Six Sigma Steps

- Define
- Measure
- Analyze
- Improve
- Control

Cross Functional Team

NAME	POSITION
SS	Greenbelt – Team Leader
RB	Engineering Manager
AT	Q A Manager
JS	Process Manager
SM	Machining Manager
JC	Die Cast Supervisor
MC	Set up man

Project Plan

ACTIVITY	START	END
Define the problem	3/2/2004	3/5/2004
Measure the defects	3/15/2004	3/19/2004
Analyze the data	3/22/2004	3/26/2004
Plan the improvement	4/5/2004	4/19/2004
Control the process	5/4/2004	5/14/2004

Objective & Goal

Business case:

Reduce the scrap of oil pan. This will help the company to achieve a corporate quality goal of reducing scrap rate and cost of poor quality.

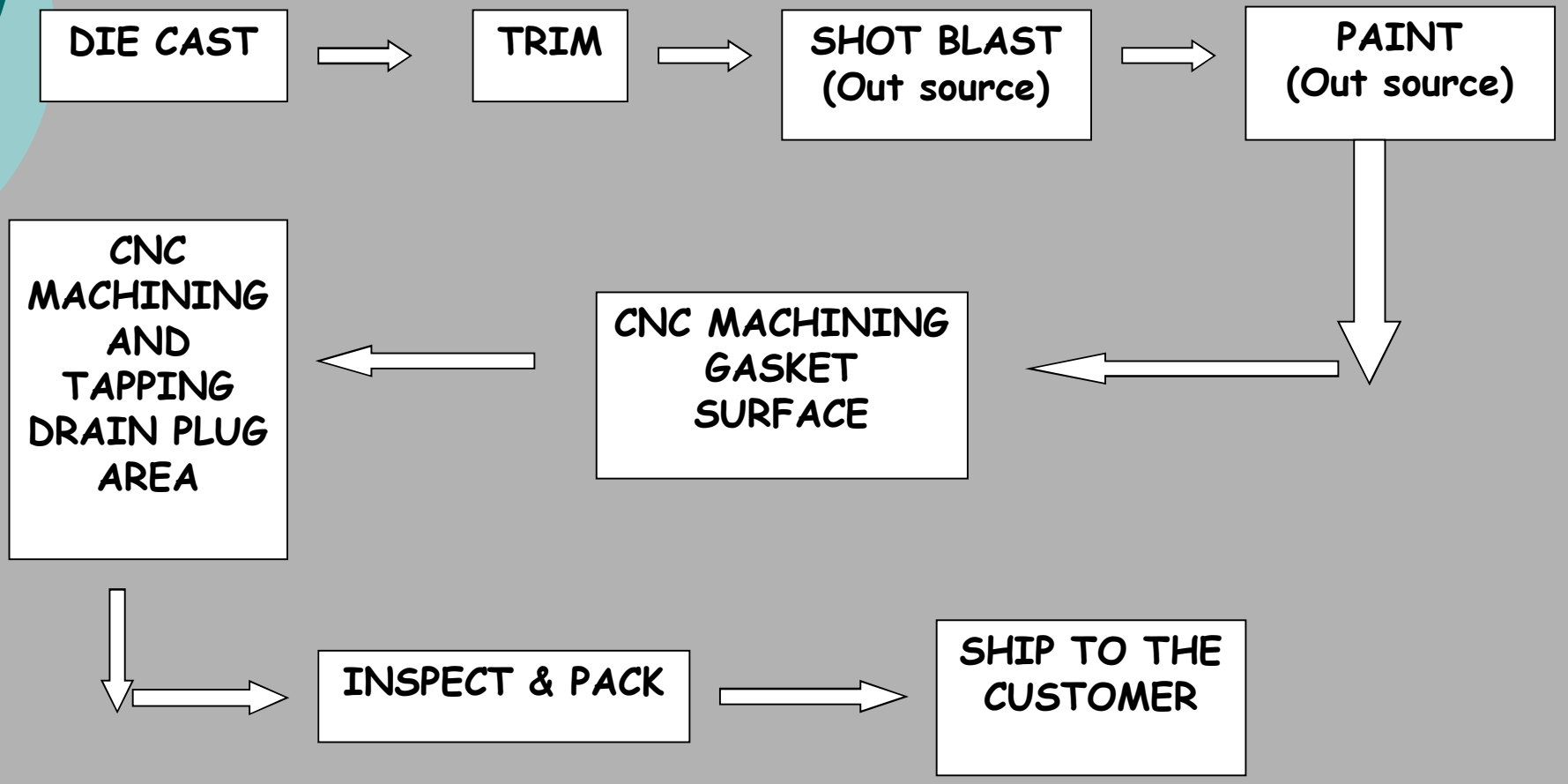
Opportunity statement

We have an order for 30,000 pieces per year @ $14.00 per piece. We have been running a scrap of 32% for the past 6 months. If we reduce the scrap to 5% we will be able to save $110,000 per year.

