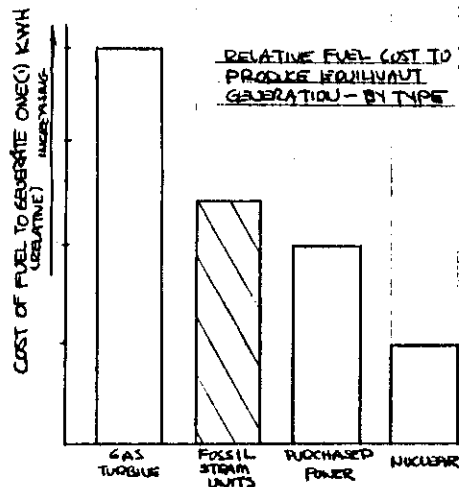
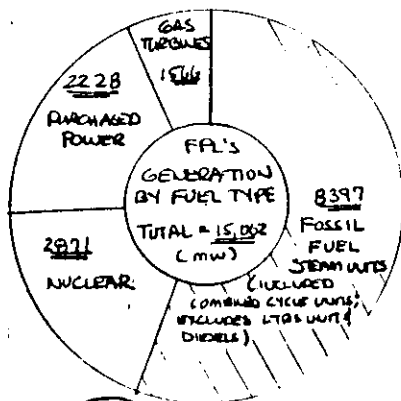


THEME:

" PERFECT EXECUTION OF FOSSIL
PLANT CYCLIC OPERATION AT
THE FORT EVERGLADES PLANT "

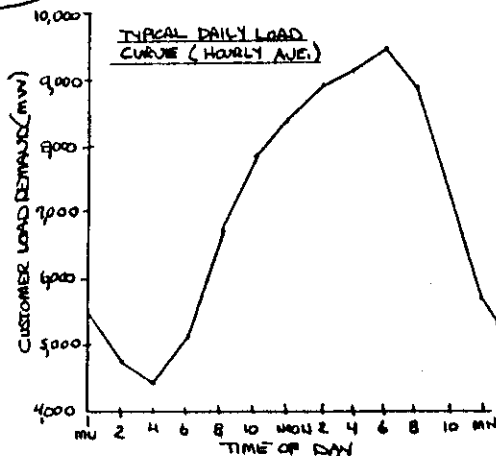
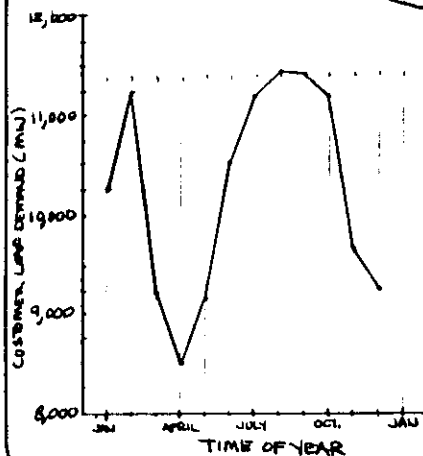
PREPARED BY: JOHN STANTON
FOR: QIP/AE ; COURSE #1 , '86-'87



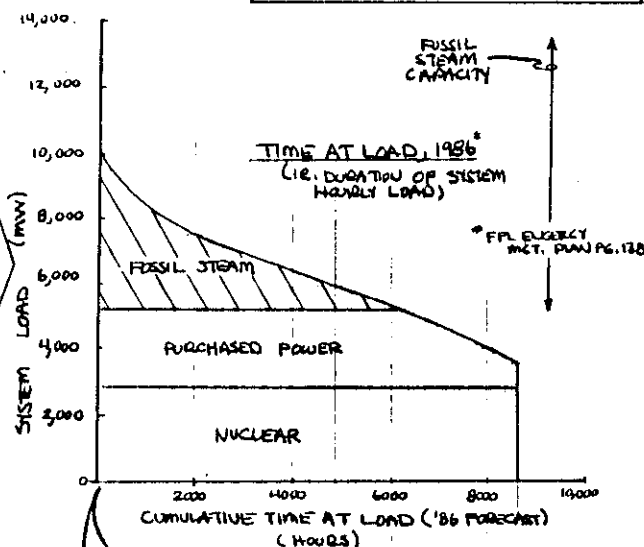
"SUPPLY"
(FPL'S ELECTRICAL GENERATION)

THE 'MISSION':
"SUPPLY POWER TO MEET CUSTOMER DEMAND AT LOWEST RELIABLE COST"

"DEMAND" (CUSTOMER'S REQUIREMENT FOR ELECTRICAL ENERGY) REFERRED TO AS 'LOAD'

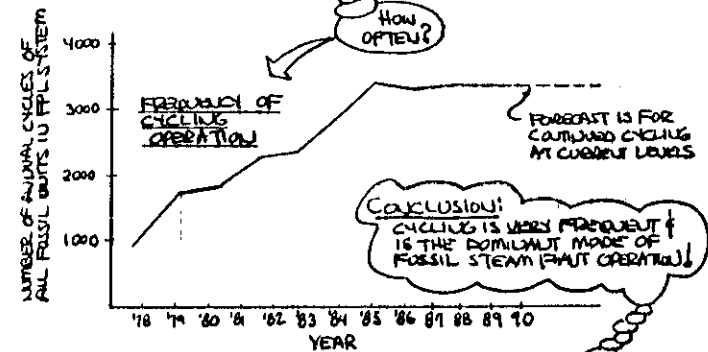


HOW DOES LOAD & COST OF GENERATION EFFECT UNIT OPERATION?



CONCLUSION!
FOSSIL UNITS MUST CYCLE OFF LINE WHEN THEIR GENERATION IS NOT REQUIRED TO MEET CUSTOMER LOAD DEMAND

How often?



CONCLUSION!
CYCLING IS VERY FREQUENT & IS THE DOMINANT MODE OF FOSSIL STEAM (PLANT OPERATION)

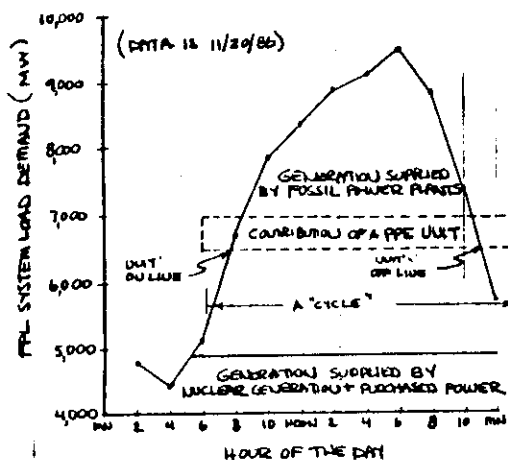
GO TO PG. 2

WHAT DOES AN INDIVIDUAL UNIT LOOK LIKE

REASON FOR SELECTING THE THEME (cont'd)

