Process Reliability: Do You Have It?— What's It Worth To Your Plant To Get It?

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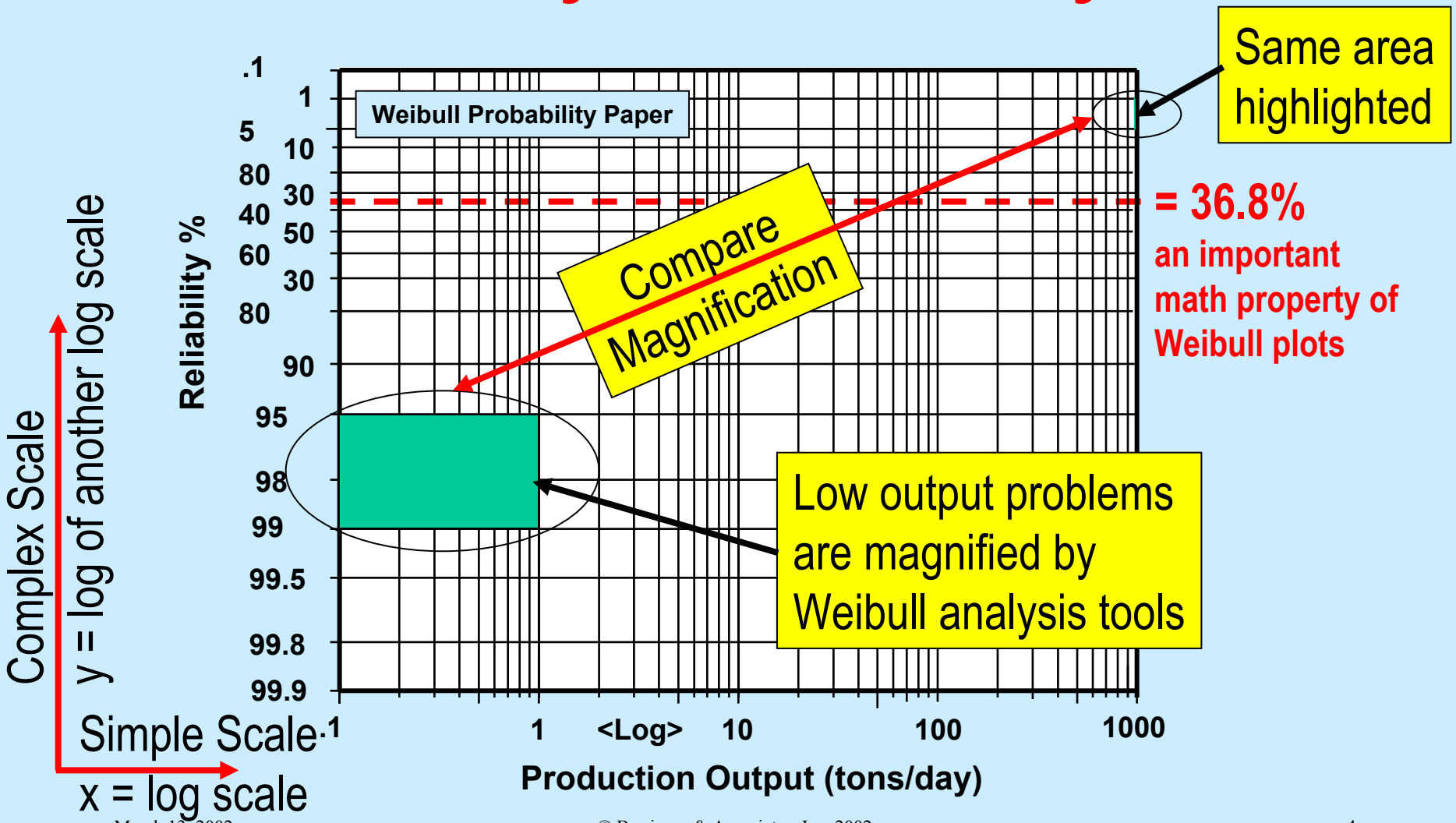
Answer These Questions?