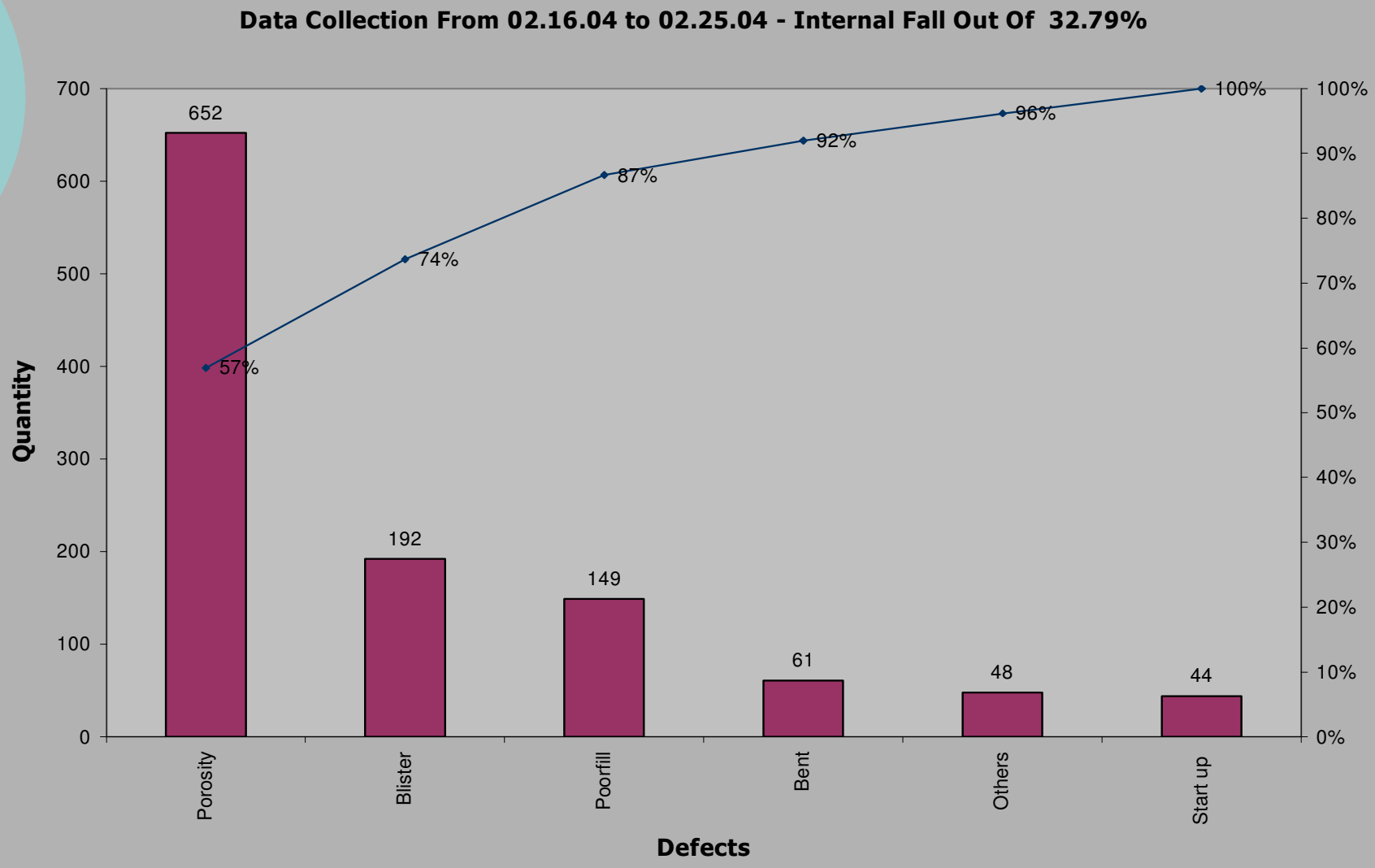
Goal:

Reduce the scrap from 32% to 5% in next 3 runs and save $110,000 over a period of 1year.