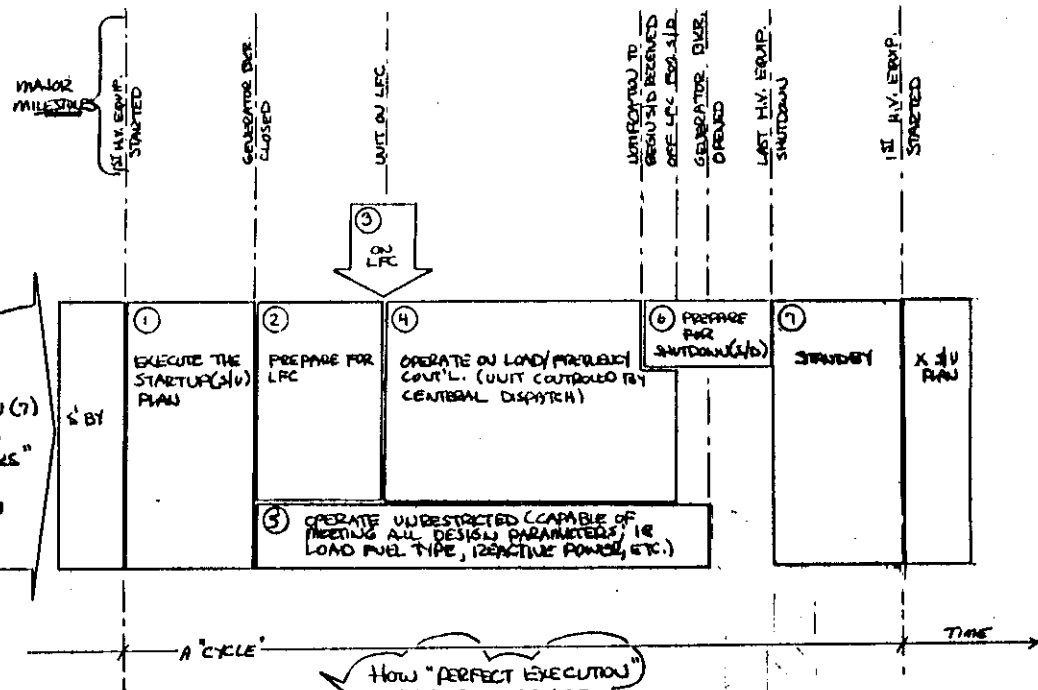
FROM PG. 1:
"WHY FOSSIL
POWER PLANT
UNITS CYCLE
ON/OFF LINE"

UNDERSTANDING THE 'MISSION' OF A FOSSIL FUEL POWER PLANT UNIT



THE SEVEN (7) "BUILDING BLOCKS" OF CYCLIC OPERATION

GRASP OF THE CURRENT SITUATION



THE 'MISSION' OF PPE'S
FOSSIL FUELED UNITS IS TO
PROVIDE THE GENERATION
NECESSARY TO FILL THE
DAILY LOAD SHADE AT THE
DIRECTION OF SYSTEM
OPERATIONS.

POWER RESOURCES
MID-TERM OBJECTIVE #2:

"INCREASE LONG TERM UNIT
RELIABILITY WHILE REDUCING
THE NEED TO PURCHASE
OVERHAUL RESOURCES
REQUIREMENTS IN THE 1990'S"

THEME

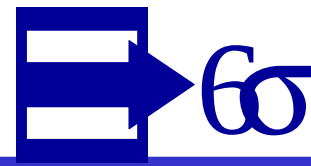
"PERFECT EXECUTION
OF FOSSIL PLANT CYCLIC
OPERATION AT THE
PORT EVERGLADES PLANT"

"BLOCK"	"MEASURES OF SUCCESS"	TARGET
1	SATURATED TEMP. RISE (°F/HR)	100
	1st STG. METAL TEMP. AT BVR CLOSED (REQ'D -VS- ACT) (Δ°F)	φ
	TIME FROM ROLL TO BVR CLOSED (MIN.)	φ CYCLE-TO-CYCLE DEVIATION
2	TIME FROM BVR CLOSED TO "ON LFC" (MIN.)	φ CYCLE-TO-CYCLE DEVIATION
	1st STG. METAL TEMP. RISE (°F/HR)	100
	SATURATED TEMP. RISE (°F/HR)	100
3	SUPERHEAT TEMP. RISE (°F/HR)	100
	ON CONTR'L TIME -VS- TIME REQUESTED (Δ MIN)	φ
	1st STG. METAL TEMP. ; REQ'D -VS- ACT (Δ°F)	φ
4	THRUSTLE PRESSURE ; REQ'D -VS. ACT (PSID)	φ
	SUPERHEAT TEMP. ; REQ'D -VS. ACT. (Δ°F)	φ
	LOAD ; REQ'D -VS- ACT (Δ MW)	φ
5	OCCURRENCES (NO. OF)	φ
6	OCCURRENCES (NO. OF)	φ
7	1st STAGE METAL TEMP. DECREASE (°F/HR)	100
	BVR OPEN TIME ; EST. -VS- ACT. (Δ MIN)	φ
	SAT. TEMP. DECREASE (°F/HR)	φ CYCLE-TO-CYCLE DEVIATION
	1st STAGE METAL TEMP. DECREASE (°F/HR)	φ CYCLE-TO-CYCLE DEVIATION

GO TO
PG 8!



Measure Step - Discussion



What Tools Would You Use to Show the Performance of These "Measures of Success?"

"BLOCK"	"MEASURES OF SUCCESS"	TARGET
1	SATURATED TEMP. RISE ($^{\circ}\text{F}/\text{HR}$)	100
	1 st STG. METAL TEMP. AT BVR CLOSED (ROLL VS. ACT ($\Delta^{\circ}\text{F}$))	ϕ
	TIME FROM ROLL TO BVR CLOSED (MIN.)	ϕ CYCLE-TO-CYCLE DEVIATION
2	TIME FROM BVR CLOSED TO "ON LFC" (MIN.)	ϕ CYCLE-TO-CYCLE DEVIATION
	1 st STG. METAL TEMP. RISE ($^{\circ}\text{F}/\text{HR}$)	100
	SATURATED TEMP. RISE ($^{\circ}\text{F}/\text{HR}$)	100
	SUPERHEAT TEMP. RISE ($^{\circ}\text{F}/\text{HR}$)	100
3	ON CONT'L TIME -VS- TIME REQUESTED (Δ MIN)	ϕ
	1 st STG. METAL TEMP.; REQ'D -VS- ACT ($\Delta^{\circ}\text{F}$)	ϕ
	THRUSTLE PRESSURE; REQ'D -VS. ACT (REQ'D)	ϕ
	SUPERHEAT TEMP.; REQ'D -VS. ACT. ($\Delta^{\circ}\text{F}$)	ϕ
	LOAD; REQ'D -VS- ACT (Δ MW)	ϕ
4	OCCURANCES (NO. OF)	ϕ
5	OCCURANCES (NO. OF)	ϕ
6	1 st STAGE METAL TEMP. DECREASE ($^{\circ}\text{F}/\text{HR}$)	100
	BVR OPEN TIME; EST. -VS- ACT. (Δ MIN)	ϕ
7	SAT. TEMP. DECREASE ($^{\circ}\text{F}/\text{HR}$)	ϕ CYCLE-TO-CYCLE DEVIATION
	1 st STAGE METAL TEMP. DECREASE ($^{\circ}\text{F}/\text{HR}$)	ϕ CYCLE-TO-CYCLE DEVIATION



WHAT COMMON "YARDSTICK" SHOULD BE USED FOR COMPARING PERFORMANCE BETWEEN MENUS

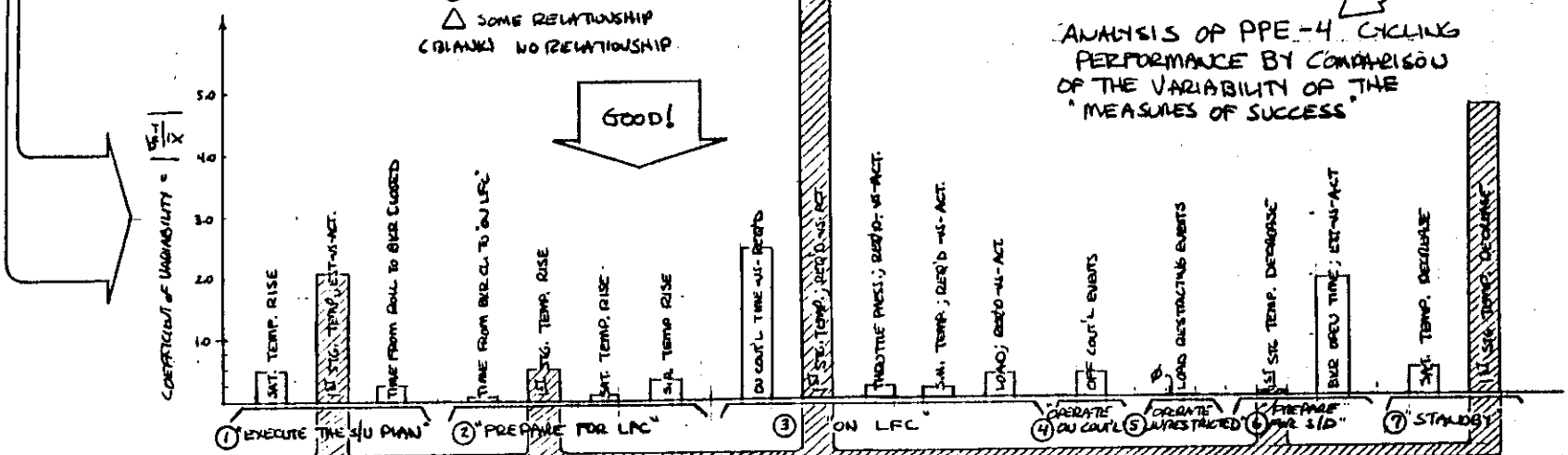
From pg. 2,
"MEASURES OF
SUCCESS"