- What's the availability of your process?
- What's the reliability of your process?
- What causes process failures and how often?
- How predictable is your process?
- Weibull analysis of process data helps answer these questions on one side of one sheet of paper for important reasons—money and the time span for the study!

Expanded Weibull Analysis

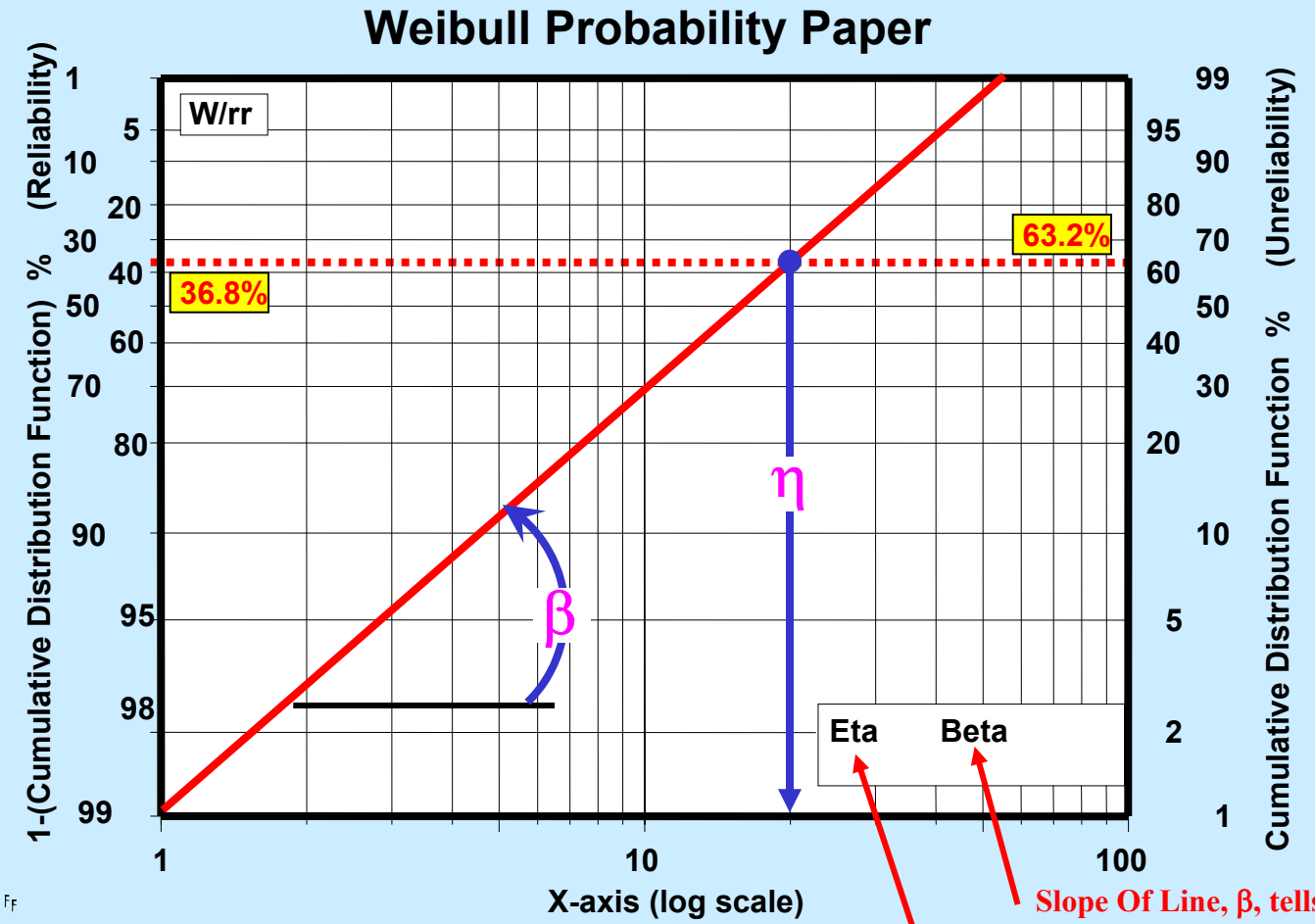
- The method plots daily production data on a Weibull plot to disconnects the data from a time sequence.
- Patterns of problems emerge from the data—straight lines, cusps, steep & shallow slopes
- The tool shows details in the time/money regime so everyone can understand the problems on one sheet
- Weibull analysis tells the size of the hidden factory but not what is the problem or where you will find it, nor how to correct deficiencies.

