

NAPSC Troubleshooting Machine Overview

Machine Overview

Machine is 6 years old.

Cycle Time: 56 Sec to get part from 'Load' point to 'Unload' point using 1 T/M.

Servo transfer is used only when Transfer Robot is down. Servo is not as fast as robot.

Manual Backup: Current machine access points require 3 T/Ms with guards open and using '11th finger' push rod. Cycle time = 50 seconds.

Each part sensor is critical to be 'made' for data in processes after the Troubleshooter.

Known Machine Issues

- Robot and Servo home position is lost on machine power down or bypass switch.
- There is a pneumatic air leak on the main valve that has been annoying the operator due to his extra sensitive ears.
- Roller just after transfer station sticks and only affects production when Servo Transfer is used because it does not push part far enough to catch the next set of rollers after the defective ones.

Open Work Orders

Work Order #219: Production put in a work order 1 month ago for the Load Conveyor gearbox leaking oil on the floor.

Current Preventive Maintenance and Daily Checks

Operator Startup Checks:

- parts are available
- machine starts when the start button is pressed

Maintenance PMs

- Check roller belts for wear; Yearly
- Fill lube tank; Yearly
- Check Hydraulic and pneumatic leaks; Yearly
- Inspect suction cups for wear; Yearly

Machine Failure/Breakdown History

- Roller belts have broken, stretched or slipped causing stationary parts in conveyors; change belt.
Frequency: 5 times in the last year
Caused DT: 15 minutes per breakdown
- Suction cups don't suck causing use of Servo Transfer; Changed out cups.
Frequency: 3 times in 2 years
Caused DT: 0
- Door guard sensor damaged; Found needed part on the other side of the plant; replaced
Frequency: 1 time in 5 years
Caused DT: 1 hour
- Light Curtain not working; Re-aligned
Frequency: Happens atleast 1 per month
Caused DT: 5 mins
- Part sensors got damaged during weekend maint.; Used backup until breaktime fix
Frequency: 1 time in 5 years
Caused DT: 5 mins
- Unload cylinder sluggish movements; seals inside worn; Replaced
Frequency: 1 time in 5 years
Caused DT: 1 hr
- Robot pendant damaged/ dropped; Robot did not work properly afterwards; Replaced pendant
Frequency: 1 time in machine life.
Caused DT: 2 mins
- Hydraulic line broken from T/M using to step on during production; replace line, clean mess
Frequency: 1 time in machine life.
Caused DT: 2 hours