Process Map

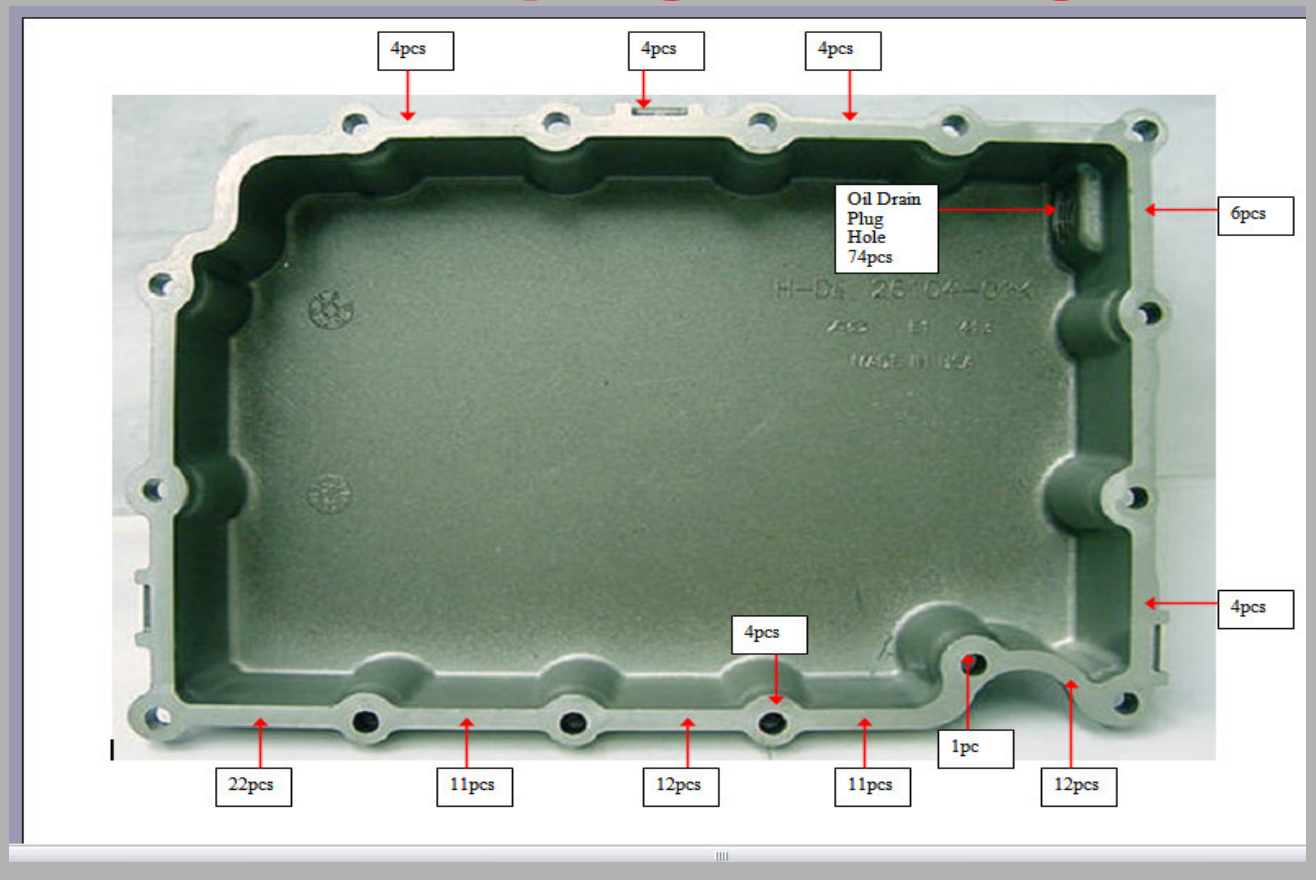

DIE CAST
TRIM
SHOT BLAST (Out source)
PAINT (Out source)
CNC MACHINING GASKET SURFACE
CNC MACHINING AND TAPPING DRAIN PLUG AREA
INSPECT & PACK
SHIP TO THE CUSTOMER

Data Collection – Pareto Chart



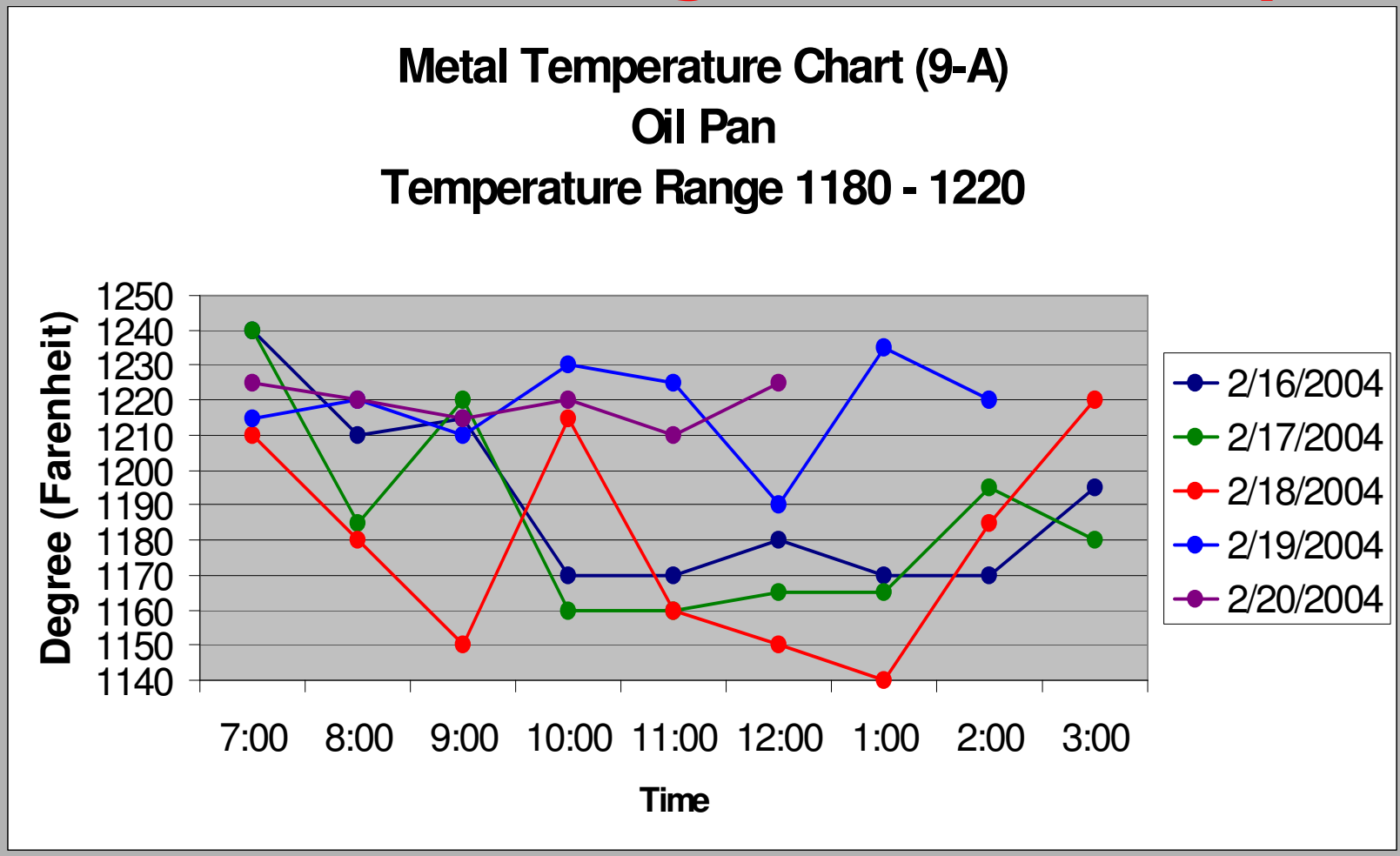
Concentration Diagram

From 190 defective parts 74 defects in drain plug area & rest in the opposite to the drain plug and on gasket area