Weibull Analysis Probability Plot



Weibull Plot--Important Features

Reliability + Unreliability = 1



Slope Of Line, β, tells about variability in process output

Characteristic Value, η, (at 36.8% R or 63.2% CDF) tells about the process size

Why Make A Weibull Plot?

- Most production data, under tight control for scatter in output (devoid of reliability problems), plots as a straight line on Weibull probability paper
- When production data varies from small scatter to large scatter, a cusp is evident on the Weibull plot which tells about a failure and the cusp defines a failure and thus a reliability value
- Scalar production data converts into X,Y plotting points by use of a statistical tool called Benards median rank
- Weibull plots are easy to make and easy to read

How Does Scalar Data Fit An X-Y Plot?

- Rank production data (the X-values) from low to high
- For each "X" data point, assign a median rank plotting position, i, using Bernard's median rank approximation to get a "Y" %CDF location or a % R location
- Plot the X-Y data on a Weibull plot
- Assess the data, draw conclusions, take action

Bernard's median rank cumulative distribution function (CDF = Unreliability)

= (i - 0.3)/(N + 0.4)

(1 – CDF) = Reliability

i	Y%CDF	X-tons	Y %R
1	0.19157	1	99.80843
2	0.46524	1	99.53476
3	0.73892	1	99.26108
4	1.01259	1	98.98741
5	1.28626	1	98.71374
6	1.55993	100	98.44007

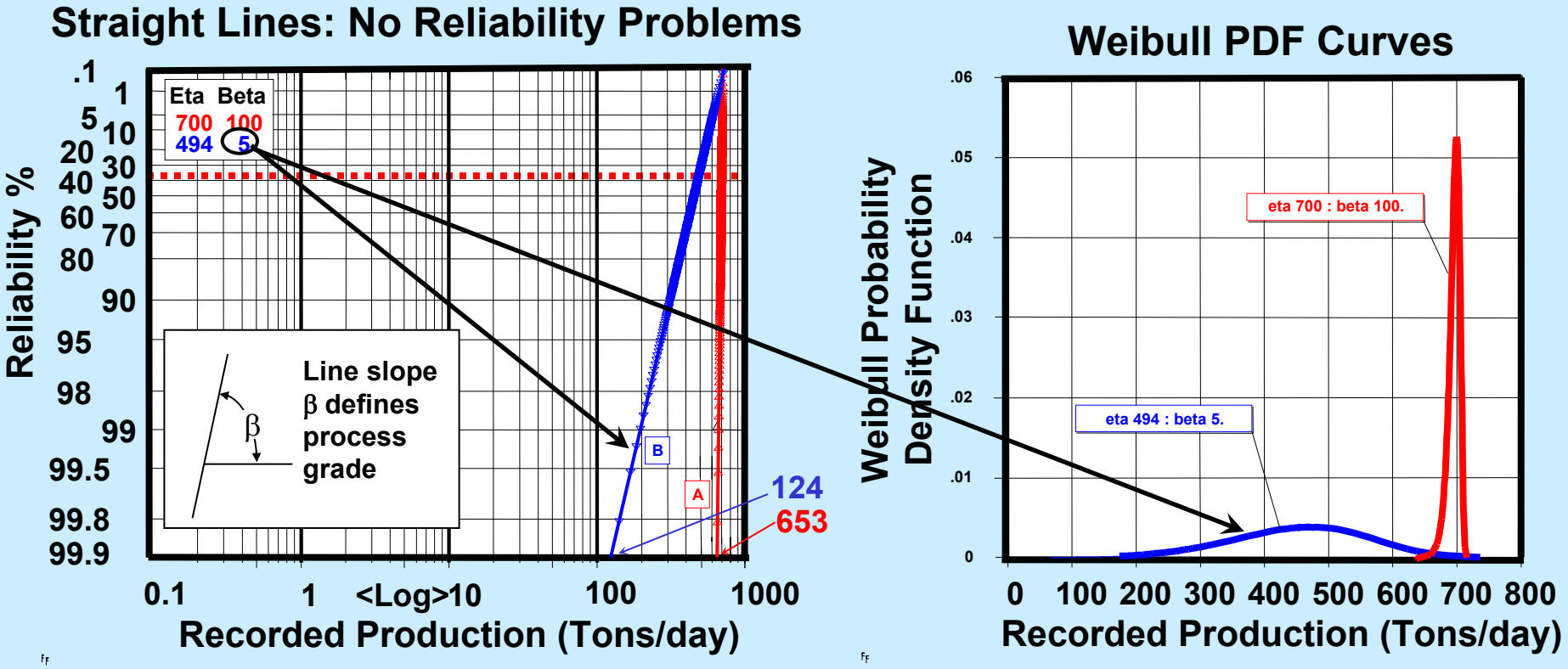
364	99.53476	818	0.46524
365	99.80843	818	0.19157

