

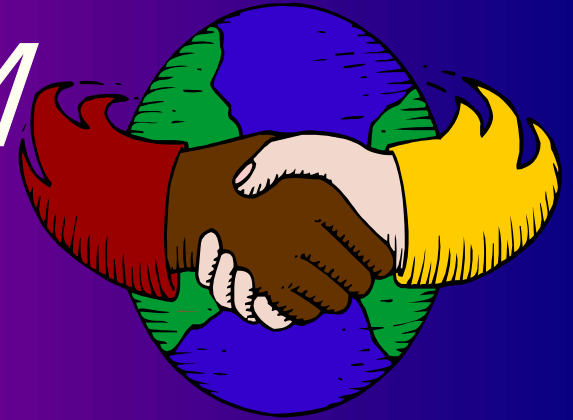


QUALITY CIRCLE

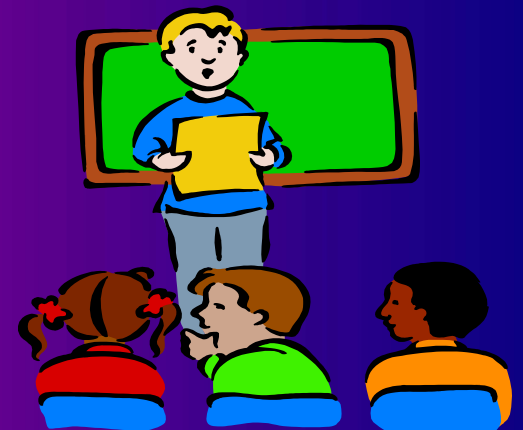
ALUMINIUM

WELCOME

TO THE CASE-STUDY
PRESENTATION



YOU





INTRODUCTION



OUR COMPANY

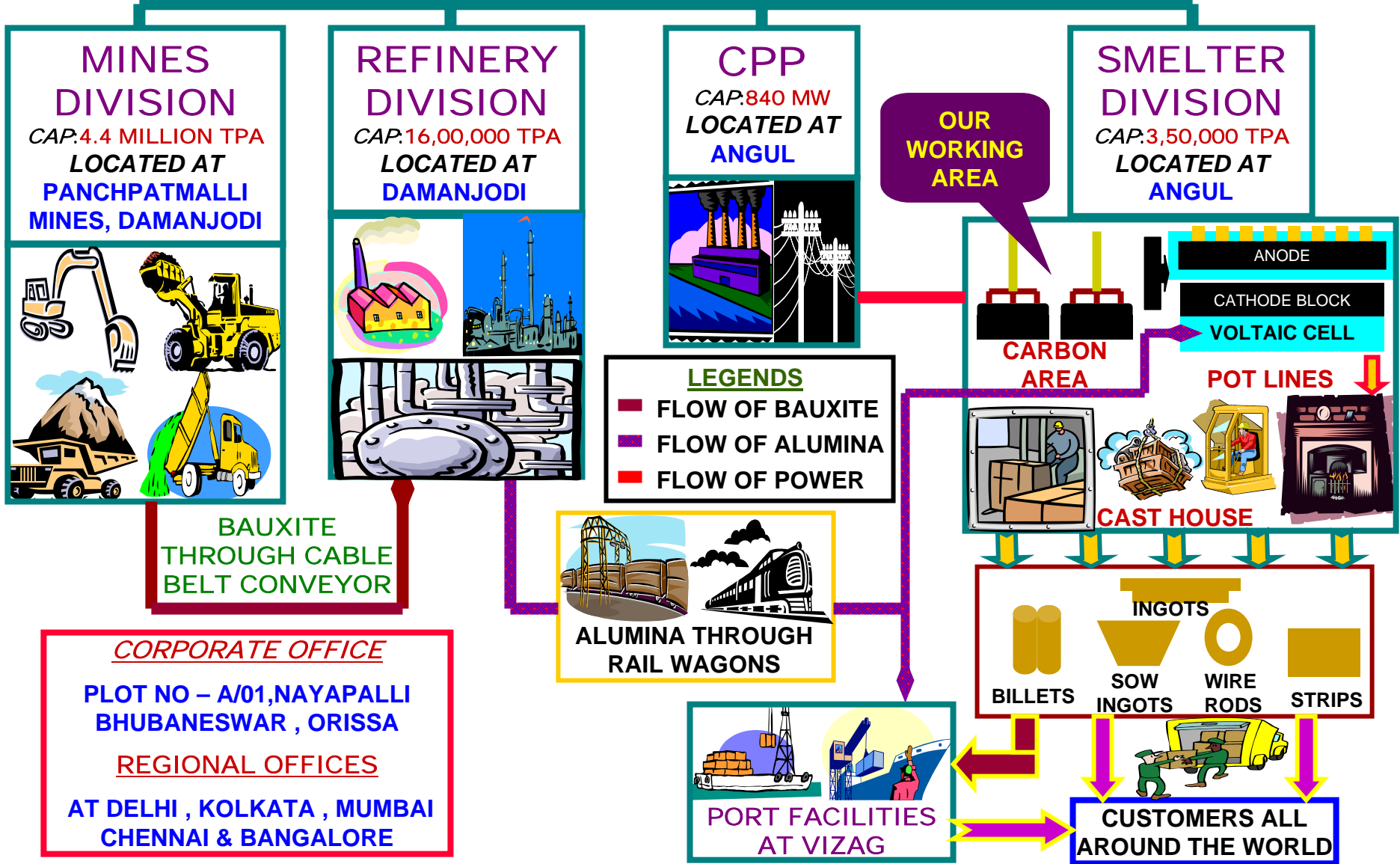
OUR NATIONAL ALUMINIUM COMPANY LIMITED IS A PREMIER PSU OF THE COUNTRY. WE ARE PRODUCING WORLD CLASS HIGH GRADE PURIFIED ALUMINIUM THROUGH " HALL & HAROULT METHOD " OF ALUMINA SMELTING. OUR PRODUCTS HAVE BEEN REGISTERED IN LME. OUR COMPANY HAS BAGGED CAPEXIL AWARDS FOR 10 CONSECUTIVE YEARS. DUE TO THE GLORIOUS AND CONSISTENT TRACK RECORDS OUR COMPANY HAS BEEN AWARDED " MINIRATNA " BY GOVT. OF INDIA.



- ❖ REGN. NO : 24 OF SMELTER PLANT
- ❖ DATE OF REGISTRATION : 24.10.1997
- ❖ WORKING AREA : RODDING SHOP (MECH)
CARBON PLANT,SMELTER UNIT
- ❖ LEADER : P.C.MOHAPATRA
- ❖ Dy. LEADER : G.B.DASH
- ❖ MEMBERS : U.K.PANDA ,G.C.LENKA & D.GAGARAI
- ❖ FACILITATED BY : Mr.D.K.SAHU, JR.MGR(M)
- ❖ CIRCLE MEETINGS HELD -C.YEAR : 44/48 (SCH)
- ❖ PERCENTAGE OF ATTENDANCE : 90 %
- ❖ PROJECTS TAKEN UP/COMPLETED: 11 / 09 NOS

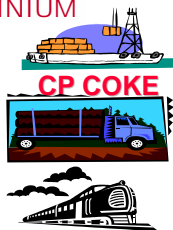


NALCO - AT A GLANCE



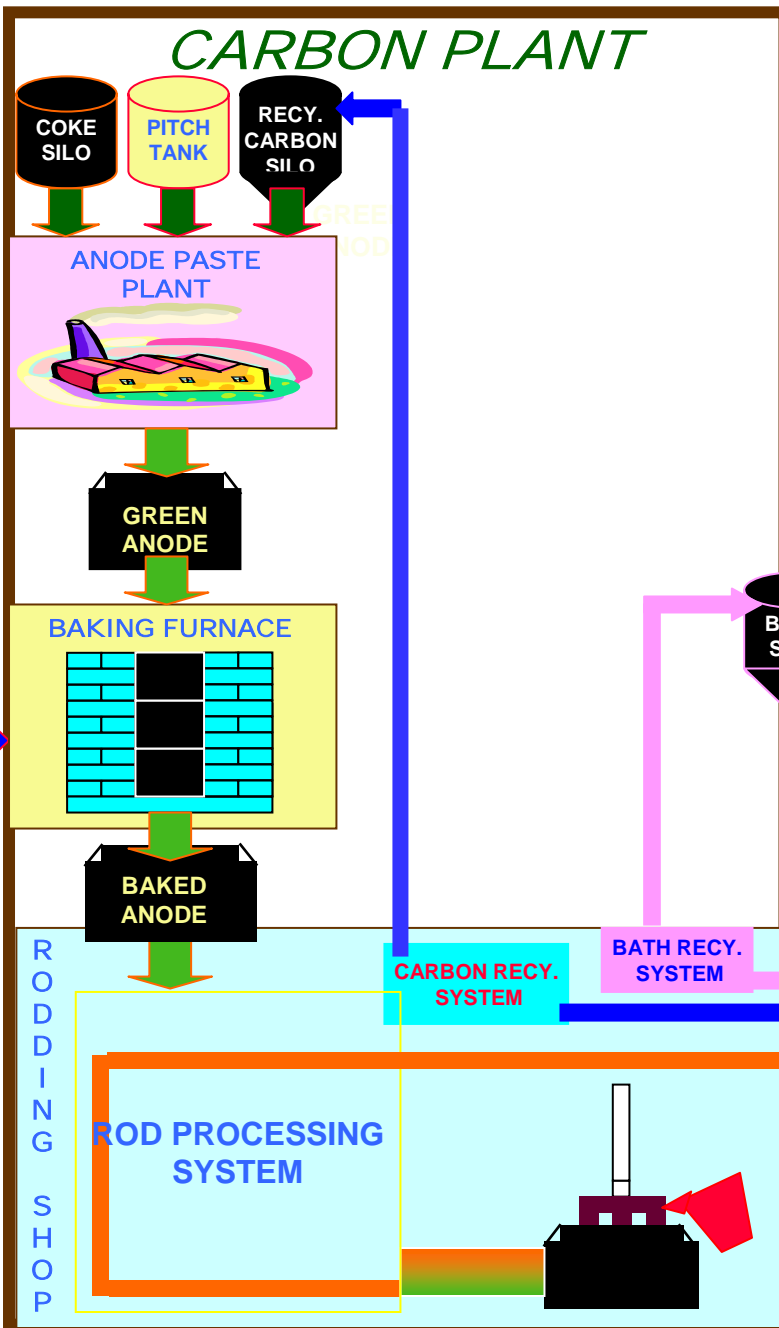


ALUMINIUM



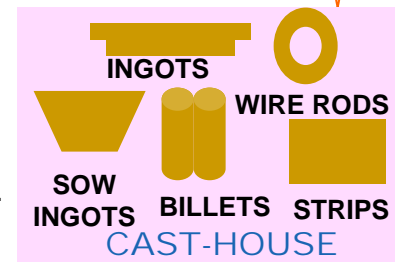
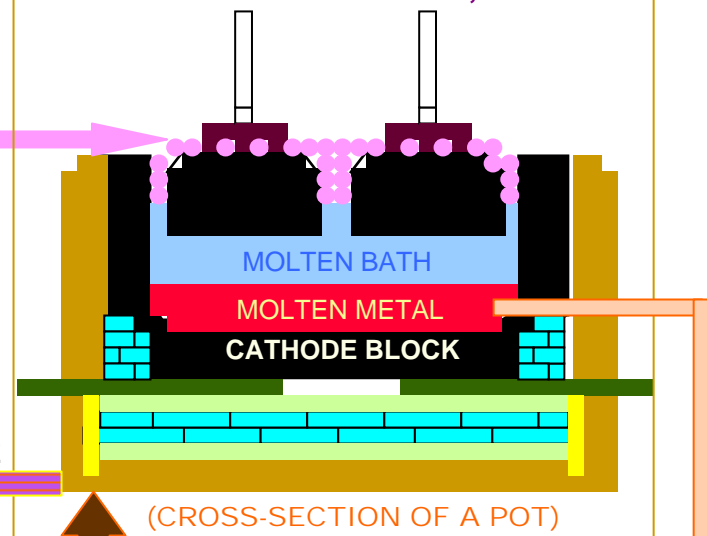
PRODUCTION CYCLE OF ANODES IN NALCO SMELTER

CARBON PLANT



POT LINES

SMELTING METHOD : HALL & HAROULT
METHOD OF ALUMINA SMELTING
TYPE OF POTS : 180 KVA POTS
REQUIRED INPUTS: ELECTRIC POWER, ANODIC CARBONS, ALUMINA



- Green arrow: FLOW OF INPUTS.
- Pink arrow: FLOW OF BATH
- Blue arrow: FLOW OF BUTT
- Orange arrow: FLOW OF STEM/BRACKET ASSY.(ROD)
- Brown arrow: FLOW OF ANODIC CARBON.
- Light orange arrow: FLOW OF HOT METAL

PROBLEM SELECTION

i) PROBLEM IDENTIFICATION

PROBLEM IDENTIFICATION CRITERIA

- INTERNAL CUSTOMER FEEDBACK
- DIRECT LOSS OF PRODUCTION (> 3 Hours/ Month)
- AGENDA OF DISCUSSION IN SHOP FLOOR MEETINGS
- IDENTIFIED AS PROBLEM IN MONTHLY ANALYSIS REPORT
- SAFETY OF WORKING PERSONNEL DURING MAINT. ACTIVITIES

➤ TOTAL NO. OF PROBLEMS IDENTIFIED : 55

ii) PROBLEM PRIORITIZATION

TECHNIQUE USED: NOMINAL GROUP TECHNIQUE

CRITERIA USED: 1-Production Loss 2- Single Line Equipment
3- Safety Concern 4- Repair Time 5- Financial Implication

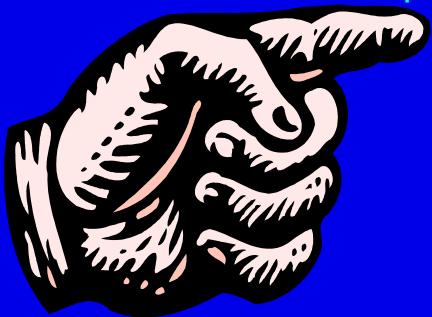
➤ TOTAL NO. OF PROBLEMS PRIORITISED : 15

iii) PROBLEM SELECTION

TECHNIQUE USED: CONSENSUS CRITERIA RATING METHOD

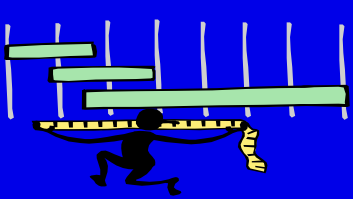
CRITERIA USED: 1-Direct loss of production(1.75) 2- Job Criticality(0.40)
3 – Financial Implication(0.75) 4 – safety(0.50) 5- Departmental Importance(1.50)

**“INCONSISTENT BRUSHING
OF ANODE STEMS”**





ALUMINIUM



PROJECT PLAN



MONTH/YR. ACTIVITIES	SEP 2000	OCT 2000	NOV 2000	DEC 2000	JAN 2001	FEB 2001	JUL 2001	AUG 2001	SEP 2001	OCT 2001	NOV 2001	DEC 2001	JAN 2002	FEB 2002	MAR 2002	APR 2002	MAY 2002	MAY 2003	JUN 2003	JUL 2003
OBSERVATION	■ ■																			
ANALYSIS & ROOT CAUSE		■ ■																		
PREPARATION OF DRAWINGS			■ ■																	
FAB. OF STRUCTURES					■ ■			■												
ERECTION OF STRUCTURES							■						■							
TR. RUNNING AND CHECKING			■					■						■						
ONSITE ADOPTION								■						■						
FINAL HOOKING-UP									■					■						
CHECKING & STANDARD.										■					■					

