

To: Shop Ops Team
From: Chris Peters
Re: Welcome to Parck

Dear Transition Team:

Jan Johanson, VP of Business Development for Essex, asked me to provide information and guidance related to the Shop Operations function at Parck. I have attached a copy of the standard work descriptions for all operations.

I suggest you be prepared to brief the rest of your team the following questions:

1. What is the current capacity of the TTBA production line?
2. Assuming that sales will remain flat (approximately 2,000 units per month), are there any operations that are currently limiting?
3. Construct a Value Stream Map (VSM) and share it with the rest of your team. Are there any additional insights gained from viewing the VSM?

I hope this information is helpful.

Sincerely,

Chris Peters

Chris Peters, Manager of Shop Operations

To: Shop Ops Team
From: Tracy Peterson
Re: Shop Scheduling Information

Dear Transition Team:

I was asked to provide you with information related to shop scheduling. Here are some key metrics you should be aware of:

1. The TTBA line works only two shifts – When Essex acquired Parck the TTBA line was only working two shifts. Because of increased overtime costs in running a third shift, Essex has a strict policy for avoiding third shifts at all costs. As you look to increase capacity, simply adding a third shift will not be an option.
2. The Rotor line works three shifts – When Essex acquired Parck the Rotor line was working three shifts. Essex leadership has challenged the transition team to find a way to cut this to two shifts over the next year.
3. Each shift is eight (8) hours with two 30 minute breaks – This creates an effective work time of seven (7) hours per shift.
4. The plant operates six (6) days a week – Overtime rate (1.5 x normal) is paid for Saturday overtime. The Rotor line works three shifts on Saturday while the rest of the plant works only two shifts.
5. Straight time and overtime rates – Current straight time rate at Parck is \$32.00/hour. Saturday overtime rate is \$48/hour. Sunday overtime rate would be \$64/hour though Sunday overtime is forbidden by Essex.
6. Holidays and Shut Down – Essex provides thirteen (13) federal public holidays to its workers. Plant is shut down on these days. There are also two weeklong plant shut downs scheduled throughout the year. Average work days per month is 24.
7. Demand for the last quarter was 5,760 units – Demand was spread evenly throughout the last quarter.

I hope this information is helpful.

Sincerely,

Tracy Peterson

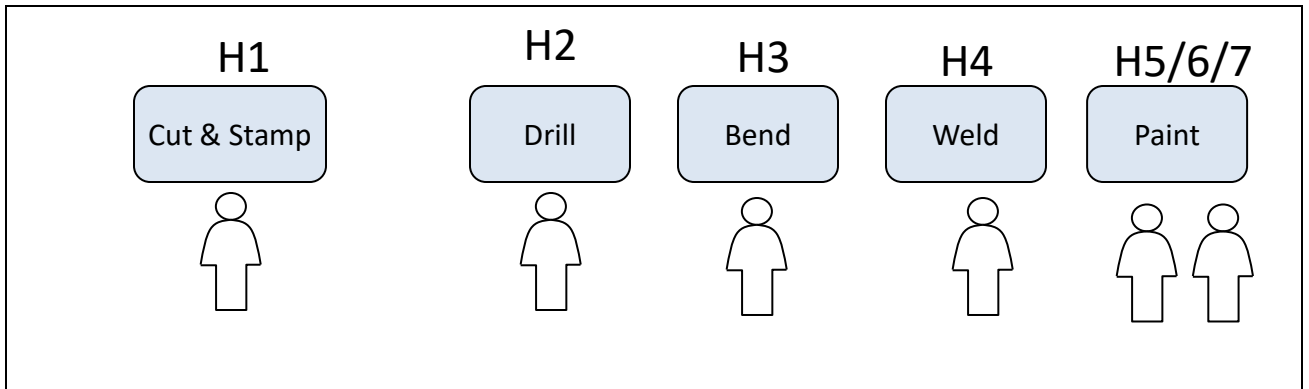
Tracy Peterson, Quality Manager



Standard Work Documentation R50 TTBA

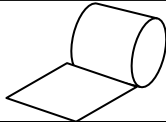
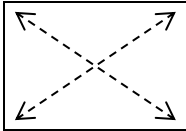
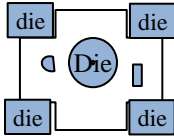
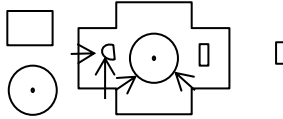
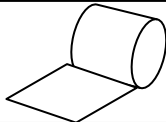

Production Package: Housing Fab & Paint

Work Area Schematic (not to scale):



Design Drawing: 987-664-2668, Housing

Area: Housing Production
H1 Operation: Cut, Size, & Punch

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Unroll 48" stock from spindle, measure, cut to workable size 48" x 54" for housing	Hand held electric Power shear, Tape measure		1.5 minutes
2	Measure to drawing, mark, make 2 cuts to get to final 47"x53" size per housing drawing. After cut, measure diagonals to verify blank is square	Tape measure, flat bed sheet metal power shear		3 minutes
3	Repeat steps 1 & 2 40 times to make 40 precut housing blanks			180 minutes batch Total
4	Changeover die set for power conn access hole (115vac or 240vac type)	211 Ton press	Die for power conn opening 2 types(115vac or 240vac)	10 minutes changeover
5	Get & Load housing blank into press. Use positioning pins to correctly locate blank. Stamp out 4 corners, center, printer access opening & power conn in a single strike.	211 Ton press		2 minutes
6	Verify dimensionally correct. Use test blocks each corner, center, and print access opening. Tape measure verify each hole location wrt 2 corners or edges.	Test blocks, tape measure		2.25 minute
7	Repeat steps 5 & 6 to create batch of 40 punched out housing blanks			170 minutes batch Total
8	Unroll 48" stock from spindle, measure, cut to workable size 48" x 15" for condenser cover	Hand held electric Power shear, Tape measure		1.5 minutes
9	Measure & mark & cut to 14" wide. Cut 5 pieces from the strip to final 9" x 14" size per cover drawing.	Tape measure, flat bed sheet metal power shear		4 minutes
10	Repeat steps 8 & 9 (8 times) to make 40 precut condenser cover blanks			44 minutes batch Total

Total Observed Production Time =>

404 minute Total
Batch time for 40 each
Housing & cover units
(10.1 minutes per set)

Area: Housing Production
 Operation: Cut, Size, & Punch

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time

No Scheduled PM or unscheduled downtime experienced on handheld strip cutter

Scheduled PM on power shear

Quarterly: Remove cutting bar each quarter & take to tool shop for sharpening.

This is scheduled in advance by the tool shop and is done during 1st shift. Shear is down until cutting bar reinstalled. Typically takes 4 hrs including remove and install cutting bar.

Changeover: 211 Ton Press has changeover time included in standard work.

punch and die for power connector must be changed when switching from 115vac to 240 vac configuration.

This is done by using wrench to remove existing punch/die set, position new punch/die set to marked location and tighten with wrench. Then manually turning the press flywheel until contact with the punch/die is made to ensure punch and die are correctly positioned before stamping new parts.

Scheduled PM on 211 Ton press

Monthly: check hydraulic oil level & lube shafts/pivots. Inspect air hoses. 30 min.

Quarterly: send out each cutting punch/die set to tool shop for sharpening. 4 hrs includes transport & sharpen time. Only one punch/die set sharpened in any day due to tool shop Resource limitations.

Punch/Die sets only sharpened during 1st shift. Operator is notified in advance by the tool shop and expected to Drop off the set off at beginning of 1st shift. Typically one set is sharpened every 3 weeks.

Unscheduled downtime on 211 Ton press

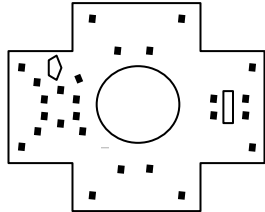
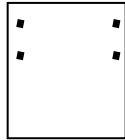
Due to burned out motor, broken hydraulic pump, broken cutter/die, malfunction of clutch, break in air hose.

Typically downtime is fixed within 4 hrs if it occurs during 1st shift except for motor burnout which takes 2 day.

If Breakdown occurs during 2nd shift, press is down until 1st shift when maintenance workers available.

Lead Time

Time through cut & punch operation from beginning of a shift until 1st housing blank and cover blank is available to drill operator is dependent on 40 item batch mode operation.

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Set blank housing piece on worktable. Position a Thin metal template over the blank taking care to align sides flush. Locate & mark holes per housing drawing (26 places) with colored markers. Use spring loaded punch to dimple location of each marked hole to locate start for drill.	Template, sheet steel marking pen, spring punch		2.0 minutes
2	Insert & tighten 3/8" drill bit and Drill 3/8" holes (2) marked in blue	Pneumatic hand drill		0.5 minutes
3	Insert & tighten 1/8" drill bit and Drill 1/8" holes (12) marked in Red	Pneumatic hand drill		0.5 minutes
4	Insert & tighten 3/16" drill bit and Drill 3/16" holes (4) marked in black	Pneumatic hand drill		0.5 minutes
5	Insert & tighten 1/4" drill bit and Drill 1/4" holes (4) marked in green	Pneumatic hand drill		0.5 minutes
6	Insert & tighten 5/16" drill bit and Drill 5/16" holes (4) marked in taupe	Pneumatic hand drill		0.5 minutes
7	Set blank cover piece on worktable. Carefully align thin metal template to mark holes per condenser cover drawing (4 places) and dimple with spring loaded punch. Insert & tighten drill 1/8" bit and drill holes (4)	Template, marker, spring punch, Pneumatic hand drill		1.2 minutes
Total Observed Production Time To drill one set housing & covers =>				5.7 minutes

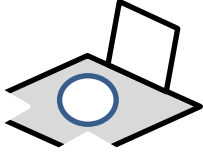
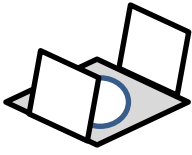
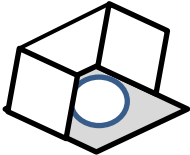
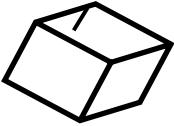
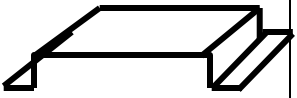
Scheduled PM

Weekly: PM for this small light industrial duty hand drill consists of checking air hose for leaks and Exchanging worn drill bits for sharpened bits at the tool crib. All bits are exchanged whenever operator determines any of them is worn to the point that planned time cannot be met. Typical exchange takes 20 minutes and occurs once a week.

Unscheduled downtime

Caused by broken air hose. Typical time to get maintenance to replace hose is 4 hrs during 1st shift If air hose breaks during 2nd shift, operator crimps hose and secures with duct tape. Drill is down until 1st shift when maintenance workers available

Area: Housing Production
H3 Operation: Bend

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Load flat housing blank and feed 1 st end flap into Box Brake. Ensure blank is square against the stops. Slowly bend until reach bend stop. Remove from Box Brake	Manual Press Pan Box Brake		1.0 minutes
2	Reposition housing blank & feed opposite end flap into box Brake. Ensure blank is square against the stop. Slowly bend until reach the bend stop. Remove from Brake	Manual Press Pan Box Brake		1.0 minutes
3	Reposition housing blank & feed one side flap into box Brake. Ensure blank is square against the stop. Slowly bend until reach the bend stop. Remove from Brake	Manual Press Pan Box Brake		1.0 minutes
4	Reposition housing blank & feed last side flap into box Brake. Ensure blank is square against the stop. Slowly bend until reach the bend stop. Remove from Brake & set on bench	Manual Press Pan Box Brake		1.0 minutes
5	Use test block to test each bend for square 4 sides	Test block		1.0 minutes
6	Form condenser cover using manual press brake. 2 Bends each side of cover. Reposition cover between each bending operation.	Manual Press Pan Box Brake		1.7 minutes

Note: current productions times must be Determined from the factory

Total Observed Production Time =>

6.7 minutes

Scheduled PM

Daily or weekly: No PM is scheduled for this light industrial duty manual press brake.

Monthly: the fingers of the box forming dies are checked and realigned to ensure no problems Will occur when mating housing to baseplate at final assembly. Typical time is 2 hrs.