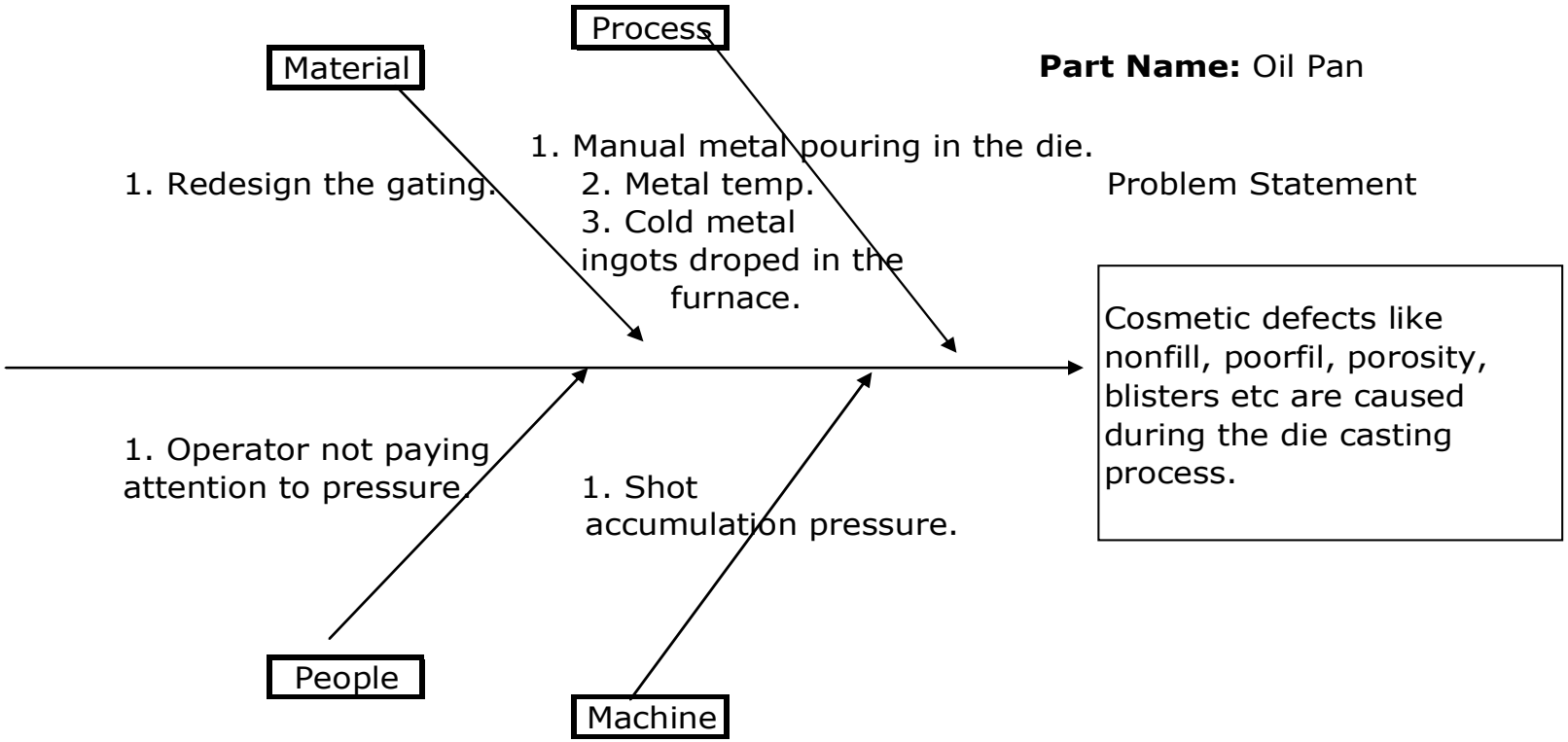
Temperature Chart

46% of the readings were out of specs.



Causes of Defects

C A U S E & E F F E C T D I A G R A M



Design of Experiment

- Cold metal:

Throwing cold metal ingots affects the metal temperature of the furnace bath.

- DOE

We dropped 5 cold metal ingots in two different size of furnaces

- Result:

In one furnace by machine # 9 temperature dropped 100 degrees in 20 minutes and in the other furnace it dropped by 40 degrees in 20 minutes.

