined operating pattern. Further, each process should expect to have a varying amount of availability and performance efficiency losses, such as unplanned downtime, that will be identified by looking at surrogate data in Section B. If the surrogate / historical data shows consistent manufacturing times and quantities for all time periods, it is likely that the data will need to be investigated.

Maximum Possible Parts (P) ≥ ∑ [Required OEE (Q) + Scrap (H) + Rework (R) + Changeover (G1&G2)]

A7 Shared Process – Total Allocation Plan – Required for operations that are shared / cross loaded

A7) Shared Process - Total Allocation Plan	-		-	
U Total % Allocation from "Shared Loading Plan" Sheet				

U **AUTO-LOAD. Total % Allocation from "Shared Loading Plan" sheet** (note: this field is prepopulated from the "Shared Loading Plan").

YELLOW: Total Allocation is >90%, therefore a Detailed Shared Loading Plan is mandatory.

RED: Total Allocation is >100%

RED & "Check Shared tab" : Please check date in "SHARED LOADING", row 71

SECTION B: Supplier Demonstrated OEE – Run&Rate (Cap Ver)

B1 Equipment Availability

The amount of time the machine or process was available to be run compared to the amount of time that it was scheduled to run. Equipment availability cannot be greater than 100%, but may achieve 100%.

B. Supplier Demonstrated OEE - PPAP (Run&Rate)			
B1) Equipment Availability		-	-
V	Total Available Time (Include ACTUAL changeover time for		
W	Shared) (minutes) Planned Downtime - lunches/breaks/mtgs. (minutes)		
X	Net Available Time (minutes) [V - W]	-	-
Y	Shared Equip Changeover Time ACTUAL (minutes)		
Z	Shared Equip Changeover Time Weekly Scaled (minutes) [Y * (X / 60) / (G / G 2)]	-	-
AB	Observed Unplanned Downtime (minutes)		
AC	Operating Time (minutes) [X - Y - AB]	-	-
AD	**Equipment Availability [(X - Z - AB) / X * 100]**	**-**	**-**

V **Total Available Time** (include ACTUAL changeover time for Shared (minutes).

W **Planned Downtime** – lunches / breaks / meetings (minutes).

X **CALCULATED. Net Available Time** (minutes).

Y **Shared Equipment Changeover Time ACTUAL** (minutes).

Time used should be the amount of time to changeover INTO this specific part number. If changeover time is greater than planned (G1), row Z cell turns YELLOW. An action plan may be desired to close gap between plan and actual.

Z **CALCULATED. Shared Equipment Changeover Time Weekly Scaled** (minutes).
The changeover time used is based on the actual changeover time entered in Row Y.
YELLOW: Actual/Demonstrated Changeover Time (row Y) is significant lower or higher than planned (G1), please check the figure to ensure it is reflecting the real Changeover time.

AB **Observed Unplanned Downtime** (minutes).
Place any downtime not recorded in W

AC **CALCULATED.** Operating Time (minutes).

AD **CALCULATED.** Equipment Availability.
RED : One of the following issues

- Missing Change Over Time ACTUAL (Y) when there is a planned CHOT identified in Section A) (rows G1 & G2)
- Higher downtime (W+Y+AB) than Total Available Time (V). Please check operating time

---

B2 Performance Efficiency

Determines how closely equipment or process runs to its ideal cycle time. Performance Efficiency cannot be greater than 100%, but may achieve 100%.

B2) Performance Efficiency		
AE Total Parts Run (Good, Scrapped, & Reworked)		
AF Net Ideal Cycle Time (seconds/part) [N]	-	-
AG **Performance Efficiency (AE * AF / AC)**	**-**	**-**
AH "Availability" and/or "Performance Efficiency" Losses Not Captured (minutes) [AC - (AE * AF)]	-	-

AE **Total Parts Run** (Good, Bad, and Reworked).

AF **CALCULATED. Net Ideal Cycle Time** (seconds / part).

AG **CALCULATED. Performance Efficiency**.