WHICH ONE
SHOULD BE LOOKED
AT FIRST?

1	2	3	4	
L	L	M	H	AMOUNT OF AVAILABLE DATA
200	200	300	400	SIZE OF UNIT (ml)
39.3	50.3	62.1	56.7	CAPACITY FACTORY (%)

MOST IMPACT!

LEGEND:  DIRECT RELATIONSHIP
 INDIRECT RELATIONSHIP
 SOME RELATIONSHIP
 (BLANK) NO RELATIONSHIP



ANALYSIS OF PPE-4 CYCLING PERFORMANCE BY COMPARISON OF THE VARIABILITY OF THE "MEASURES OF SUCCESS"

Finding:

CONTROL OF TURBINE FIRST STAGE METAL TEMPERATURE APPEARS TO BE THE MOST... VARIABLE PROCESS IN EXECUTING CYCLIC OPERATION.

CONCLUSION:

IF THE SOURCE OF THE VARIABILITY CAN BE IDENTIFIED & IT'S ROOT CAUSE CORRECTED CYCLIC OPERATION CAN BE GREATLY IMPROVED.

PROBLEM STATEMENT:

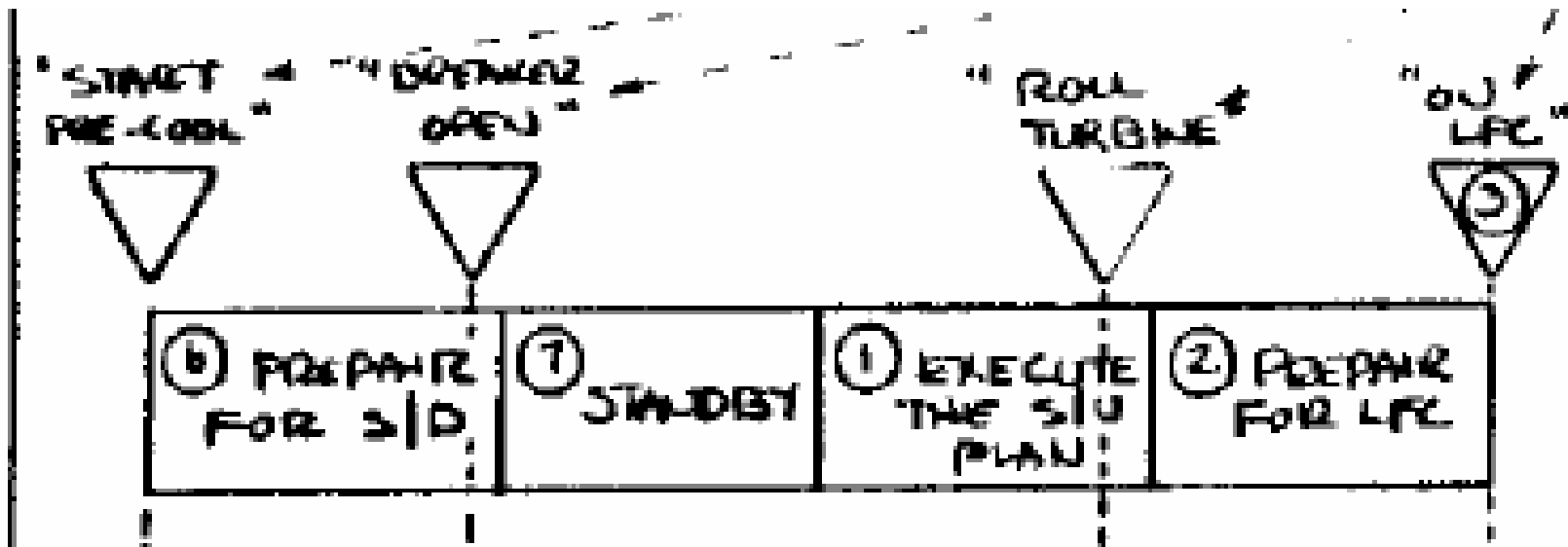
DECREASE THE SOURCE OF FIRST STAGE
METAL TEMPERATURE VARIABILITY

TARGET:

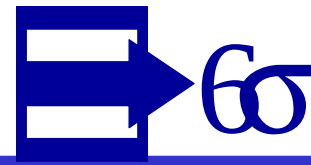
50% REDUCTION

John Stanton is Focusing on *Variation in Turbine First Stage Metal Temperature.*

How Could You Help John Decide Where the Variation is the Largest (Process Shown Below)?