OA Focus Activity Steps

1 **Audit the Machine "Set Target"**

2 **Improve Machine's Backup**

3 **Complete Open W/O's**

4 **Divide the Machine**

5 **Clean Machine**

6 **Evaluate each PLC input / Improve Panelview**

7 **Clarify Normal Conditions**

8 **Evaluate spare parts recorded in Step 5**

9 **Kaizen A Rank Parts**

10 **Reduce MTTR of A Rank Parts**

11 **FMEA/Risk Evaluation/ Countermeasures**

OA FOCUS STEP DETAILS

STEP 1	<p>Audit the Machine and set a Target Use the OA FOCUS Machine Audit.xls file to evaluate the current condition of the machine before any work is done. Look at the audit with the TEAM and determine an achievable goal.</p>
STEP 2	<p>Improve the Machine's backup This machine was chosen most likely due to its low OA or High equipment Rank. If the machine has no backup, investigate how to install one. A perfect backup can eliminate line downtime. If the machine has a backup, investigate improving the time to activate it. This may include procedures or hardware. Investigate improving its cycle time if it can not maintain takt.</p>
STEP 3	<p>Complete all open W/O's Any and all Work Orders or open Counter Measure shall be completed before moving forward. Why look for more problems when you already know about some.</p>
STEP 4	<p>Divide the machine into usable/manageable sections The sections chosen will serve two functions. The sections will need to be small enough so that the cleaning and spare parts list written are not overwhelming. The sections chosen will be used on the Panelview later to separate the machine into easy to troubleshoot areas. For an example a large lifter may have : 1= Entrance Area, 2 = Main Lifter, 3 = Sub Lifter, 4 = Exit Area A team member should be able to get to the area on the Panelview very quickly and troubleshoot, move machine in manual or bypass inputs.</p>
STEP 5	<p>Thoroughly clean each of the Machine sections Make the Machine new Again!!!! Team members of the TEAM shall take a section of the machine and clean the area fully. The team member shall make a list of parts that may ever fail in that area. These parts will be looked at later in step 7.</p>
STEP 6	<p>Evaluate each PLC input / Improve Panelview This step requires a lot of thought but can make a very large impact on OA. Use the OA FOCUS INPUT EVAL.xls sheet to record the Inputs that exist in the Processor. Answer the questions the sheet ask and fix the gaps in logic or panelview. Improve the Panelview by upgrading it to the shop standard. The Layout screen shall have a picture of the entire machine with the sections laid out to select. The sections shall be the same as the layout determined on step 4. Once the section PB has been chosen the operator will get a choice of Manual,I/O details and Bypasses just for that area. This will simplify the troubleshooting and manual recovery. Sometimes manual functions will be on several different section pages. Ask the maintenance T/M's if something could be added to help them recover in a breakdown.</p>
STEP 7	<p>Clarify Normal conditions This step is going to make inspection of the equipment easier. The goal is to make an Abnormal condition stand out. If the Normal condition is easy to see then it will be easier to maintain. Examples: Variable = Abnormal Machine Function Countermeasure = If fault lights are normally ON then it becomes normal. Eliminate nuisance alarms to help Clarify Normal. Variable = Guide Rail Wear Countermeasure = A clean floor under the machine helps identify metal fragments. Variable = Chain Slack Countermeasure = Mark green area for Normal and Red for Abnormal. Variable = Lifter Stop Positions Countermeasure = Mark green area with an arrow on the Table for Normal positions Variable = Visual inspection is difficult without proper lighting. Countermeasure = Add lighting</p>
STEP 8	<p>Evaluate each spare part recorded in step 5 Use the OA FOCUS WORK SHEET.xls to evaluate each part found in a given machine section. Enter the parts into the work sheet and then complete the Maintenance Network section. Rank each part using the OA FOCUS PART AUDIT.xls sheet as a reference.</p>
STEP 9	<p>Kaizen A rank parts to down rank them Use the OA FOCUS WORK SHEET.xls to indentify the A rank parts. As a TEAM, kaizen the part or assemblies to down rank the part. The TEAM shall ask if a bypass can be installed?</p>

If the part fails can maintenance keep the machine running without it?
If a procedure can be written to have maintenance help the machine maintain takt safely then write it. The procedure shall be stored in the Procedure Document File and a copy shall be placed in the MNET book.

STEP 10 Reduce MTTR of A rank parts

Reduce the Mean Time To Repair parts that are still A Rank by doing the following:

1. Write repair procedures and place a copy in the MNET book.
2. Remove guarding where it is not needed.
3. Kaizen the replacement by adding wing nuts or maybe electrical plugs
4. Have a tool box with tool required near by.

STEP 11 Maintain the improvements

Consolidate the parts list generated in step 5 with the original spare list. Update all parts YN#'s. A copy of the spare list shall be placed in the MNET book.

All PM's shall be reviewed and updated to include inspections on all A rank parts.

A refresher PM shall be written to train maintenance on the system.

Train the T/M's on the new panelview screens and how to navigation.

The refresh PM shall also make a note of any Repair procedure that has been written.

The refresh PM shall also make a note of any Backup procedure including the Machine Backup procedure.