No Unscheduled downtime.

Area: Housing Production
H4 Operation: Weld

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain formed housing box from WIP and set upside down upon welding table. Apply clamp to hold			0.5 minutes
2	Weld 1 st corner seam from inside of the formed box	TIG welder Fume extraction booth	Welder rate is 12" Per minute	0.5 minutes
3	Reposition the housing to access next corner and Weld 2 nd seam from inside of the formed box	TIG welder Fume extraction booth	Welder rate is 12" Per minute	0.5 minutes
4	Reposition the housing to access next corner and Weld 3 rd seam from inside of the formed box	TIG welder Fume extraction booth	Welder rate is 12" Per minute	0.5 minutes
5	Reposition the housing to access next corner and Weld 4 th seam from inside of the formed box	TIG welder Fume extraction booth	Welder rate is 12" Per minute	0.5 minutes
6	Grind off weld spatter on outside corners of box. 4 places. Reposition box for each grind. Remove welded housing from table and place on WIP pallet	Hand held pneumatic grinder		2.5 minutes
Total Observed Production Time =>				5.0 minutes

Scheduled PM

Weekly per shift: 20 minutes. Obtain new package of abrasive pads or welding rods from tool crib.
Quarterly: Change filters in fume extraction booth and oil fan motors. Allow 2 hrs.

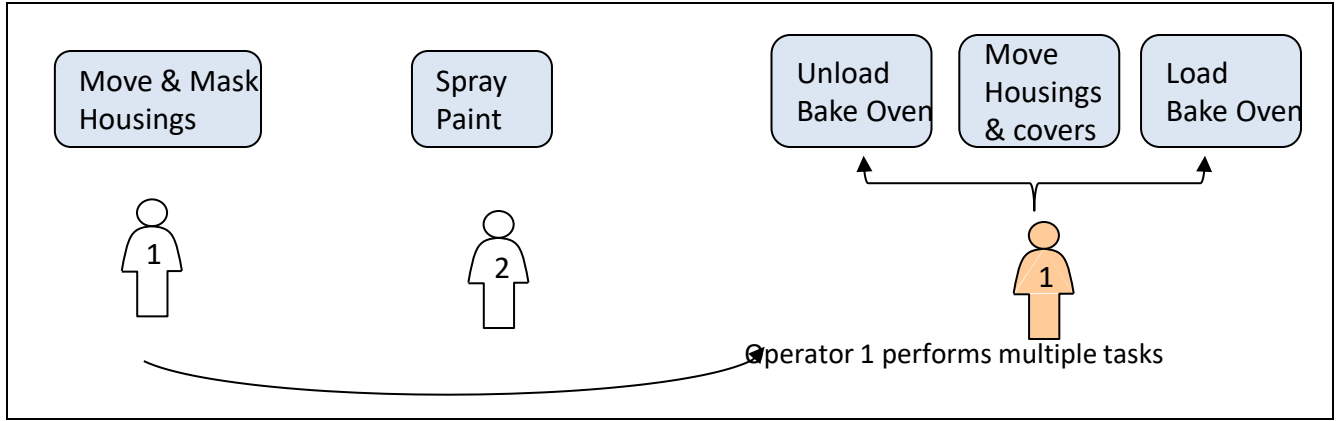
Unscheduled downtime:

Power supply failure in TIG welder or cable failure requires 1st shift maintenance support to fix.
New parts can be shipped in 2 days.

Air hose to grinder can break. Operator calls for maintenance and crimps hose with duct Tape to slow air leakage. Typical time to get maintenance to replace hose is 4 hrs during 1st shift
If air hose breaks during 2nd shift, operator crimps hose and secures with duct tape. Grinder is down until 1st shift when maintenance workers available

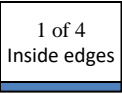
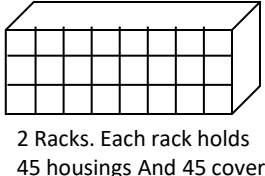
Production Package: Housing Fab & Paint

Paint Area sub-operation details (not to scale):



Housing Paint Operation Workflow																
	7AM							3PM							11PM	6AM
	Shift 1							Shift 2							Overnight	
workhour	1	2	3	4	5	6	7	1	2	3	4	5	6	7		
Bake Oven	Paint Bake hrs 9 - 12														Paint Bake hrs 1 - 8	
Worker 1	Move & Mask Housings.						Unload bake booth & Move to WIP storage.						Load Bake			
Worker 2	Paint Housings						PM	Paint Housings.						PM		

Area: Housing Production
H5 Operation: Move, Mask & Load

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Move housings/covers from fab to paint area. Manual pallet lifter used to pull 8 sets per load.	Manual pallet lifter	Round trip to fab area takes 12 minutes per pallet	1.5 minutes (each set of Hsg/Cover)
2	Mask lower ½" <u>inside</u> edge of 4 sides to ensure conductive interface when attached to baseplate. Stack by paint booth.	½" masking tape roll		1 minutes (each Hsg)
Batch Steps 1 & 2	Repeat steps 1 & 2 to move & mask housings for 1 day planned production while waiting for overnight Bake Oven to be done	Manual pallet lifter & ½" tape roll		Batch operation
3	Unload previous shift housings & covers from Bake booth after 12 hr bake time for overnight batch is done. Unmask and inspect. Place 8 sets of Hsg/Covers on each pallet.	Stack 8 on pallet. 4 each layer with cardboard between layers		1.5 minutes (each set of Hsg/cover)
4	Transport pallet of 8 painted hsgs/Cover sets to store room for semi-clean storage. Each trip takes 20 minute round trip.	Manual pallet lifter	Round trip to storage Area takes 20 min	1.0 minutes (each set)
5	At end of 2 nd shift load Bake Booth with batch of painted wet housings & covers. Bake Booth holds up to 90. Start timer to Bake housings 12 hrs at 125 deg F	Bake Booth with temp control & timer. 2 racks & 1 aisle.		0.6 minutes (each set of Hsg/Cover)

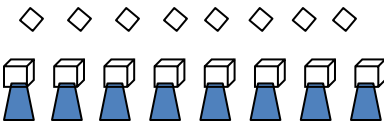
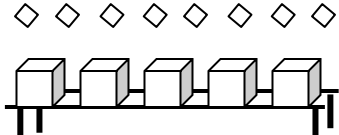
Total Observed Production Time =>

5.6 minutes
Per housing & cover set

Scheduled PM
Quarterly: None

Unscheduled downtime: None.

Area: Housing Production
H6 Operation: Paint Housings

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Load Paint booth. Move batch of 8 housings into booth & place on individual paint stands. Move batch of covers into booth & hang from rod..			8 minutes (batch of 8) Housings & covers
2	Spray Paint top & 4 sides each housing by walking around each. Paint both sides each cover. Paint time 6 min ea set of housing & covers	Overspray booth with powered Vent system. Protective garb.		22 minutes (batch of 8)
3	Unload Paint Booth. Move 8 wet paint housings to area outside Bake booth. Pickup by bottom edge. Move 8 wet covers and hang from rods.	Special racks hold painted housings & covers		8 minutes (batch of 8)
4	At end of each shift, purge paint lines and clean paint nozzles. Next shift can change paint color if needed.			30 minutes* Total Once per shift

Total Observed Production Time =>

42 minutes for batch of 8*
*does not include line purge

Average time per unit = 5.2 minutes

Changeover Time

Paint booth has changeover time when paint color selection is switched. Changeover includes purging current paint from spray system lines & hoses. Then Switch sprayer to different can of paint. Remove and switch to a clean spray nozzle. Currently paint selection is only changed is at beginning of each shift since lines, hoses, nozzles are purged and cleaned at end of each shift. Therefore new shift can start with any color. Changeover time 30 min.

Scheduled PM

Daily: Standard work includes 30 minutes to clean nozzles & purge Paint lines, hoses at end of each shift.

Weekly: Change filters in paint booth ventilation system. 30 min. to obtain and replace.

Weekly: Check pressure regulators, drain water from compressor air tank, detail clean nozzles & hoses. 30 min

Quarterly: Calibrate pressure gage . Oil motor on vent fan. 4 hrs

Unscheduled downtime

Paint nozzles can clog at any time during day. 30 min to purge lines and clean nozzle.

Central compressed air goes down if major system leak occurs. Typical time to repair is 4 hrs during 1st shift.

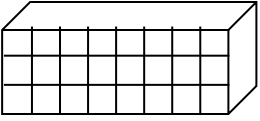
No Repair during 2nd shift since maintenance is not available.

Ventilation fan motor burnout. Repair takes 2 days to overnight express a replacement motor.

Lead Time

Due to one day batch operation for Bake, painted housings & covers stack up during shift 1 & 2 before going into Bake Booth. Paint bake dry takes another 12hrs.

Area: Housing Production
H7 Operation: Paint Bake

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	At end of 2 nd shift Start Bake Booth with contains batch of painted wet housings & covers. Bake Booth holds up to 90 sets Housings/covers. Start timer to Bake housings 12 hrs at 125 deg F	Bake Booth with temp control & timer. 2 racks & 1 aisle.	 <p style="text-align: center;">2 Racks. Each rack holds 45 housings And 45 covers</p>	12 hrs for Batch of 110 Hsg/Cover sets

Total Observed Production Time =>

Average 6.7 minutes
Per housing & cover set
When 12 hour bake
with batch of 110 sets

Scheduled PM

Quarterly: Check Bake booth temp & timers. 2 hrs

Unscheduled downtime

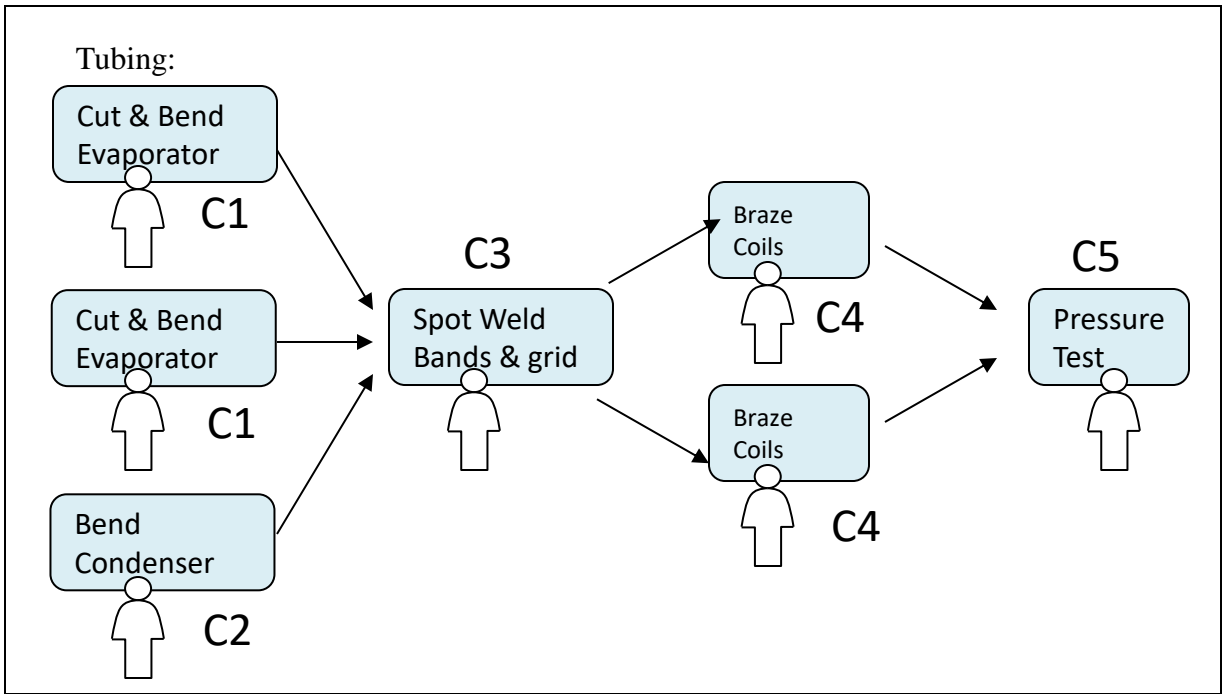
One of multiple Electric heating elements in Bake booth burns out.
Repair takes 2 days to overnight express a replacement.