AH **CALCULATED. "Available" and / or "Performance Efficiency" Losses Not Captured** (minutes).
Losses that are not captured indicate incomplete data collection methods, or problems with the raw data (may include downtime not captured, inaccurate cycle time, incorrect total available time, etc.).

B3 Quality Rate

The total number of good parts produced compared to the total number of parts run. Quality Rate cannot be greater than 100%, but may achieve 100% for zero scrap and rework.

B3) Quality Rate		#	%	#	%
AJ	# Parts scrapped		-		-
AK	# Parts Reworked		-		-
AL	**Quality Rate [(AE - AJ - AK) / AE]**	**-**		**-**	

AJ **# Parts Scrapped**
Percent Scrapped is calculated in the column to the right (# Scrapped / Total Parts).
YELLOW: Percent scrapped is greater than planned (H). An action plan may be desired to close gap between plan and actual.

AK **# Parts Reworked**
Percent Reworked is calculated in the column to the right (# Reworked / Total Parts).
Only count in-line rework that is re-run through the process, since that rework is using manufacturing time that could have been used to make good parts the first time through. Do not count off-line rework. If off-line rework is significant, consider adding an additional process – elimination of all rework, insomuch as practical, must always be a manufacturing goal.
YELLOW: Percent reworked is greater than planned (R). An action plan may be desired to close gap between plan and actual.

AL **CALCULATED. Quality Rate.**

B4 CALCULATED. Overall Equipment Effectiveness (OEE)

A measure of the ability of a piece of equipment or process to consistently produce a part which meets quality standards at the designed cycle rate without disruption.

B4) Overall Equipment Effectiveness (OEE)			
AM	**Phase 0 OEE [AD * AG * AL]**	-	-

AM **Phase 3 OEE (Scaled for Shared Process Changeovers)**

B5 CALCULATED. Process Specific Weekly Part Estimate

B5) Process Specific Weekly Part Estimate [P * AM]	-	-	-	-

The Process Specific Weekly Part Estimate is a calculation that takes into consideration the Maximum Parts Possible / Week (P) and adjusts it based on the demonstrated OEE. This cell is directly correlated to OEE – if the Process Specific Weekly Part Estimate is less than the required good parts / week, it is given that the Demonstrated OEE is also less than the Required OEE (C).

OVERALL PROCESS SPECIFIC WEEKLY PART ESTIMATE

- If all processes are assessed GREEN / OK, then refer to the last process in row B5.
- If any process is assessed RED / RISK or OEE > 100%, a capacity gap exists and the value in row B5 is not a reliable estimate.

B6 Observed Average Cycle Time (sec / part)

B6) Observed Average Cycle Time (sec/cycle)		

Collect 15-20 cycles and calculate average cycle time; used as confirmation that the cycle time continues to be production representative. For processes with multiple operations, use the constraint cycle time.

YELLOW: Observed Average Cycle Time is higher/lower than Planned NICT (N)

SECTION C: Gap Analysis – Required OEE vs. Demonstrated OEE

Section C is a graphical representation of capacity risk, showing the relationship between Demonstrated OEE and Required OEE. However, some subtle differences exist between the worksheets in the Predicted Good Parts per week area of Section C.

C CALCULATED. Gap Analysis - Required OEE vs. Demonstrated OEE; Predicted Good Parts / Week.

C. Gap Analysis - Required OEE vs. Demonstrated OEE; Predicted Good Parts / Week						
Process Description						
	CPV Result	Max Peak Result	CPV Result	Max Peak Result	CPV Result	Max Peak Result
Capacity Analysis Results						

Capacity Analysis Results: There are five possible outcomes for each process.