Date: _____ Equipment: _____
 Plant: _____ Evaluator: _____

	Item	Pt. Value	Before Kaizen			After Kaizen			Item Detail Instructions:
			Judge	Total		Judge	Total		
PM	A	PM Audit O = 2 X = 0	O = PM Audit is complete		0	O = PM Audit is complete		0	PM Audit is complete. This includes writing and modifying the PM's to address the issues found during the audit. (See PM Audit Guidelines)
	B	PM Condition/WO O = 4 X = 0	O = No PM'S or WO'S problems open in the database.		4	O = No PM'S or WO'S problems open in the database.		4	Should be no open PM problems or WO's
	C	Refresher PM's O = 5 X = 0	O = Refresher PM's exist		0	O = Refresher PM's exist		0	Refresher PM's for running the machine in manual, bypassing and backups
Training	D	Backup WIS O = 3 U = 1 X = 0	Training complete = O No training = U No WIS = X		0	Training complete = O No training = U No WIS = X		0	WIS should be written and team members trained. WIS should be located in MNET Book
	E	Backup vs. Takt Time O = 2 U = 1 X = 0	O = Backup Meets Takt Time U = Cannot Meet Takt Time Consistently X = Cannot Back up		2	O = Backup Meets Takt Time U = Cannot Meet Takt Time Consistently X = Cannot Back up		2	Score based on backup vs. takt time. If no backup is possible then it receives an X rating.
	F	# of T/Ms required for backup O = 2 U = 1 X = 0	O = 1 U = 2-3 X = 4+		1	O = 1 U = 2-3 X = 4+		1	Based on # of T/Ms identified on Backup WIS. If no backup is possible then it received and X rating.
Documentation	G	OJT Status O = 8 U = 4 X = 0	O = 3+ T/M U = 1-2 T/M X = 0 T/M		8	O = 3+ T/M U = 1-2 T/M X = 0 T/M		8	Based on # of T/Ms that have completed fundamental OJT training associated with this equipment and can demonstrate proficiency (See OJT Status Guidelines).
	H	Electrical Prints O = 4 X = 0	O = Present, Bound & in Good Cond.		4	O = Present, Bound & in Good Cond.		4	Should be present, bound and in good condition or NA. A copy should also be located in the MNET Book at equipment.
	I	Pneumatic Prints O = 4 X = 0	O = Present, Bound & in Good Cond.		0	O = Present, Bound & in Good Cond.		0	Should be present, bound and in good condition or NA
	J	Mechanical Prints O = 3 X = 0	O = Present, Bound & in Good Cond.		0	O = Present, Bound & in Good Cond.		0	Should be present, bound and in good condition or NA. At a minimum, there should be an assembly drawing showing all views of equipment.
	K	Fault Recovery Flow. O = 1 X = 0	O = Present, Bound & in Good Cond.		0	O = Present, Bound & in Good Cond.		0	Should be present in MNET book or NA
	L	Sequence of Operation O = 1 X = 0	O = Present, Bound & in Good Cond.		1	O = Present, Bound & in Good Cond.		1	Should be present in MNET book or NA
	M	Input/Output Cross Ref. O = 1 X = 0	O = Present, Bound & in Good Cond.		1	O = Present, Bound & in Good Cond.		1	Should be present in MNET book or NA
	N	Spare Parts List O = 4 X = 0	O = Complete w/ YN #		0	O = Complete w/ YN #		0	Should be present in MNET book. Includes copy of Manufacturer's suggested spare parts list and printout of all associated parts in Maximo.
	O	Spare Parts Audit O = 2 X = 0	O = Complete		0	O = Complete		0	Audit complete per WIS. This includes setting up any parts not found during the audit in General Stores. (Reference spare parts audit WIS)
	P	Repair Procedures O = 2 X = 0	O = Complete		0	O = Complete		0	All A Rank parts should have a procedure of how to replace
Program Backup	Q	Backup Requirements Checklist O = 1 X = 0	O = Checklist exists that identifies components that require program backup and back ups are available or N/A		0	O = Checklist exists that identifies components that require program backup and back ups are available or N/A		0	Checklist and actual backup documentation and files should exist in MNET book OK indicates list exists and backups are present. NA = OK. A PM should also exist to verify all document/saved information is latest revision
	R	Battery Change Documented O = 1 X = 0	O = Battery Change Dated and < 5yrs. Or N/A		0	O = Battery Change Dated and < 5yrs. Or N/A		0	Battery change should be documented on battery covers and less than 5 years old. NA = OK
MNET Book	S	Breakdown Reports O = 1 X = 0	O = Major Breakdown reports filed in book		0	O = Major Breakdown reports filed in book		0	Major breakdown reports are filed in MNET book.
	T	Current PM Listing O = 1 X = 0	O = Present w/ Latest review < 1yr. Old.		0	O = Present w/ Latest review < 1yr. Old.		0	Filed in MNET book. List all existing PM's