Lead Time

Bake booth is turned on at end of 2nd shift so 8 hrs of bake occur overnight.
Paint bake continues during 4 hrs of 1st shift since bake needs total of 12hrs.
Unload, unmask, inspect & transport one set of 8 housings to Store room takes another 40 min.

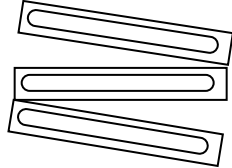
Production Package: Cooling Coils

Work Area Schematic (not to scale):



Design Drawing 987-87564-274A, Coil Assembly

Area: Cooling Coil Production
C1 Operation: Cut & Bend Evaporator Tubing

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Take 8' length of tubing stock from storage rack. Measure with tape measure. Cut to 4 ft length and place into pallet box	Tape measure. Rotary Chop saw		1 minute
2	Remove tubing stock from pallet box. Install cleaning hoses to each end. Turn on cleaning machine and allow to run for two cycles to steam flush tube of all debris, oil, contaminants. Remove hoses	Steam cleaning machine. Each cycle is 1 minute.		1.5 minutes
3	Bend tube using bending jig. Prior to bend each bend area is heated with a torch to make it more pliable. 5 bends needed.	Manual Custom bending jig		6 minutes
4	Mark exact final tubing length by applying a marking jig to ends while still in the bending jig. Cut off excess tubing both ends.	Marking jig, marking pen Manual tube cutter		2 minute
5	Visual check: ensure no crimping at bend points.			0.5 minute

Total Observed Production Time* => 11.0 minutes

Scheduled PM

Daily: 1st shift operator turns up temp and pressure gages on Steam cleaning machine and checks Water level. It takes 10 minutes for Steam cleaner to achieve temperature.

Machine is set to "off shift temperature & pressure levels" at end 2nd shift each day.

Weekly: Clean reusable contaminant filter on Steam cleaning machine. Check hoses. 20 minutes

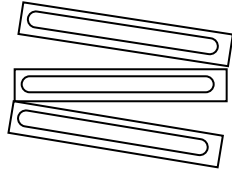
Quarterly: Replace abrasive cutting disc on rotary chop saw since it is essentially used up. 30 minutes.

Unscheduled Downtime

Abrasive Cutting disk for rotary chop saw breaks unexpectedly. Obtain replacement at tool crib. 30 minutes
Steam clean heat element burns out. Replacement obtained in 2 days overnight..

Scrap: Average scrap rate of 2% is encountered due to tube crack & crimping at bend points

Area: Cooling Coil Production
C2 Operation: Bend Condenser Tubing

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Take 8' length tubing stock from pallet box. Install cleaning hoses to each end. Turn on cleaning machine and allow to run for two cycles to steam flush tube of all debris, oil, contaminants. Remove hoses	Steam cleaning machine. Each cycle is 1 minute.		1.3 minutes
2	Bend tube using bending jig.. Total of 11 bends needed. Condenser bends are much wider than evaporator. No preheat with torch is needed.	Manual Custom bending jig		3.0 minutes
3	Visual check: ensure no crimping at bend points.			1 minute

Total Observed Production Time* => 5.3 minutes

Scheduled PM

Daily: 1st shift operator turns up temp and pressure gages on Steam cleaning machine and checks Water level. It takes 10 minutes for Steam cleaner to achieve temperature.

Machine is set to "off shift temperature & pressure levels" at end 2nd shift each day.

Weekly: Clean reusable contaminant filter on Steam cleaning machine. Check hoses. 20 minutes

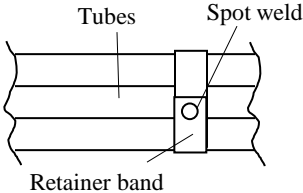
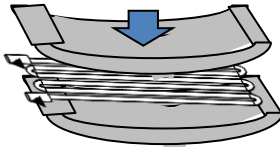
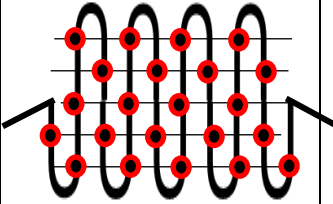
Quarterly: Replace abrasive cutting disc on rotary chop saw since it is essentially used up. 30 minutes.

Unscheduled Downtime

Abrasive Cutting disk for rotary chop saw breaks unexpectedly. Obtain replacement at tool crib. 30 minutes
Steam clean heat element burns out. Replacement obtained in 2 days overnight..

Scrap: Average scrap rate of 2% is encountered due to tube crack & crimping at bend points

Area: Cooling Coil Production
C3 Operation: Spot Weld Bands & Grids

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Take Evaporator coil from bin; wrap retainer bands around bent tubing, secure with spot weld. Two places, for each tubing bundle	Spot welder		2 minutes
2	Place banded coils into fixture and bend entire coil assembly to match the curved contour of the detector	Manual custom bending jig		2.5 minutes
3	Take Condenser coil from bin along with 5 grid wires. Lay into fixture. Spot weld grids to the coils in alternating pattern. Total of 22 spot welds depicted in diagram	Manual custom bending jig		4.7 minutes

Total Observed Production Time* => 9.2 minutes

PM Schedule

Daily: Inspect welder tips 5 minute. Replace as needed. 30 min to obtain replacement set of tips.
Weekly: None
Quarterly: None.

Unscheduled Downtime

Spot Welder power supply burnout. Allow 2 days for replacement.

Area: Cooling Coil Production
C4 Operation: Coils Braze

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Place banded evaporator coil assy in fixture. Clean tube assembly ends. Apply flux to end of each tube.	Fixture		0.5 minutes
2	Get 2 compression connectors from bin. Clean and slide on each tube end. Apply more flux to area to be brazed..			0.5 minutes
3	Braze: Warm each connector with torch. braze by run solder 360 degrees around each compression fitting.	Torch brazer, flux & braze filler. Ventilation hood		1.5 minutes
4	Reposition coils in fixture. Flux the areas where 4 mounting nuts are to be brazed to the tube assembly. Get 4 mounting nuts from bin & position..			0.5 minutes
5	Braze 4 mounting nuts to tubes... Let cool before removing.	Torch Brazer and flux & braze filler		2.0 minutes
6	Place condenser assy in fixture. Repeat steps 1 – 5 for condenser as was done for the evaporator	Torch Brazer and flux & braze filler		3.0 minutes

Total Observed Production Time =>

8.0 minutes

Scheduled PM

Daily: Torch tip needs to be cleaned out occasionally when operator does not have "good" flame. This takes 5min with a small gage piece of wire and occurs once a shift typically.

Weekly: Acetylene and oxygen tanks must be replaced when they run out. Tank swap takes 30 minutes since tanks must be obtained from safety storage area out by the loading docks and moved with a special hand truck made for gas cylinders.

Weekly: Replenish braze filler or flux with a run to the tool crib which takes 15 minutes.

Quarterly: Replace ventilation hood filter. Also oil fan motor. 2 hrs.

Unscheduled Downtime:

Caused by regulator failure or tank changeover that results in gas leak due to cross threading of regulator connection. If this occurs, someone is sent to a local welding and gas supply shop for replacement hardware.

Downtime can be 4 hrs during 1st shift or entire 2nd shift since gas supply shop not open after 5pm.

Area: Cooling Coil Production
C5 Operation: Pressure Test

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Take banded evaporator coil assembly from bin, load onto test machine. Connect pressure hoses to both ends of coil assembly.			0.5 minutes
2	Run pressure tester through cycle, observing pressure readings. If falling pressure indicates a leak use sudsy water to locate source of leak and mark	Custom pressure test machine		1.5 minutes
3	Take condenser coil assembly from bin, load onto test machine. Connect pressure hoses to both ends of coil assembly.			1.0 minutes
4	Run pressure tester through cycle, observing pressure readings. If falling pressure indicates a leak use sudsy water to locate source of leak and mark	Custom pressure test machine		2 minutes

Total Observed Production Time =>

5 minutes

Scheduled PM

Daily: None.

Weekly: None.

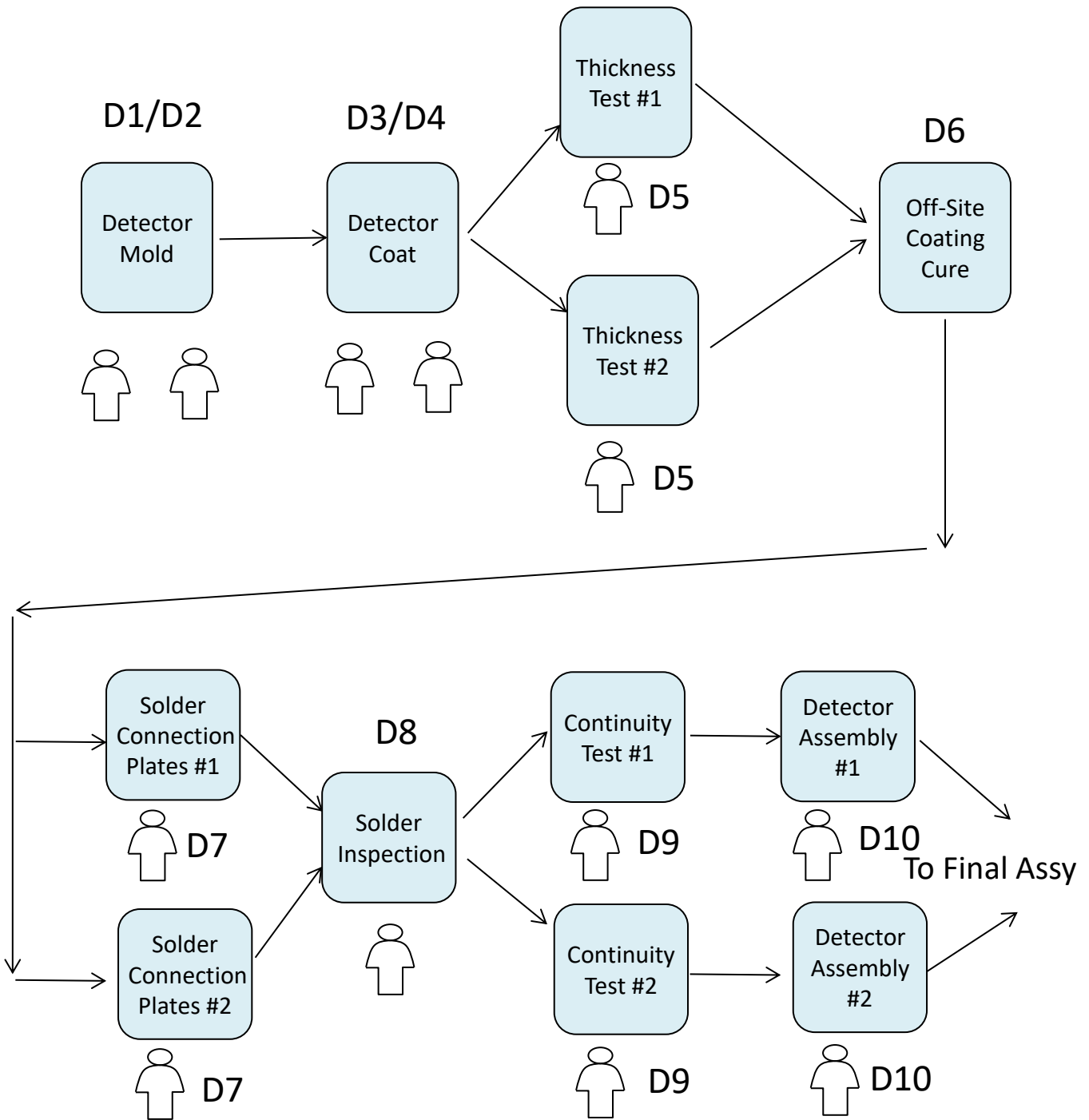
Quarterly: Oil pump motor on pressure tester. Check hoses for cracks. 1 hrs.

Unscheduled Downtime:

Pressure tester pump may fail or tester hoses may crack and develop leaks.