N

Bernard's median rank calculation helps remove bias in the Y-axis for location of the data points

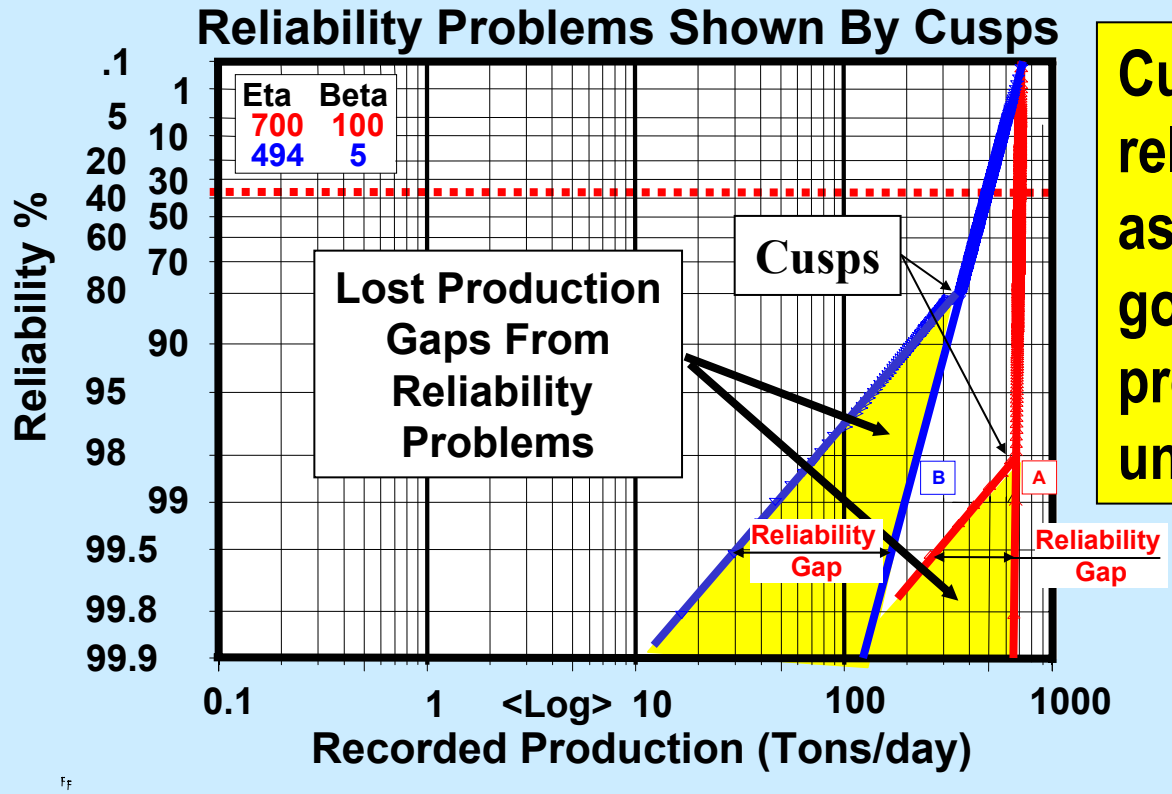
X-Y positions for Weibull plot

Weibull Probability Plot—No Problems