	U	Equipment Repair Log O = 1 X = 0	O = Equip. Repair Sheets Filed in Book		0	O = Equip. Repair Sheets Filed in Book		0	Filed in MNET book. Reference for future investigation. All work completed on equipment should be tracked in this log.
	V	Procedures O = 1 X = 0	O = Procedures in MNET Book and on Maintenance Server		0	O = Procedures in MNET Book and on Maintenance Server		0	All procedures related to equipment should be filed in MNET book and on the Maint. server. Includes backup, calibration, light curtain, etc.
Meth	W	Daily Check Sheets O = 1 X = 0	O = Daily checks present at the equipment		0	O = Daily checks present at the equipment		0	Daily checks are present at the equipment and are being checked every shift.
	X	Mutilation O = 1 X = 0	O = Possible mutilation points identified and covered		0	O = Possible mutilation points identified and covered		0	Applies to equip. that synchronizes with vehicle. NA for equip. that doesn't come close to painted surfaces. Assure no mutilation potential exists.
5s	Y	5s Condition O = 10 U = 2 X = 0	O = 100% Clean U =>50% Clean X =<50% Clean		0	O = 100% Clean U =>50% Clean X =<50% Clean		0	Overall evaluation of equip. 5s condition. This includes inside panels, document holder, in, under and around equipment.
	Z	Repairable During Backup O = 2 X = 0	O = Equipment can be repaired during backup		2	O = Equipment can be repaired during backup		2	OK only if equipment can be repaired during backup. X - no backup available or cannot be repaired in backup.
Reliability	AA	Special Equip. for Repair O = 1 X = 0	O = No special equipment needed to repair (ie genie boom, crane, etc.)		1	O = No special equipment needed to repair (ie genie boom, crane, etc.)		1	OK only if no special equip. needed to repair. (ie. JLG, forklift, crane, etc.)
	BB	Component Lifespan Schedule O = 1 X = 0	O = Replacement schedule exists for components identified as having fixed lifespan		0	O = Replacement schedule exists for components identified as having fixed lifespan		0	OK = Itemized schedule exists for replacement of parts that have fixed life span. (contactors, VFD's.) NA if none exist. (See Component Lifespan Guidelines)
Mitigating Points	CC	Production Startup Checks O = 3 U = 1 X = 0	O = checksheet exists and followed or NA U = Checksheet Exists not followed X = No Checksheet exists		0	O = checksheet exists and followed or NA U = Checksheet Exists not followed X = No Checksheet exists		0	OK = Check sheet exists and completed daily or NA.
	DD	Clarify the Normal O = 8 U = 4 X = 0	O = 100% of normal marked U =>50% of normal marked X =<50% of normal marked		4	O = 100% of normal marked U =>50% of normal marked X =<50% of normal marked		4	Are components marked for normal condition. Anyone shall be able to determine normal. Normal limit switch position, chain slack, wear etc...
	EE	Self Diagnostics O = 1 X = 0	O = Equip. includes self diagnostics		1	O = Equip. includes self diagnosis		1	OK if equipment program contains items that will help identify that the equipment variation that could indicate an abnormality.
	FF	Special Checks or periodic Renewal O = 1 X = 0	O = Schedule exists for special checks or renewal of inaccessible items		1	O = Schedule exists for special checks or renewal of inaccessible items		1	OK if program is in place to do periodic rebuild or replacement of components that could cause extended breakdown due to inaccessibility. (See Periodic Renewal Guidelines)
	GG	Auto oilers or greasers O = 1 X = 0	O = Automatic oiling or greasing equipment exists and is operational		0	O = Automatic oiling or greasing equipment exists and is operational		0	OK if equipment contains automatic lubrication that lessens component wear.
	HH	Component Redundancy O = 3 X = 0	O = Components have been reviewed for possible redundancy		0	O = Components have been reviewed for possible redundancy		0	OK if all components have been reviewed for redundancy or back up. For example; limit switches to back up encoder.
	II	PV Function O = 4 U = 1 X = 0	O = 100% of standard/clear U =>50% of standard/clear X =<50% of standard/clear		4	O = 100% of standard/clear U =>50% of standard/clear X =<50% of standard/clear		4	The Panelview should be in standard format. The Panelview should be easy to navigate and find manual PB's and Bypass PB's.
	JJ	Lighting O = 4 X = 0	O = Well lit		4	O = Well lit		4	Well lit machines help to PM, troubleshoot and repair.
KK	I/O Labeling O = 5 X = 0	O = All inputs and output devices are clearly labeled		5	O = All inputs and output devices are clearly labeled		5	All inputs should be clearly mark for easy identification from outside the machine.	
			Score	43	TARGET = 74			Score	0