1) **"OK": Demonstrated OEE ≥ Required OEE. The individual process at CPV or Max Peak volume is OK given the inputs and demonstration data. Nevertheless, if any cell of the process is highlighted with YELLOW, the risks need to be evaluated.**
2) **"OEE>100": Required OEE or Demonstrated OEE is >100%, there is an error.**
   Required OEE cannot be greater than 100% (revisit Section A), nor can Demonstrated OEE be greater than 100% (revisit Section B).
3) **"RISK": Demonstrated OEE < Required OEE, the process is a capacity risk.**
   An Action Plan must be developed to resolve the capacity gap.
4) **"See Row U": Total allocation is not in place (the corresponding Phase needs to be selected in the Introduction Sheet) or Total allocation is higher than 100%**
5) **"See Row S": Process OEE cannot contain Changeover, Scrap & Rework assumption. Required OEE is not feasible to be sustained.**

Predicted Good Parts per Week:

Predicted Good Parts per wk	Average	Maximum
Required Capacity (CPV/MAX Peak)		
Demonstrated Capacity		
Commitment (APPC/MPPC)		

Planned / Demonstrated Capacity: All phases provide an estimate of the number of parts the entire process can produce based on the bottleneck process and associated downstream losses. They are calculated using the worst downstream scrap rate (from planned or demonstrated)

Capacity planning's estimate (Planned Capacity) is based on surrogate / historical data.

Cap Ver's estimate (Cap Ver Demonstrated Capacity) is based on the Significant Production Run results.

Capa Results": Capacity Analysis Results RED warning is not allowing to properly calculate Demonstrated Capacity.

"Missing Process Data": A process identified with data in A) Section has no data in B) section to verify capacity.

RED & Message of downstream scrap (see following picture): Due to planned or demonstrated downstream scrap, there is no enough capacity. Bottleneck process due to downstream scrap is identified in the row below Process description:

C. Gap Analysis - Required OEE vs. Demons
Process Description
Process 1 bottleneck due to downstream scrap
Capacity Analysis Results

Commitment (APPC/MPPC): This is an area for the supplier to enter the average and maximum capacity commitments (PPC: Purchased Part Capacity). These values must correspond to the APPC and MPPC values entered on the Part Submission Warrant (PSW)

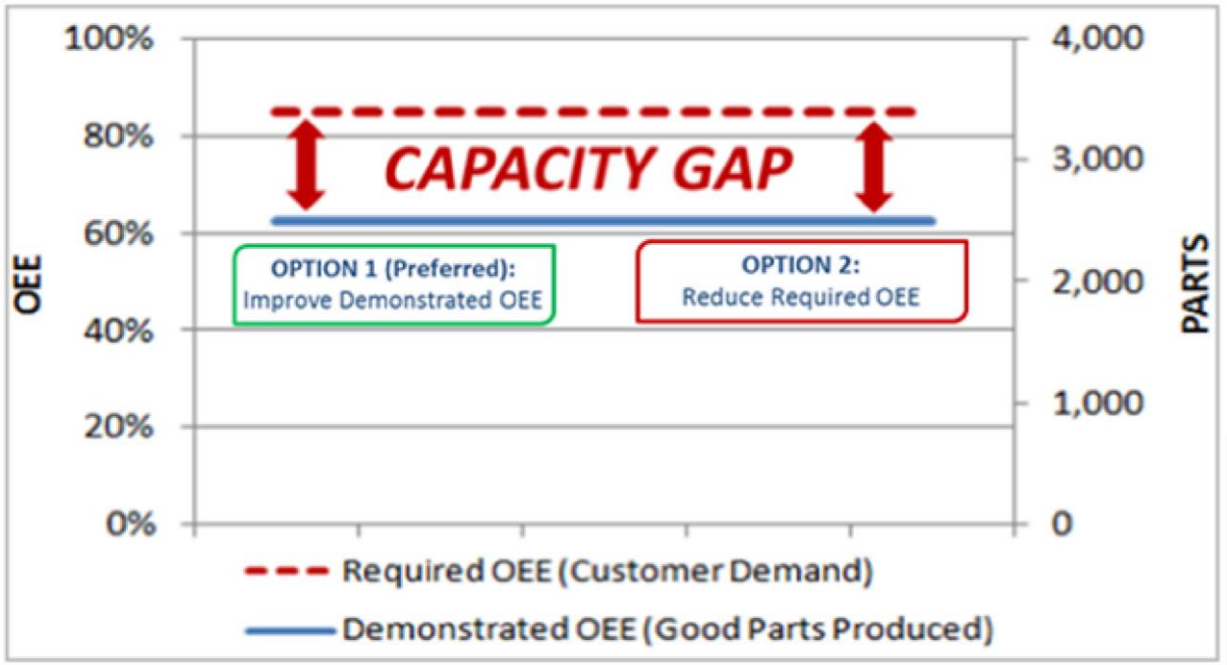
When PPC is significant higher than Required Capacity, it needs to be checked that Cap Ver OEE can be sustained and all sub-tiers can provide these higher volumes.