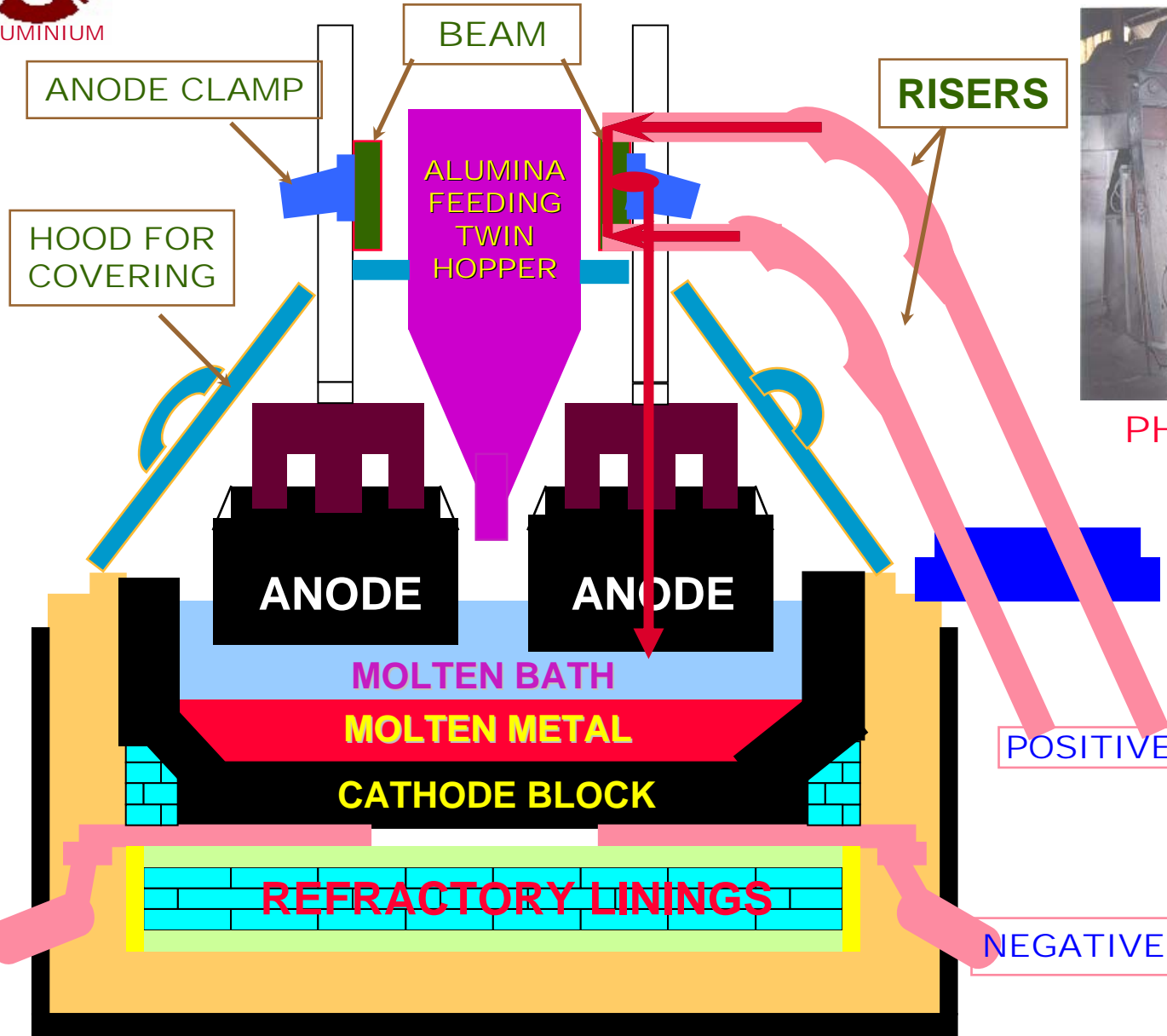
■ PLANNED

■ ACTUAL



ALUMINIUM

TYPICAL ARRANGEMENT OF POT CELL



PHOTOGRAPH OF NALCO'S ELECTROLYTIC POT

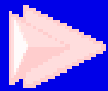


STEM BRUSHING AT RODDING SHOP

(SECTIONAL VIEW OF 180 KA ELECTROLYTIC POT)



IMPACT OF THE PROBLEM



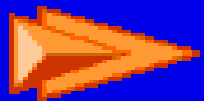
ORGANIZATIONAL:

- ELECTRICAL ENERGY CONSTITUTES 36% OF THE DIRECT COST OF MAKING ALUMINIUM. ENERGY SAVED WILL HAVE BEARING ON PRICING OF ALUMINIUM.
- ENHANCEMENT OF CURRENT EFFICIENCY OF POTS IS A STRATEGIC OBJECTIVE OF MANAGEMENT.
- BAD STEM CONTACT IN POTLINE LEADS TO PITTING & DAMAGE OF ALUMINIUM STEMS & BEAMS ■

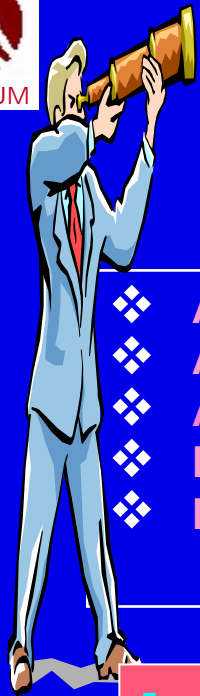


DEPARTMENTAL:

- RODDING SHOP OPERATION HAS BEEN STRESSING ON IMPROVEMENT IN BRUSHING.
- CRITICAL PROCESS REQUIREMENT LEADING TO NON FULFILLMENT OF INTERNAL CUSTOMER'S REQUIREMENT



REDUCTION IN 01 mV HAS THE POTENTIAL OF SAVING Rs. 8.20 LAKHS/ YEAR



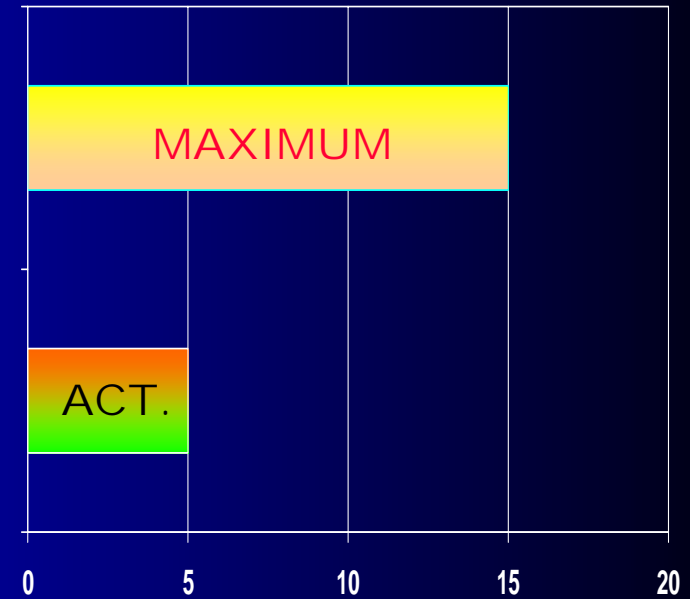
OBSERVATION

FROM 01.08.1999 TO 31.08.2000

- ❖ AVG. BRUSH CONSUMPTION: 01 NO/MONTH
- ❖ AVG. VOLTAGE DROP IN USED STEM: 40 mV
- ❖ AVG. VOLTAGE DROP IN NEW STEM: 25 mV
- ❖ LOSS OF ELECT. ENERGY: 129.56 KWH/MT
- ❖ LOSS OF ELECTRICAL ENERGY IN TERMS OF RUPEES (@ Rs. 1.10/Unit): Rs. 3.28 CRORES

- VOLTAGE DROP DEPENDS ON
 - 1) STEM SURFACE CONDITION
 - 2) BEAM SURFACE CONDITION
- ACCEPTABLE VOLTAGE DROP : 20 mV
- WORLD'S BOP: 15 mV

**AVG. BRUSHING QUALITY: 05
(AS PER FEEDBACK RECEIVED FROM OPRN. IN A SCALE 1-15)**



PROJECT GOAL

**TO ELIMINATE INCONSISTENCY
IN BRUSHING BY 100 %**



FISHBONE DIAGRAM

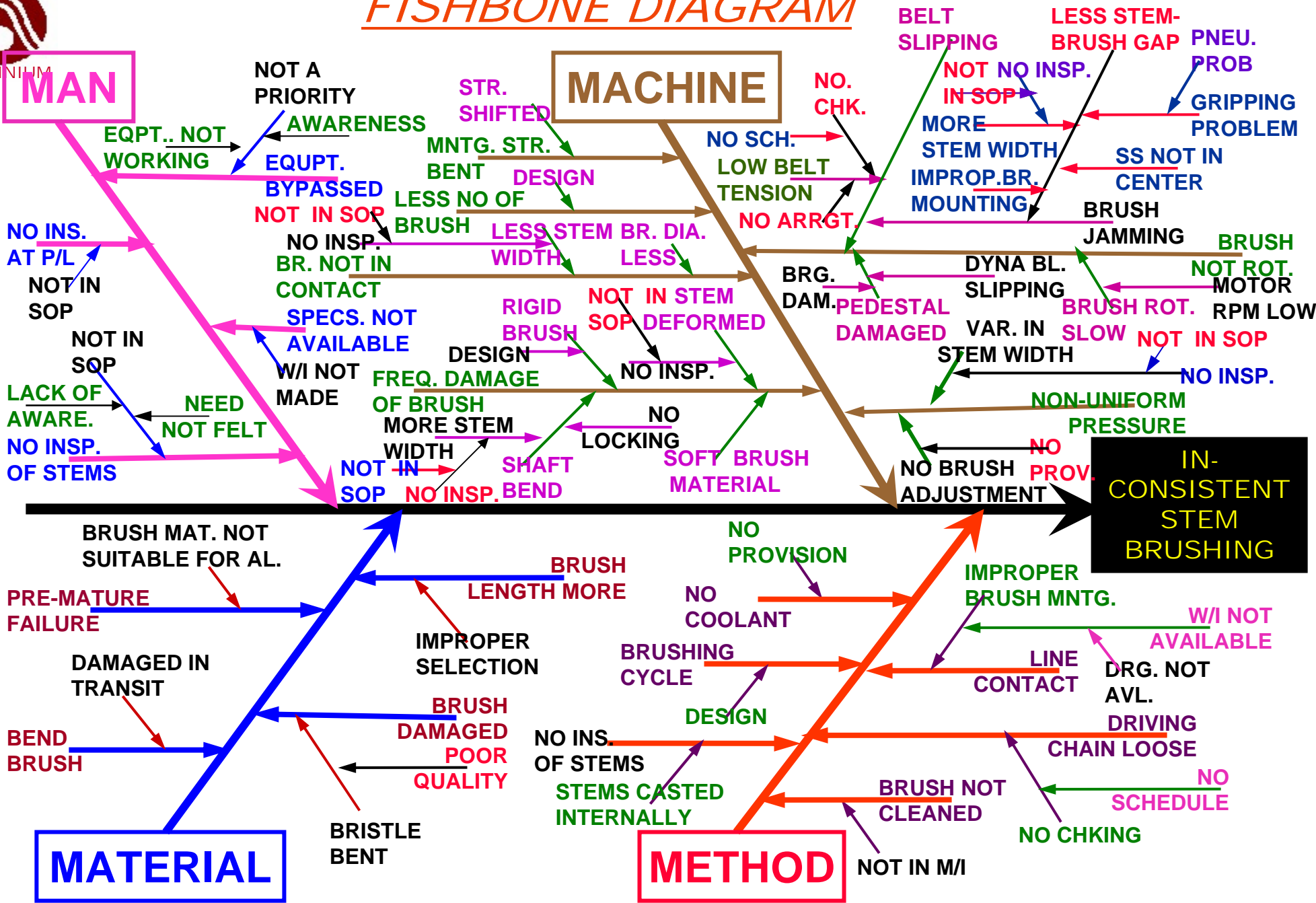
MAN

MACHINE

MATERIAL

METHOD

IN-CONSISTENT STEM BRUSHING



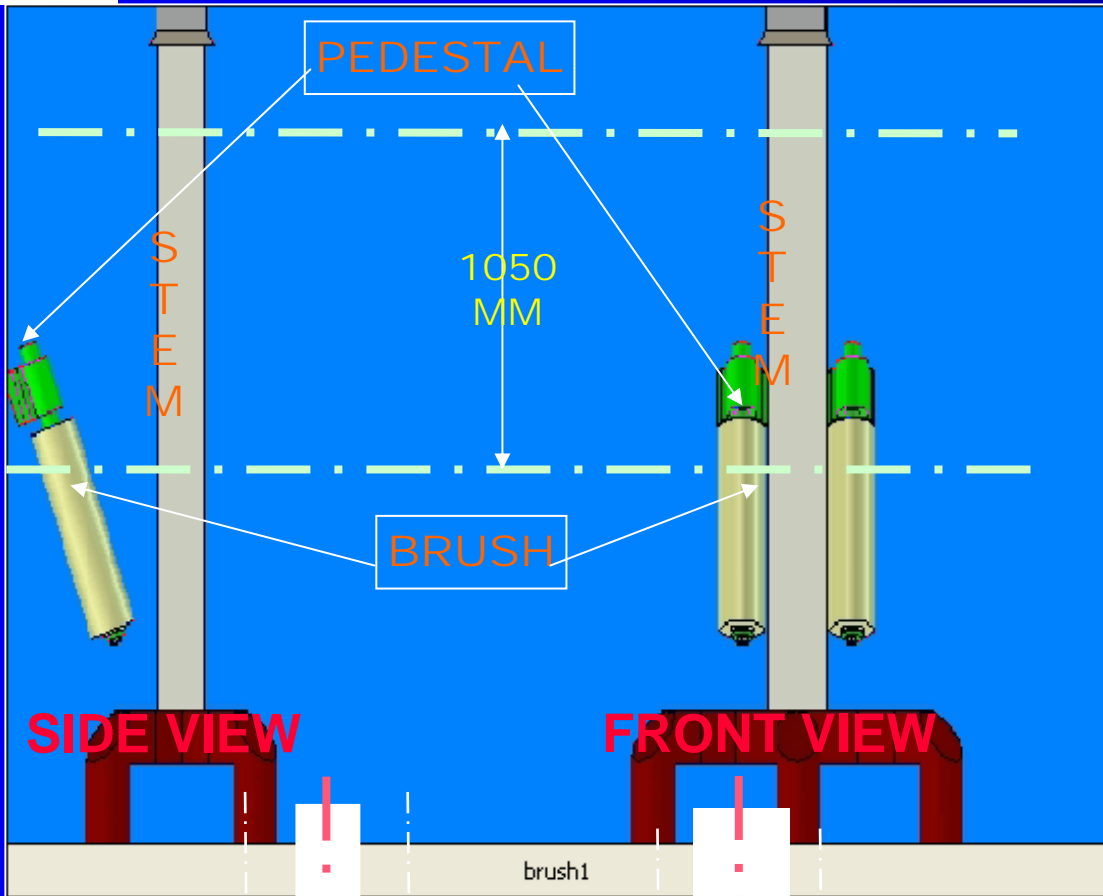


ROOT CAUSE ANALYSIS

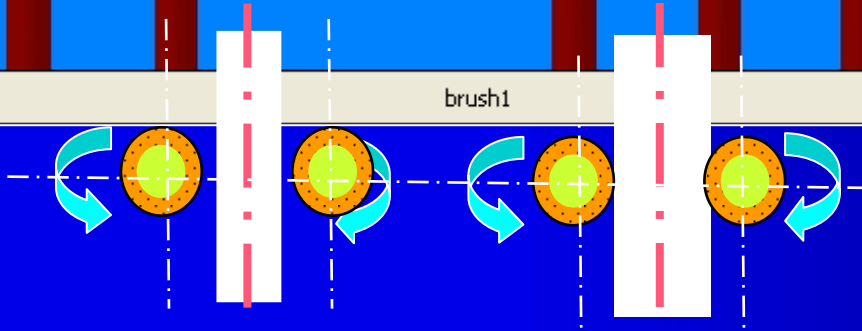
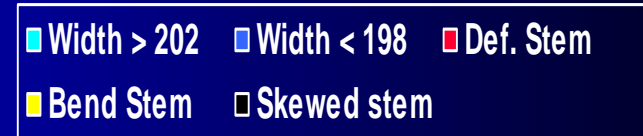
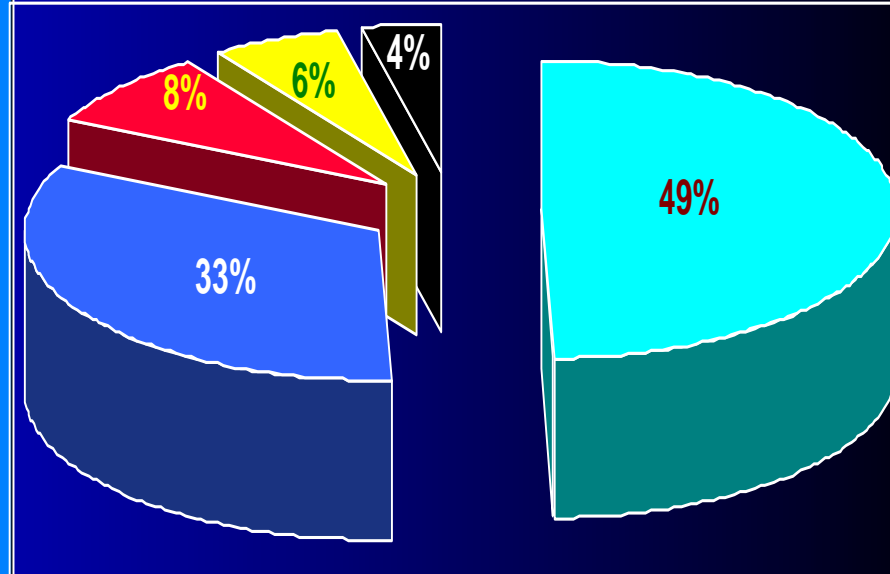
	MACHINE RELATED CAUSES	METHOD OF CHECKING	OBSERVATIONS	RESULT
8	NO LOCKING ARRGT. FOR BRUSH	DRG. 1208-561	AS PER THE DEIGN	INVALID
9	SOFT BRUSH MATERIAL SO FREQ. DAM. OF BRUSH	RODDING SHOP MANUAL OEMS/ SPECS	AS PER THE DESIGN SUPPLIED BY OEM	INVALID
10	NO PROVISION FOR BRUSH ADJUSTMENT	DRG. 1208-561	AS PER THE DRAWING	INVALID
11	VAR IN STEM WIDTH LEADING TO NON-UNIFORM PR.	ACTUAL SITE OBSERVATION IN SHIFTS	- JAMMING OF BRUSHES FOR MORE WIDTH - NO CONTACT FOR LESS WIDTH	VALID
12	DYNA BLOCK SLIP LEADING PEDESTAL DAMAGE	-DO- AND LAST INSTALL. RECORD	NO SLIPPAGE	INVALID
13	BRG. DAM. LEADING PEDESTAL DAMAGE	PHYSICAL INSPECTION OF BEARING AT SITE	BEARING IS OK	INVALID
14	LOW MOTOR RPM SO BRUSH NOT ROT	DISCUSSED WITH ELECT. TECO- READING	1440 ROM AS PER SPECS	INVALID
15	SS NOT IN CENTER SO LESS STEM-BRUSH GAP	ACTUAL SITE MEASUREMENT RODDING SHOP LAYOUT DRG.	15 MM OUT FROM FURNACE SIDE	VALID
16	GRIPPING PROB. SO LESS STEM-BR. GAP	DRG: 1208-561	AS PER SPECIFICATION	INVALID
17	IMPROPER BR. MOUNTING SO LESS STEM-BR GAP	-DO-	-DO-	INVALID
18	MORE STEM WIDTH SO LESS STEM-BRUSH GAP	ACTUAL SITE OBSERVATION	BRUSH JAMMING FOR STEM > 202 MM	VALID
19	NO SCH. TO CHK. BELT TENSION	DOC. F5/CPM/4.9	INCLUDED IN THE CHECK SHEET	INVALID
20	NO ARRANGEMENT TO TENSION THE BELT	DOC. F5/CPM/4.9	NO PROVISION IN THE DRAWING	INVALID