The Equipment Diagnostics system is intended to provide an overall evaluation of the ability of a piece of equipment to perform its function related to vehicle processing. The evaluation score should provide some information that reflects this capability as well as identifying areas that can be improved.

The ideal piece of equipment has few breakdowns, can be backed up with low ergonomic impact, can be repaired during backup, can be operated and maintained safely, is well documented, well maintained, and produces a high quality vehicle. This type of equipment should typically score near 100%.

Due to the wide variety of equipment in Assembly, there will also be a wide variety of evaluation scores. There will also be some pieces of equipment with inherently low scores due to lack of backup (lifters and conveyors)

In recognizing this weakness, it becomes important to identify items that may lessen the probability of breakdown. These items could include:

- > Baseline measurements of Chains, rails etc.
- > Identifying items that should be replaced due to fixed life span. (inverters, servo drives, etc.)
- > Establishing rebuild schedules for items that are critical and/or difficult to access (lifter lock eq.)
- > Adding diagnostic checks to programs that can monitor abnormal variations in eq. Cycle.
- >Ex: Program to export I/O condition to external file during fault condition

For any item that is NA or not needed for a piece of equipment, then it does not represent an operational risk. It should then receive an OK rating for that item.

Item Detail Instructions:

A	PM Status	PM Audit is complete. Utilize PM audit Guidelines
B	PM Condition	Should be no open PM problems
C	Refresher PM's	
D	Backup WIS	WIS should be written and team members trained. WIS should be located in MNET book
E	Backup vs. Takt Time	Score based on backup vs. takt time. If no backup is possible then it receives an X rating.
F	# of T/Ms Req'd. for B.Up	Based on # of T/Ms identified on Backup WIS. If no backup is possible then it received an X rating.
G	OJT Status/Versatility	Based on # of T/Ms that have completed fundamental OJT training associated with this equipment.
H	Electrical Prints	Should be present, bound and in good condition or NA A Copy should also be located in document holder at equipment
I	Pneumatic Prints	Should be present, bound and in good condition or NA
J	Mechanical Prints	Should be present, bound and in good condition or NA At a minimum, there should be an assembly drawing showing all views of equipment.
K	Fault Recovery Flow.	Should be present in MNET book or NA
L	Sequence of Operation	Should be present in MNET book or NA
M	Input/Output Cross Ref.	Should be present in MNET book or NA
N	Spare Parts List	Should be present in MNET book. Includes copy of Manufacturer suggested list and printout of all associated parts in Maximo.
O	Spare Parts Audit	Audit is complete per WIS
P	Repair Procedures	All A Rank parts should have a procedure of how to replace
Q	Backup Req. Checklist	Checklist should exist in MNET book that identifies software items that should have backup or parameter list. OK indicates list exists and backups are present. NA = OK Use and attach checklist
R	Battery Change Docum.	Battery change should be documented on battery covers and less than 5 yrs old. NA = OK
S	Breakdown Reports	Major Breakdown reports should be filed in the MNET book.
T	Current PM Listing	Filed in MNET book. List all existing PM's
U	Equipment Repair log	Filed in MNET book. Reference for future investigation. All work completed on equipment should be tracked in this log.
V	Procedures	All procedures related to equipment should be copied and filed in MNET book. Includes back-up, light curtain, calibration, etc.

W	Daily Check Sheets	Daily checks are present at the equipment and checked every shift.
X	Mutilation	Applies to equip. that synchronizes with vehicle. NA for equip. that doesn't come close to painted surfaces. Assure no mutilation potential exists.
Y	5s Condition	Overall evaluation of equip. 5s condition per PM sheet.
Z	Repairable During Backup	OK only if equipment can be repaired during backup. X - no backup available or cannot be repaired in backup.
AA	Special Equip. for Repair	OK only if no special equip. needed to repair. (I.e.JLG, crane etc.)
BB	Component Life Span Schedule	OK = Itemized schedule exists for replacement of parts that have fixed life span. (inverters, servo drives, etc.) NA if none exist. Utilize Component Lifespan Guidelines.
CC	Production Startup Cks.	OK = Check sheet exists and is used or NA.
DD	Clarify the Normal	Are components marked for normal condition. Anyone shall be able to determine normal. Normal limit switch position,chain slack,wear etc...
EE	Self Diagnostics	OK if equipment program contains items that will help identify that the equipment variation that could indicate an abnormality
FF	Special Checks or Periodic Renewal	OK if program is in place to do periodic rebuild or replacement of components that could cause extended breakdown due to inaccessibility. (lifter lock equipment)
GG	Auto Oilers or Greasers	OK if equipment contains automatic lubrication that lessens component wear.
HH	Component Redundancy	OK if all components have been reviewed for redundancy or back up. For example; limit switches to back up encoder.
II	Work Orders	No open work orders should exist.
JJ	PV Function	The Panelview should be in standard format. The Panelview should be easy to navigate and find manual PB's and Bypass PB's.
KK	Lighting	Well lit machines help to PM,troubleshoot and repair.
LL	I/O Labeling	All inputs should be clearly mark for easy indentification from outside the machine.

MNET STEP #4 "DIVIDE MACHINE"