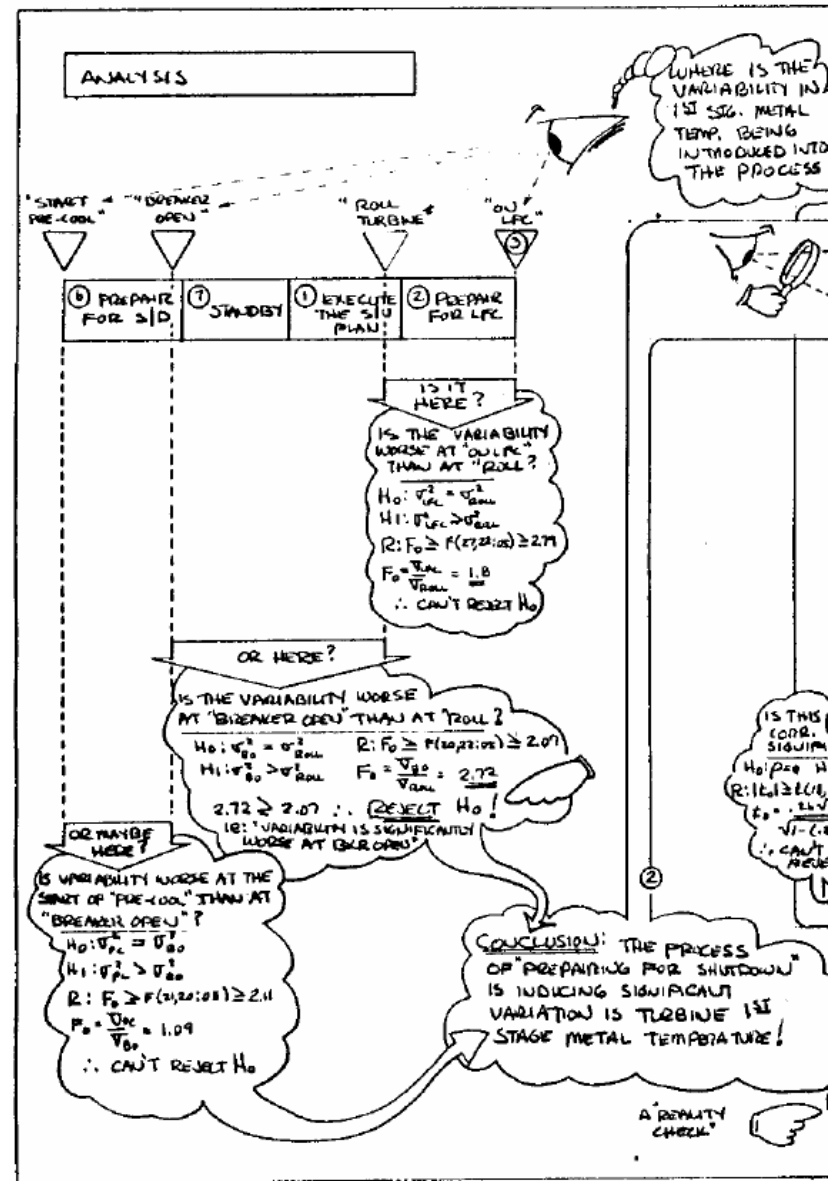


Analysis Step - Discussion

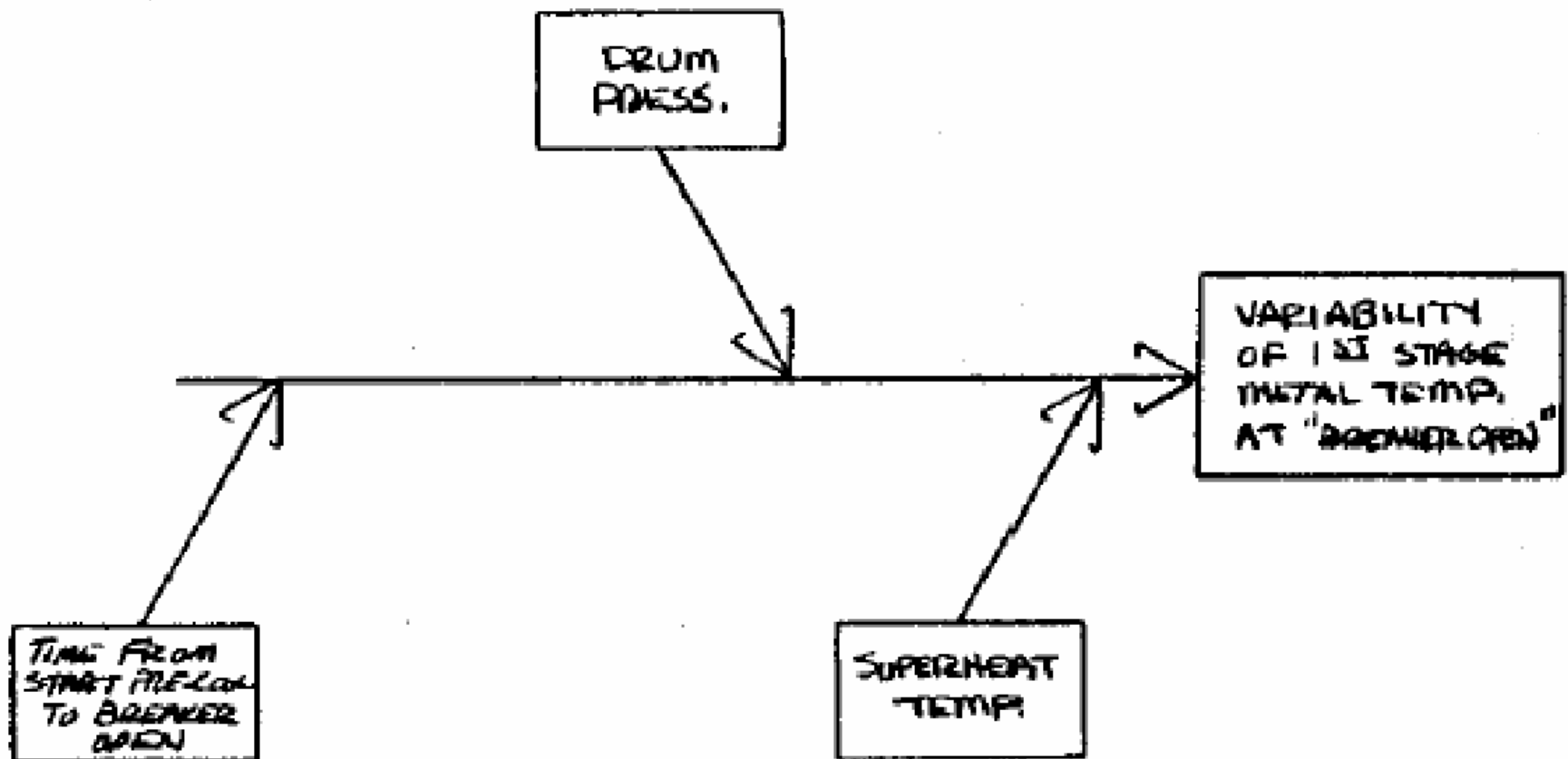


John Stanton is Focusing
on *Variation in Turbine
First Stage Metal
Temperature.*

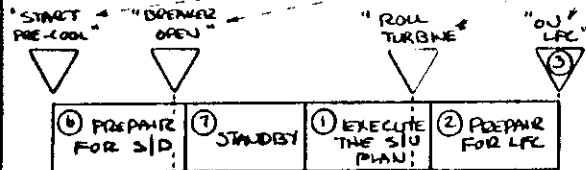
He Used Hypothesis
Tests (of Variance) to
Answer the Variation
Question:



How Would You Attempt to Verify These Potential Root Causes?



ANALYSIS



IS IT HERE?
IS THE VARIABILITY WORSE AT "ON LFC" THAN AT "ROLL"?
 $H_0: \sigma_{LFC}^2 = \sigma_{Roll}^2$
 $H_1: \sigma_{LFC}^2 > \sigma_{Roll}^2$
 $R: F_0 \geq F(17, 22; .05) \geq 2.71$
 $F_0 = \frac{\sigma_{LFC}^2}{\sigma_{Roll}^2} = 1.8$
 $\therefore$ CAN'T REJECT H_0

OR HERE?

IS THE VARIABILITY WORSE AT "BREAKER OPEN" THAN AT "ROLL"?
 $H_0: \sigma_{BO}^2 = \sigma_{Roll}^2$
 $H_1: \sigma_{BO}^2 > \sigma_{Roll}^2$
 $R: F_0 \geq F(10, 22; .05) \geq 2.07$
 $F_0 = \frac{\sigma_{BO}^2}{\sigma_{Roll}^2} = 2.72$
 $2.72 \geq 2.07 \therefore$ REJECT H_0 !
IE: "VARIABILITY IS SIGNIFICANTLY WORSE AT BKR OPEN"

OR MAYBE HERE?

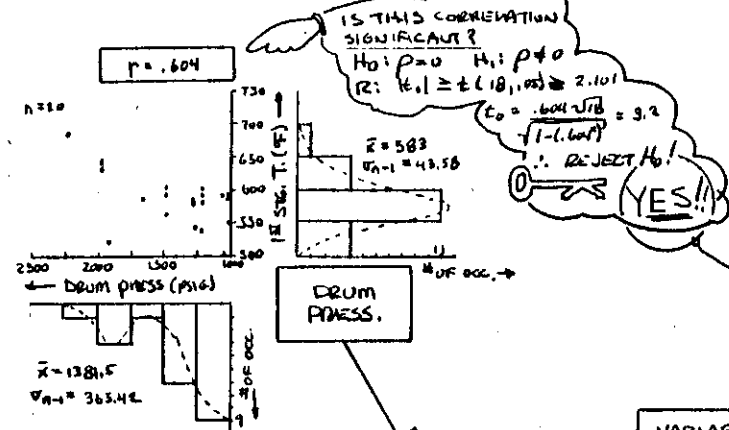
IS VARIABILITY WORSE AT THE START OF "PRE-COOL" THAN AT "BREAKER OPEN"?
 $H_0: \sigma_{PC}^2 = \sigma_{BO}^2$
 $H_1: \sigma_{PC}^2 > \sigma_{BO}^2$
 $R: F_0 \geq F(3, 20; .05) \geq 2.11$
 $F_0 = \frac{\sigma_{PC}^2}{\sigma_{BO}^2} = 1.09$
 $\therefore$ CAN'T REJECT H_0

CONCLUSION: THE PROCESS OF "PREPARING FOR SHUTDOWN" IS INDUCING SIGNIFICANT VARIATION IN TURBINE 1ST STAGE METAL TEMPERATURE!