- **Flat slopes on Weibull plot show wide scatter**

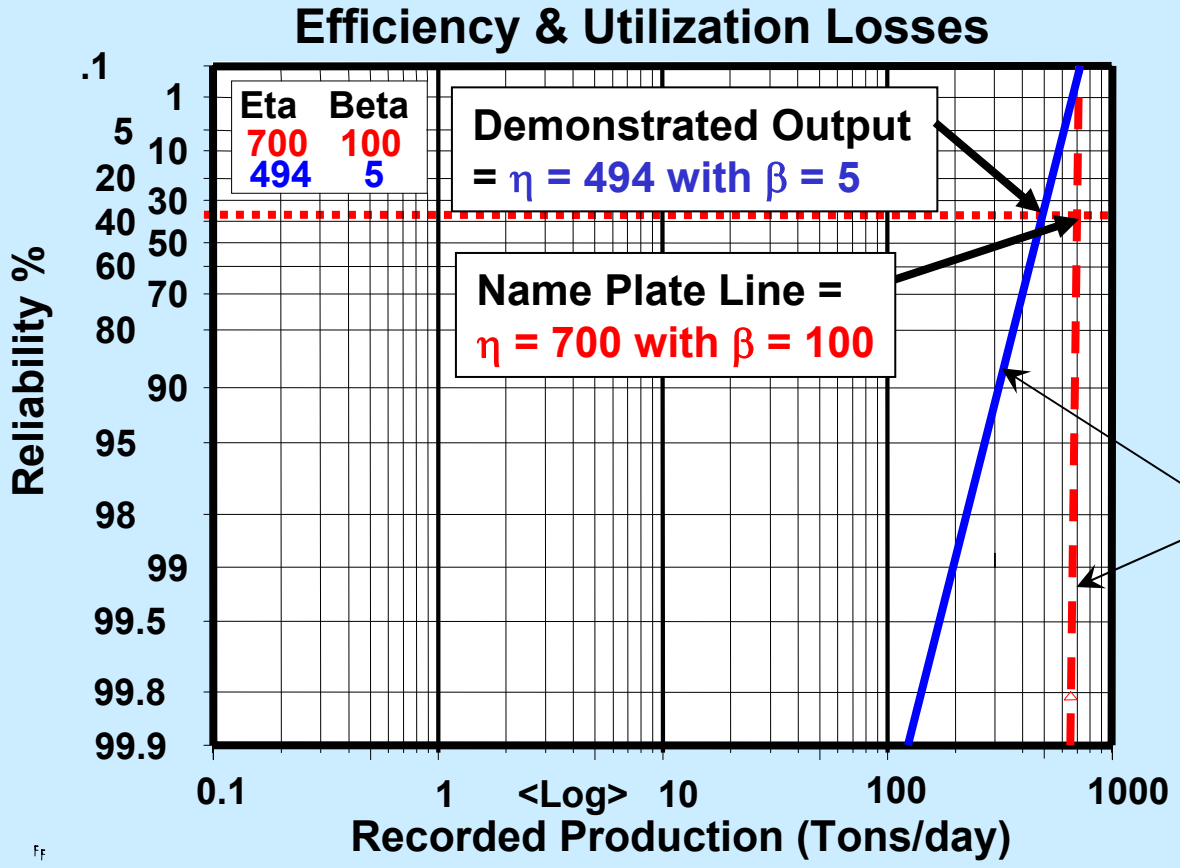
Weibull Probability Plot With Problems



Cusps define a reliability failure as the process goes from predictable to unpredictable