1. Charge/ Load Area Function:

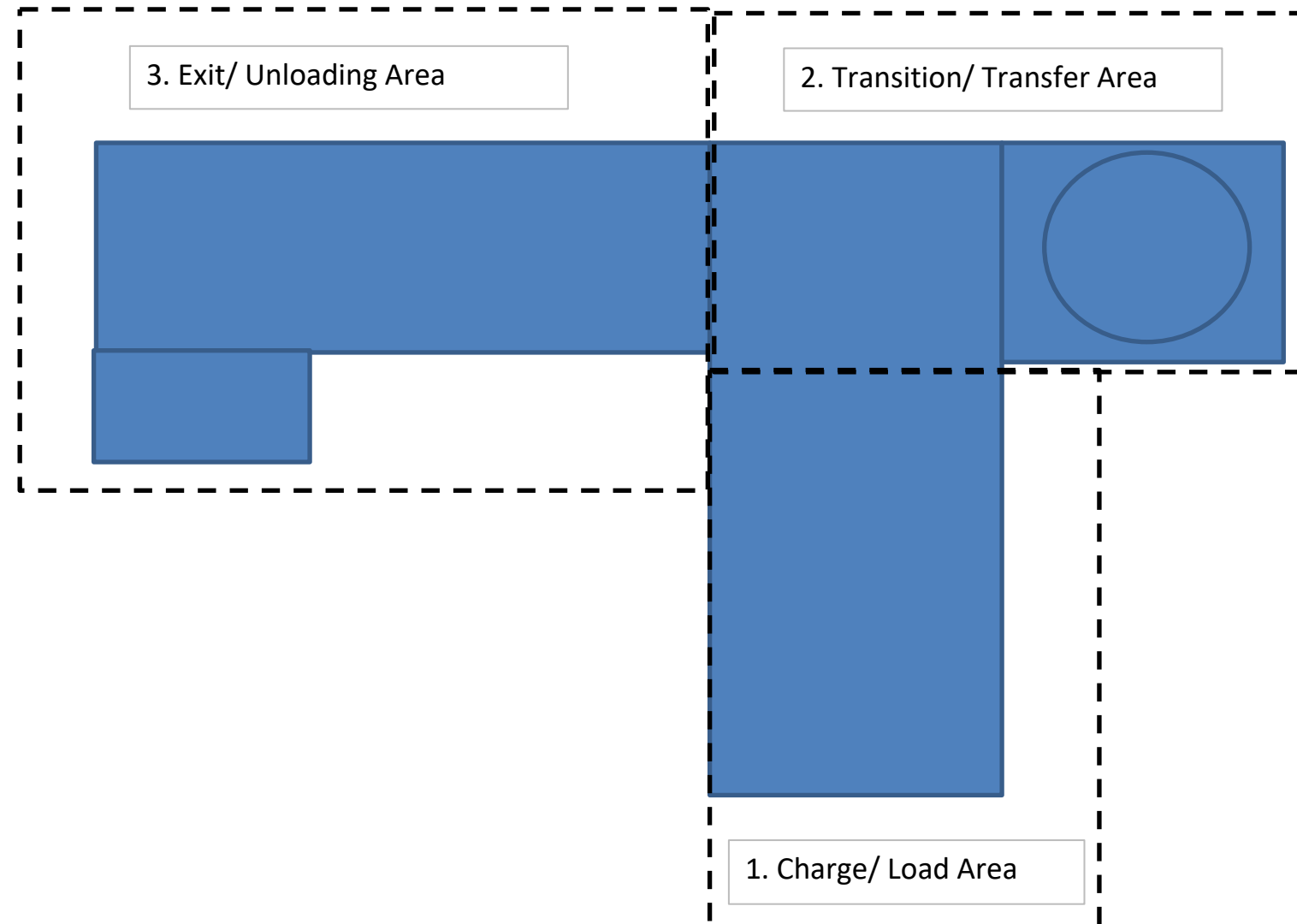
To carry part from load position into the transition/transfer area while maintaining alignment of the part and process takt time.

2. Transition/ Transfer Area Function:

To move part into exit/ Unload area changing direction part moves while maintaining proper orientation of part and process takt time.

3. Exit/ Unload Area Function:

To unload part from exit conveyor to the unload position with proper part orientation and process takt time.



OA FOCUS TPM Step 5 Parts List

Equipment: Troubleshooter
Machine Section:
Name:
Date:

Part Description	Part #	Quantity
<i>Charge/ Load Section</i>		
Light Curtain		1
Finger Switch		1
Rollers		
Roller belts		
Access Door Safety Switch		1
Left Guide bar		1
Right Guide bar		1
Lube Pump/unit		1
Conveyor Motor/Electric		1
Conveyor Gearbox		1
Conveyor Drive Shaft		1
#60 Chain		1
Conveyor Motor Coupling		1
Conveyor chain sprockets		2
Conveyor shaft plastic pulleys		
Conveyor shaft plastic spacers		
Conveyor drive shaft bearings		4
Laser sensor/reflector		1
Laser sensor brackets		1
Anti-back cylinder		1
Anti-back cylinder bracket		1
<i>Transition/ Transfer Section</i>		
Fanuc Robot		1
Control Panel		1
Robot teach pendant		1
Access door safety switches		2
Power panel		1
Wiring		
Suction cups		2
Pneumatic air lines		
Robot vacuum/ venturi block		1
Laser sensor/reflector		1
Part Pusher linear guide		1
Part Pusher Servo motor		1
Part pusher bracket		1
Linear guide position sensors		1
<i>Exit/ Unload Section</i>		
Part enter Laser sensor/ reflector		1
Hydraulic unit motor		1
Hydraulic unit hoses		2
Hydraulic unit pump		1
Hydraulic unit filter		1
Hydraulic unit filter guage		1
Hydraulic unit pressure out guage		1
Conveyor drive motor/ Hydraulic		1