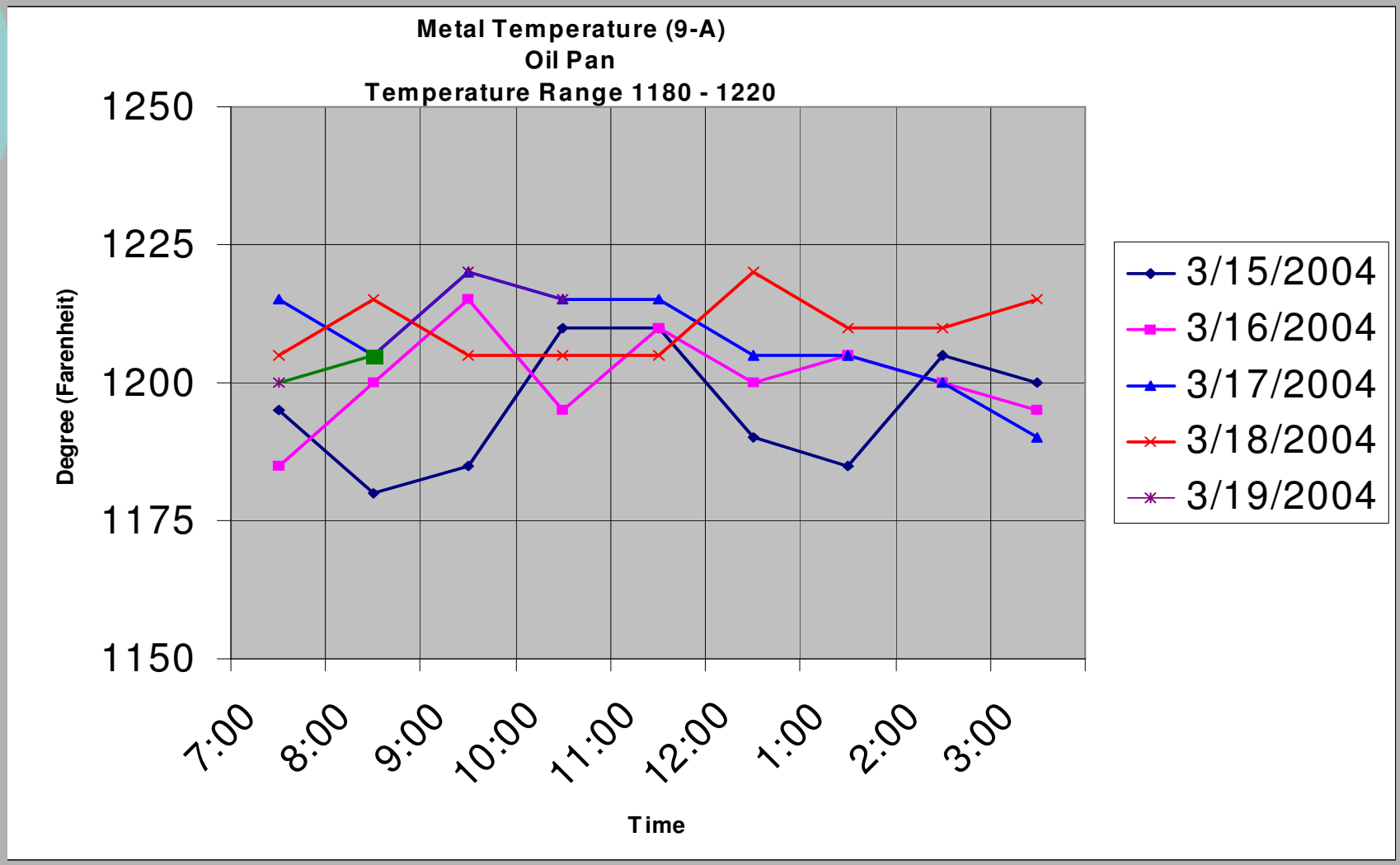
Improvement Action

- Place a second furnace by machine # 9.
- Only molten metal will be poured in the furnace of machine # 9 and NO METAL INGOTS.
- Modified the gate for better flow of the metal.
- Bring 5 parts to the machining department and machine them in drain plug area.

Measurement Plan

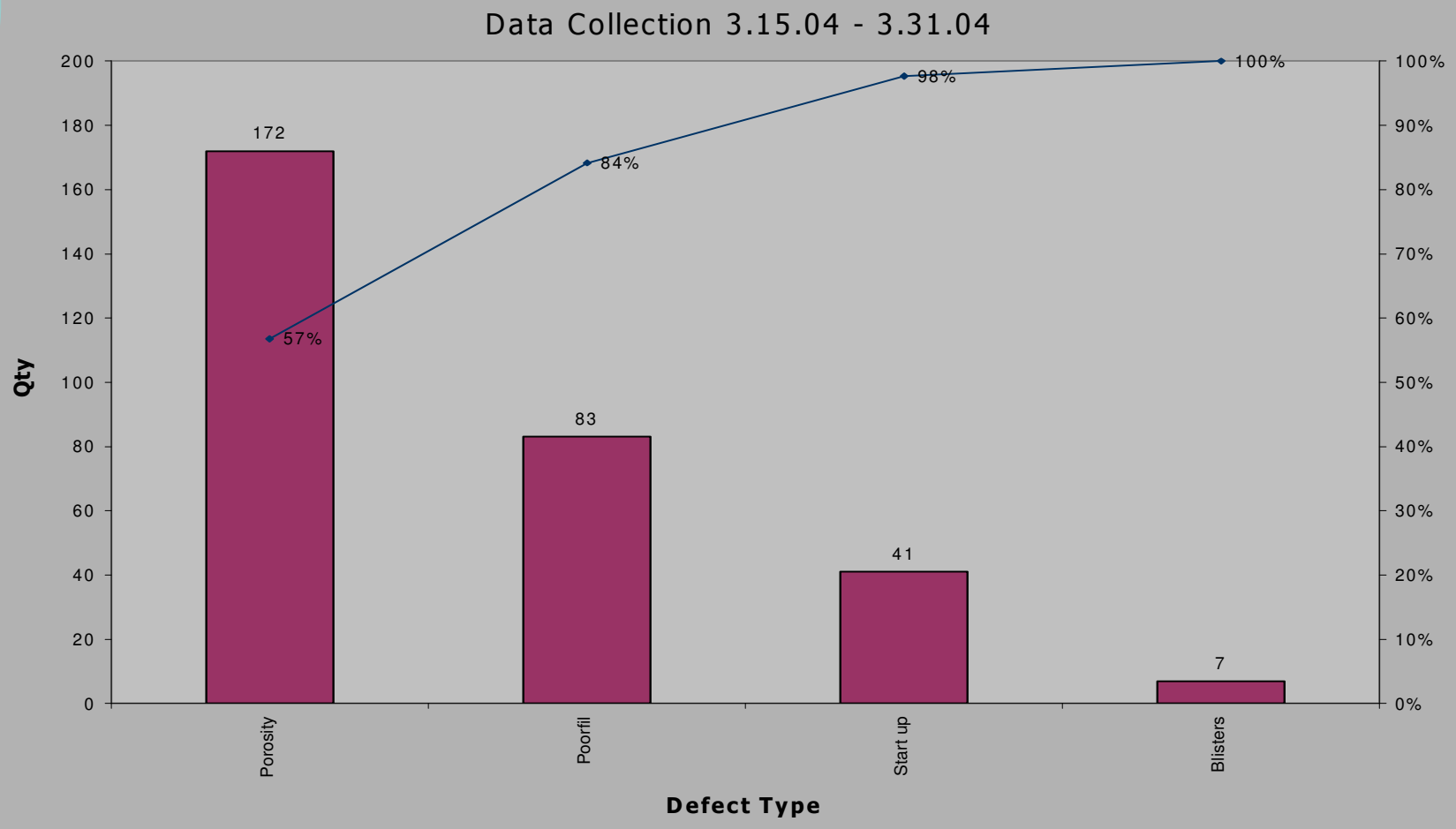
- 100 parts every hour at die casting process
- Machine 5 parts every hour
- Monitor furnace metal temperature every hour
- Real time correction of process