- **Cusps tell of big problems—output scatter increases**

KPI's From Weibull Probability Plots

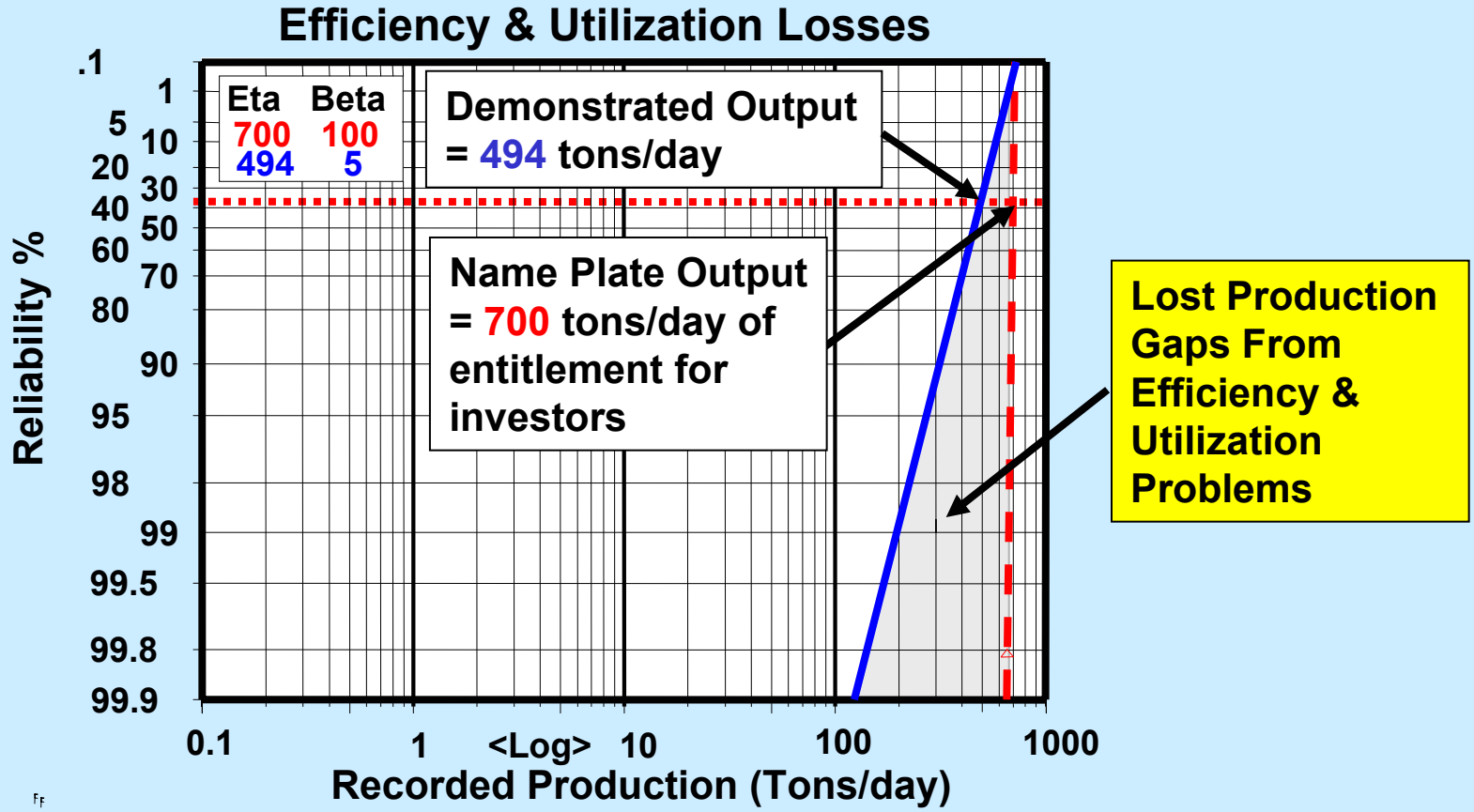


Demonstrated line: What you have achieved with your system if you did not have reliability problems

Nameplate line: The potential for what you could do or a typical benchmark line

- Big η's (large output) and steep β's (predictability) are desired along with high reliability!!