Ensure that PPC entries in PSW are aligned with the CAR before sign-off.

RED: Commitment volumes are lower than Required Capacity or higher than Demonstrated Capacity.

Capacity GAP: Resolving Potential Capacity Risks

If there is an identified gap between Demonstrated OEE and Required OEE, such as in the following chart, the resolution process can vary greatly based on the conditions at the supplier, the reasons for the gap, etc.



Improve Demonstrated OEE (Preferred)	**Improve Demonstrated OEE through implementation of lean practices.**	**Reduce cycle times, increase equipment availability through downtime reduction, revisit line balancing, reduce scrap and rework, etc.**
Reduce Required OEE (Not Preferred)	**Reduce Required OEE through changes in the planned operating patterns.**	**Increase the number of hours planned for part production, adding equipment or manpower, adjust planned allocation, etc.**

Improving Demonstrated OEE (preferred):

To improve Demonstrated OEE, concentrate on the individual elements of OEE – Availability, Performance Efficiency, and Quality Rate. By reviewing the process and applicable demonstration data, improvement opportunities will likely fall within at least one of the three elements. Enablers that assist in improving Demonstrated OEE include:

Availability

- ✓ **Track & Pareto Losses to Reduce Unplanned Downtime;**
- ✓ **Identify Special & Common Causes;**
- ✓ **Analyze Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR);**
- ✓ **Utilize Rapid-Response Maintenance Teams;**
- ✓ **Review Preventative Maintenance Schedules for optimization;**
- ✓ **Prioritize Equipment for Maintenance Activities;**
- ✓ **For shared equipment, reduce changeover times.**

Performance Efficiency

- ✓ **Implement Production Boards to ensure Performance to Constraint Ideal Cycle Time;**
- ✓ **Identify Blocked & Starved Conditions, Including the installation of strategic buffers to prevent such conditions;**
- ✓ **Ensure Cycle Times Support Tact Time Requirements;**
- ✓ **Machine / Equipment – IE Study to Identify Gap, and Assignment of Appropriate Technical Resources for Closure;**
- ✓ **Address Operator Shortages, Imbalanced Work, and Lack of Standardization.**

Quality Rate

- ✓ **Track, Pareto, and Reduce Scrap & Rework Losses;**
- ✓ **Install Poke Yokes or Other Error Proofing Devices;**
- ✓ **Communicate Good vs. Bad Parts (Boundary Samples);**
- ✓ **Allocation of Problem Solving Resources and Process Experts to Launch.**

Reducing Required OEE (not preferred):

Although traditionally associated with increased cost, reducing Required OEE during early phases of capacity planning may be possible without potential commercial implications. Opportunities may include

- ✓ **Adjusting Machine & Equipment Design for Reduced Cycle Times (including both value-added and non-value-added time within the operation);**
- ✓ **Track & Optimize Cycle Times during Ramp Up;**
- ✓ **Investigate Incremental Tooling Upgrades;**

It may be required to simply adjust the operating pattern by expanding planned shifts, increasing hours, increasing allocation percentages, or reducing breaks (by incorporating items such as tag-relief, etc.)

All translations must be approved by LSM-SCM-403 Document Owner

Process Owner: SUPPLY CHAIN MANAGEMENT

See LSM-Q-501a on the **Plastic Omnium Lighting Integrated Management System (VIMS)** website for Owner's Name and ADID (Active Directory Identification)

Record of Revision

Date	New Revision	Description of Change
2019-01-16	01	Initial Release
2020-04-01	02	Annual review and update according to the valid form
2021-04-09	03	Annual review
2021-04-27	04	Update according to the valid form VF-SCM-403c Capacity Analysis Report
2022-11-08	05	Global document rebranding and recoding process. A: eP#19615