A REALITY CHECK

WHERE IS THE VARIABILITY IN 1ST STG. METAL TEMP. BEING INTRODUCED INTO THE PROCESS?

CAUSE & EFFECT

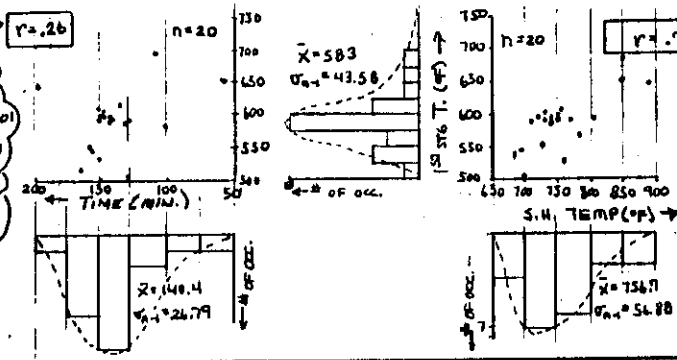


VARIABILITY OF 1ST STAGE METAL TEMP. AT "BREAKER OPEN"

TIME FROM START PRE-COOL TO BREAKER OPEN

SUPERHEAT TEMP.

IS THIS CORR. SIGNIFICANT?
 $H_0: \rho = 0$
 $H_1: \rho \neq 0$
 $R: |t_0| \geq t(18, .05) \geq 2.101$
 $t_0 = \frac{r \sqrt{n}}{\sqrt{1-r^2}} = 1.41$
 $\therefore$ CAN'T REJECT H_0
NO!!



GO TO PG. 5.

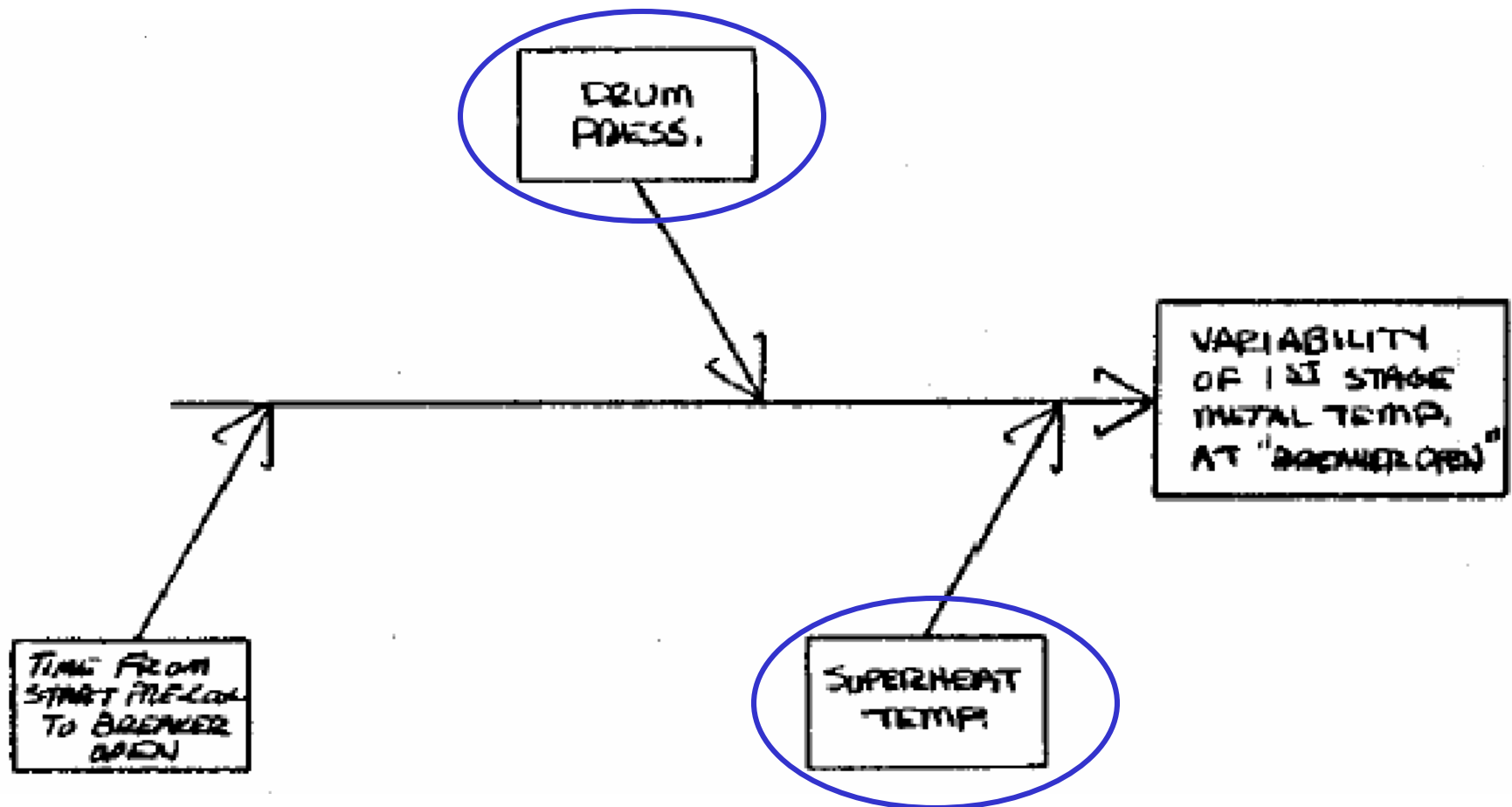
THE SKEPTIC QUESTIONS:

"ISN'T THAT OK BECAUSE OF THE VARIATION IN THE TIME THE UNIT IS OFF LINE?"

THE FACTS ANSWER:

"NO! THE $\Delta T(F)$ BETWEEN BKR OPEN / ROLL IS NOT SIGNIFICANT $R: |t_0| \geq t(19, .05) \geq 2.093$ WHERE $t_0 = \frac{\bar{d}}{\sqrt{\frac{s_d^2}{n}}} = \frac{3.9}{4.93} = .79$ "

Given that Drum Pressure and Superheat Temperature are Important Factors, How Could You Help The Operator Control the Variation in **First Stage Metal Temperature**?



ANALYSIS (CONT'D)

FROM PG. 4

LET'S FOCUS A LITTLE CLOSER ON THE PROCESS!