Weibull Probability Plot--Point Estimates



- Demonstrated Output—what you have done
- Name Plate Capacity—what you can do

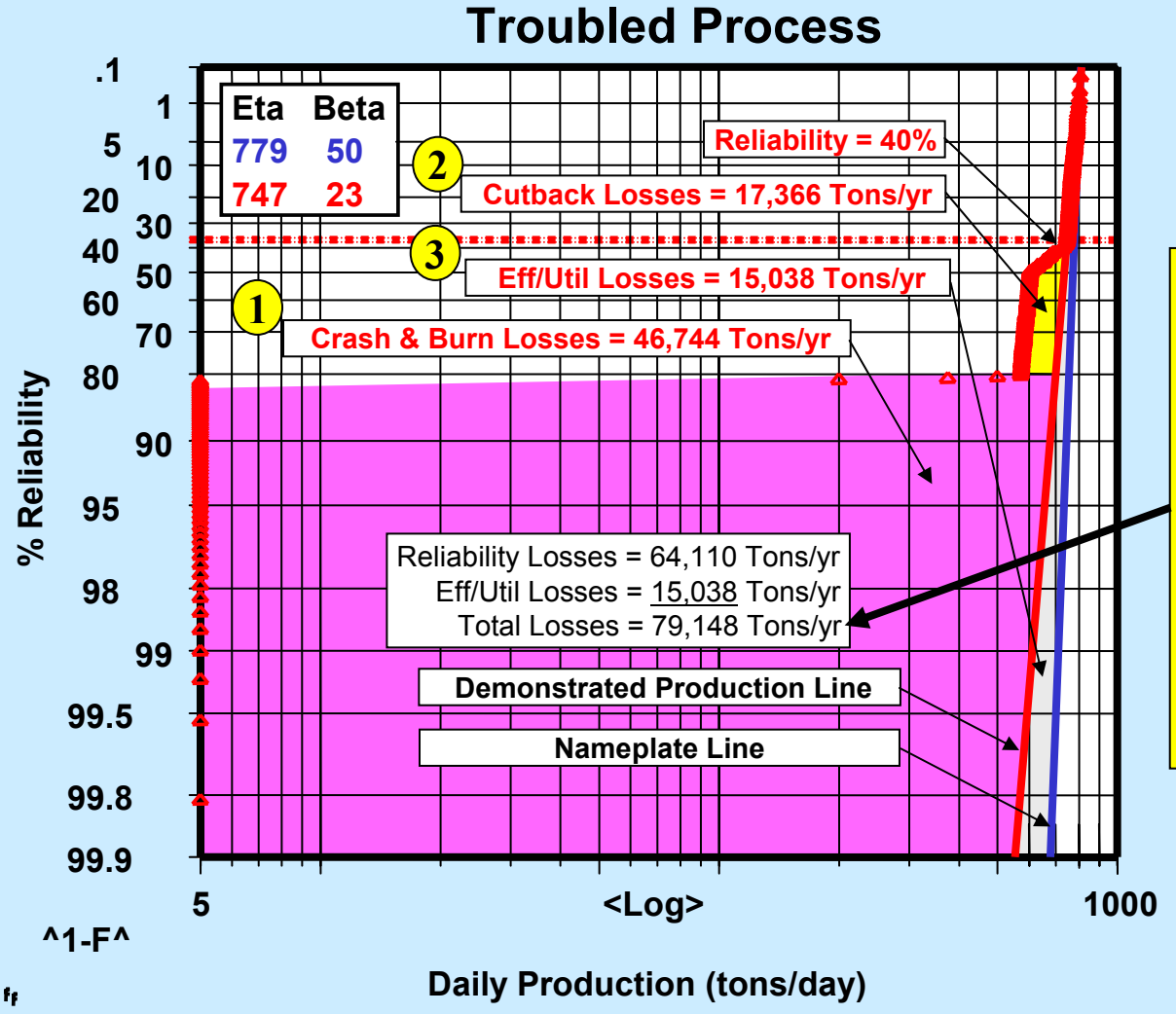
Nameplate Line Slopes

- Find nameplate line slopes by benchmark or by coefficient of variation—this is the entitlement line for investors
- The nameplate line always lies to the right
- Steep nameplate slopes are desired

Poor control	$\beta \approx 5$	Excellent control	$\beta \approx 25$
Fair control	$\beta \approx 10$	World class control	$\beta \approx 100$
Tight control	$\beta \approx 25$	Seldom achieved	$\beta \approx 200$

- Flat β slopes = low grade processes
  Steep β slopes = high grade processes

Weibull Probability Plot--Point Estimates



This is a troubled process with a hidden factory of 79,148 tons/yr or $7,915,000/yr of lost gross margin which is equal to 102 days of lost output per year at nameplate rating

- **Hidden factory is worth $7,915,000 per year!**

Actual Data—What Did We Learn

- We have a reliability problem worth 46,744 tons/yr + 17,366 tons/yr = 64,110 tons/yr or $6,411,000/yr
- We have an efficiency/utilization problem worth 15,038 tons/yr or $1,504,000/yr
- The hidden factory consumes 110 days/yr of production
- Work priority to correct losses:
  1) Plant is down ~1 day out of 5 for $4,674,000/yr,
  2) Cutbacks result in losses of $1,737,000/yr
  3) Efficiency/utilization losses (a management problem) results in losses of $1,504,000/yr

Causes For Reliability Losses

- Equipment cutbacks and lack of orders
- Turnarounds and equipment failures
- Process fouling
- Logistic problems
- Lack of raw materials and orders