Failure Modes and Effects Analysis

Date: 11/1/2012

Project Name: RCMNET

Equipment Name: NAPSC Troubleshooter

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Analysis Group Members: Rusty Hallett, Jeff Whitaker, Lee Higgins

Item #	Component/ Function	Failure Mode	Root Cause	Effect	Sev.	Prob.	C/M'd?	Risk	Recommendation
Charge/ Load Section									
1	Light Curtain	Mis-aligned	Operator hit with part	Machine will not run	1	B	N	L	
2	Finger switch	Damaged	Shorted wire	Machine will not cycle	1	D	N	L	
3	Rollers	Worn	Short life cycle	Won't transfer or move parts	1	D	N	L	
4	Roller belts	Broken	End of life cycle	Parts hang-up	1	A	N	L	
5	Access door safety switch	Damaged	Over head water leak	Machine won't cycle	1	B	Y	L	
6	Left guide bar	Loose	Operator mis-adjusted	Parts mis-aligned and jammed	2	B	N	M	Daily operator check of guide rail marked locations
7	Right guide bar	Loose	Operator mis-adjusted	Parts mis-aligned and jammed	2	B	N	M	Daily operator check of guide rail marked locations
8	Lube Pump/Unit	Broken Lube line	Pressure fatigue	Lube fault; machine won't run	1	B	Y	L	
9	Conveyor drive motor/electric	Bearing worn	Mis-aligned at install	motor seizure; conveyor stop	3	B	N	M	Yearly Infrared thermography check of bearing housing.
10	Conveyor drive gearbox	Leaking	Fill plug left loose	Gearbox seizure; conveyor stop	2	A	N	M	Check Oil level via sight glass installed and no leaks Monthly.
11	Drive shaft	Shaft sprocket set screw broken	Chain slack play	Will not transfer parts	3	B	N	M	Check no chain slack and sprocket key is in good condition; 6 mos.
12	Drive chain	worn	no lubrication	drive chain broke; no part transfer	3	A	N	H	Install lines from lube system or instal separate lube system.
13	Drive motor coupling	set screw loose	Untightens over time	Erradic movement of rollers; not meeting cycle time	2	B	N	M	Check drive coupling tightness; 6 mos. With installed coupling quick access guard.
14	Shaft block bearings	locked-up	No lubrication	Damage to line shaft; possible no parts transfer	3	C	N	M	Yearly lubrication of shaft bearings.
15	Chain sprockets	worn	No lube	chain wears and possibly breaks; no parts move	3	A	N	H	Install lubrication system for sprockets
16	Laser sensor/reflector	Mis-aligned	hit during load sequence	machine will not cycle	1	A	N	L	
17	Safety Switch	damaged	Hit by conveyance	Machine will not cycle	1	A	N	L	
18	Anti-back cylinder	bent rod	hit by part	cylinder will not cycle	1	A	N	L	
19	Plastic pulleys	broken	dropped part in conveyor	roller will not turn	1	A	N	L	
20	plastic spacers	worn	End of life cycle	pulley movement; belt stretching	2	D	N	L	
21	Laser sensor brackets	broken	hit in load sequence	loose laser sensor; machine won't cycle	1	C	N	L	
22	anti-back cylinder brackets	broken	hit by part	Loose cylinder; Jammed part	1	C	N	L	
Trans./ Transfer Section									
23	Control panel	dis-connected	weekend maint.	Machine won't run	1	D	N	L	
24	Robot teach pendant	broken	dropped	Robot won't work	2	D	Y	L	
25	Access door safety switch	Mis-aligned	bumped	m/c won't operate	2	D	N	L	
26	Robot power control	corrosion	air moisture	Robot won't work	4	E	N	L	
27	Wiring	loose	Not tightened	machine won't run	3	C	N	M	Check wiring condition Yearly Possible thermal checks.
28	Robot suction cups	worn	rough parts	run back-up pusher	1	B	Y	L	
29	Pneumatic air lines	split	wear	run back-up pusher	1	C	Y	L	
30	Venturi block	clogged	dirty air; broken filter	run back-up pusher	2	C	Y	M	Check pneumatic component rack component conditions Yearly
31	Laser sensor	bent	hit on loading	machine won't cycle	1	D	N	L	
32	Pusher linear guide	sticking	Plant dirt	can't use servo pusher	1	D	Y	L	
33	Pusher servo motor	Loose/broken wire	Maint. Knocked loose	no pusher when needed	1	C	Y	L	
34	Laser reflector	broken	hit by maint.	line stop	1	D	N	L	
35	anti-back solenoid	bent	hit by part	line stop	2	C	N	M	Check stopper operation at startup checks
36	Robot	belt/bearing worn	No lube	Back up pusher	1	C	Y	L	
Exit/ Unload Section									
37	Laser enter confirm laser	Mis-aligned	bracket hit	part won't exit	1	B	N	L	
38	Hydraulic motor/pump	cavitates	no fluid; broken hose	shutdown machine	2	C	N	M	Thermal check of motor/pump yearly
39	Hydraulic filter	clogged	dirt entering fill screen	hydraulic temp fault	2	C	N	M	Daily check of hyd. Filter pressure guage in marked range