BRUSHING OPERATION (BEFORE)



ON-SITE DATA ANALYSIS

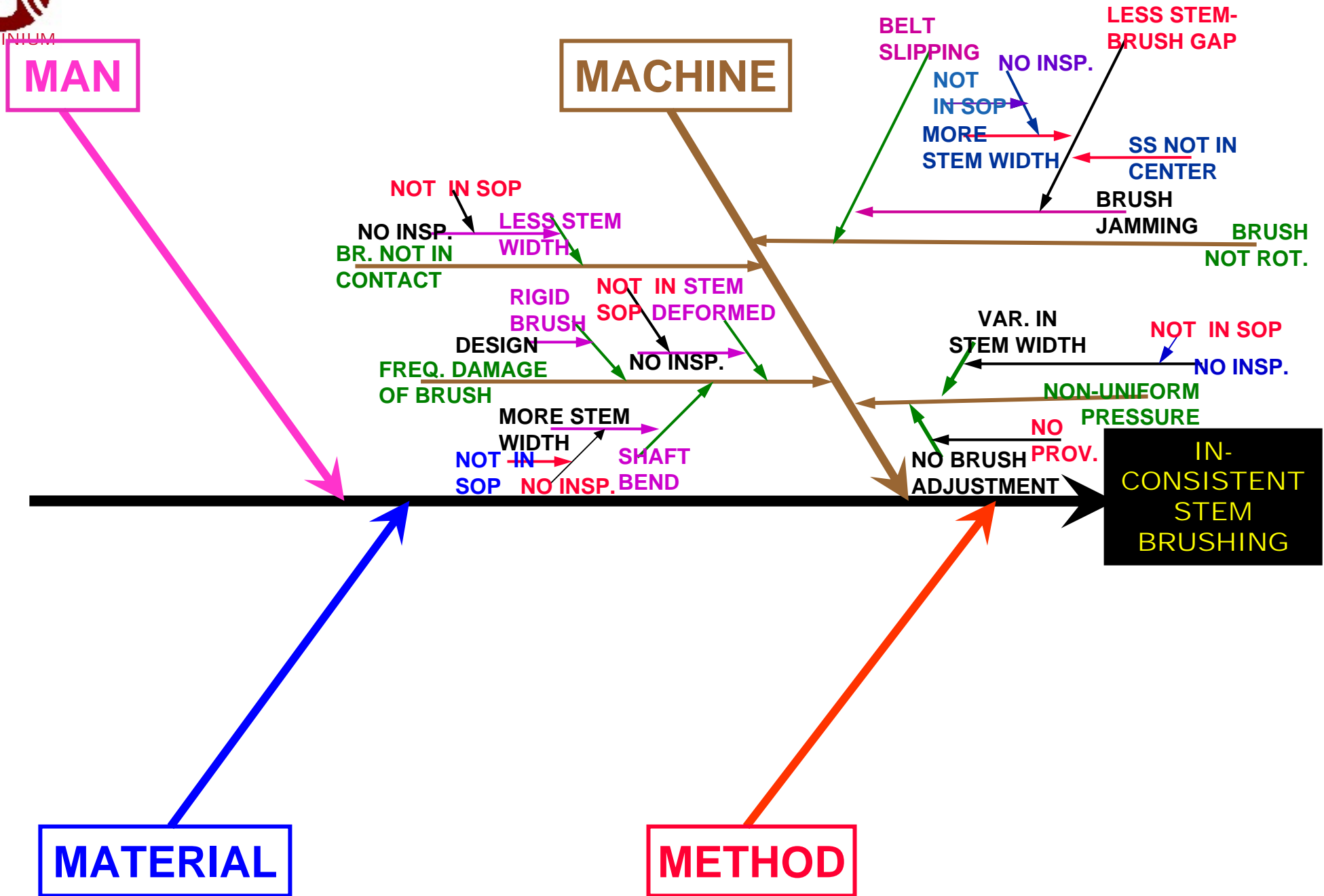


TYPE OF CONTACT
FOR LESS STEM
WIDTH < 198 mm

TYPE OF CONTACT
FOR MORE STEM
WIDTH > 202 mm

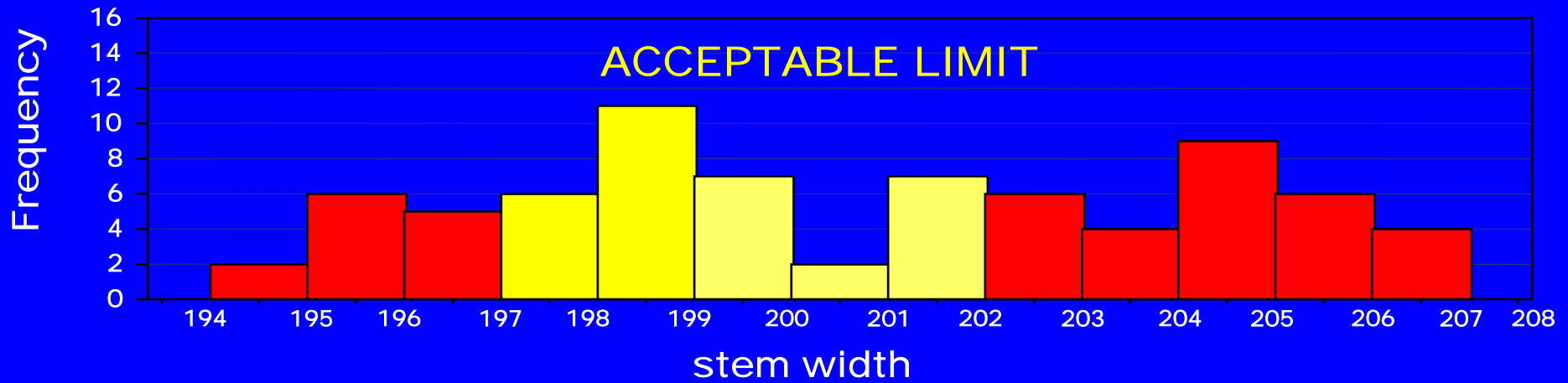
REVISED FISHBONE DIAGRAM

ALUMINIUM

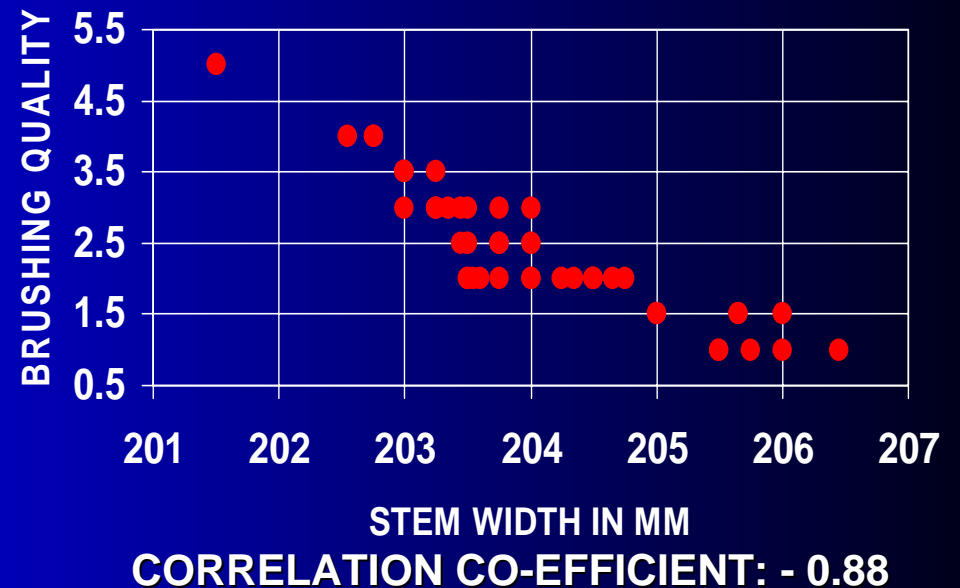
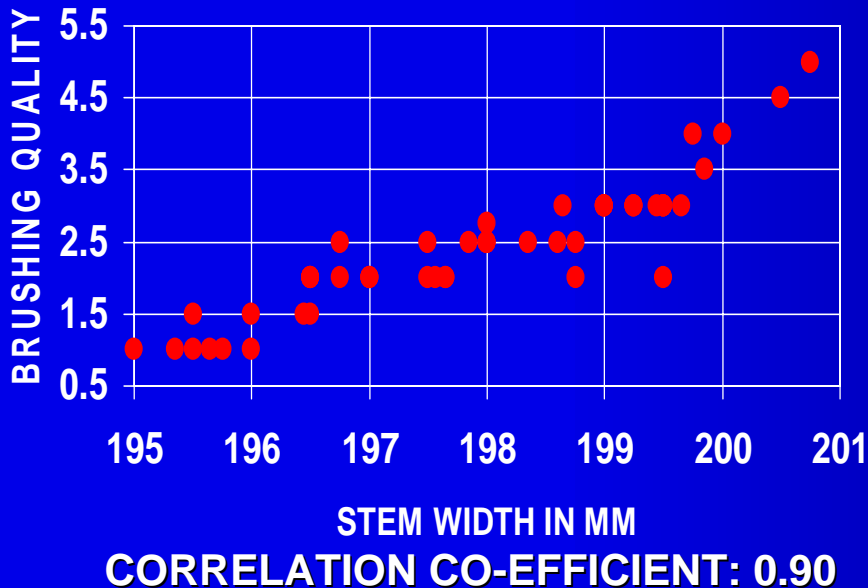




DISTRIBUTION OF STEMS



RELATIONSHIP BETWEEN STEM WIDTH & BRUSHING QUALITY

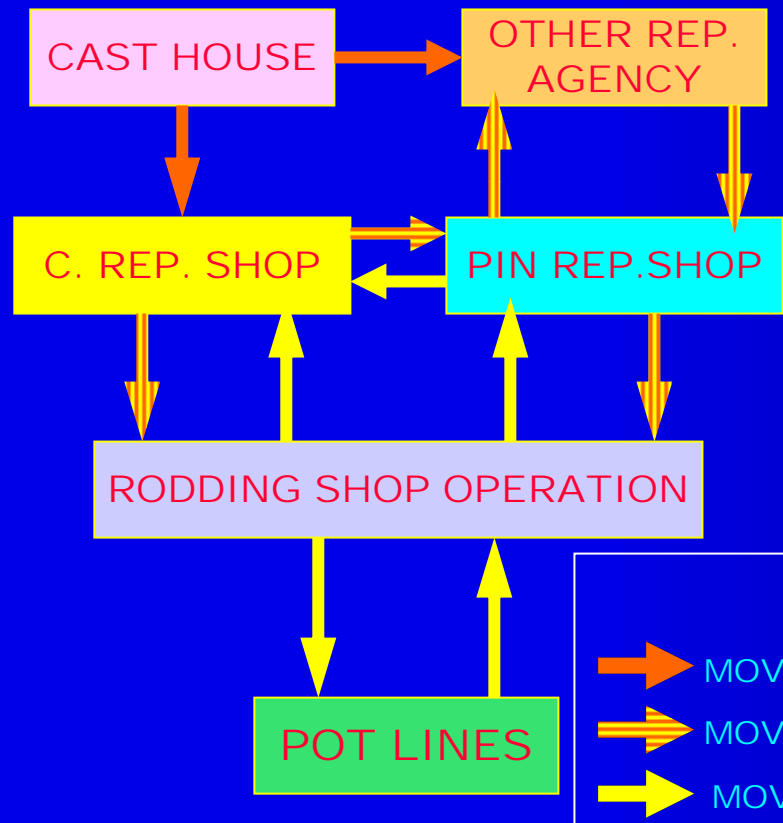




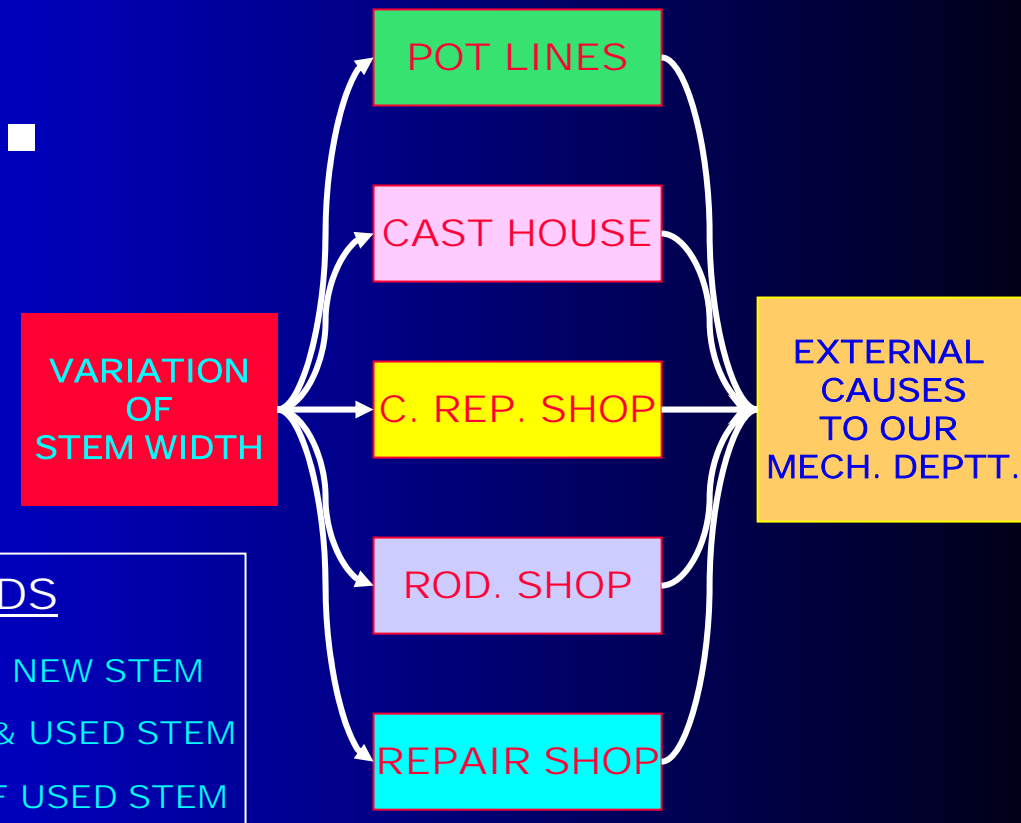
FINDINGS OF DATA ANALYSIS

- ❖ 60% OF THE STEMS ARE OUT OF SPEC. LIMIT OF 200-2 mm & 200+2 mm
- ❖ BRUSHING QUALITY IS LOW FOR STEM FALLING OUTSIDE THE ACCETABLE LIMIT
- ❖ BRUSHING QUALITY IS 5 (max) EVEN IF THE STEM WIDTH IS WITHIN THE ACCEPATBLE LIMIT OF 200-2 mm & 200+2 mm