000

WHAT IS THIS RELATIONSHIP?

$$T_{\text{METAL}} = (A) + (B_1)T_{\text{STEAM}} + (B_2)P_{\text{STEAM}} + (B_3)F_{\text{STEAM}}$$

DETERMINE FACTORS FROM REGRESSION ANALYSIS (SAS)

- I DIDN'T COLLECT P_0 VALUE DATA. HOW STRONG IS MY RELATIONSHIP IF I IGNORE IT?

$$T_m = 128.7 + .618T_s - .009P_s$$

TABLE OF ANOVA

S.V.	S.S.	df	m.s.	F ₀
R	19761.94378	2	9880.97189	10.284
E	16354.05622	17	960.82684	
T	36096.0000	19		

$$F(2,17, .05) = 3.59 < 10.284$$

∴ REJECT H_0 , OR CONVERSELY, ACCEPT THE STRENGTH OF THE RELATIONSHIP AS "SIGNIFICANT"

- THE FACTOR FOR (B_2) DOESN'T LOOK LIKE IT CONTRIBUTES MUCH. HOW STRONG IS THE RELATIONSHIP IF WE ONLY LOOK AT STEAM TEMP?

$$T_m = 154.65 + .566T_s$$

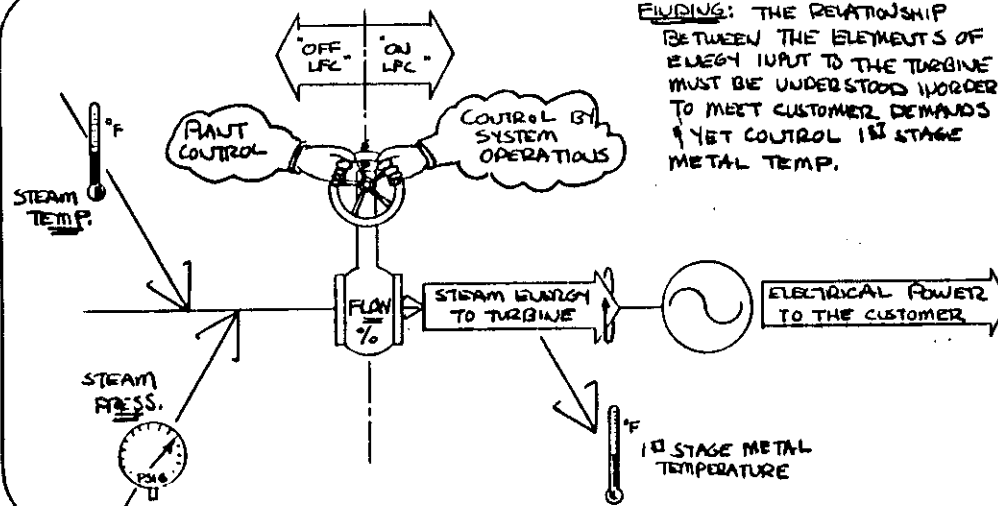
TABLE OF ANOVA

S.V.	S.S.	df	m.s.	F ₀
R	19698.34826	1	19698.34826	21.623
E	16397.65174	18	910.98063	
T	36096.0000	19		

$$F(1,18, .05) = 4.41 < 21.623$$

∴ REJECT H_0 & OBSERVE THAT THIS RELATIONSHIP IS EVEN STRONGER!

FINDING: THE RELATIONSHIP BETWEEN THE ELEMENTS OF ENERGY INPUT TO THE TURBINE MUST BE UNDERSTOOD IN ORDER TO MEET CUSTOMER DEMANDS & YET CONTROL 1ST STAGE METAL TEMP.



GO TO PG. 6
"COUNTERMEASURES"

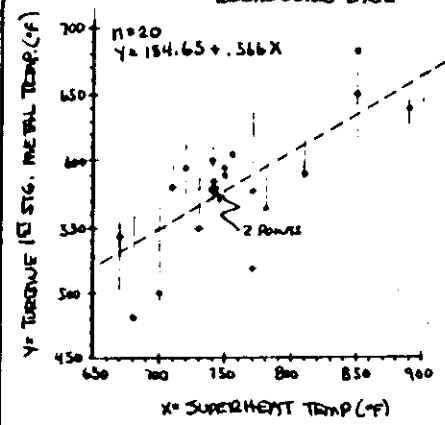
CONCLUSION:

$T_m = 154.65 + .566T_s$
ADEQUATELY DEFINES THIS RELATIONSHIP & CAN BE USED TO CONTROL 1ST STAGE TEMP.

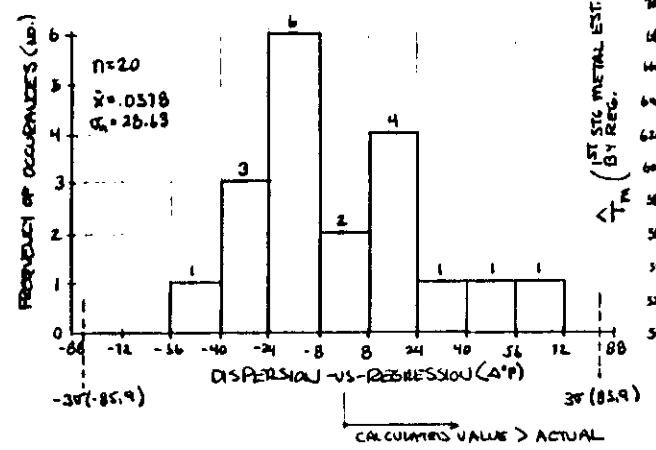
COUNTERMEASURES

From
pg. 5

① PLOT THE CALCULATED
REGRESSION LINE

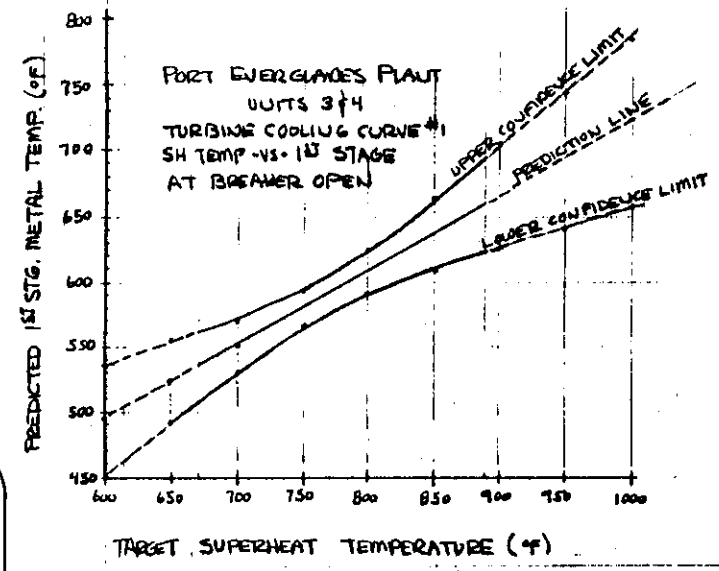
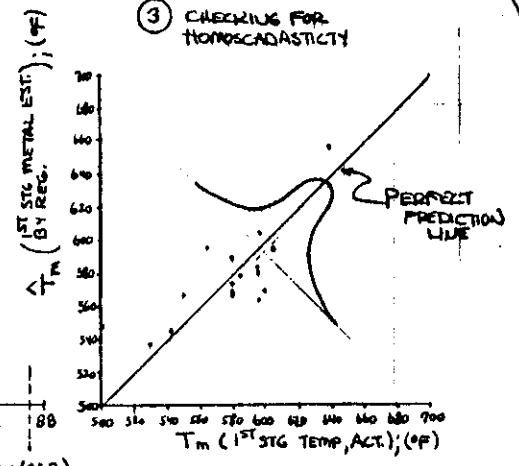