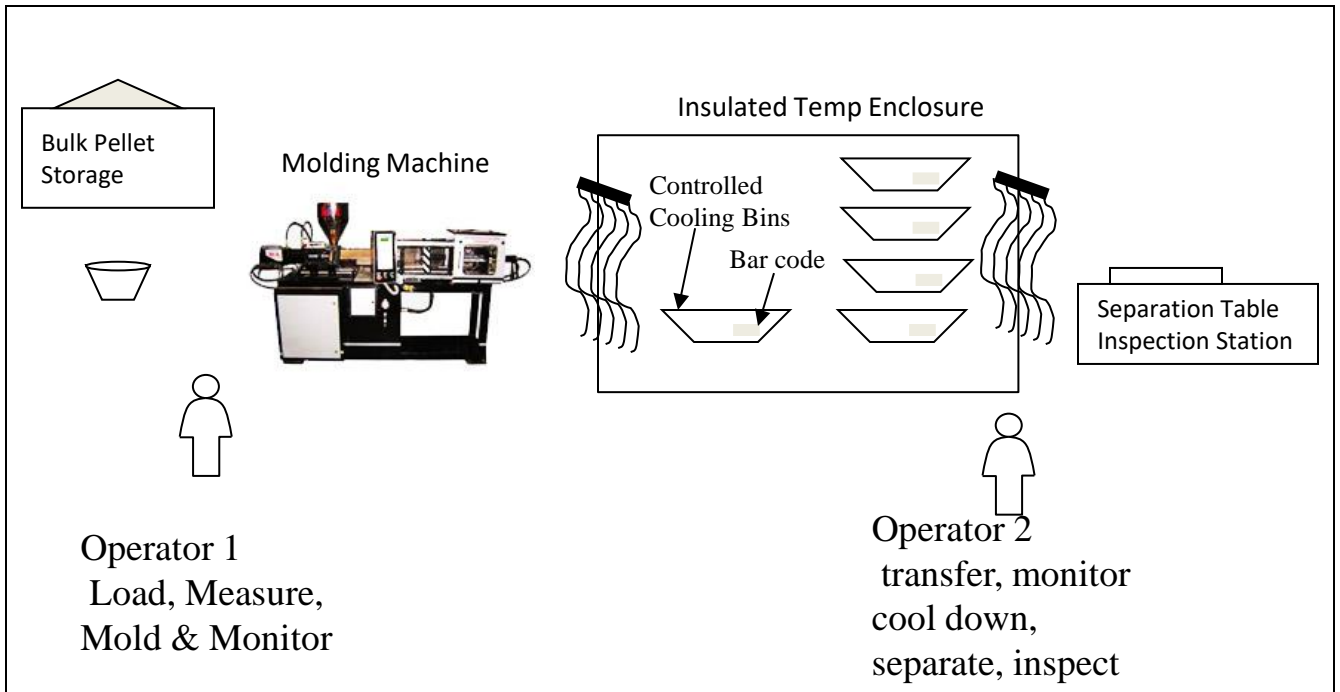
Replacements must be rush ordered. Expect 2 days downtime.

Detector Manufacturing Steps



Production Package: Detector Molding

Work Area Schematic (not to scale):



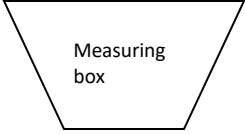
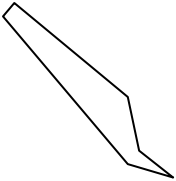
Process Description:

The Detector Molding Production area utilizes two operators to produce plastic detector cores to exacting specifications. Each molding machine cycle produces two detector cores which must be separated. These cores are later coated with optical coating (O2X2). To achieve the smooth finish required for proper flow and bonding of coating, cores must be allowed to cool slowly until the detector core temperature gets down to between 98 and 103 degrees F. If the detector cores are allowed to cool too fast, the surface develops microscopic irregularities that affect both the flow and bonding of the subsequent coating operation.

The exacting standards for flatness and uniformity of cores required extensive customization of the Baxter 5000 molding machine. This is not a simple injection mold process. The properties of the core significantly impact the properties of the finished detector.

Cooling time, rather than a simple external temperature measurement, is used as the control variable for cores to move through the process. The heat inertia of the core is a critical control variable to ensure each detector core surface is properly prepared for the next operation (coating) and is best assessed from cooling time.

Area: Detector Molding
D1 Operation : Load, Measure & Monitor

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Measure pellets using measuring box. Weigh and load directly into mold hopper for each mold operation. Each mold operation creates 2 detector blanks.	Measuring box		1.0 minutes
2	Initiate the preheat cycle to melt the raw pellets in preparation for molding	Baxter 5000 molding machine		3.0 minutes
3	Initiate molding cycle. Monitor gauges and make adjustments as necessary to keep molding temperature and time within spec	Baxter 5000 molding machine		5.7 minutes
4	Initiate cooling cycle of mold. Once mold temp is below 135 deg F, activate ejector to separate the mold/die. Carefully remove the interconnected dual part from mold & place on transfer rack for Operator 2 to take.	Baxter 5000 molding machine. Protective gloves. Removal tool.		3.7 minutes

Total Observed Production Time =>

13.4 minutes
(for 2 parts)

Scheduled PM

Daily (each shift): Check hydraulic pump and cooling water pressures & clean mold hopper. 10 minutes

Weekly: Check level of hydraulic fluid. Inspect hydraulic hoses for leaks. 15 minutes.

No PM done on heater which heats lexan pellets.

Quarterly: Swap out mold/die to ensure highest quality detector part smoothness. Exchange at tool crib.

4 hr to remove, exchange, install. Tool room inspects mold/die, cleans and hones surfaces.

Operators monitor gages and adjust temp up/down based on experience and feel for process. One Operator compared running the molder to roasting coffee where current humidity and air temp affects the result.

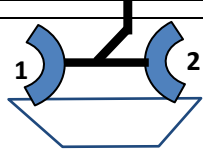

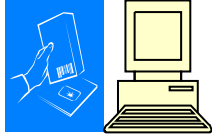
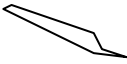
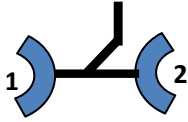
Unscheduled Downtime

Molder can breakdown due to loss of hydraulic pressure (pump, hose, low fluid), loss of cooling water (low line Pressure or hose issue), heater problem (burnt out element). Repair time for hoses is 4 hrs during 1st shift.

Problems during 2nd shift must wait until 1st shift maintenance. Molder is down until then.

Hydraulic pump failure or heating element failure takes 2 days since parts must be ordered.

Area: Detector Molding
D2 Operation : Separate, transfer, and monitor

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Place each dual core from molding machine into cooling bin. Parts can not be separated until the molds are cooled to 100 deg	Heat resistant gloves, cooling bin		1 minutes
2	Move cooling bin into insulated controlled temp enclosure. Swipe bar code on each bin to register start of cooling time.	Bar code reader connected to computer and time clock		1.5 minutes
3	Monitor cooling time & move cooling bin from controlled temp enclosure after bar code swipe shows sufficient cooling time has occurred. Time to cool is 30 minutes +/- 2 min. Place bin on separation table.			1.5 minutes
4	Separate each detector core from mold interconnect waste using separation tool. Great care is needed to ensure detector surface is not marred prior to curing.	Separation tool 	 Molded detector cores	4.4 minutes
5	Place each detector core onto inspection fixture & visually inspect			2 minutes
6	Place each detector core into transportation box and stack in pallet box	Open transport box holds 24 detector blanks	Box is 18" x 24"	1 minutes

Total Observed Production Time =>

11.4 minutes
(2 cores)

Scheduled PM.
None

Unscheduled downtime:

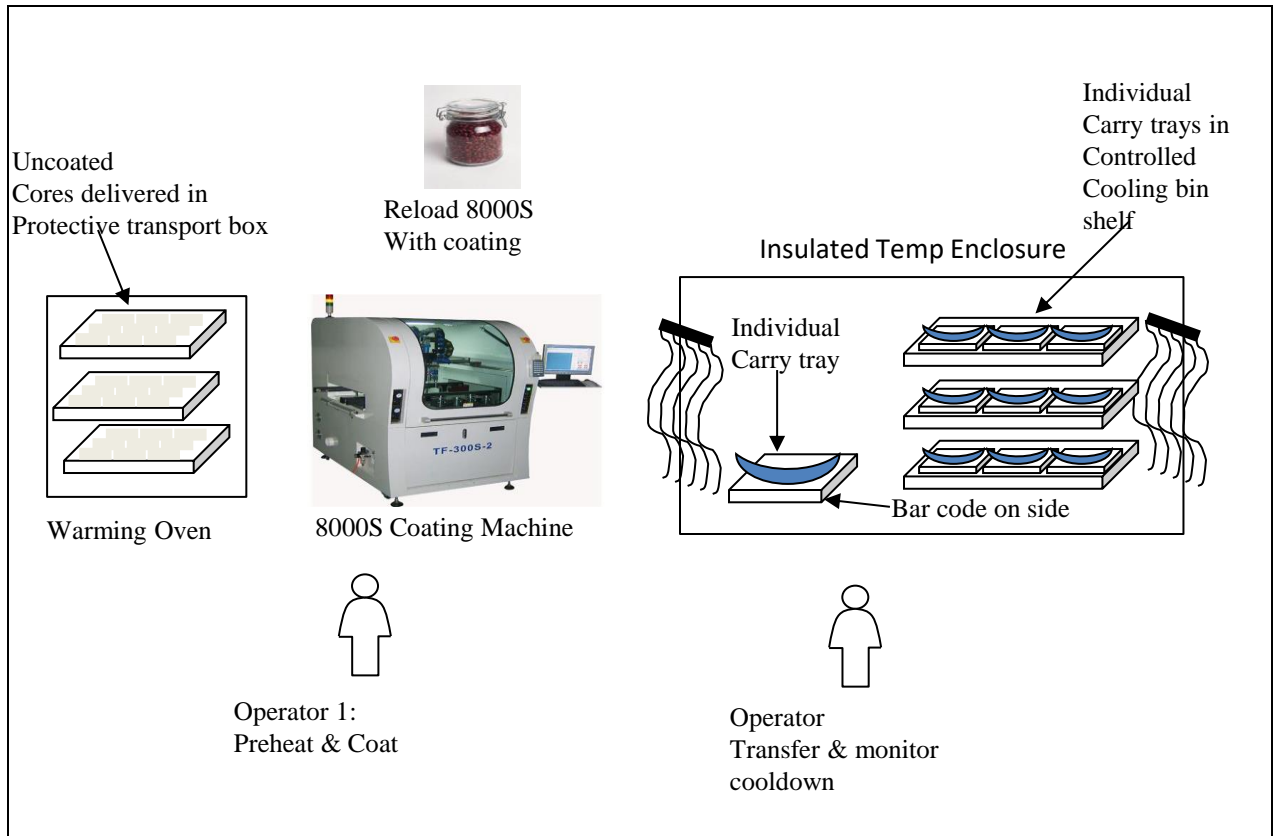
Computer hangs up. Typical Fix by reboot in 10 min. Bar code unit failure or computer dies. Call Tech support during 1st shift. Response by Techs may be up to 4 hrs. No support during 2nd shift.

If bar code reader can't be fixed at the station within 30 min, tech support will obtain a working Replacement unit from their store room. This takes another hour for bar code reader.

If Computer can't be fixed at the station within 30 min, tech support will replace it with a backup. This takes another 2 hrs since SW needs to be loaded & Verified.

Production Package: Detector Coating

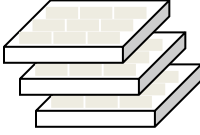
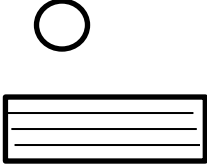

Work Area Schematic (not to scale):



Process Description:

The Detector Coating Production area utilizes two operators to coat plastic detector cores with optical coating. For proper flow and bonding of coating, the uncoated cores must be preheated to 135 deg F and stay above 125 deg during the coating process and coated detectors must then be slowly cooled to 105 deg to “fix” the coating. Cooling should be done at rate that does not exceed 10 deg per hour. If detectors are subjected to normal jarring that occurs during transport before they become “fixed”, the coating thickness can be disturbed which results in thickness variations.