Temperature Chart

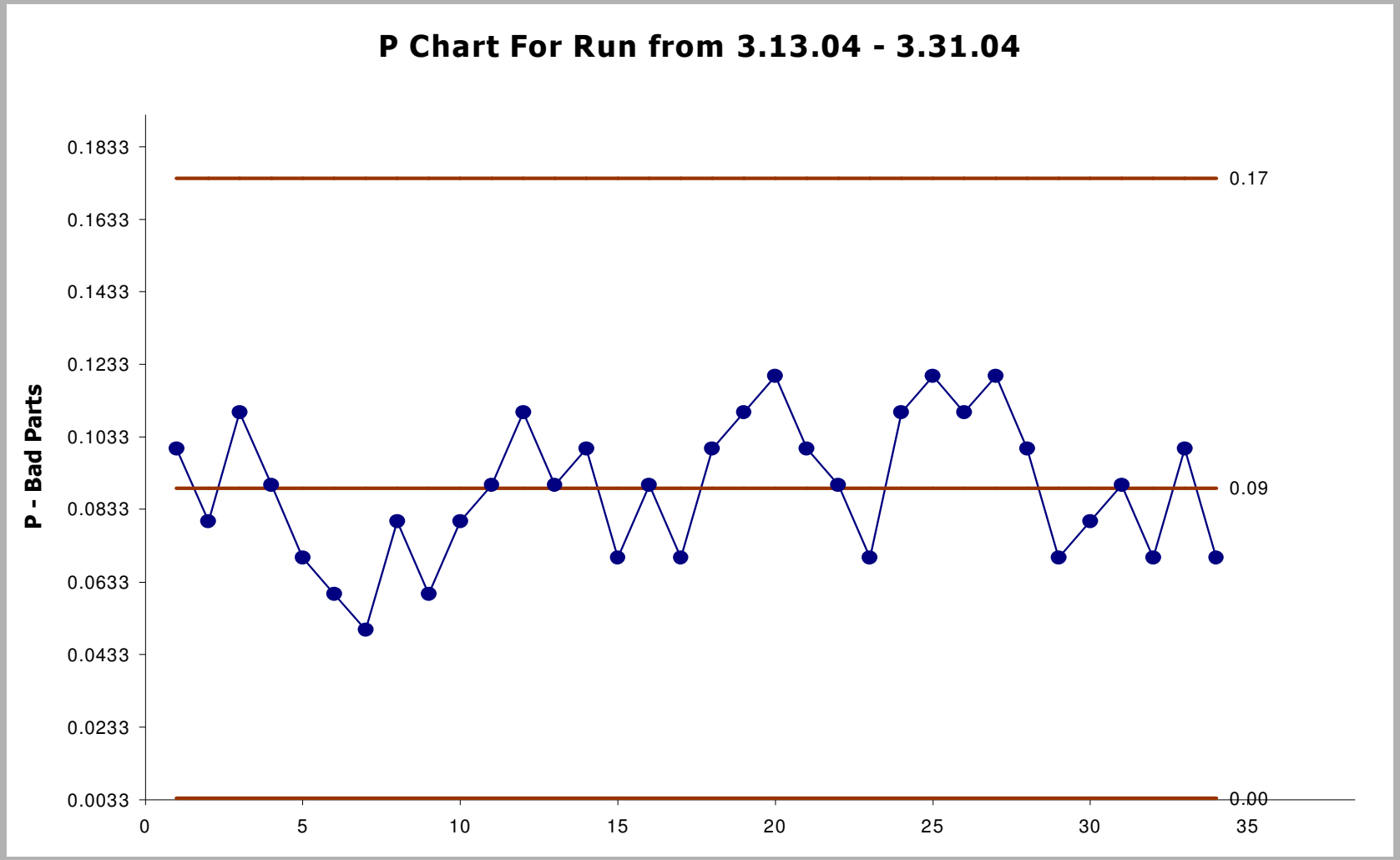


P Chart

Reduced the scrap from 32.79% to 8.96%



P Chart For Bad Parts



Closer Look At The Process Parameters

- Porosity and Poorfill amount to 84% of defects.
- Team identified 4 parameters on set up sheet
- Clamp pressure, plunger size, spray type & spray ratio

Die Casting Machine Set-up Sheet

Customer:
Part No.
Part Name: Oil Pan

Date: 3/15/2004
Die No. 481
Machine No. 9-A

Metal and Die Data

Metal & Alloy	413	Al
No. of Cav.	1	
Shot Weight (Lbs)	4	approx.
Plunger size (in.)	3	
Metal Temp.(F)	1200	± 20° (F)
Spray Type	840-d	
Spray Ratio	60-1	
Heatup time (Min.)	40	approx.
Cycle Rate (per hr.)		
Ladle Size (lbs.)	5	

Die Temperature

Cover Half (F)	480	± 20° (F)
Ejector Half (F)	450	± 20° (F)

Timers

Shot (sec)	N/A
Dwell (sec)	7

Machine Data

	OFF	ON
Cover Core	X	
Ejector Core	X	
Ejection	X	
Bumper		X
Intensifier		X
Slow Approach		X

Slow Approach Length (in.)	10	
Slow Approach Speed (i.p.s)	20	approx.
Fast Shot Speed (i.p.s.)	159	approx.
Fill Time (sec)	8	
Clamp Pressure (p.s.i)	1,200	± 50 psi
N2 Precharge Press Shot (N)	800	± 50 psi
Shot Accumulation Pr.(p.s.i.)	1,200	± 50 psi
Core Pressure (p. s. i.)	N/A	± 50 psi
Sleeve Length (in)	23	

Special areas to watch
Todas las aguas abiertas en el dado

Set-up by: **F.L.**

TWO (2) FULL SHOTS ARE TO BE KEPT WITH DIE AFTER THE RUN IS COMPLETE.
F-38 Rev. A 06/01/2000

Revised The Process Parameters

Customer:
Part No.
Part Name: Oil Pan

Date: 4/19/2004
Die No. 481
Machine No. 9-A

Metal and Die Data

Metal & Alloy	413	Al
No. of Cav.	1	
Shot Weight (Lbs)	4	approx.
Plunger size (in.)	2 1/2	
Metal Temp.(F)	1200	± 20° (F)
Spray Type	1024-B	
Spray Ratio	70-1	
Heatup time (Min.)	40	approx.
Cycle Rate (per hr.)		
Ladle Size (lbs.)	5	