FLOW DIAGRAM OF STEM



SOURCES OF VARIATION



LEGENDS

- ➡ MOVEMENT OF NEW STEM
- ➡➡ MOV. OF NEW & USED STEM
- ➡➡➡ MOVEMENT OF USED STEM



OPTIONS AVAILABLE

SL. NO	OPTION	IMPACT TO THE COMPANY
01	PUTUP REQUEST TO MANAGEMENT FOR 100% INSPECTION OF THE STEMS AND REPLACE THE DEFECTIVE STEMS	TIME CONSUMING PROCESS & THE FINANCIAL IMPLICATION TO THE TUNE OF Rs.20Crores
02	INTRODUCTION OF ONLINE INSPECTION OF STEMS FOR STEM WIDTH	THIS WILL ADD TO CYCLE TIME THERE BY AFFECTING TARGET PRODUCTION
03	TO CONSULT OUR TECHNOLOGY PROVIDER ALUMINIUM PACHINEY OF FRANCE FOR IMPROVING BRUSHING QUALITY TO THE DESIRED LEVEL OF 15	CONSULTED IN PAST. NO CONCRETE SOLUTION RECEIVED.
04	ACCEPTANCE OF BRUSHING QUALITY OF 5 AS AGAINST THE EXPECTATION OF 15	THIS WILL CONFLICT THE MGT. OBJECTIVE OF IMPROVING THE CURRENT EFFICIENCY
05	INSENSITISE THE EXISTING BRUSHING MACHINE AGAINST ALL FACTORS WHICH ARE CONSTRAINTS FOR ACHIEVING BRUSHING QUALITY OF 15	IMPACT CAN ONLY BE ESTABLISHED IN A LATER STAGE
06	TO THINK FOR A BREAK-THROUGH SOLUTION WHICH WILL GIVE A BRUSHING QUALITY OF 15 CONSISTENTLY IRRESPECTIVE OF STEM WIDTH	IMPACT CAN ONLY BE ESTABLISHED IN A LATER STAGE
07	CLOSING OF THE PROJECT AND REGISTRATION OF A NEW PROJECT	PROBLEM WILL BE THERE. DEMOTIVATION FOR THE MEMBERS



ALTERNATE SOLUTIONS

SL. NO	OPTION	ALTERNATE SOLUTION	REMARK
01	INSENSITISE THE EXISTING BRUSHING M/C AGAINST ALL FACTORS WHICH ARE CONSTRAINTS FOR ACHIEVING BRUSHING QUALITY OF 15	➤ TO DOUBLE THE BRUSHING TIMING	NO RESULT
		➤ TO PROVIDE 04 BRUSHES IN PLACE OF EXISTING TWO	NO SPACE
		➤ TO INCREASE ROTATIONAL SPEED & KW OF THE MOTOR	NO RESULT
		➤ TO CHANGE THE BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	CONSIDERED
		➤ TO PROVIDE GRAVITY LOADED BRUSH IN EXISTING M/C	CONSIDERED
		➤ TO PROVIDE SPRING LOADED BRUSH IN EXISTING M/C	CONSIDERED
		➤ TO CLEAN THE DUST MANUALLY AFTER RODDING BY SAND WHEEL	REJECTED BY MGT.
02	TO THINK FOR A BREAK-THROUGH SOLUTION WHICH WILL GIVE A BRUSHING QUALITY OF 15 CONSISTENTLY IRRESPECTIVE OF STEM WIDTH	➤ TO PROVIDE SELF ADJUSTING SPRING LOADED BRUSH TO SUIT ALL STEM PROFILE WITH CHANGE IN BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	CONSIDERED
		➤ TO PROVIDE SELF ADJUSTING GRAVITY LOADED BRUSH TO SUIT ALL STEM PROFILE WITH CHANGE IN BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	CONSIDERED
03	INTRO. OF ONLINE INSPECTION OF STEMS FOR STEM WIDTH	➤ TO PROVIDE A SYSTEM FOR ENSURING THE USE OF REQD.QUALITY OF STEM (REGARDING WIDTH, DEFORM. ETC.) & THEN TO MACHINE OR REPLACE ALL STEMS HAVING THE DEVIATION FROM THE REQD. QUALITY	REJECTED BY MGT.

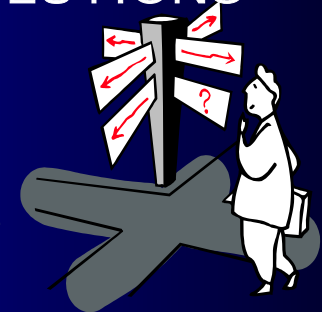
EVALUATION OF ALTERNATE SOLUTIONS

SL. NO.	SUGGESTED SOLUTION	EVALUATION CRITERIA						CONCLUSION
		C1	C2	C3	C4	C5	C6	
01	TO CHANGE THE BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	R	R	A	R	R	A	REJECTED
02	TO PROVIDE GRAVITY LOADED BRUSH IN EXIST. EQUPT.	A	R	R	A	R	R	REJECTED
03	TO PROVIDE SPRING LOADED BRUSH IN EXIST. EQUPT.	R	R	R	A	R	R	REJECTED
04	TO PROVIDE SELF ADJUSTING SPRING LOADED BRUSH TO SUIT ALL STEM PROFILE WITH CHANGE IN BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	R	R	R	R	R	A	REJECTED
05	TO PROVIDE SELF ADJUSTING GRAVITY LOADED BRUSH TO SUIT ALL STEM PROFILE WITH CHANGE IN BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	A	A	A	R	R	A	ACCEPTED

CRITERIA FOR EVALUATION OF ALTERNATE SOLUTIONS



- C1- ACCEPTANCE BY ALL MEMBERS
- C2- DEPARTMENTAL CONSENT
- C3- FINANCIAL INDICATOR
- C4- TIME FRAME
- C5- ADAPTABILITY TO EXISTING EQUIPMENT
- C6- EASE OF OPERATION & MAINTENANCE





ACCEPTED SOLUTION

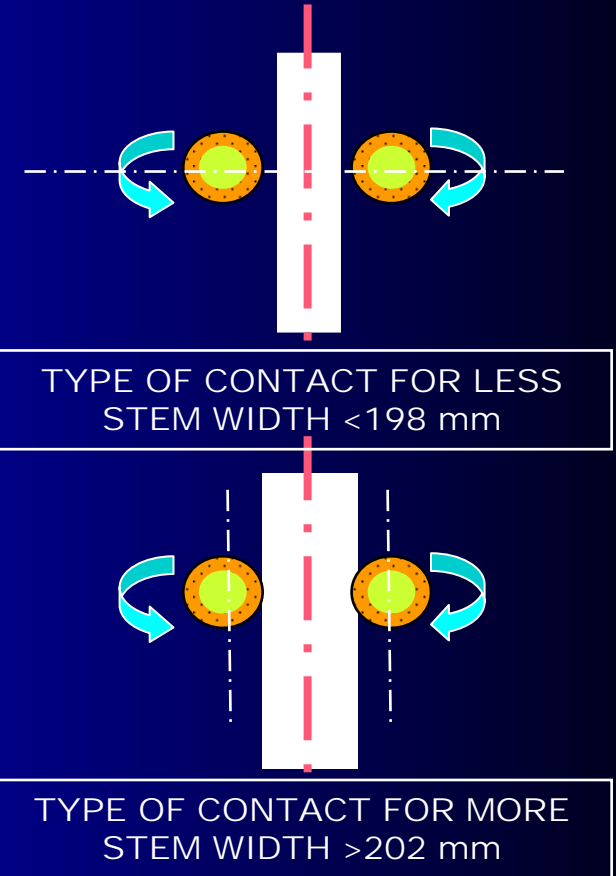
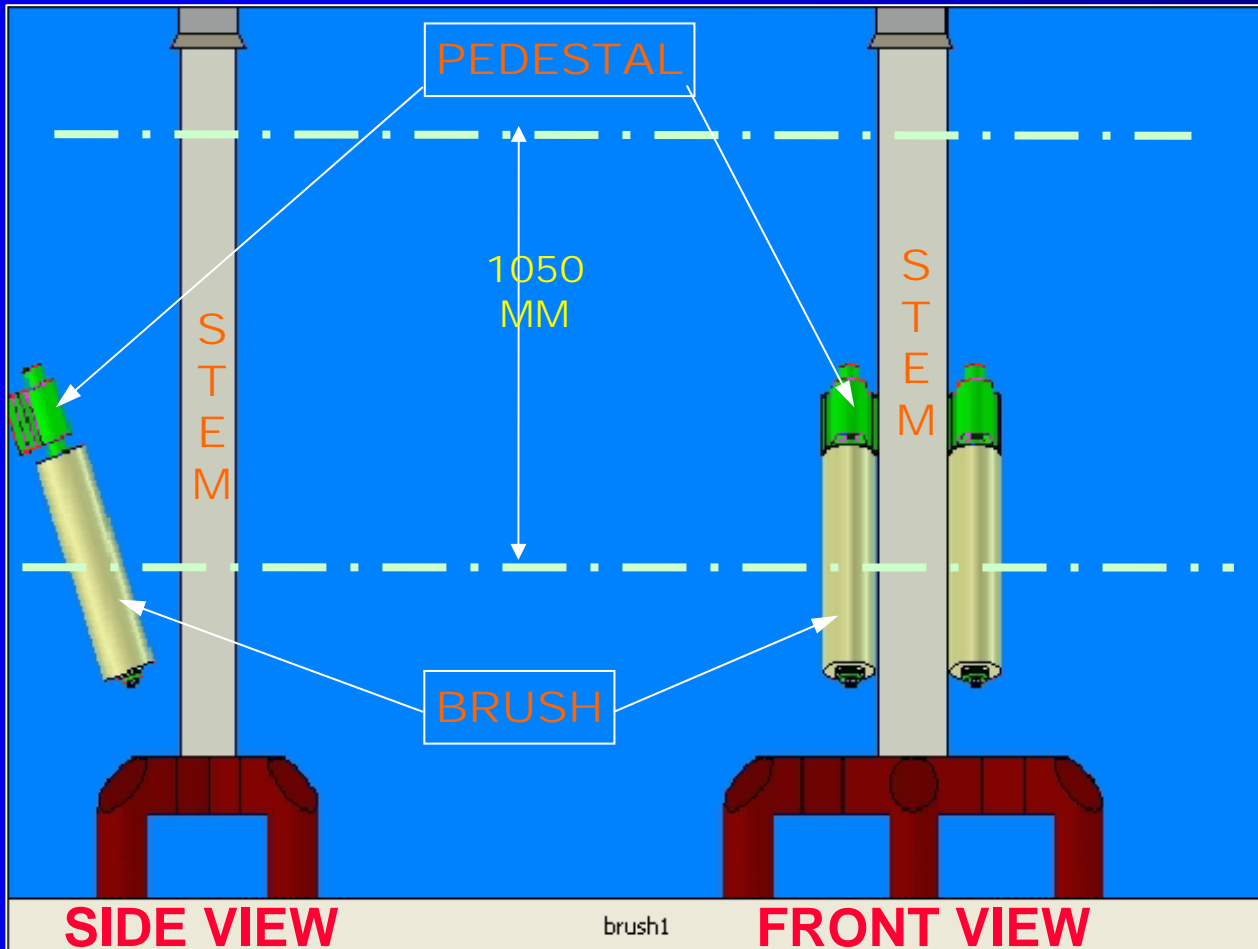


INPUTS FOR BREAK-THROUGH SOLUTION

- ✓ CYCLE TIME
- ✓ BRUSHING QUALITY OF 15
- ✓ VARRYING STEM WIDTH
- ✓ USABILITY OF SPARES OF EX. EQUPT.
- ✓ EASE OF MAINTENANCE
- ✓ FINANCIAL IMPLICATION

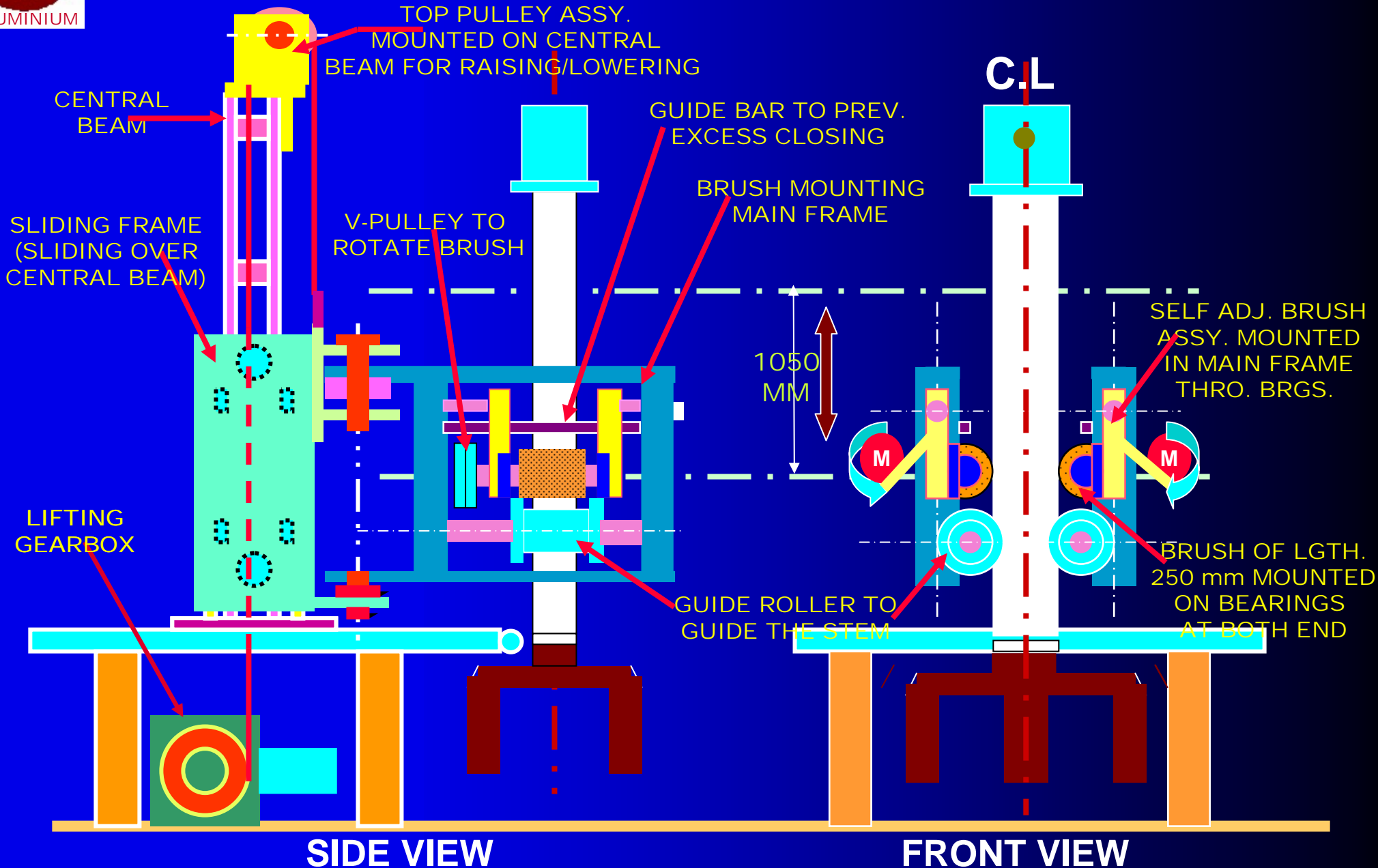
TO PROVIDE SELF ADJUSTING GRAVITY LOADED BRUSH TO SUIT ALL STEM PROFILE WITH CHANGE IN BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION

BRUSHING OPERATION (BEFORE)



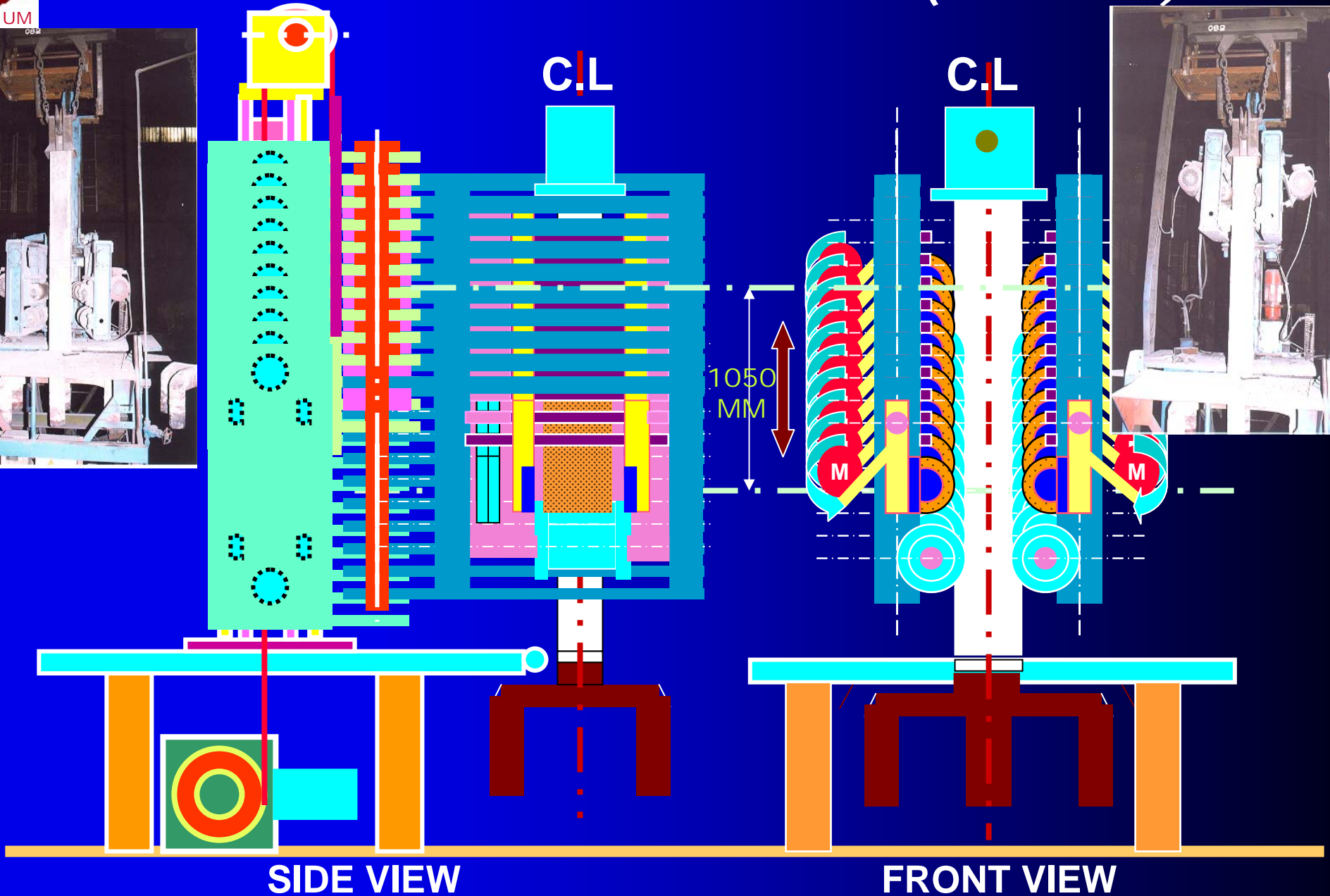
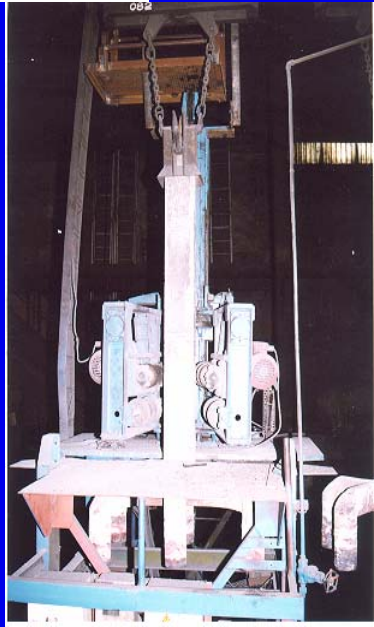