② CHECKING OF THE
DISPERSION AGAINST
THE REGRESSION LINE



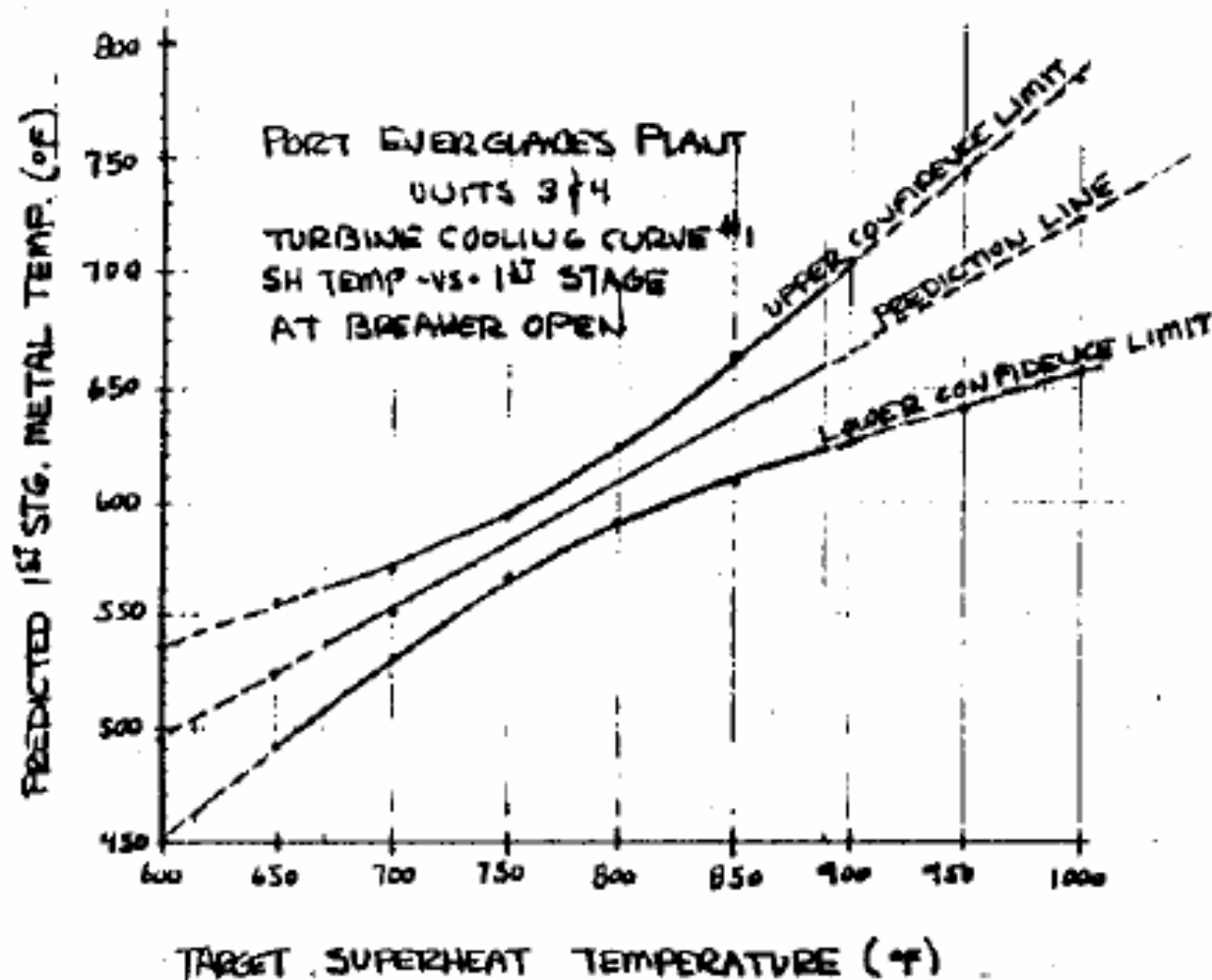
④ DEVELOP A "TOOL"
FOR THE OPERATOR
IN ORDER THAT HE OR
SHE CAN CONTROL THE
STEAM TEMPERATURE
TO ACHIEVE ANY
DESIRED TURBINE
1ST STAGE METAL
TEMPERATURE.

③ CHECKING FOR
HOMOSCEDASTICITY



GO TO PG. 7

Now That John Understands the “X & Y” Relationships,
What’s Next?

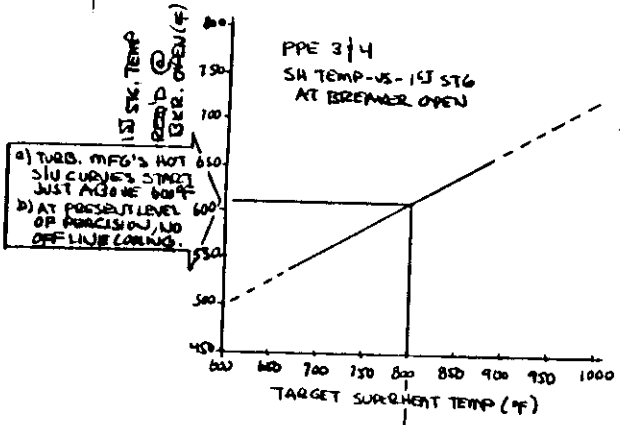


COUNTERMEASURES (CONT'D)

From PG. 6

TRIAL IMPLEMENTATION

- 1) SELECT "REQ'D" VALUE FOR 1ST STG. TEMP. @ BKR. OPEN



2

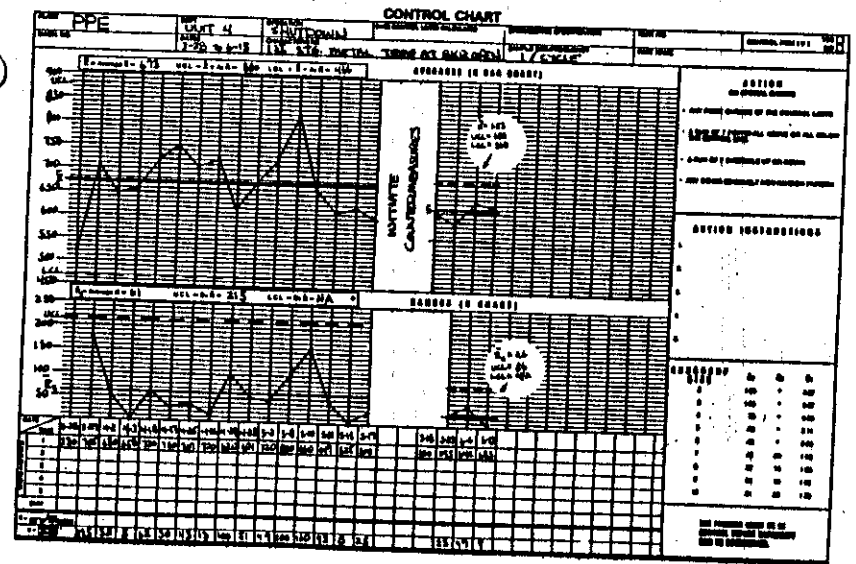
PORT EVERGLADES
TEMPORARY
OPERATING
PROCEDURE

~~~~~  
BREAKER OPEN  
SH TEMP. TARGET  
800°F  
~~~~~

APPROVED,
OPER. SUPT.

So, How did it work?

RESULTS



FINDING: ALTHOUGH THERE ARE ONLY A FEW DATA POINTS SINCE IMPLEMENTING TRIAL COUNTERMEASURES, THERE APPEARS TO BE AN IMPROVEMENT

	$\bar{x}$	σ_{n-1}	V	TARGET: $V_A/V_B \leq 50\%$
BEFORE	673	68.9	4753	
AFTER	623	20	400	RESULTS: 91% REDUCTION

QUESTION:
THE TARGET WAS ACHIEVED, BUT IS IT SIGNIFICANT WITH SO LITTLE DATA?