Die Temperature

Cover Half (F)	480	± 20° (F)
Ejector Half (F)	450	± 20° (F)

Timers

Shot (sec)	N/A
Dwell (sec)	7

Machine Data

	OFF	ON
Cover Core	X	
Ejector Core	X	
Ejection	X	
Bumper		X
Intensifier		X
Slow Approach		X

Slow Approach Length (in.)	10	
Slow Approach Speed (i.p.s)	20	approx.
Fast Shot Speed (i.p.s.)	159	approx.
Fill Time (sec)	8	
Clamp Pressure (p.s.i)	1,500	± 50 psi
N2 Precharge Press Shot (N)	800	± 50 psi
Shot Accumulation Pr.(p.s.i.)	1,200	± 50 psi
Core Pressure (p. s. i.)	N/A	± 50 psi
Sleeve Length (in)	23	

Special areas to watch
Todas las aguas abiertas en el dado

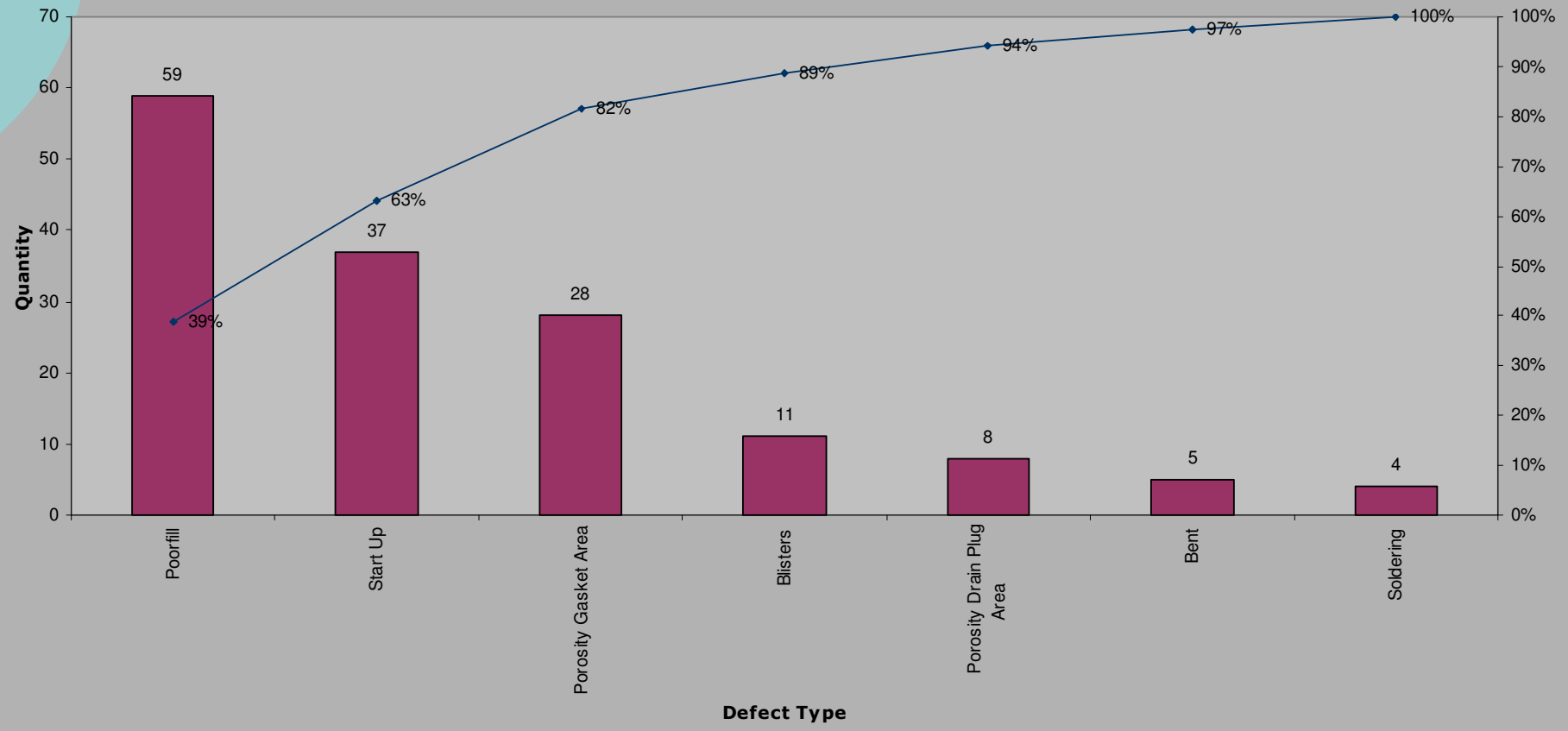
Set-up by: **F.L.**

TWO (2) FULL SHOTS ARE TO BE KEPT WITH DIE AFTER THE RUN IS COMPLETE.
F-38 Rev. A 06/01/2000

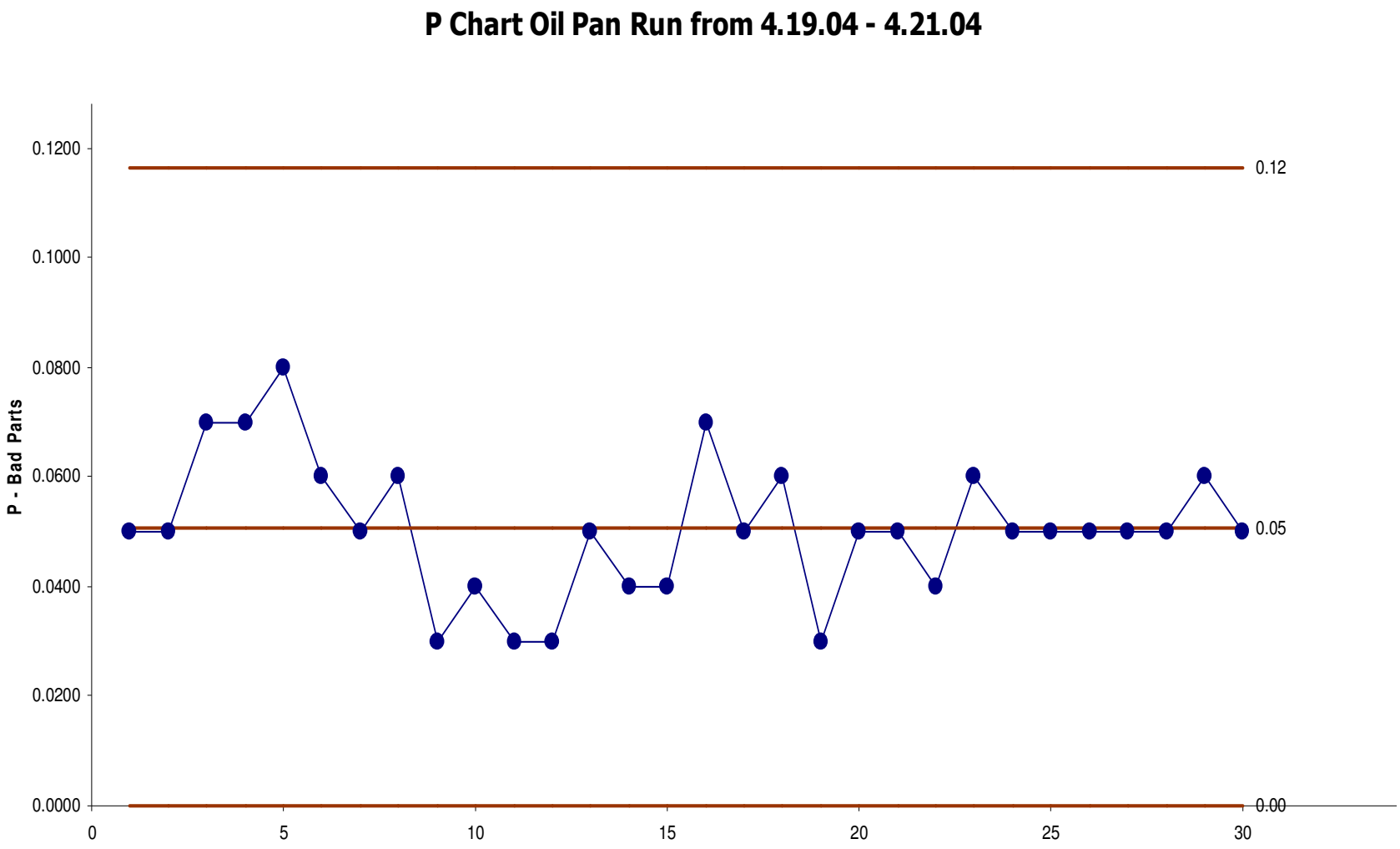
- Increased the clamp pressure to 1500 psi
- Reduced the plunger size to 2 ½ inches
- Changed the spray type to 1024-B and ratio to 70-1

P Chart

Scrap was reduced from 8.96% to 4.78% during 4.19.04 to 4.23.04 production run



P Chart For Bad Parts



Hypothesis

- Before the project, process yield was 67.21%
- After the project, process yield increased to 95.22%
- Hypothesis question is: is this improvement because of common cause variation?
- When data is plugged into hypothesis test for equality of two proportion P value is calculated as ZERO / less then 0.05

Hypothesis

Hypothesis Test for the Equality of Two Proportions

Number of elements in sample #1 in category of interest:	x1	1146
Size of Sample #1:	n1	3495
Number of elements in sample #2 in category of interest:	x2	152
Size of Sample #2:	n2	3181
	p1 = x1/n1	0.327896996
	p2 = x2/x2	0.047783716
	Zo Statistic	28.883
	P-Value (2-tail)	0.000

Hypothesis

Hypothesis Test for the Equality of Two Proportions