BRUSHING OPERATION (AFTER)





BRUSHING OPERATION (AFTER)



SIDE VIEW

FRONT VIEW



MANAGEMENT OF RESISTANCE

SL. NO	ASPECTS	AGENCY	APPROACHES
01	CHANGE IN THE BASIC STRUCTURES	ED(S & P)	-- DEPARTMENTAL PRESENTATION MADE -- DETAIL DISCUSSION BY HOD IN MORNING MEETING & BROUGHT OUT THE ADVANTAGES
02	SHUTDOWN REQUIREMENT FOR IMPLEMENTATION	GM(O & M)	- 60 DAYS SHUTDOWN WAS SOUGHT. AFTER DISCUSSING THE DETAILED IMPLEMENTATION PLAN
03	-ADDITIONAL MAINTENANCE REQUIREMENT ON ACCOUNT OF CHANGES - DIFFICULTY IN BRUSH REPLACEMENT	R.SHOP - MECHANICAL	- MASSIVE ORGANIZATIONAL BENEFITS EXPLAINED - NEW SIMPLIFIED MAINTENANCE PRACTICE HIGHLIGHTED WITH DRAWINGS - ALSO IT WAS EXPLAINED THAT ONE SPARE BRUSH ASSY. CAN BE MADE READY FOR EASY IN BRUSH REPLACEMENT
04	RE-ROUTING OF CABLES AND FIXING OF PROXIES	ELECTRICAL MAINT.	- NEW MODIFICATIONS EXPLAINED. NEED FOR RE-ROUTING & MOUNTING OF PROXIES EXPLAINED TO IN-CHARGES & WORKING PERSONNEL.
05	CHANGES IN PLC PROGRAMMING	INSTRUMENTATION MAINT.	- DISCUSSED THE NEW SEQUENCE OF OPERATION AND NEED FOR CHANGE IN PROGRAMMING.
06	a) APPREHENSION ABOUT WEARING OF STEM b) STEM INSPECTION c) NEW SEQUENCE OF OPERATION	OPERATION	-- MOCK BRUSHING DISPLAYED TO PERSONNEL -- EXPLAINED THE ADVANTAGES OF BRUSHING IN POTLINE (INTERNAL CUSTOMER) -- NEW PRACTICES EXPLAINED AND IMPROVEMENTS EXPECTED EXPLAINED.

IMPLEMENTATION

- **PREPARATION OF DRAWINGS :**
P.C. MOHAPATRA , G.B. DASH & D.GAGARAI
- **FABRICATION OF STRUCTURES :**
G.B. DASH,G.C. LENKA ,D. GAGARAI, U.K.PANDA



- **INSTALLATION OF STRUCTURE :**
P.C. MOHAPATRA, U.K. PANDA, G.B. DASH, D. GAGARAI & G.C. LENKA
- **TESTING & CHECK :** ALL MEMBERS



TRIAL IMPLEMENTATION

DATE OF TRIAL RUNNING : 14.02.2002

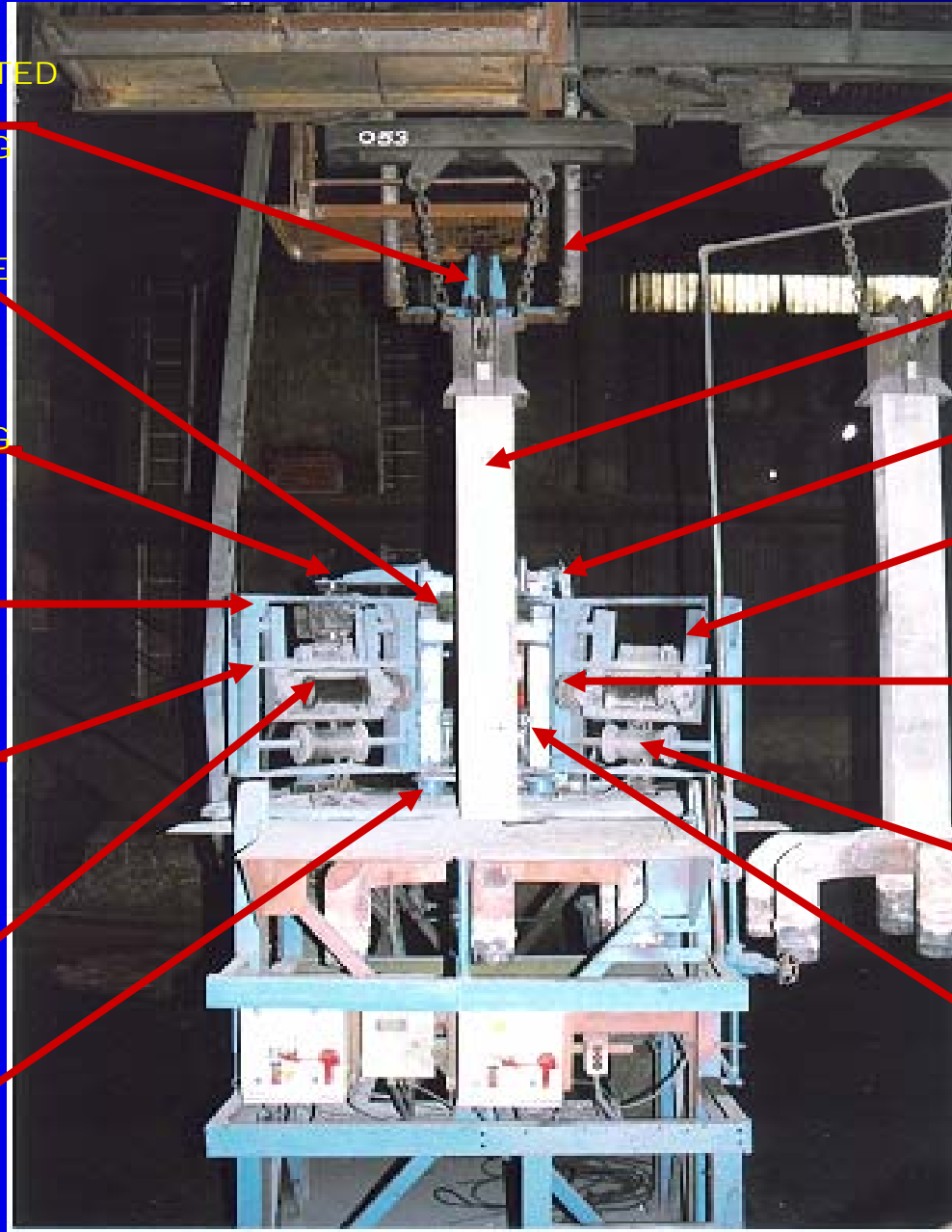
SL. NO	PROBLEM FACED	ACTION TAKEN	DATE OF IMPLEM.	PRESENT STATUS
01	BRUSH WAS GETTING DAMAGED FROM THE EDGE	BRUSH LENGTH INCREASED FROM 215 mm TO 250 mm TO ACCOMMODATE BUFFER LENGTH	14.03.2002	THE BRUSH IS GIVING A LIFE OF 04 MONTHS WITHOUT ANY EDGE DAMAGE
02	VIBRATION IN THE CENTRAL STRUCTURE DURING RAISING / LOWERING OF BRUSH ASSEMBLIES.	TOP BRACING ALONG WITH RUBBER PADS PROVIDED TO ARREST VIBRATION	25.04.2002	AFTER PROVIDING THE BRACING THE VIB. REDUCED (PHYSICAL ESTIMATE)
03	RAISING/LOWERING MOTOR TRIPPING DURING OPERATION (OCCASIONALLY)	MOTOR REPLACED WITH A HIGHER RATING MOTOR (FROM 0.75 KW TO 1.1 KW) IN CONSULTATION WITH ELECT. MAINTENANCE	20.06.2002	AFTER REPL. THE EQUPT. IS RUNNING SINCE LAST 01 YEAR & 06 MONTHS WITHOUT ANY TRIPPING
04	FREQUENT SNAPPING OF ROPE I.e.ROPE LIFE IS VERY SHORT(03 WEEKS)	RAISING/LOWERING DRIVE SHIFTED TO BOTTOM FOR VERTICAL DRAGGING & 14mm ROPE FITTED IN PLACE OF 10mm ROPE	11.12.2002	ROPE LIFE INCREASED FROM 03 WEEKS TO 14 WEEKS (I.e.03 MONTHS)

DATE OF REGULAR IMPLEMENTATION : 10.02.2003



ALUMINIUM

PHOTOGRAPH OF NEW BRUSHING M/C



TOP PULLEY ASSY. MOUNTED ON CENTRAL BEAM FOR RAISING/LOWERING

BRUSH MOUNTING FRAME OPERATING PINION

BRUSH OPENING/CLOSING CYLINDER MOUNTING

BRUSH MOUNTING MAIN FRAME

GUIDE BAR TO PREV. EXCESS CLOSING

BRUSH OF LGTH. 250 mm MOUNTED ON BRGS. AT BOTH END

STRUCTURE RESTING BOTTOM PAD

TOP BRACING TO ARREST VIBRATION

STEM TO BE BRUSHED (POSITIONED BY STOP STN.)

ARM OP/CL PROXY (CONTROLLING MECHANISM)

SELF ADJ. BRUSH ASSY. MOUNTED IN MAIN FRAME

V-PULLEY TO ROTATE BRUSH

GUIDE ROLLER TO GUIDE THE STEM

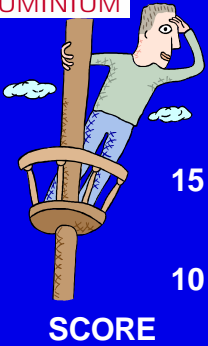
SLIDING FRAME (SLIDING OVER CENTRAL BEAM)



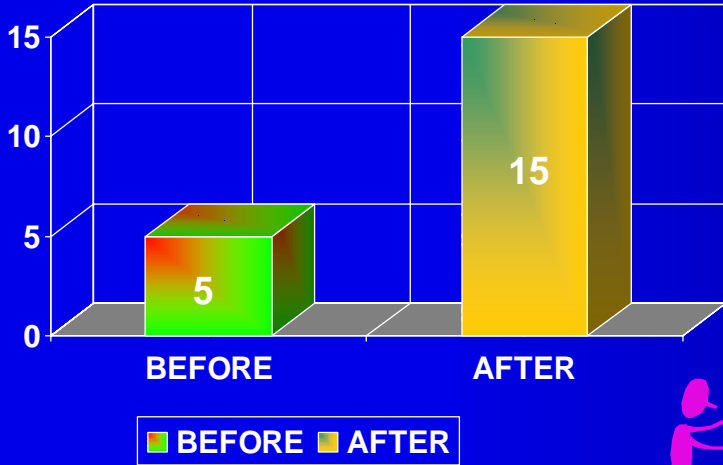
POST IMPLEMENTATION CHECKS



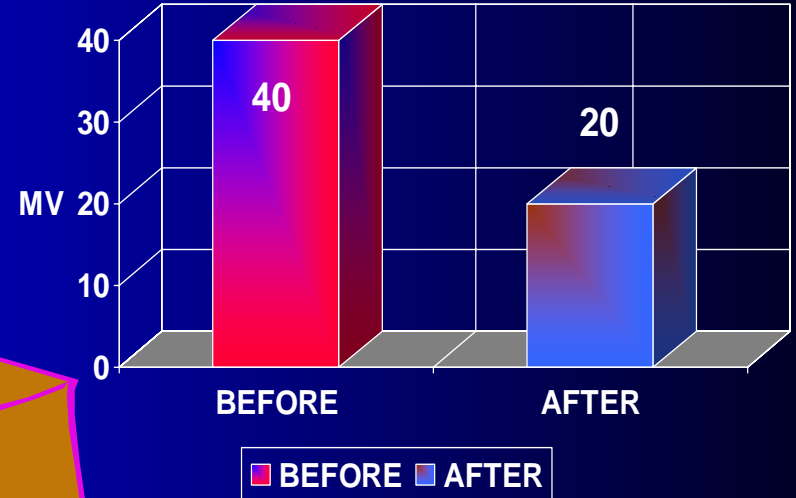
Period: MARCH '2003 – TILL DATE



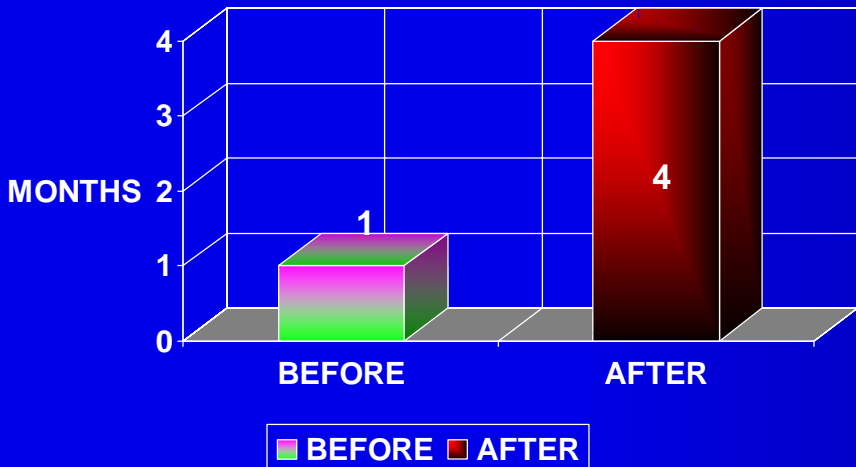
BRUSHING QUALITY OF STEM



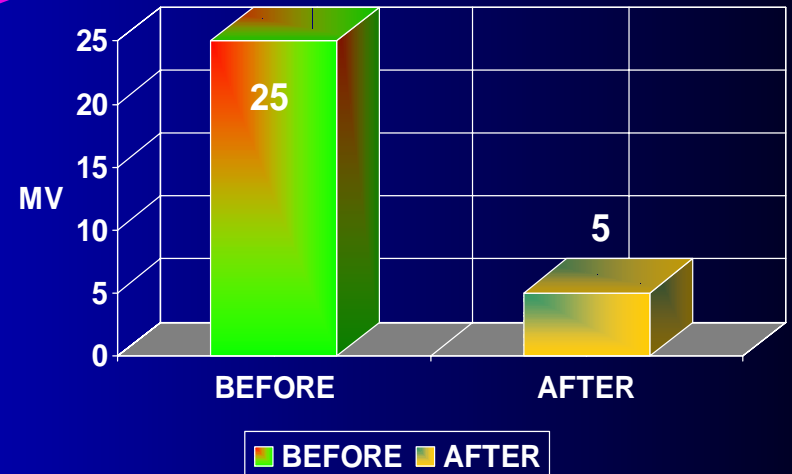
AVG. VOLTAGE DROP IN USED STEM



BRUSH LIFE(in months)



AVG. DROP IN NEW STEM



POST IMPLEMENTATION CHECKS

BRUSHING QUALITY THROUGH PHOTOGRAPH



BRUSHING QUALITY (BEFORE)



BRUSHING QUALITY ON DIFF. TYPE OF STEMS (AFTER)