Failure Modes and Effects Analysis

Date: 11/1/2012

Project Name: RCMNET

Equipment Name: NAPSC Troubleshooter

Page: 1 of 2

Analysis Group Members: Rusty Hallett, Jeff Whitaker, Lee Higgins

Item #	Component/ Function	Failure Mode	Root Cause	Effect	Sev.	Prob.	C/M'd?	Risk	Recommendation
40	Hydraulic hose	Leaking/ broken	used as step by prod.	Low press. Fault	3	A	N	H	Semi annual hyd. Line check. Install guarding of hoses.
41	Hydraulic powered motor	worn	dirty oil	shutdown machine	3	D	N	M	Oil analysis yearly for dirty and filter cart as needed
42	Main air valve	leaking	no tephlon tape	shutdown machine	2	D	N	L	
43	Guages	wrong; broken	hit by conveyance	air pressure Possible over pressurize system;	1	C	N	L	
44	Pressure relief valve	sticking	dirty air; broken filter	over pressure fault	1	D	N	L	
45	pressur sensor	broken	hit by conveyance	machine pressure fault	2	D	N	L	
46	Adjustable solenoid valves	mis-adjusted	T/M over adjusted	slamming cylinder	2	C	N	M	Startup operator check valve adjustment are correct. In markes range.
47	Rollers	Damaged/ wiorn	End of life cycle	Parts won't move	2	B	N	M	Semi annual roller free roll condition check
48	Roller belts	broken	over-tensioned	Parts won't move	2	B	N	M	Semi annual roller belt condition check
49	Roller belts	stretched	over-tensioned	Parts won't move	2	B	N	M	Semi annual roller belt condition check
50	Drive shaft	Bent	improper installation	parts won't move; burn up motor; fault	3	D	N	M	Yearly conveyor drive train condition check; possible thermal
51	Drive shaft bearings	locked-up	no lube	parts won't move; burn up motor; fault	3	D	N	M	Yearly conveyor drive train condition check; possible thermal; lube bearings
52	Plastic sleeves/pulleys	broken	wear	parts won't move	3	D	N	M	Check sleeves and pulleys yearly
53	Pneumatic reed switches	Mis-aligned	bumped	false pusher confirmation	3	D	N	M	Paint marks and check Monthly

					Unlikely	Can happen	Has happened in industry	Has happened in the last 5 years	Has happened in last 1 year
Cost	Safety	Quality	Line Stop		E	D	C	B	A
Capital >20% of Asset	Severe Injury	Continuous Defects	8+hours production stop	4	26,				
>5% of Asset	Lost time/ Minor Injury	>20% of Parts Defective	1+hour line stop entire plant	3		41, 50, 51, 52, 53,	14, 27,	9, 11,	12, 15, 40,
Capital <5% of Asset	OSHA Record; No Lost Time	>10% of Parts Defective	1+hour line stop, Mixitorium	2		20, 24, 25, 42, 45,	30, 35, 38, 39, 46,	6, 7, 13, 47, 48, 49,	10,
Increased Operating Costs	Non OSHA Recordable	<10% of Parts Defective	Near Miss line stop	1		2, 3, 23, 31, 32, 34, 44,	21, 22, 29, 33, 36, 43,	1, 5, 8, 28, 37,	4, 16, 17, 18, 19,
None	None	None	None	0					

Rank	PDCA	PDCA	PDCA	PD	Nothing	Rank	Safety	Line Stop	Cost
	Unlikely	Can happen	Has happened in industry	Has Happened at Toyota in last 5 yr	Has Happened at Toyota in last 1 yr				
Rank	E	D	C	B	A	Rank			
4						4	Severe Injury	> 8 hrs Line Stop	Capital >20% of Asset
3						3	Lost Time / Minor Injury	>1 Hr Line Stop All Shops	>5% of Asset
2						2	OSHA Recordable No Lost Time	> 1 hr Line Stop Any Shop	Capital < 5% of Asset
1						1	Non OSHA Recordable	Near Miss on Line Stop	Increased Operating Cost
0						0	None	None	None