Area: Detector Coating
D3 Operation : Preheat and Coat

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
Background	Load boxes of uncoated cores into 135 deg Preheat oven. Each protective transport box has 12. Preheat oven holds 3 boxes. Each box should be warmed for minimum of 1 hr	Preheat Oven		0.5 minutes per box. Overlaps with Step 2
1	Verify coat thickness setting and deposition rate on 9000S. Open preheat oven, take one core and Load into 8000S coating machine being careful to position level and center in the chamber	Hand Protection Metal holding Ring Plastic Level guide		1.0 minutes
2	Start coating process. Monitor gauges, make adjustments to keep coating temperature and time within specs. While 8000S is coating, load boxes of uncoated cores into Preheat oven as needed to keep filled	8000s coating machine		3.5 minutes Machine cycle For 0.01325 Inch coating
3	Unload coated detector from 8000S. Place in individual carrying tray.	Gloves Individual Carrying Tray		0.5 minutes
Total Observed Production Time =>				5.5 minutes

Scheduled PM




Daily (each shift): Check preheat oven temp & check coating powder level. 10 minutes
 Monthly: oil 8000S vacuum pump motor. Inspect vacuum hoses for leaks. 15 minutes.
 No PM done on preheat oven.

Operators monitor gages and adjust temp up/down based on experience and feel for process. One Operator compared running the 8000S to baking bread from scratch.

Unscheduled Downtime

8000S can breakdown due to loss of vacuum pressure (pump, hose), heater problem (burnt out element). Repair time for hoses is 4 hrs during 1st shift.
 Problems during 2nd shift must wait until 1st shift maintenance. 8000S is down until then.
 Vacuum pump failure or heating element failure takes 2 days since parts must be ordered.

Area: Detector Coating
D4 Operation : Transfer and Monitor

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Transfer each individual carrying tray into the insulated temp enclosure. Place into cool down bin. Swipe bar code to record start of cooling time.	Bar code reader connected to computer		2.3 minutes
2	Monitor cool down times of all individual detectors with interim bar code swipes and rotate the carrying trays based on time in the cool down enclosure.	Bar code reader connected to computer		2 minutes
3	When a coated detector achieves prescribed 2 hr cooling time Swipe bar code again to record end of cooling time. Move the detector carry tray out to the WIP transport box	Bar code reader connected to computer		1 minutes

Total Observed Production Time =>

5.3 minutes

Scheduled PM.

Daily Each Shift: Record temperature of insulated temp enclosure on daily log sheet. 5 minutes.

Unscheduled downtime:

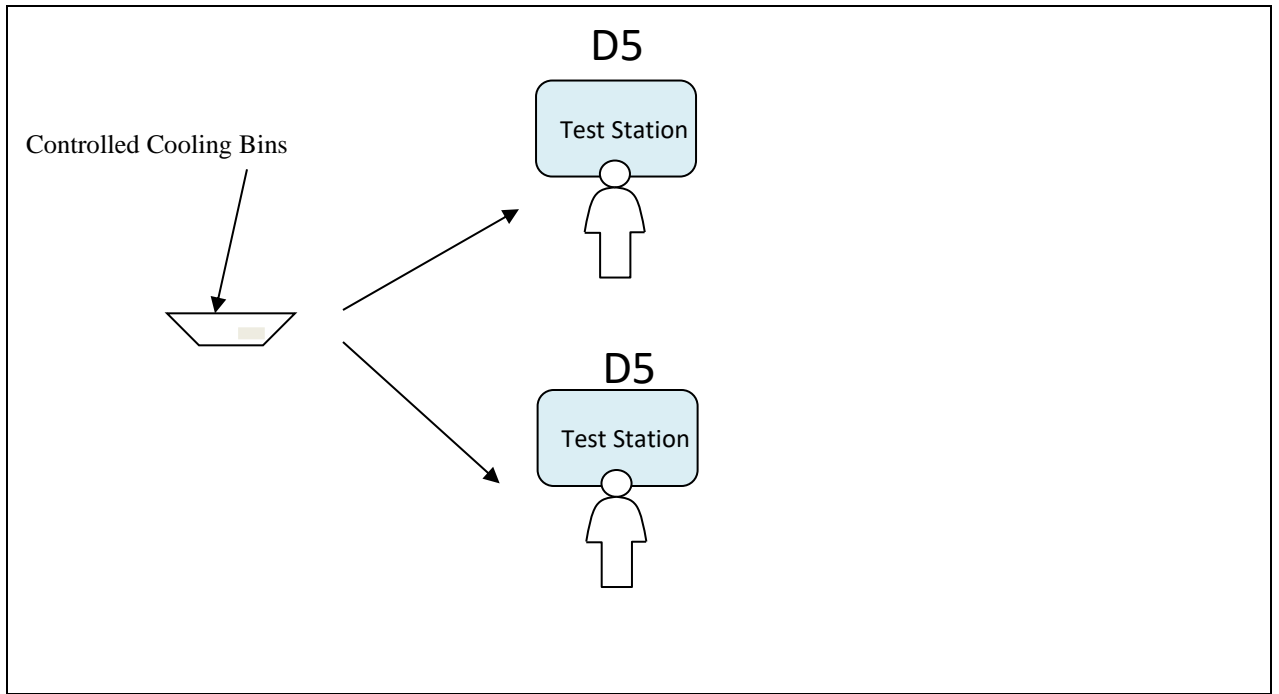
Computer hangs up. Typical Fix by operator with a reboot in 10 min. If not, call tech support.

Bar code unit failure or computer can't be fixed with reboot. Call Tech support during 1st shift. Response may be up to 4hrs. No support during 2nd shift. If can't be fixed by tech support at the station, tech support will obtain a working replacement unit from their store room. This takes another hour for bar code reader.

Computer replacement with backup unit takes another 2 hrs since SW needs to be loaded & Verified.

Production Package: Detector Thickness Test

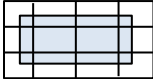
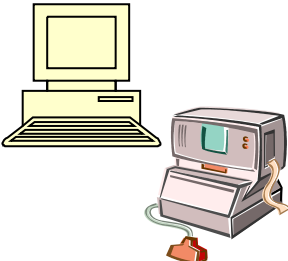
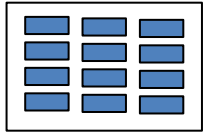
Work Area Schematic (not to scale):



Process Description:

Perform multiple, detailed measurements to ensure proper coating thickness across the entire surface of the detector.

Area: Detector Thickness Test
D5 Operation: Thickness Test

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Remove coated detector from individual carry tray. Place each detector on measurement bench and position grid fixture over each.	Grid fixture	 Grid fixture over a detector	1 minutes
2	test thickness in multiple areas per engineering specifications. One measurement is made in each of the grid areas (total 12 measurements per detector)	Computer controlled Optical Film Thickness measurement system		11.4 minutes
3	Remove tested detector from measurement bench and place in special shipping case that prevents damage to sensitive coating.	Shipping box with foam indentations for 12 coated detectors		1 minutes
Total Observed Production Time =>				13.4 minutes

Scheduled PM:

Quarterly: calibrate the integrated spectrometer system using known thickness standards consisting of certified coated plates. Calibration is done during 1st shift in the temperature controlled Calibration lab.

Calibration is scheduled by the lab in advance and takes 4 hrs from pickup to return.

Due to resource limitations, only one system can be calibrated at a time so the two thickness measurement systems are scheduled for calibration on different days.

Unscheduled downtime

Spectrometer Lamp burnout. Fix is obtain replacement from Cal lab. If Cal lab is out of lamps, equipment is down for 2 days while replacement is ordered. Also computer system hang ups occur on regular basis which is Usually fixed by operator with a system reboot in 10 minutes. If computer dies IT tech support is needed Which can take up to 4 hrs during 1st shift depending on their workload. No tech support is available during 2nd shift. Computer can be replaced by tech support with a working spare from tech support lab. Set up a new computer with SW reload takes another 2 – 3 hrs including measurement system verification.

If measurement system goes down, there is no replacement available.

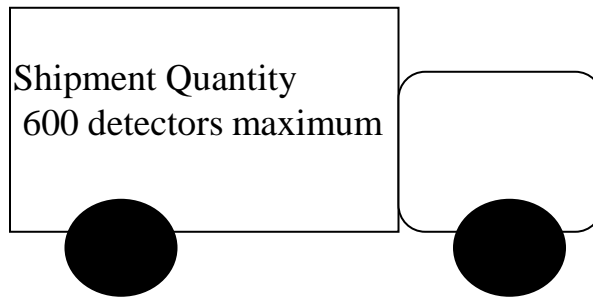
IT will work with vendor to fix or order a replacement. Takes 1 to 4 days.

Production Package: D6 Off-Site Curing Process

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Cure coated detectors in oven for 6 hours. Batch size is 50 maximum. There is a 1 hour changeover between batches to load/unload oven.	Vendor curing oven	Note: Curing oven involves heat & UV light cycles. Curing batches occur twice per day. 6 days a week.	260 minutes (4.3 hrs) for each batch size up to 50.

Average Observed Time per cured Detector =>

5.2 minutes



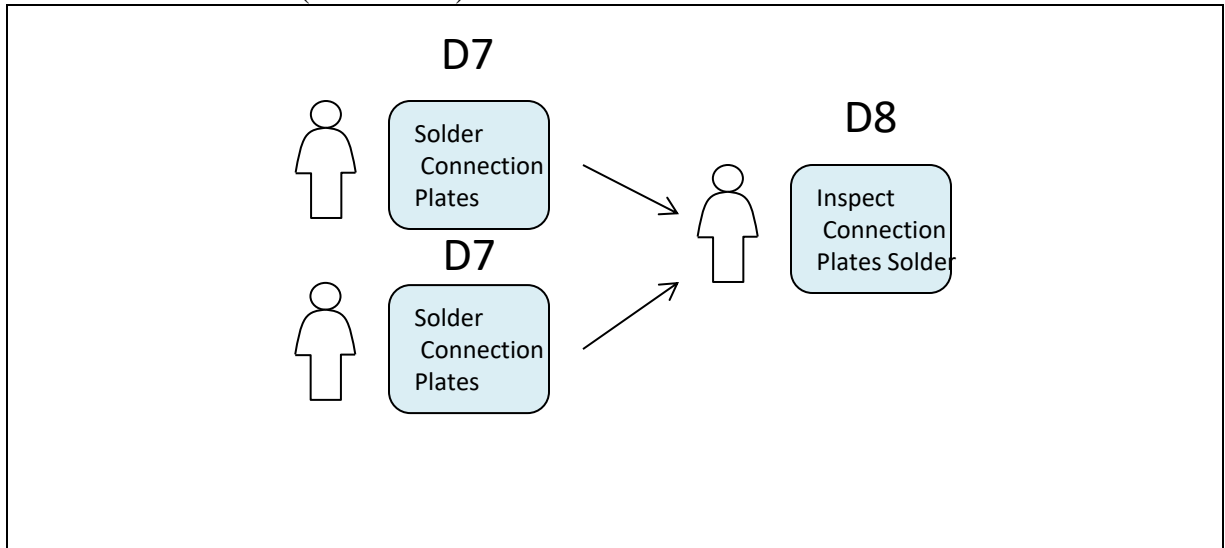
Shipment Frequency = Weekly

Note: Truck arrives on Monday with completed detectors from prior week. Returns to vendor with current week production (up to 600 detectors max) ready for final curing.


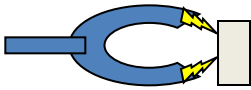
Time for off site curing operation is 1 week
Which equals 6 Parck working days.

Production Package: D7 Detector Soldering

Work Area Schematic (not to scale):



Area: Detector Soldering
D7 Operation: Solder Connection Plates

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain two connection plates and two lead wires from bins.			0.5 minutes
2	Place connection plates in holding fixture, scribe center of plate, and solder lead wires to center of each plate.	Electric Soldering iron		2 minutes
3	Attach BNC connectors to free ends each lead wire by crimping.	Manual Pin crimp tool		2 minutes
4	Place detector in plate soldering fixture under ventilation hood.		 Fixture	1 minutes
5	Solder connection plates to detector coating. Place on inspection rack when cool enough to handle.	Dual end gas Soldering torch, flux & silver solder	 Dual Torch	5.1 minutes

Total Observed Production Time =>
Per worker.