PHOTOGRAPH OF ANODE PALLETS KEPT IN THE BAY

PREVENTION MEASURES

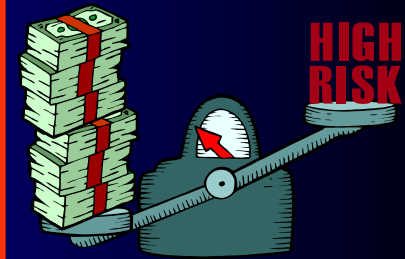


- ✓ CHECK CONDITION OF THE BRUSHES: WEEKLY
- ✓ CHECK BRUSH DRIVE BELT, PILLOW BLOCK & PULLEY: WEEKLY
- ✓ CHECK FREE MOVEMENT OF BRUSH MOUNTING FRAME: WEEKLY
- ✓ CHECK FUNCTIONING OF GRIPPING CYLINDER: WEEKLY
- ✓ CHECK CONDITION OF ROPE & DRUM: WEEKLY
- ✓ CHECK WORKING OF ALL PROXY & LS: FORTNIGHTLY
- ✓ CHECK FREE ROTATION OF ROLLERS IN CENTRAL FRAME: WEEKLY
- ✓ GREASE THE BEARINGS OF CENTRAL FRAME: MONTHLY
- ✓ GREASE THE BRUSH ROTATION BEARINGS : FORTNIGHTLY
- ✓ GREASE BRUSH MOUNTING FRAME BEARINGS: QUARTERLY
- ✓ CHECK FREE MOVEMENT OF TOP PULLEYS: WEEKLY
- ✓ CHK THE CONDITION OF TOP PULLEY, ITS PIN ETC. : FORTNIGHTLY
- ✓ CHK THE TIGHTNESS OF ALL FASTNERS : WEEKLY
- ✓ REPLACE THE 14mm ROPE (LENGTH 08Mtrs) : QUARTERLY



ITEMS	QTY.	EST. COST
BRUSH MOUNTING FRAME INCLUDING P. BLOCK, PULLEY, BELTS, LOCK NUT, BEARING, PULLEY LOCK, SHAFT, LOCK PLATE ETC.	02 SETS	30,000 = 00
DRIVE PULLEY, ROPE PULLEY & ROPE	01 SET	15,000 = 00
MISC. STRUCTURAL, BRACINGS ETC.	LS	5,000 = 00
CENTRAL BEAM WITH ROLLERS (SCRAP)	1 SET	10,000 = 00
TOTAL EXPENSES	-----	60,000 = 00

PROJECT COST



INTANGIBLE BENEFITS

BENEFITS

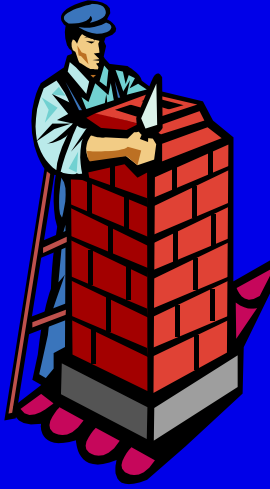
TANGIBLE BENEFITS

- ❑ **POTENTIAL SAVINGS IN DC ENERGY CONSUMPTION TO THE TUNE OF Rs. 1.23 CRORES/ANNUM**
- ❑ **SAVINGS DUE TO BRUSH CONSUMPTION: Rs. 2.0 Lakhs/ ANNUM**



- ❖ **EACH OF THE GROUP HAS BEEN ENLIGHTENED AND MOTIVATED TO TAKE UP HIGHER CHALLENGES IN FUTURE AFTER RECEIVING LETTER OF APPRECIATION FROM DIRECTOR (P) FOR THIS PROJECT.**
- ❖ **THE APPRECIATION LETTER WAS READ OUT IN MORNING MEETING IN PRESENCE OF SENIOR EXECUTIVES OF SMELTER COMPLEX. THIS IS A RARE BENEFIT TO ANY OF THE QUALITY CIRCLE IN THE ORGANIZATION.**

STANDARDISATION

- 
- ROUTINE CHECKING ACTIVITIES INCLUDED IN WEEKLY PM SHEET (F5/CPM/4.9) FOR REGULAR MONITORING
 - DETAILS OF MODIFICATION RECORDED IN CORRECTIVE ACTION RECORD FOR COMPLIANCE TO ISO-9001
 - NEW DRAWING ROD/SP/MECH. /A1/6312 INDICATING DETAILED B.O.M. HAS BEEN ISSUED.
 - OPERATION GROUP WERE EXPLAINED AND EXPOSED ON THE NEW OPERATIONAL PRACTICES
 - WIRING DIAGRAM & PLC HAS BEEN MODIFIED & DOCUMENTED BY ELECTRICAL & INSTRUMENTATION
 - EXHIBIT FOR BRUSHING QUALITY YET TO BE DISPLAYED NEAR THE M/C



STATUS AS ON DATE

- OPERATING & INSTRUCTION MANUAL IS UNDER COMPILATION AND LIKELY TO BE COMPLETED BY DEC-2005
- NEW STOP STATION HAS BEEN SHIFTED AND ALIGNED WITH M/C CENTER ON 17.04.2002
- OTHER ASPECTS SUCH AS BEAM CLEANING & ANODE CLAMP TIGHTENING RELATED TO POTLINES WERE PUT-UP TO MANAGEMENT FOR INITIATING ACTIONS.





OUR SINCERE THANKS TO...



FUTURE PLAN

- CENTRAL REPAIR SHOP
- RODDING SHOP (OPERATION)
- ELECTRICAL & INSTRUMENTATION
- MECH. MAINT. DEPTT.
- TQM DEPARTMENT

- 9TH PROJECT "FALLING OF OH CHAIN TROLLEYS AT CASTING CARROUSEL" IS AT THE IMPLEMENTATION TAGE
- MENTORING OTHER Q.CS

AS THEY SAID ABOUT THE PROJECT

"THIS MODIFICATION IS EXPECTED TO RESULT IN CONSIDERABLE SAVING IN ENERGY CONSUMPTION IN THE SMELTING PROCESS"

-Mr.S.B.NAYAK, Ex. D(P)

"NALCO'S STEM BRUSHING IS THE BEST IN THE WORLD"

-ALUMINIUM PECHINEY

THANK YOU



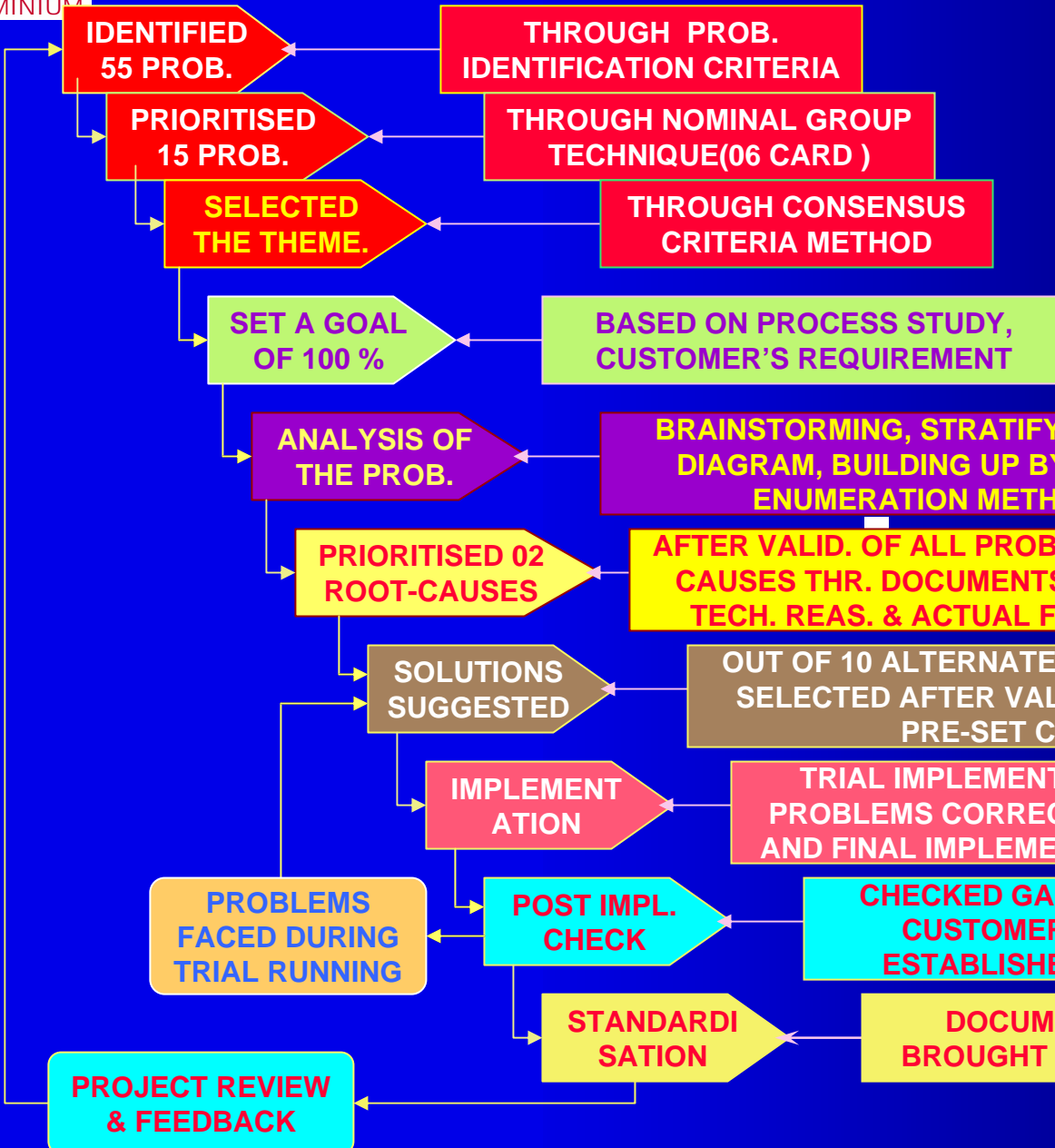
POINTS TO PONDER

"QUALITY IS NOT EXPENSIVE, IT IS PRICELESS..."M.K. GANDHI

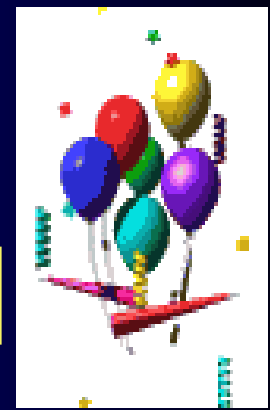
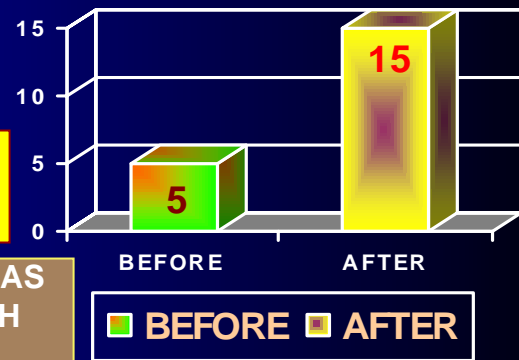


SOLUTION MATRIX OF THE PROJECT

LEARNING POINTS
 ✓ OUR IMPLEMENTATION GOT DELAYED DUE TO OTHER OPERATIONAL PRIORITIES. THIS ASPECT IS TO BE CONSIDERED CAREFULLY WHILE TAKING UP "C" CATEGORY PROBLEM



BRUSHING QUALITY





OUR SINCERE THANKS TO...



FUTURE PLAN

- CENTRAL REPAIR SHOP
- RODDING SHOP (OPERATION)
- ELECTRICAL & INSTRUMENTATION
- MECH. MAINT. DEPTT.
- TQM DEPARTMENT

- TO COMPLETE 9TH PROJECT
“FALLING OF OH CHAIN TROLLEYS
AT CASTING CARROUSEL” WITHIN
DEC '2003
- MENTORING OTHER Q.CS

AS THEY SAID ABOUT THE PROJECT

“THIS MODIFICATION IS EXPECTED TO RESULT IN CONSIDERABLE SAVING IN ENERGY CONSUMPTION IN THE SMELTING PROCESS”

-Mr.S.B.NAYAK,Ex. D(P)

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POINTS TO PONDER

“ QUALITY IS NOT EXPENSIVE, IT IS PRICELESS...”

M.K. GANDHI

THANK YOU



POINTS TO PONDER

“ QUALITY IS NOT EXPENSIVE, IT IS PRICELESS...”

M.K. GANDHI

TheEnd_Yellow1



ROOT CAUSE ANALYSIS

CAUSE		METHOD OF CHECKING	OBSERVATIONS	RESULT
MATERIAL				
1	BRUSH MATERIAL NOT SUITABLE FOR ALUMINIUM	DESIGNERS' MANUAL OF RODDING SHOP	BRUSH SUPPLIED BY OEM	INVALID
2	BRUSH GOT BENT DURING TRANSIT	OSRD DOCUMENTS OF STORE	NO CASES DAMAGE FOUND IN TRANSIT	INVALID
3	IMPROPER SELECTED BRUSH LENGTH	DRG. NO: 1208-561 ACTUAL MEASUREMENT FROM SITE	AS PER THE DRAWING	INVALID
4	POOR QUALITY OF BRUSH MATERIAL	RODDING SHOP MANUAL LAST SUPPLY	AS PER THE SPECIFICATION SUPPLIED BY OEM	INVALID
METHOD				
1	NO PROVISION FOR COOLANT	BRUSHING MANUAL	COOLANT WILL LEAD PROBLEM OF OXIDATION	INVALID
2	BRUSHING CYCLE IS LOW	DESIGNER'S MANUAL	AS PER THE OEM'S RECOMM.	INVALID
3	INTERNALLY CASTED STEMS LEADING TO NO INSP	INSPECTION PROC. AT BILLET CASTING	AS PER THE STEM DRAWING	INVALID
4	W/I FOR BRUSH MOUNTING NOT AVAILABLE	DOC. F5/CPM/4.9	AVAILABLE IN THE WORK INSTRUCTION	INVALID
5	NO SCHEDULE TO CHK CHAIN LOOSENESS	DOC. F5/CP/4.9	-DO-	INVALID
6	BRUSH CLEANING NOT IN MAINT. INST.	DOC F5/CPM/4.9	-DO-	INVALID



ROOT CAUSE ANALYSIS

CAUSE		METHOD OF CHKING	OBSERVATIONS	RESULT
MAN				
1	INSP OF STEMS NOT IN SOP	DOC. NO: RS(O)/4.9	INCLUDED IN THE STEM INS. STATION	INVALID
2	INSP. OF STEMS AT P/L NOT IN SOP	PL(O)/4.9	PART OF QAP	INVALID
3	EQUPT. NOT WORKING SO BYPASSED	RODDING SHOP LOG	WORKING BUT NOT EFFECTIVE	INVALID
4	W/I NOT MADE SO SPEC. NOT AVAILABLE	DRG. NO: 1208-561	SPECS. AVAILABLE	INVALID
MACHINE				
1	MOUNTING STRUCTURE SHIFTED	DRG: 1208-561 ACT. MEASUREMENT	AS PER DRAWING	INVALID
2	LESS NO OF BRUSHES	RODDING SHOP MANUAL	AS PER ORIGINAL SPECIFICATION	INVALID
3	LESS STEM WIDTH SO NO CONTACT	ACTUAL STEM WIDTH MEASUREMENT (85 SAMPLES) STEM SPECIFICATION	DEVIATION FROM THE SPECS	VALID
4	LESS BRUSH DIA. SO NO CONTACT	DRG 1208-561 ACTUAL MEASUREMENT	AS PER DRAWING	INVALID
5	DEFORMED STEM LEADING TO FREQ. BRUSH DAM.	ACTUAL MEASUREMENT AT RANDOM POINTS	DEVIATION OBSERVED	VALID
6	BRUSH IS NOT FLEXIBLE	DRG. 1208-561	AS PER THE DEIGN	INVALID
7	MORE STEM WIDTH	ACTUAL STEM WIDTH MEASUREMENT (85 SAMPLES) STEM SPECIFICATION	DEVIATION FROM THE SPECS	VALID



VALID CAUSES AFTER VALIDATION

CAUSES		METHOD OF CHECKING	OBSERVATIONS	RESULT
3	LESS STEM WIDTH SO NO CONTACT	ACTUAL STEM WIDTH MEASUREMENT (85 SAMPLES) STEM SPECIFICATION	DEVIATION FROM THE SPECS	VALID
5	DEFORMED STEM LEADING TO FREQ. BRUSH DAM.	ACTUAL MEASUREMENT AT RANDOM POINTS	DEVIATION OBSERVED	VALID
7	MORE STEM WIDTH	ACTUAL STEM WIDTH MEASUREMENT (85 SAMPLES) STEM SPECIFICATION	DEVIATION FROM THE SPECS	VALID
11	VAR IN STEM WIDTH LEADING TO NON-UNIFORM PR.	ACTUAL SITE OBSERVATION IN SHIFTS	- JAMMING OF BRUSHES FOR MORE WIDTH - NO CONTACT FOR LESS WIDTH	VALID
15	SS NOT IN CENTER SO LESS STEM-BRUSH GAP	ACTUAL SITE MEASUREMENT RODDING SHOP LAYOUT DRG.	15 MM OUT FROM FURNACE SIDE	VALID
18	MORE STEM WIDTH SO LESS STEM-BRUSH GAP	ACTUAL SITE OBSERVATION	BRUSH JAMMING FOR STEM > 202 MM	VALID