Number of elements in sample #1 in category of interest:	x1	2349
Size of Sample #1:	n1	3495
Number of elements in sample #2 in category of interest:	x2	3029
Size of Sample #2:	n2	3181
	p1 = x1/n1	0.672103004
	p2 = x2/x2	0.952216284
	Zo Statistic	28.883
	P-Value (2-tail)	0.000

Inference

- Calculated P value for good parts and for bad parts is ZERO.
- This is less than 0.05
- This means that our hypothesis: "this improvement is because of common causes" is wrong
- This improvement is because of "special causes". This special causes of variations are removed as a result of this project.

Control Actions

- Set up sheet was revised to reflect the new process parameters.
- Extra furnace was permanently placed next to this machine.
- Partial FMEA was revised to reflect the revision of RPN # from 414 to 60
- Control plan and inspection parameters were revised to reflect 5 piece inspection every hour for die casting defects.
- Company bought an x-ray machine to avoid destructive tests.
- We also installed a robot ladle system to ensure uniformity of material quantity during every pour.

Project Savings / Results

DESCRIPTION	BEFORE	AFTER	IMPROVEMENT
DPMO	327,897	47,783	85.43%
Defects as % of scrap	32.79%	4.78%	85.43%
Process sigma level	1.97	3.17	62.56%
$ savings	-	117,264	-

Lessons Learned

- Psychology of zero defects very important.
- Eliminating special causes can do the major improvement.
- Relate the project to the corporate goal.
- Team work, collection of data and responding to the data is very important.

Lessons Learned (cont.)

- Informed timely decisions can save the company a lot of money.
- Everything is available within the company, we need to look hard to see it.
- Similar methodology can be applied to many other jobs.

Personal Information

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