10.6 minutes

Scheduled PM

Daily: torch tip needs to be cleaned out occasionally when operator does not have "good" flame. This takes 5min with a small gage piece of wire and occurs once a shift typically.

Weekly: Acetylene and oxygen tanks must be replaced when they run out. Tank swap takes 30 minutes since tanks must be obtained from safety storage area out by the loading docks and moved with a special hand truck made for gas cylinders.

Weekly: Only one roll of silver solder is kept at workstation due to its high cost. When operator gets low on solder a run to the tool crib is made which takes 15 minutes.

Quarterly: Replace filter in ventilation hood. Oil fan motor. 2 hrs.

Unscheduled Downtime:

Caused by regulator failure or tank changeover that results in gas leak due to cross threading of regulator connection. If this occurs, someone is sent to a local welding and gas supply shop for replacement hardware.

Downtime can be 4 hrs during 1st shift or entire 2nd shift since gas supply shop not open after 5pm.

Area: Detector Soldering
D8 Operation: Inspect Solder Connections

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain soldered detector and secure into inspection fixture.	2 axis moveable fixture		1 minutes
2	Inspect soldering of lead wire to each connection plate.	4X magnifier with light		1 minutes
3	Inspect soldering of each connection plate to detector to ensure no gaps in bead around entire connection plate. Inspect for cracks in detector coating	6X magnifier with light		2 minutes
4	Inspect BNC on end of each lead wire and physically mate with male BNC on inspection fixture to assure mateability.			0.7 minutes
5	Affix inspection stamp to detector if pass. Tag if fail and return to soldering station.			1.0 minutes

Total Observed Production Time =>
Per worker.

5.7 minutes

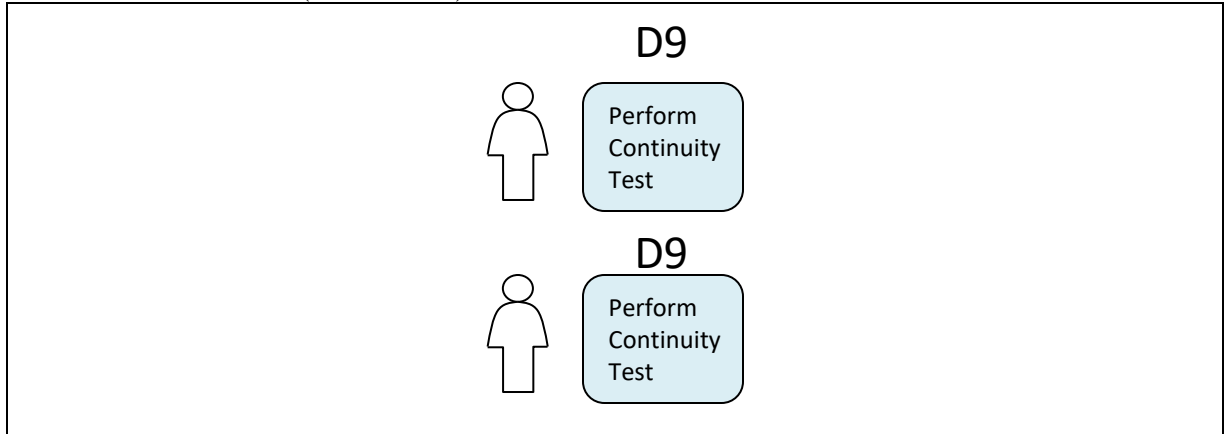
Scheduled PM
None

Unscheduled downtime:

Light on magnifier can burn out. Replacement lamps available from the store room. Down time is usually 20 minutes to retrieve lamp and replace. However, there are times when store room has no lamps. Operator must obtain and rig up temporary light source which takes another hour. When replacement bulb is obtained, allow 20 min to fix.

Production Package: Continuity Test

Work Area Schematic (not to scale):



Area: Continuity Test
D9 Operation: Continuity Test

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain an inspected soldered detector and connect to continuity test fixture.	Test fixture with "gold" EPU and precision potentiometer to create Variable production quality light source.		2 minutes
2	Perform continuity check of each connection plate individually. Record measured results in test data sheets	Precision volt-ohmmeter		1.4 minutes
3	Perform an end to end check on the Detector. Record measured results in test data sheets. Data collected from EPU at full lumens, +/- 5%, +/- 10%			7 minutes
4	Affix test pass stamp to detector if pass. Tag if fail and return to soldering station.			1 minutes

Total Observed Production Time =>
Per worker.

11.4 minutes

Scheduled PM

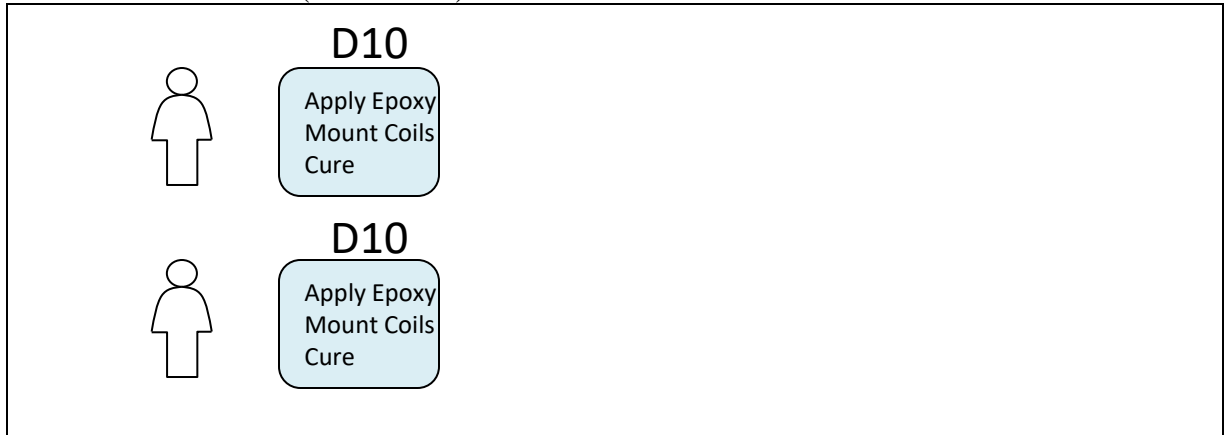
Quarterly: Calibrate precision voltmeter & variable Potentiometer used to control the light source. Since these items are in use each Shift, calibration is scheduled in advance. The Cal lab takes 4 hrs (from pickup To return) for each item. Due to resource limitations at Cal lab, only one Item can be calibrated at a time. Therefore calibration is scheduled for different days.

Unplanned downtime

Lamp or EPU may fail. Go to Cal lab for replacement. 30 minutes. If no replacement lamps available go to Raw Material Store Room and complete forms allowing production asset to be "borrowed". Allow extra 1.5 hrs for approvals. If any instrument cannot be correctly calibrated the Cal Lab attempts to fix. If instrument is still under warranty It will be returned to vendor and arrangements made for a loaner. If no warranty the device has to be replaced. Either way downtime can likely exceed 2 days.

Production Package: D10 Detector Assembly

Work Area Schematic (not to scale):



Design Drawing: 987-87564-274A

Area: Detector Assembly
D10 Operation: Epoxy, mount coils, cure

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain epoxy fixture. Scrape out residual epoxy from prior use.			3 minutes
2	Take detector from bin. Put with coating side down in epoxy fixture. Get tube of 431-R epoxy			1 minutes
3	Squeeze entire tube contents across backside of detector. Use spatula tool to spread epoxy and achieve uniform depth across whole plate.			5.3 minutes
4	Obtain cooling coil and place on epoxy. Apply steady pressure to push the coils into the epoxy and firmly seat the coils against the detector surface			3 minutes
5	Inspect epoxy to ensure it uniformly oozes in between each coil. Correct where not uniform			3 minutes
6	Place entire holding fixture with detector assembly onto curing storage rack.			1 minutes
7	Start 10 hr timer attached to the drying rack.			0.5 minutes

Total Observed Production Time =>
Per worker.

16.8 minutes

Scheduled PM
None

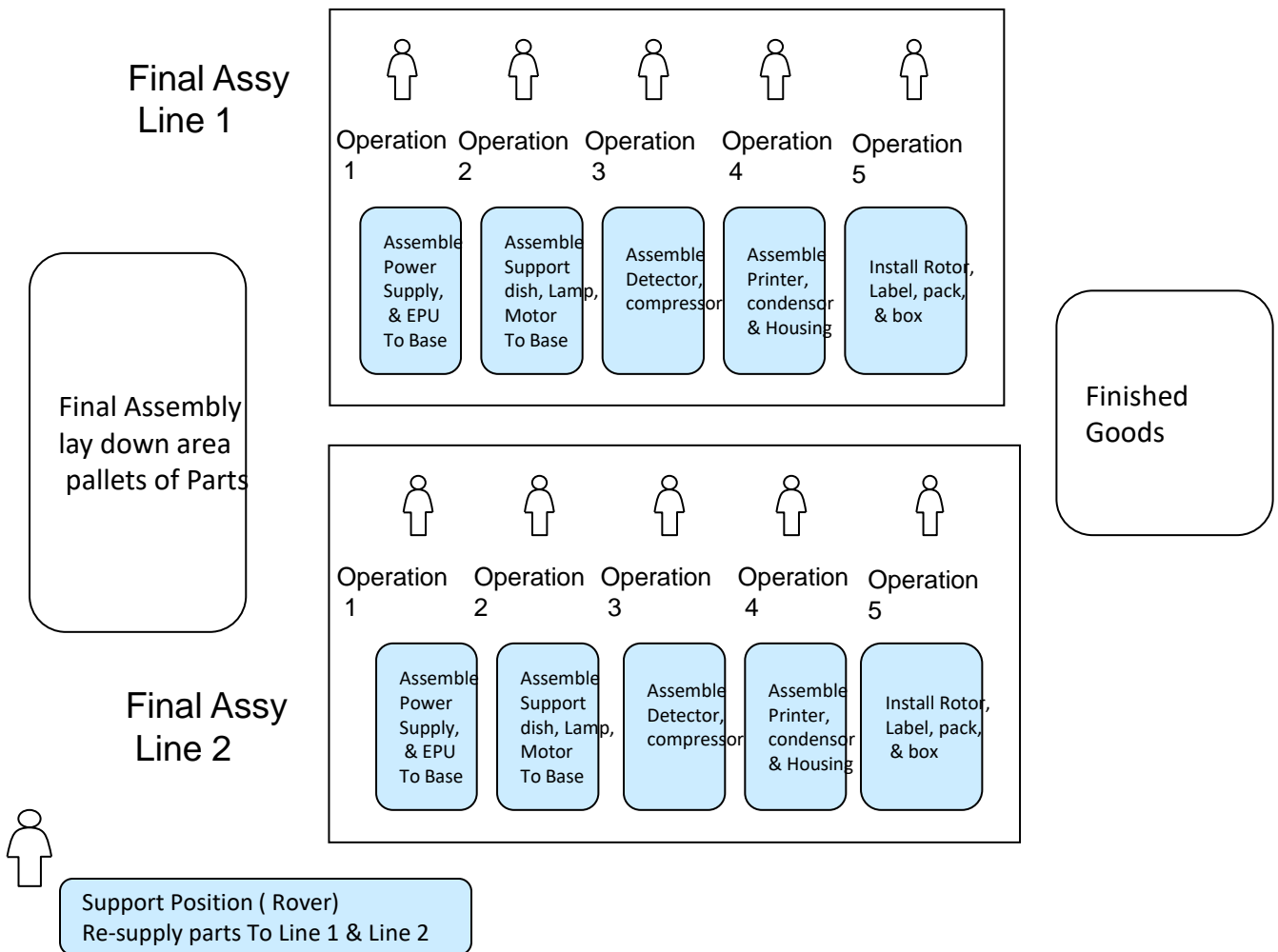
No Unscheduled downtime: If timer fails, operators just write down time and use a clock or watch while a supervisor runs out to Local hardware store to buy a replacement timer.