ALUMINIUM

EVALUATION OF ALTERNATE SOLUTIONS

SL. NO.	SUGGESTED SOLUTION	EVALUATION CRITERIA						CONCLUSION
		C1	C2	C3	C4	C5	C6	
01	TO DOUBLE THE BRUSHING TIMING	R	R	R	A	A	A	REJECTED
02	TO PROVIDE 04 BRUSHES IN PLACE OF EXISTING TWO	R	A	R	A	R	R	REJECTED
03	TO INCREASE ROTATIONAL SPEED & KW OF THE MOTOR	A	R	R	A	R	A	REJECTED
04	TO CHANGE THE BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	R	R	A	R	R	A	REJECTED
05	TO PROVIDE GRAVITY LOADED BRUSH IN EXIST. EQUPT.	A	R	R	A	R	R	REJECTED
06	TO PROVIDE SPRING LOADED BRUSH IN EXIST. EQUPT.	R	R	R	A	R	R	REJECTED
07	TO CLEAN THE DUST MANUALLY AFTER RODDING BY SAND WHEEL	R	R	A	R	R	R	REJECTED
08	TO PROVIDE A SYSTEM FOR ENSURING THE USE OF REQD. QUALITY OF STEM (REGARDING WIDTH, DEFORM. ETC.) & THEN TO MACHINE OR REPLACE ALL STEMS HAVING THE DEVIATION FROM THE REQD. QUALITY	R	R	R	R	R	A	REJECTED
09	TO PROVIDE SELF ADJUSTING SPRING LOADED BRUSH TO SUIT ALL STEM PROFILE WITH CHANGE IN BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	R	R	R	R	R	A	REJECTED
10	TO PROVIDE SELF ADJUSTING GRAVITY LOADED BRUSH TO SUIT ALL STEM PROFILE WITH CHANGE IN BRUSHING ORIENTATION FROM RADIAL TO LINEAR MOTION	A	A	A	R	R	A	ACCEPTED



FORMULA FOR ENERGY SAVED

- POWER CONSUMPTION = 184.5×4.33

- D.C ENERGY SAVED/mV/MT = $\frac{2.98 \times mV \times 1000}{\text{CURRENT EFFICIENCY}}$ KWH
 $\frac{2.98 \times 1 mV \times 1000}{0.92 \times 1000}$ KWH
= 3.239 KWH /MT
= Rs 3.56/MT (@ Rs 1.10/Unit)

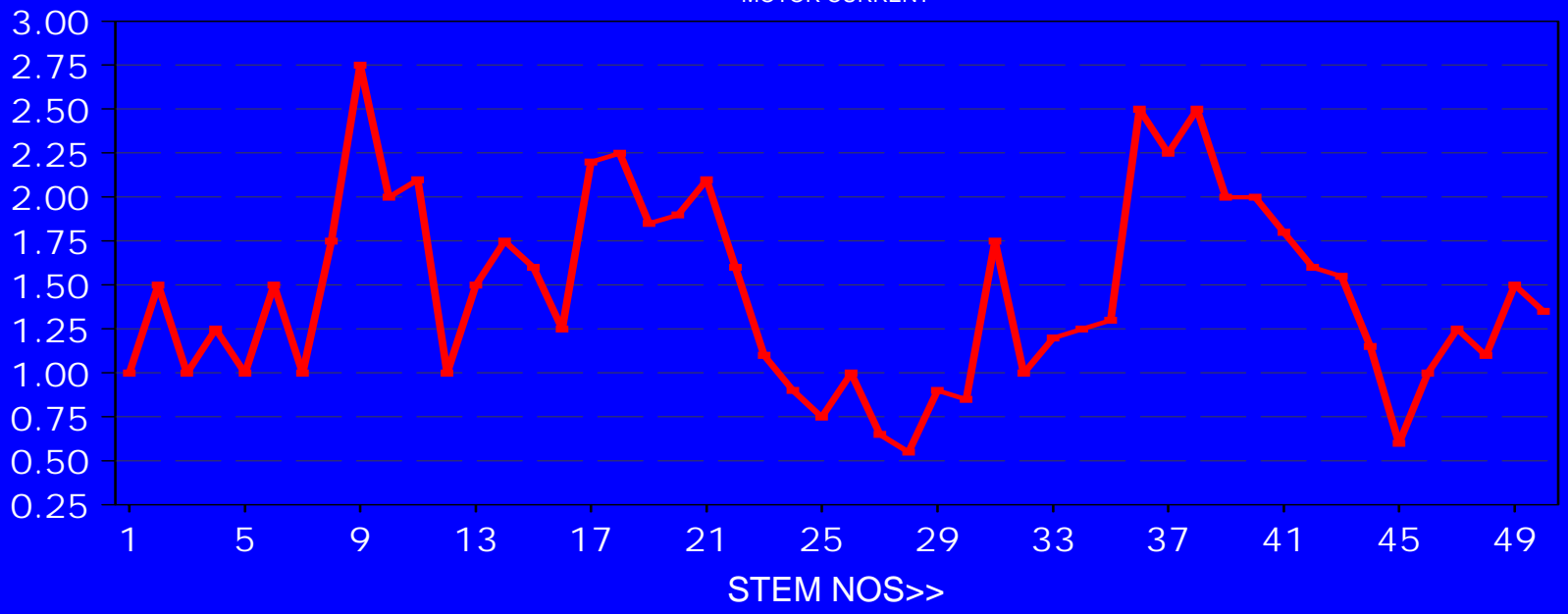
- TOTAL PRODUCTION CAPACITY = 3,45,000 MT/ANNUM

- SO EXPECTED SAVINGS = $Rs\ 3.56 \times 3,45,000$
= Rs 1,228,200.00 (Apprx.)



MOTOR CURRENT

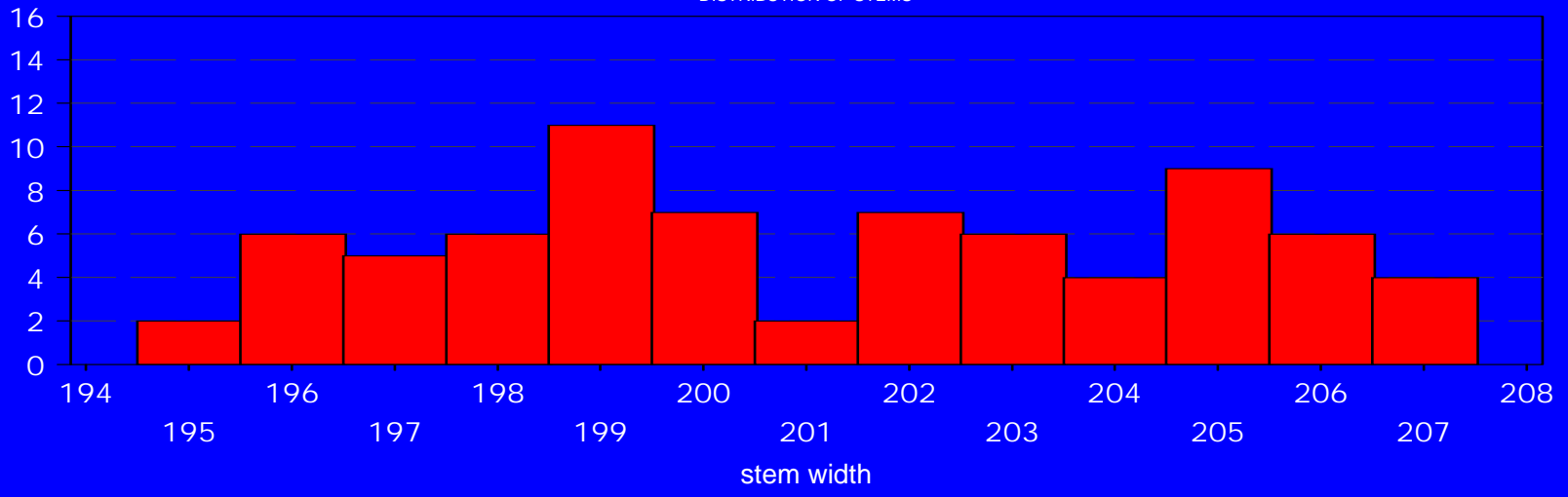
AMPERE



STEM NOS>>

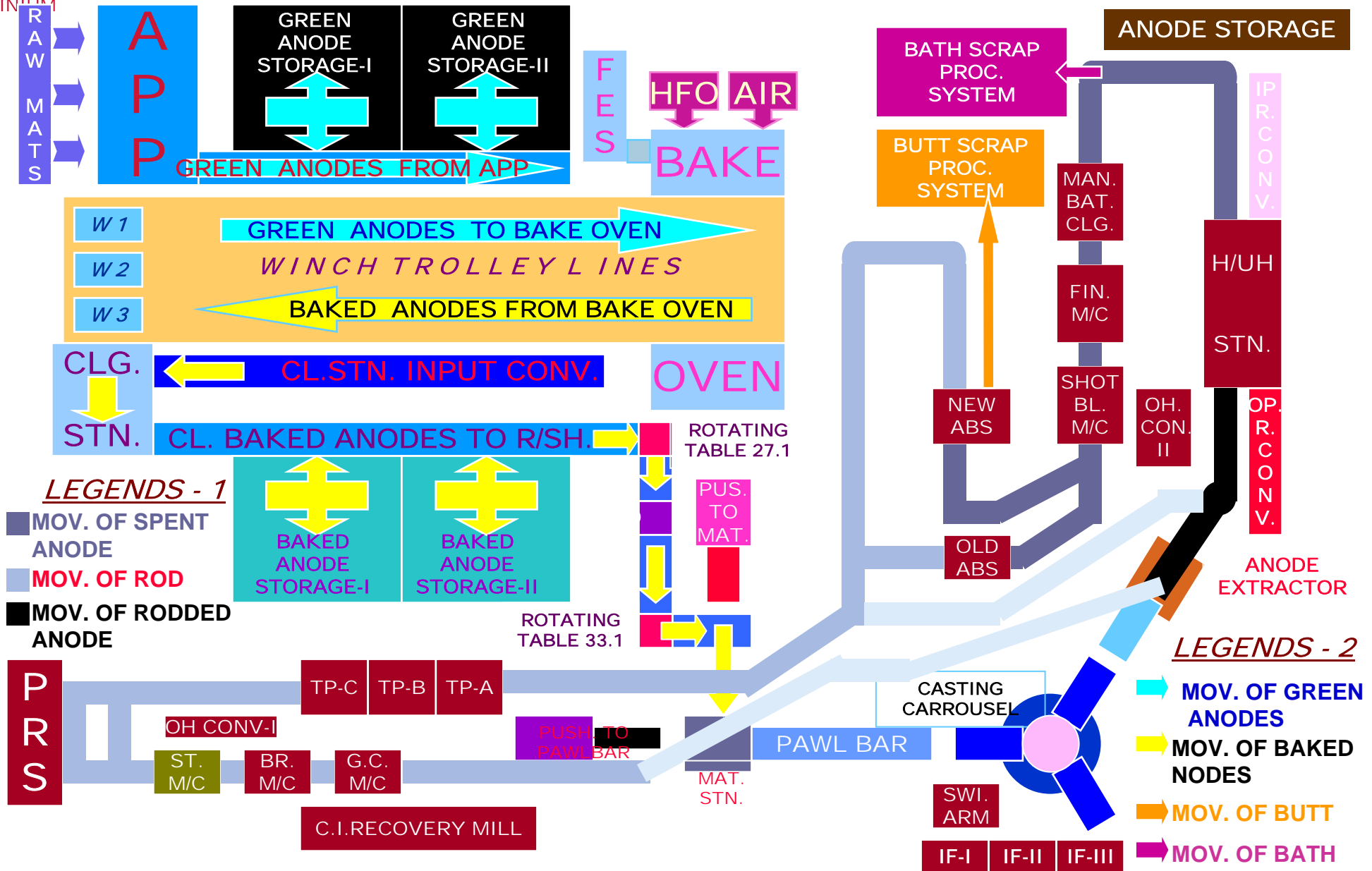
DISTRIBUTION OF STEMS

Frequency



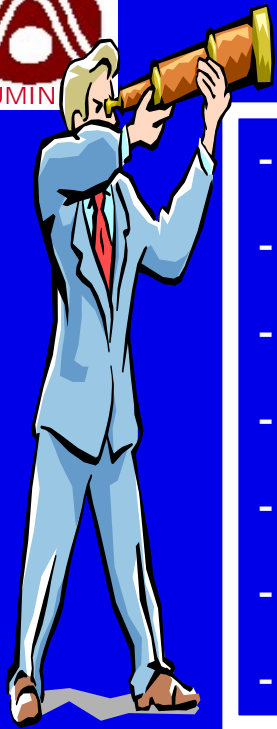


CARBON AREA - AN OVERVIEW





OBSERVATIONS-I



- BRUSHING LENGTH : 1050 MM
- DIAMETER OF THE BRUSH: 150 MM
- WIDTH OF THE BRUSH SURFACE: 160 MM
- BRUSHING ACTION: BY ROTARY & RADIAL MOTION OF THE BRUSH
- BRUSH RPM: 480
- BRUSHING AREA: 160 X 1050 MM
- STEM WIDTH: 200 ± 2 MM ■