CONCLUSION:
THE COUNTERMEASURES WERE SUCCESSFUL

$$H_0: V_B = V_A; H_1: V_B > V_A$$

$$R: F_0 \geq F(\alpha; 3; .025) \geq 8.7$$

$$F_0 = \frac{V_B}{V_A} = \frac{4753}{400} = 11.9$$

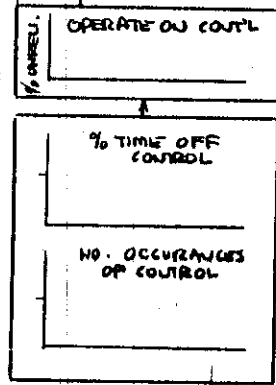
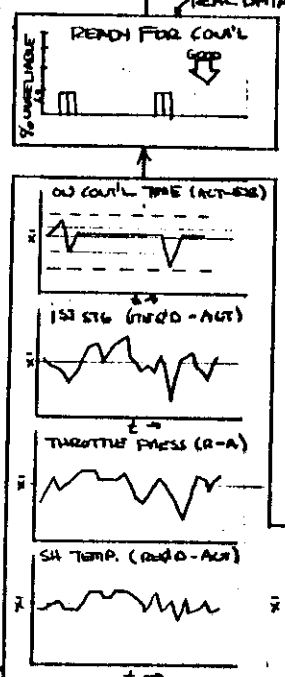
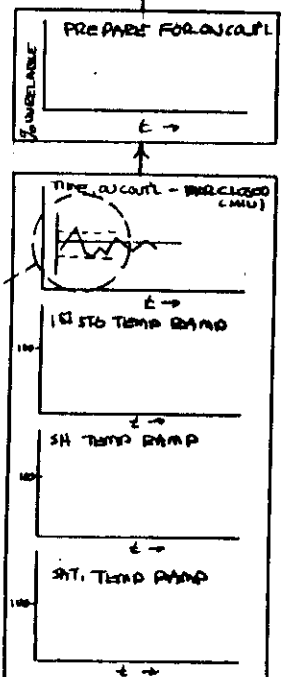
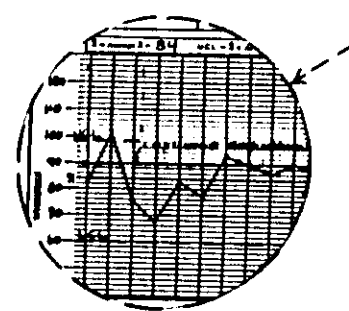
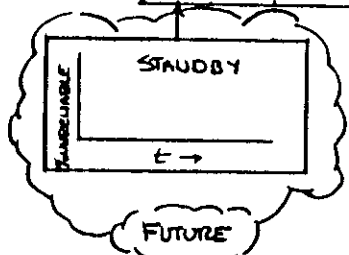
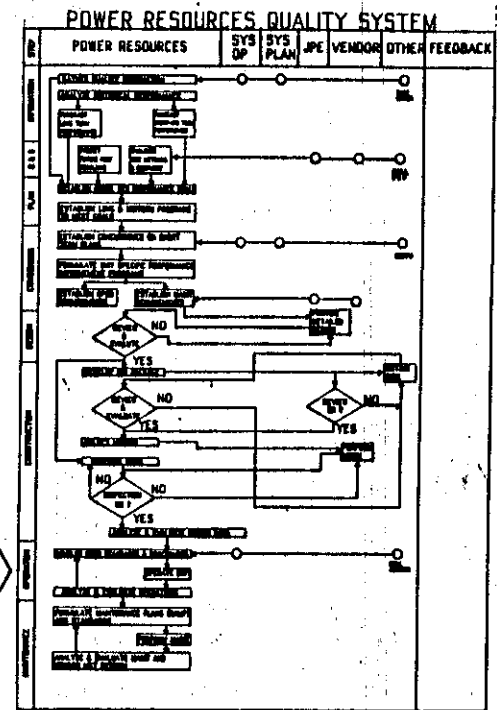
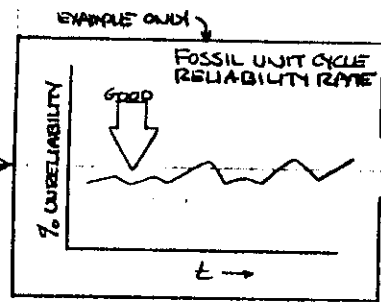
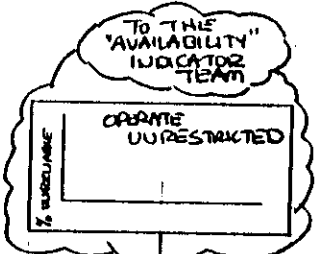
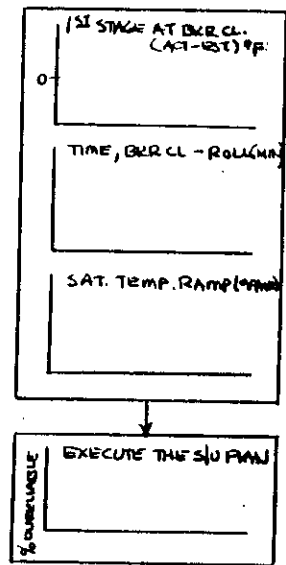
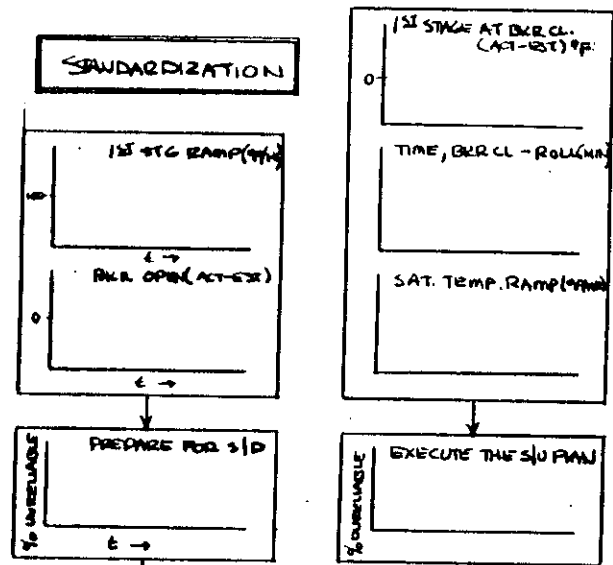
REJECT H_0

LET'S TEST IT!

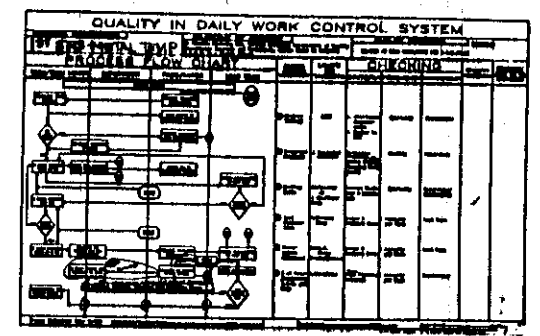
12: "VARIABILITY IS SIGNIFICANTLY LESS SINCE IMPLEMENTING THE COUNTERMEASURE"

TO PG. 8

① DEVELOP A HIERARCHY OF INDICATORS...
 ② ... IN SUPPORT OF POWER RESOURCES' QUALITY SYSTEM.
 PILOT PROGRAM IN PROGRESS AT PPE!



③ DEVELOP QIDW CONTROL SYSTEMS FOR:
 a) THE ADMINISTRATION OF THE INDICATORS
 b) TECHNICAL PROBLEM SOLVING FOR EACH INDICATOR



FUTURE PLANS

ACTION ITEM	RESPONSIBLE PARTY	EST. COMPLETION DATE
AS PART OF THE POWER RESOURCES INDICATOR PROJECT THE CYCLING PROCESS INDICATORS WILL BE REPLICATED AT OTHER PLANTS.	J. L. THOMAS	T.B. A.
PORT EVERGLADES' NEXT QIP/AE PARTICIPANT WILL FOLLOW ON WITH THE THEME OF "PERFECT EXECUTION OF CYCLIC OPERATION"	D. H. ARNOTT	3-1-88 (EST. COMP. DATE OF QIP/AE, COURSE 2)
- PORT EVERGLADES' HAS SELECTED PERFECT EXECUTION OF CYCLIC OPERATION AS A 1988 POLICY DEPLOYMENT PROJECT IN ORDER TO: 1) BE IN CONTROL AT POINT WITHIN THE PROCESS. 2) BE CAPABLE OF MEETING SYSTEM OPERATIONS' VALID REQUIREMENTS AT ALL POINTS WITHIN THE PROCESS.	D. H. ARNOTT	12-31-88