Summary of Final Assy Operations

Assembly Operation	Components Utilized	Cables/Hoses
Operation 1 FA1	Base Plate, feet Power Source EPU	Cable C1 EPU/PS Cable P4 PS/EPU
Operation 2 FA2	Motor Support Dish Lamp	Cable P6 Motor/PS Cable C2 Motor/EPU Cable P5 PS/Lamp
Operation 3 FA3	Compressor & TEV Detector Assy	Cable C4 Det/EPU Cable C3 EPU/compr Cable P3 PS/compr Coolant Tubes T1, T2
Operation 4 FA4	Housing & handles Condenser & Cover Printer	Cable P2 PS/Printer Cable C5 EPU/Printer Coolant tubes T3, T4
Operation 5 FA5	Charge R134a cooling Rotor w cap Power on Test	Cable P1 AC power

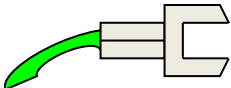
Production Package: Final Assembly & Packaging

Work Area Schematic (not to scale):



- Factory layout for Line 1 and Line 2 of Final Assembly.
- Line 1 and Line 2 are identical (5 operations each)
- Line 1 and Line 2 are arranged in parallel. Pallets of components are delivered by electric pallet truck and positioned near to the workstations in each line.
- Each line is 100 ft long (approx 20 ft per workstation)
- One operator (rover) re-supplies parts to both lines 1 & 2.
 - Painted housings are moved from clean storage to the lines in groups of 8 per pallet. Most other components including rotors are moved in groups of 50 per pallet
 - Each Round trip to store room for components takes 20 minutes.

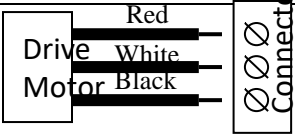
Area: Final Assembly
 Operation FA1: Assemble Power Source, EPU & rubber feet to Base

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain bare base plate from raw material pallet and set into horizontal holding fixture	Horizontal bench fixture	Note: base plate must Match work order for 115vac or 230vac	1 minutes
2	Obtain Power Source from parts bin on overhead rack and remove from box. Discard box in recycle bin.		Note: power source Must match work order For 115vac or 230vac	1 minutes
3	Crimp spade connector to pre-stripped ground wire (green)	Crimp tool		1 minutes
4	Position Power Source on Base Plate and fasten from below with four threaded fasteners at corners. Fasten ground wire lug to Base plate with screw.	Pneumatic 90deg screwdriver with torque limiter		2 minutes
5	Get 4 rubber feet from parts bin. Fasten feet to bottom corners of base plate with 4 threaded screws	Pneumatic screwdriver torque limited		1.5 minutes
6	Obtain EPU from parts bin and remove from ESD envelope. Discard ESD envelope in trash.		Note: EPU must match Work order if special test Specified by customer	1 minutes
7	Position EPU on the base plate and fasten from below with three threaded screws.	Pneumatic 90 deg screwdriver torque limited		0.5 minutes
8	Put on ESD wrist strap	ESD strap		0.5 minutes
9	Obtain cable C1 from parts bin. Connect to EPU connector and then to Power source connector.			1 minutes
10	Obtain Cable P4 from parts bin. Connect to EPU and to power source. Remove ESD strap. Use cable ties to secure cables			1 minutes
11	Check work. Visually inspect parts, screws, cables. Remove work from fixture & move WIP to bins			0.9 minutes

Total Observed Production Time =>

11.4 minutes


Area: Final Assembly
 Operation FA2: Assemble Drive Motor, Light Source, Support Dish to Base Plate

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Get WIP from Operation 1 and set on horizontal holding fixture	Horizontal bench fixture		1 minutes
2	Obtain Drive Motor box from parts bin. Unpackage and recycle or dispose of packaging		Note: Drive motor must Match work order for 115vac or 230vac	1 minutes
3	Build Cable P6 by attaching snap connector to pre-stripped ends of exposed motor wires. Insert wires and tighten the screwdown wire fasteners.	Manual 1/8" screwdriver	 <p>The diagram shows a rectangular box labeled 'Drive Motor' on the left. Three horizontal lines extend from the right side of the box, representing wires. The top wire is labeled 'Red', the middle wire is labeled 'White', and the bottom wire is labeled 'Black'. These wires terminate in a vertical rectangular box labeled 'Connector' on the right. The connector has three circular openings, one for each wire.</p>	2 minutes
4	Position Motor on the base plate and fasten from below with three screws/lockwashers.	Pneumatic driver torque limited with socket		1 minutes
5	Attach Cable P6 to Power Source snap connector receptacle. Attach Cable C2 from Motor to EPU			0.9 minutes
6	Obtain Support Dish from component bin and place on work bench support dish fixture	Support dish holding shim block fixture		1 minutes
7	Obtain Light Source from parts bin. Take out of box. Recycle			1 minutes
8	Fasten Light source to support dish using four bolts and lockwashers/nuts.	Pneumatic torque limited screwdriver		2 minutes
9	Position support dish behind drive motor and onto base plate. Prop up with shim block & Fasten with 2 bolts and lockwasher/nut sets	Pneumatic torque limited Screwdriver. Shim block		2 minutes
10	Attach Cable P5 wires to Light source wires with wire nuts. Connect Cable P5 to power source			1.5 minutes
11	Check work. Move WIP to bins			1 minutes

Total Observed Production Time => 14.4 minutes

Area: Final Assembly

Operation FA3: Install Detector Assembly, Support Dish, Compressor, cables, tubes

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain WIP from Operation 2 and position on horizontal raised fixture			1 minutes
2	Position Detector Assembly on support dish mount and align mounting nuts with holes in dish using 2 temporary align pins inserted from bottom side of dish	Alignment pins		1 minutes
3	Fasten Detector Assembly to support dish using four bolts and lockwashers.	Pneumatic driver torque limited		1 minutes
4	Install Rotor check gage on drive shaft by aligning the keyway slots over the drive shaft wings	Rotor/Detector gap tolerance check gage		1 minutes
5	Use gap tolerance check gage to measure gap between the rotor and Detector surface. Use results to select and slide in shims as needed to achieve spec'd gap	Thin washer shims with open face		2 minutes
6	Twist the 2 lead wires from detector connection plates to create a twisted pair cable C4. Connect two lead wires from cable C4 to the receptacles on the EPU			1 minutes
7	Obtain Compressor & TEV from parts bin. Remove packaging & recycle. Fasten compressor to base plate from below with 4 threaded screws	Pneumatic driver torque limited		2 minutes
8	Attach Cable C3 between compressor and EPU, Cable P3 between compressor and power source, copper tube T1 from compressor to detector coils, copper tube T2 from detector coils to TEV.	Wrench for tube compression fittings		3.4 minutes
9	Check work. Move assy to WIP bins			1 minutes

Total Observed Production Time =>

13.4 minutes

Area: Final Assembly
 Operation FA4: Assemble Hoses, Cables, Condenser, Readout Printer and Housing

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain WIP from Operation 3 and position on horizontal fixture			1 minutes
2	Obtain Housing from storage rack. Align housing to base plate mounting holes using temporary pins. Fasten housing to sides of baseplate with eight machine screws/lockwashers	Pneumatic screwdriver with torque limiter	Note: Housing color Must match work order	2 minutes
3	Obtain Readout Printer from storage rack and remove from box. Position Readout Printer on housing and align holes for mounting using 2 temporary locator pins. Fasten Readout Printer Assembly to housing using four threaded screws with lockwashers inserted from inside the housing.	Pneumatic screwdriver with torque limit		2 minutes
4	Obtain condenser. Screw to rear of housing.			1.5 minutes
5	Obtain condenser cover. Fasten to rear of housing.			1.5 minutes
6	Install copper tubes T3 and T4 to condenser coils	Wrench for compression fittings		1 minutes
7	Attach Cable C5 from EPU to printer & Cable P2 from power source to Readout Printer from inside the housing.			2 minutes
8	Check work. Move WIP to bins			1 minutes

Total Observed Production Time => 12 minutes

Area: Final Assembly
 Operation FA5: Assemble cables, Rotor, test, inspect, and box

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Obtain WIP from Operation 4 and position on horizontal fixture			1 minutes
2	Charge cooling system with R134a refrigerant	R134a tank and hoses		2 minutes
3	Install Cable 11 from AC receptacle to power source. Attach external power cord.		Note: product caution Labels must match work Order for 115vac or 230	2 minutes
4	Obtain Rotor & Cap assembly from the storage rack and install on drive shaft			1 minutes
5	Perform visual inspection of housing for scratches, mars, dents. Install handles (2)	Pneumatic screwdriver with torque limit		1 minutes
6	Initiate power up self test cycle. While unit is performing self test affix product labels, caution & warning tags, operator tags.			1 minutes
7	While unit is performing self test obtain flat ship box and packing materials. Build up open box.	Pneumatic box stapler & box tape		1 minutes
8	Verify successful completion of power on self test. Turn unit off and unplug. Place unit into shipping box			1.4 minutes
9	Install packing foam material inside shipping box. Close box with staples and tape. Affix date code stamp to box. Move boxed unit to pallet.	Pneumatic box stapler & box tape		1 minutes
Total Observed Production Time => Per worker				11.4 minutes

Area: Final Assembly
Operation: All

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time

Changeover Time: None

Scheduled PM
None.

Unscheduled downtime

Central compressed air goes down if major system leak occurs elsewhere.

Typical time to repair is 4 hrs during 1st shift.

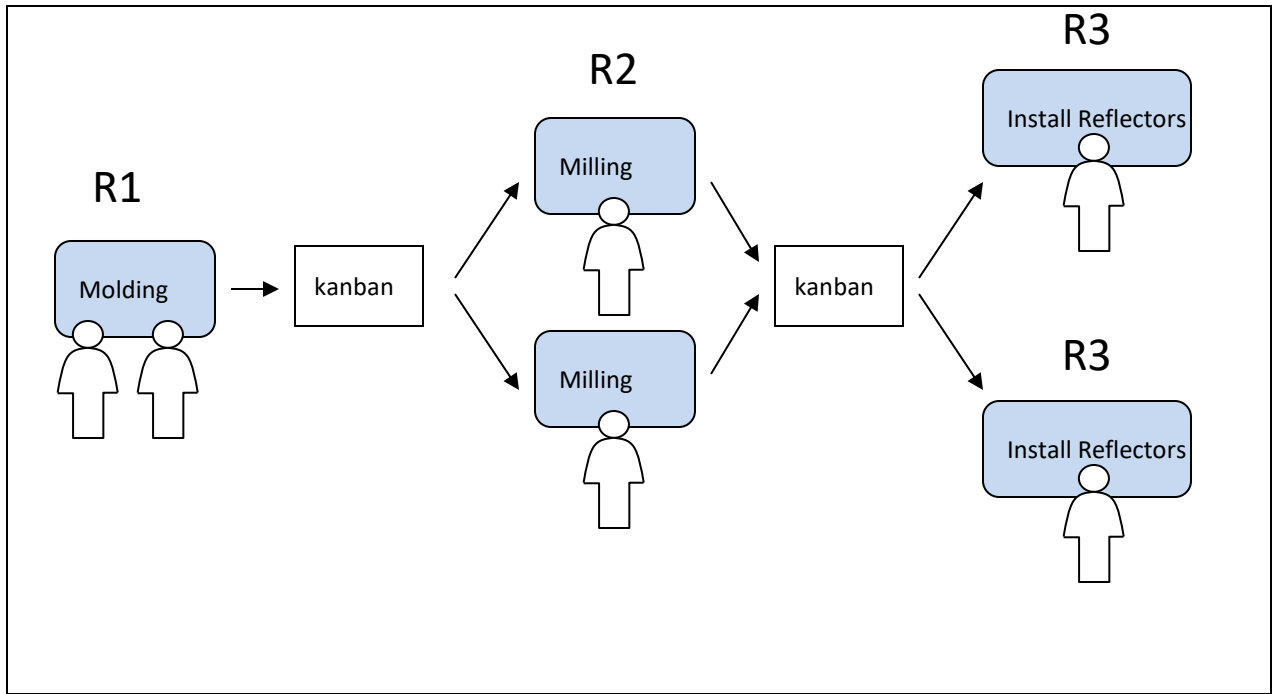
No Repair during 2nd shift since maintenance is not available.