**TYPES OF STEMS
COMING FOR
PROCESSING**

PITTED STEM

BEND STEM

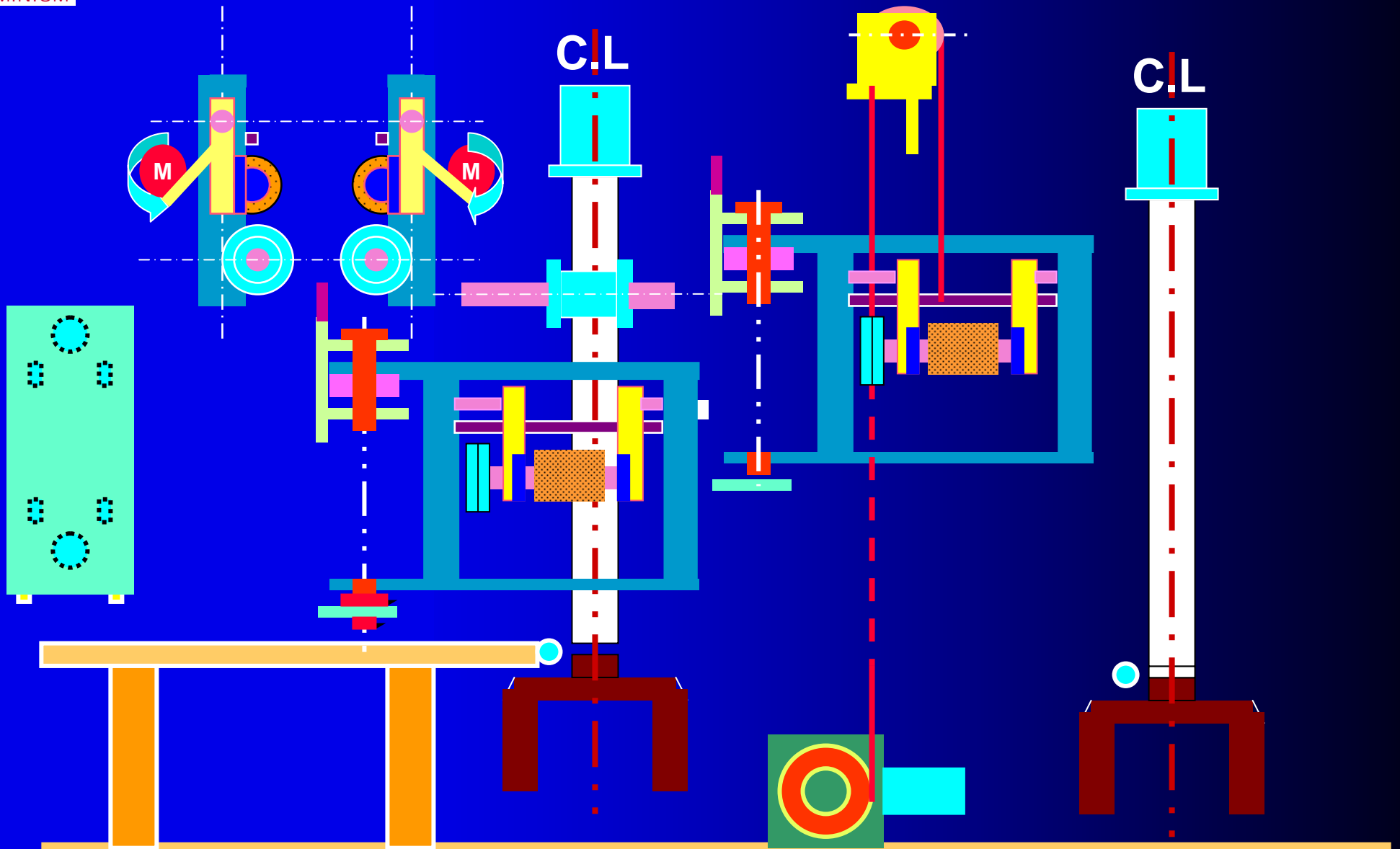
DEFORMED STEM

SKEWED STEM

STEM WITH SURFACE DAMAGE



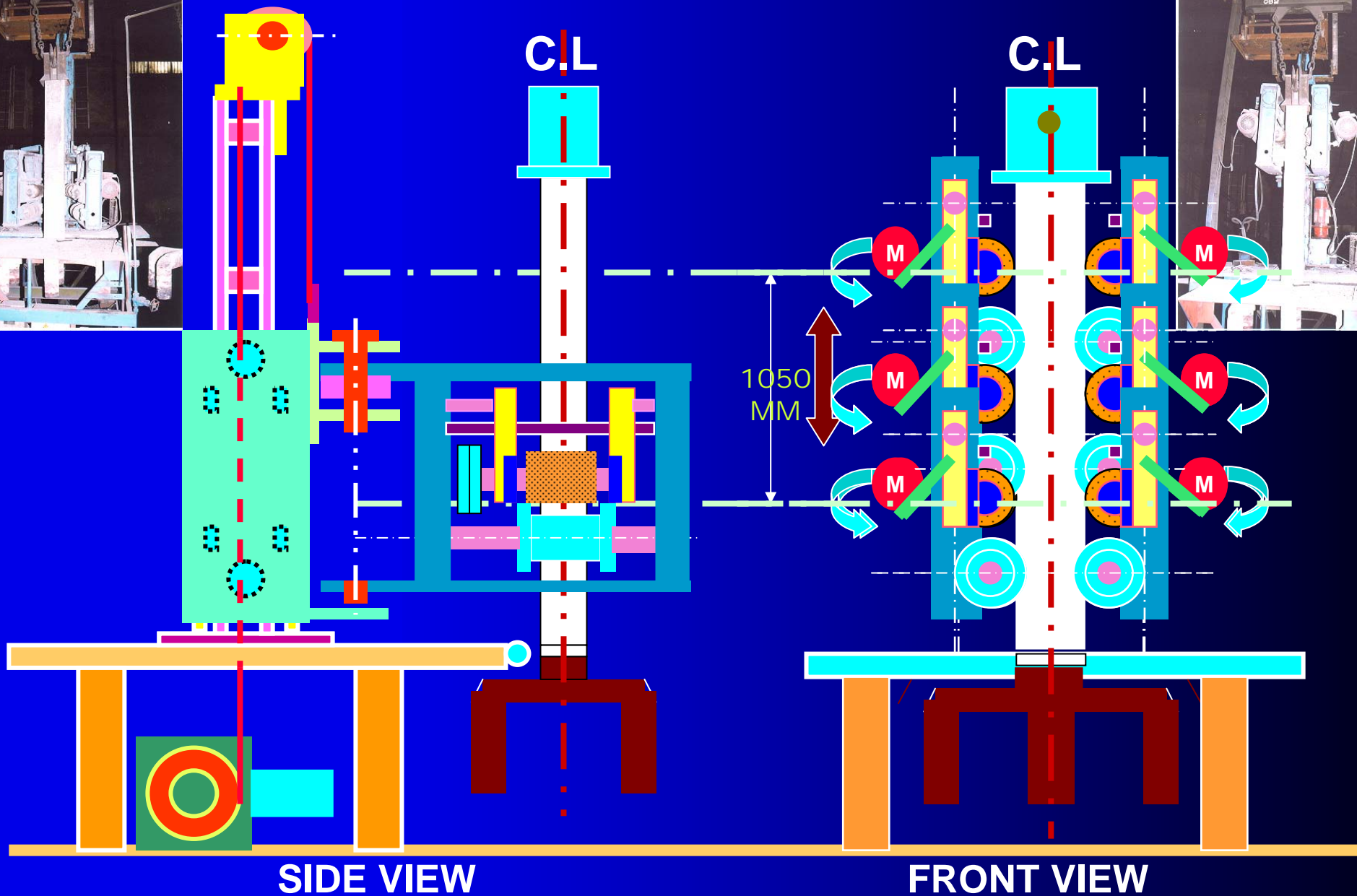
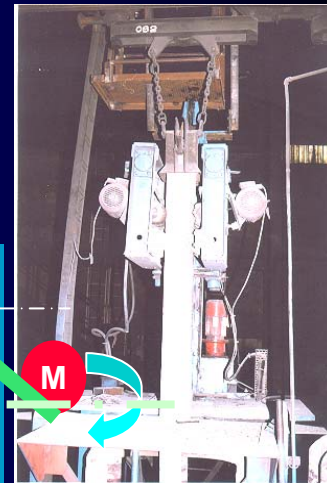
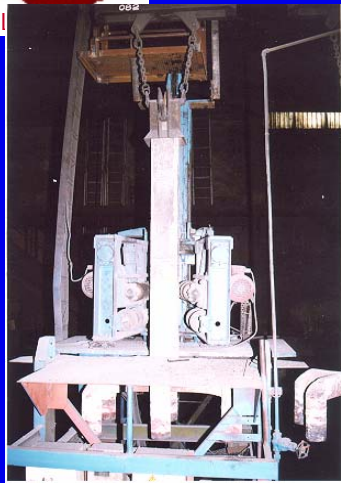
BRUSHING OPERATION (AFTER)



SIDE VIEW



BRUSHING OPERATION (AFTER)





AS THEY SAID ABOUT THE PROJECT

DIRECTOR(PRODUCTION):

ALUMINA PECHINEY(TECHNICAL COLLABORATOR):

"NALCO'S STEM BRUSHING IS ONE OF THE BEST IN THE WORLD"



**THE PROJECT JUST YOU WITNESSED IS A
BREAKTHROUGH IN ALUMINIUM
TECHNOLOGY. THE NEW BRUSHING
PROCESS WILL BE SHORTLY FILED FOR
INTERNATIONAL PATENT BY NALCO.**





PROBLEM IDENTIFICATION



PROBLEM IDENTIFICATION CRITERIA

- INTERNAL CUSTOMER FEEDBACK
- DIRECT LOSS OF PRODUCTION (> 3 Hours/ Month)
- AGENDA OF DISCUSSION IN SHOP FLOOR MEETINGS
- IDENTIFIED AS PROBLEM IN MONTHLY ANALYSIS REPORT
- SAFETY OF WORKING PERSONNEL DURING MAINT. ACTIVITIES



List of Problems Identified...

SL. NO.	PROBLEM DESCRIPTION	CATEGORY
01	FREQUENT BREAKING OF THIM. PR. PUNCH LOCK	A
02	JAMMING OF TROLLEY AT INPUT/OUTPUT OF CASTING CARROUSEL	B
03	SNAPPING OF 10mm WIRE ROPE IN 2T. HOISTS OF STACKING CRANES	A
04	JAMMING IN FINISHING M/C DOORS	A
05	FALLING OF CARRYING PALLETS DURING TILTING AT H/UH STN	B
06	DAMAGE OF INDUCTION FURNACE TILTING HOSES	A
07	FREQUENT SNAPPING OF SWIVELLING ARM CHAIN	B
08	HYD. OIL DRAINAGE DURING FAILURE OF HYD. HOSES & O'RINGS AT H/UH STN.	A
09	PROBLEM OF BAD MATING ANODES AT MATING STATION	C
10	FREQUENT FAILURE OF PUNCH RAISING/LOWERING PROXY & ACTUATOR OF TP	B
11	MORE REPAIR TIME & FR. B/D IN ST. CRANE GRAB HOIST TWIN PULLEY ASSY.	C
12	GRIPPING/ UNGRIPPING PROBLEM IN CASTING CARROUSEL	B
13	INCONSISTENT BRUSHING OF ANODE STEMS	C



List of Problems Identified...

SL. NO.	PROBLEM DESCRIPTION	CATEGORY
14	PRE-MATURE FAILURE OF ROPES IN WINCH TROLLEY LINES	B
15	PROBLEM OF NON-CLEANING OF BUTT IN SHOT BLASTING MACHINE	C
16	ACTUATION PROBLEM OF THIMBLE PRESS JAW OPENING/CLOSING	B
17	MALFUNCTIONING OF STEM - STRAIGHTENING M/C	C
18	FREQUENT DAMAGE OF WINCH TROLLEY MAGNETIC SWITCH	B
19	FAILURE OF GUIDE ROLLERS IN WINCH TROLLEY LINES	B
20	FREQUENT FAILURE OF LIFTING TABLE HOSE OF H/ UH STATION	B
21	OPENING OF ANODE GRABS PROBLEM IN STACKING CRANES	B
22	FOULING OF PUSHER ARM WITH FULL ANODES IN FINISHING M/C	B
23	JAMMING OF ANODE STEMS IN VERTICAL STRAIGHTENING OF H/UH STATION	A
24	PROBLEM IN UN-HOOKING OF ANODES IN GARLAND OF H/UH STATION	A
25	OIL LEAKAGE FROM HYDRAULIC POWER PACK OF AUTO BUTT STRIPPING	A
26	PROBLEM OF TROLLEY JAMMING NEAR AUTO BUTT STRIPPING	B
27	FAILURE OF COUNTERBALANCE VALVE OF HOOKING/UNHOOKING STATION	A
28	MIXING OF BATH AND STEEL SHOTS IN SHOT BLASTING MACHINE	C
29	FREQUENT JAMMING OF STEMS WITH ROD HANDLING ARMS	A
30	JAMMING OF SWIVELLING ARM CARRIAGE IN CASTING ZONE	B
31	PROBLEM OF RODDED ANODE EXTRACTION FROM CASTING CARROUSEL	A
32	DOUBLE ANODE PUSHING PROBLEM OF PAWL BAR IN CASTING ZONE	B
33	FREQUENT CHAIN SNAPPING IN MECHANICAL PUSHER OF ZONE-III	A
34	JAMMING OF BAKED ANODES IN TURN OVER DEVICE OF ZONE-III	B

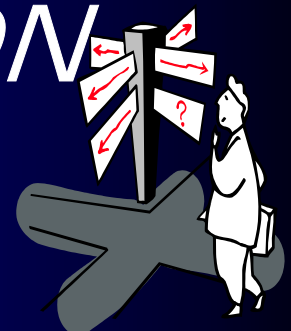


List of Problems Identified...

SL. NO.	PROBLEM DESCRIPTION	CATEGORY
35	PROBLEM OF FR. DAMAGE OF SPRINGS IN ACTUATORS OF ZONE-III ROLLER CONV.	A
36	ACCUMULATION OF SHOTS ON SPENT ANODE COMING FROM SHOT BLASTING M/C	A
37	FREQUENT DAMAGE OF HYDRAULIC HOSES OF MOBILE T.R. PRESS	B
38	FREQUENT FAILURE OF LINKS OF CAST IRON RECOVERY MILL	A
39	FREQUENT JAMMING OF CAST IRON RECOVERY MILL	A
40	PRESSURE DROP IN HE PUMP 3&4 DURING RUNNING OF IND. FURNACE-2	A
41	SPILLAGE OF MOLTEN CAST IRON FROM LADDLES IN CASTING ZONE	B
42	DAMAGE OF PIN AND BUSH OF NEW M-15 ARMS	A
43	FAILURE OF CYLINDER CLEVIS OF TOP SCRAPPER IN CLEANING STATION	A
44	FR. DAM.OF P. BLOCK AND G.BOXES IN ROLLER CONVEYOR OF H/UH STATION	A
45	FAILURE OF TILTING STRUCTURE PLUMMER BLOCK IN H/UH STN.	B
46	FALLING OF OVERHEAD CHAIN TROLLEYS AT MATING STATION	B
47	COKE SPILLAGE & DUST GENERATION IN CLG. STN. DURING ANODE CLEANING	B
48	NON-CLEANING OF BATH DEPOSITED OVER THE BRACKET AT FINISHING MACHINE	A
49	SNAPPING OF REJECT ANODE PUSHER CHAIN IN CASTING ZONE	B
50	DAMAGE OF BLOCKADOR BOLTS IN SHOT BLASTING MACHINE	B
51	FREQUENT TROLLEY DERAILMENT IN WINCH TROLLEY LINES	B
52	MORE REPAIR TIME IN REPLACEMENT OF ORIENTATION RING IN C.CARROUSEL	A
53	MORE MAINT. TIME & FREQUENT SHAFT BENDING OF ANODE DETECTING ASSEMBLY	A
54	FALLING OF OVERHEAD CHAIN TROLLEYS AT CASTING CARROUSEL	C
55	FAILURE OF TENSIONING STUD OF CATERPILLAR CHAIN OF OH CONVEYOR	A



PROBLEM PRIORITIZATION



TECHNIQUE USED: **NOMINAL GROUP TECHNIQUE**

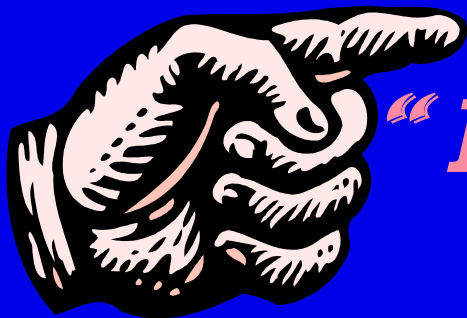
CRITERIA USED: 1-Production Loss 2- Single Line Equipment
3- Safety Concern 4- Repair Time 5- Financial Implication

PROBLEMS PRIORITISED		INDIVIDUAL SCORES					TOTAL SCORE	RANK
NO	PROBLEM	M1	M2	M3	M4	M5		
01	FREQUENT BREAKING OF THIM. PR. PUNCH LOCK	---	04	---	---	02	06	05
02	JAMMING OF TROLLEY AT INPUT/OUTPUT OF CAST. CARROUSEL	01	---	03	---	03	07	04
08	HYD. OIL DRAIN. DURING FAIL. OF HYD. HOSES & O-RINGS AT H/UH STN.	03	---	---	03	---	06	05
12	GRIPPING/ UNGRIPPING PROBLEM IN CASTING CARROUSEL	---	---	06	---	01	07	04
13	INCONSISTENT BRUSHING AT STEM BRUSHING MACHINE	---	03	---	06	---	09	02
20	FREQ. FAILURE OF LIFTING TABLE HOSE OF H/ UH STATION	02	---	---	---	06	08	03
26	PROBLEM OF TROLLEY JAMMING NEAR AUTO BUTT STRIPPING	---	---	04	01	---	05	06
30	JAMMING OF SWIVELING ARM CARRIAGE IN CASTING ZONE	05	---	05	---	---	10	01
33	FREQUENT CHAIN SNAPPING IN MECH. PUSHER OF ZONE-III	---	02	---	05	---	07	04
35	PROB. OF FR. DAM. OF SPRGS. IN ACT. OF ZONE-III ROLLER CONV.	---	01	---	---	05	06	05
40	PRESS.DROP IN HE PUMP 3&4 DURING RUNNING OF I. FURNACE-2	06	---	---	---	---	06	05
41	SPILLAGE OF MOLTEN C/IRON FROM LADLES IN CASTING ZONE	---	06	---	02	---	08	03
44	FR. DAM.OF P. BL. AND G.BOXES IN ROLLER CONV. OF H/UH STN.	---	05	01	---	---	06	05
46	FALLING OF OVERHEAD CHAIN TROLLEYS AT MATING STATION	---	---	02	---	04	06	05
54	FALLING OF O/HEAD CHAIN TROLLEYS AT CASTING CARROUSEL	04	---	---	04	---	08	03



PROBLEM SELECTION (CONSENSUS CRITERIA METHOD)

CRITERIA PROB.NO	DIRECT LOSS OF PRDN.(1.75)	DEPARTMENTAL IMP.(1.50)	FINANCIAL IMPLICATION(0.75)	SAFETY (0.60)	JOB CRITICALITY (0.40)	TOTAL SCORE
01	10x1.75= 17.5	9x1.50 = 13.50	7x0.75 = 5.25	12x0.60 = 7.2	11x0.40=4.40	47.85
02	9x1.75=15.75	10x1.50=15	12x0.75=9.0	13x0.60=7.8	6x0.40=2.40	49.95
08	13x1.75=22.75	9x1.50=13.50	10x0.75=7.50	8x0.60=4.80	10x0.40=4.0	52.55
12	7x1.75=12.25	11x1.50=16.50	8x0.75=6.0	10x0.60=6.0	12x0.40= 4.80	45.55
13	15x1.75=26.25	14x1.50=21.00	15x0.75=11.25	12x0.60=7.20	15x0.40=6.00	71.70
20	6x1.75=10.50	8x1.50=12.0	14x0.75=10.50	5x0.60=3.0	9x0.40=3.60	39.60
26	8x1.75=14.0	12x1.50=18.0	13x0.75=9.75	11x0.60=6.60	8x0.40=3.20	51.55
30	12x1.75=21.0	15x1.50=22.50	6x0.75=4.50	7x0.60=4.20	13x0.40=5.20	57.40
33	13x1.75=22.75	11x1.50=16.50	8x0.75=6.0	11x0.60=6.60	9x0.40=3.60	55.45
35	11x1.75=19.25	7x1.50=10.50	10x0.75=7.50	9x0.60=5.40	12x0.40=4.80	47.45
40	10x1.75=17.50	8x1.50=12.0	11x0.75=8.25	4x0.60=2.40	13x0.40=5.20	45.35
41	8x1.75=14.0	12x1.50=18.0	7x0.75=5.25	13x0.60=7.80	11x0.40=4.40	49.45
44	11x1.75=19.25	11x1.50=16.50	9x0.75=6.75	10x0.60=6.60	8x0.40=3.20	52.30
46	10x1.75=17.50	2x1.50=3.0	12x0.75=9.0	5x0.60=3.0	7x0.40=2.80	35.30
54	5x1.75=8.75	9x1.50=13.50	10x0.75=7.50	12x0.60=7.20	9x0.40=3.60	40.55



PROBLEM THEME
“INCONSISTENT BRUSHING
OF ANODE STEMS”