- Short term process inattention to optimize
- Catalyst fouling and downtime for catalyst change

Causes Of Efficiency/Utilization Losses

- System stress (temperature, pressure, flow, chemical concentration, and mixing efficiencies)
- Late starts/early quits
- Inattention to long term optimization
- Shifting process aim points by shift
- Lack of statistical process control
- Use of analog controls rather than digital
- Lost time for product change over

Summary

- Weibull analysis shows high level problems on one side of one sheet—look for patterns it does not tell you what is wrong or where the problem exists
- Asset utilization reports must be used to identify specific problems for corrective action
- Accurately identify nameplate ratings or else all problems will appear as reliability problems
- Identify the problems with time and money so everyone can understand them—then fix them on a priority basis so the business is more profitable!

Summary-continued

- You need process that are
  - Available (high % of uptime)
  - Reliable (free from failures)
  - Predicable Output (low scatter in output)
  - Demonstrated High Grade Output
  - Bulls-eye For Process Output Is Known & Controlled
  - Nameplate Capacity is Known & Valued
  - Profitable By Removal Of Hidden Factories
  - Problem Priorities Identification On Pareto Distributions Driven By Money Issues
- Find problems and solve them quickly with an explanation from one side of one sheet of paper with numbers that explain time and money

Reference

- You can download this slide presentation as a PDF file from the Recent Technical Papers section of:

  http://www.barringer1.com