Individual hose to pneumatic screwdriver or stapler can break.

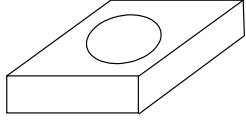
Operator disconnects from central air. Calls maintenance. Typical repair is 4 hrs if 1st shift.

Production Package: Rotor Cap Production

Work Area Schematic (not to scale):

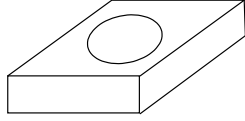
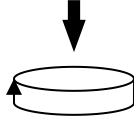



Area: Rotor Cap Production
R1 Operation: Molding

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Load mold/fixture into molding machine.	Mold/fixture		0.6 minute
2	Operate molding machine to form rotor cap blank.	High volume Mega Moldmaster		7.2 minutes
3	Remove molded rotor cap blank and fixture. Place in kanban to cool while waiting for Milling operation			0.5 minutes
Total Allowable Production Time =>				8.3 minutes

- Note: Molding operation has two workers.
- Worker #1 operates machine performing the operations described above.
- Worker #2 is material handler, taking the mold/fixture after it has been removed from the molder and transferring it to the kanban. The “mold/fixture” device serves as a mold during the molding process, then as a fixture to hold the rotor cap while it cools down prior to the milling process. Worker 2 also returns the empty mold/fixtures back to the mold machine for reuse after the rotor cap is removed for the milling operation.

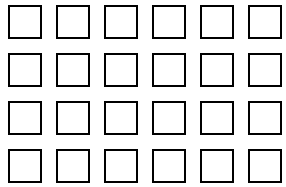
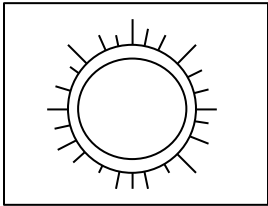
Area: Rotor Cap Production
R2 Operation: Milling

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Remove molded rotor cap from its mold fixture. Load molded rotor cap into Milling machine.	Milling fixture "A" holds rotor cap flat		1 minutes
2	Operate milling machine to mill cone shaped "blood port" opening in top of the rotor cap.	Milling Machine		7 minutes
2	Flip the rotor cap over onto fixture that positions rotor cap using the milled blood port opening..	Fixture "B" holds rotor cap for milling out mirror flange 360 deg		1 minutes
2	Operate milling machine to mill out the mirror flange around the entire outer edge of rotor cap. Fixture rotates 360 deg on machine bed to allow mirror flange to be created.	Milling Machine		9.1 minutes
3	Remove molded rotor cap blank and fixture. Place in kanban for reflector installation operation			2 minutes

Total Observed Production Time =>

20.1 minutes

Area: Rotor Cap Production
R3 Operation: Install Reflectors

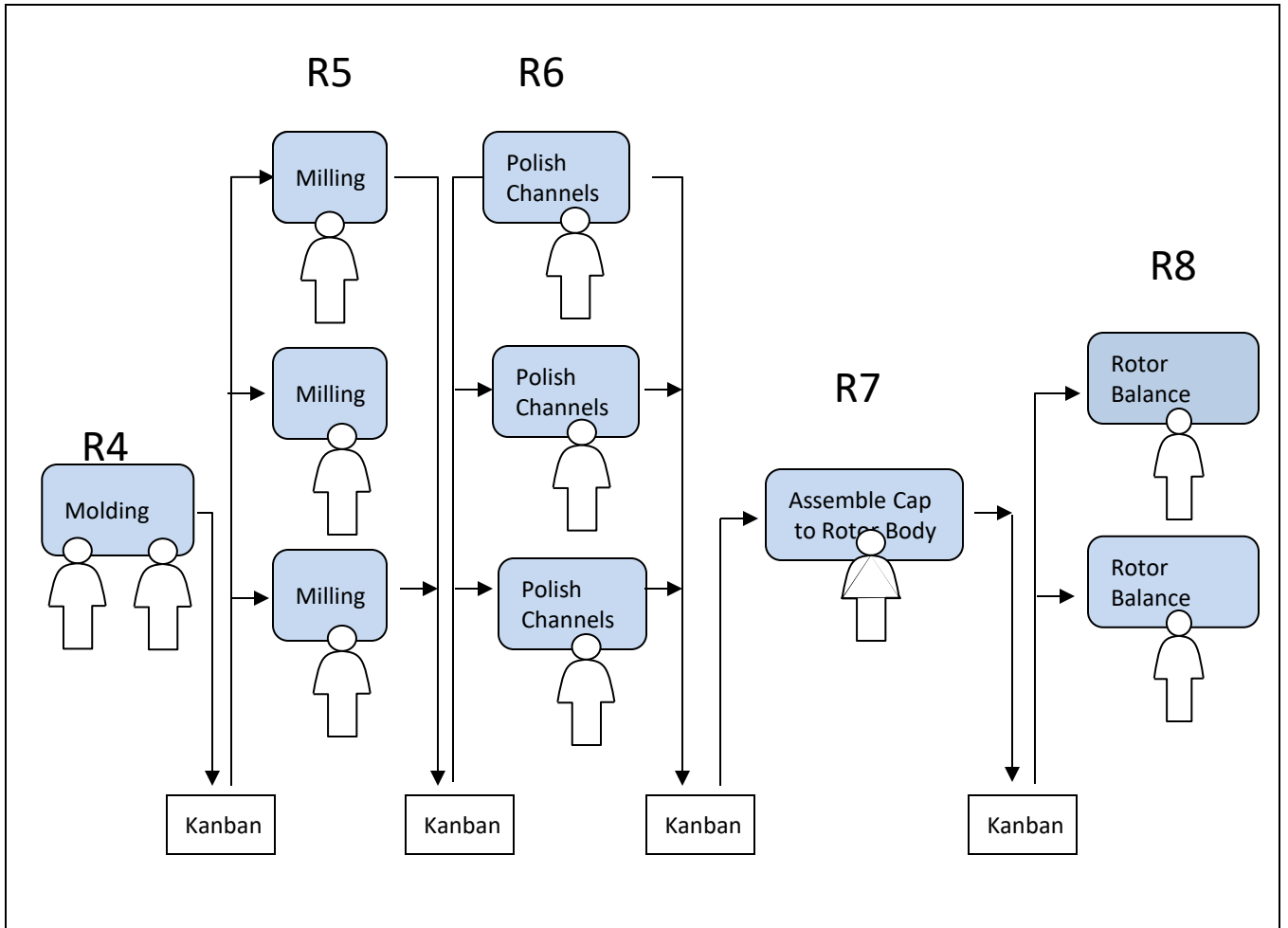
Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Position 24 reflectors on table, reflective surface down.	table		6 minutes
2	Obtain cap from the kanban and lay position it on a fixture that has marks for the position of 24 reflectors equally spaced around the circumference of the cap.	Mirror Location Fixture		3 minutes
3	Apply dab of epoxy to back side of all reflectors using pneumatic epoxy gun.	Epoxy gun		5 minutes
4	Affix reflectors to rotor cap at each position marked by the fixture. Use the mark to establish center of each reflector			8 minutes
5	Inspection. Conduct a visual inspection of all 24 mirrors. Set aside any caps that have crooked mirrors or have any epoxy on surface of mirror.			1.4 min

Total Observed Production Time =>

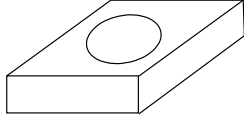
23.4 minutes

Production Package: Rotor Body Production

Work Area Schematic (not to scale):

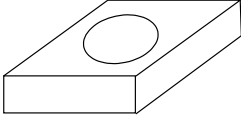


Area: Rotor Body Production
R4 Operation: Molding

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Load mold/fixture into molding machine.	Mold/fixture		30 seconds
2	Operate molding machine to form rotor body blank.	High Volume Moldmaster		7.3 minutes
3	Remove molded rotor body blank and fixture. Place in kanban to cool while waiting for Milling operation			30 seconds
Total Observed Production Time =>				8.3 minutes

- Note: Molding operation has two workers.
- Worker #1 operates machine performing the operations described above.
- Worker #2 is material handler, taking the mold/fixture after it has been removed from the molder and transferring it to the kanban. The “mold/fixture” device serves as a mold during the molding process, then as a fixture to hold the rotor body while it cools down prior to the milling process. Worker 2 also returns the empty mold/fixtures back to the mold machine for reuse after the rotor body is removed for the milling operation.

Area: Rotor Body Production
R5 Operation: Milling

Sub-Operation #	Description	Machine/Tool	Diagram (where necessary)	Observed Time
1	Load mold/fixture into Milling machine index fixture to allow the rotor body blank to be rotated around its center	Mold/fixture and indexing machine fixture		4.3 minutes
2	Operate milling machine to mill channels on top side of rotor body. (see drawing). 12 milling passes are made and mold/fixture is rotated after each pass. Each milling pass cuts 2 channels 180 deg opposite from each other	Milling Machine		10 minutes
3	Invert rotor body fixture on milling machine	Milling Machine		1 minute
4	Drill the center shaft and mill the alignment keyways to tolerance	Milling Machine		8 minutes
5	Remove milled rotor body and place in kanban for polishing operation			1 minutes
Total Observed Production Time =>				24.3 minutes

Area: Rotor Body Production
R6 Operation: Polish Channels

Sub-Operation #	Description	Machine/Tool	Diagram	Observed Time
1	Remove Rotor Body from kanban, load into channel polishing fixture. Use compressed air to blow any chips out of channels			5 minutes
2	One channel at a time: Run the manual honing block along each channel starting from center to remove any imperfections caused by the milling step and ensure each channel is completely flat.	Diamond honing block tool	Note: Time is approximately 15 seconds per channel. 24 channels.	15 minutes
2	One channel at a time: Use rotating polishing wheel to buff each channel and ensure proper smoothness.	Hand held Pneumatic polishing wheel	Note: Time is approximately 7.5 seconds per channel. 24 channels.	4.8 minutes

Total Observed Production
Time =>

24.8 minutes

Area: Rotor Body Production
R7 Operation: Assemble Cap to Rotor

Sub-Operation #	Description	Machine/Tool	Diagram	Observed Time
1	Move rotor body and rotor cap from Kanban to table . Mount body in fixture consisting of shaft with alignment ears which orients body			1 minutes
2	Position cap on rotor for a fit check. Use emery block on edge of cover if fit is too tight.	Positioning tool		2.5 minutes
3	Remove cap and apply epoxy bead around circumference of body. Rotate cap so mirrors are located over channels. Press down and hold cap in place for 10 seconds.			3.5 minutes
4	Remove rotor from fixture and place Rotor assembly in kanban for balancing operation.			1 minutes

Total Observed Production
Time =>

8 minutes

Area: Rotor Body Production
R8 Operation: Balance Rotor

Sub-Operation #	Description	Machine/Tool	Diagram	Observed Time
1	Obtain rotor assy from kanban & place in Spin Balancing machine			1 minutes
2	Perform spin balance on rotor. Machine automatically spins rotor up to 2000 rpm. Machine vibration indication is used to determine if rotor is not in dynamic balance. If so, set aside the rotor for Static precision balance.	Rotor Balancing Machine		8.8 minutes
2A	When required, perform static precision balance. Machine provides indication of where rotor may be out of static balance. Use pneumatic extra fine hand held grinder to remove material where indicated. Typically, static balance is required on 5% of rotors	Rotor Balancing Machine. Hand held pneumatic grinder		6 minutes (average 2 minutes per rotor)
3	Build up transfer box from the flat shipping cardboard. Place foam insert in box to accept rotor assembly	Pneumatic stapler		2 minutes
3	Remove rotor from spin balance and place in shipping container. Tape box and place on pallet for transportation to Shipping/Receiving.			3 minutes
Total Observed Production Time =>				16.8 minutes