

Telephone: 91-020-26902100 (EPABX)
91-020-26902151 (Library)
Fax: 91-020-26902244
e-mail: librarian@vsisugar.com (Librarian)



VASANTDADA SUGAR INSTITUTE

Manjari(Bk.)-412 307, Taluka: Haveli, District: Pune, Maharashtra, India.

ORDER FORM

Publication - 'Maintenance Book For Sugar Engineers' – K.R.Patil

Customer's Details:

Name: _____
Address: _____
City: _____ State: _____ Country: _____
Zip/Postal Code: _____
Phone No: _____
Fax No: _____
Email: _____

Order Details:

Item	Quantity	Cost per Book (By Hand)	By Regd. Post			Order for	
			Quantity	Postage Charges	Total Amount	Quantity	Total Amount
Purchase of Book titled – "Maintenance Book for Sugar Engineers" – K.R.Patil	One copy (For Sale In India)	Rs.550.00	One (1)	Rs.50/-	Rs.600/-		
			Two (2)	Rs.75/-	Rs.1175/-		
			Five (5)	Rs.150/-	Rs.2900/-		

I enclose a cheque/demand draft (D.D.) of _____ (Rupees _____ only) for payment and the details are as below,

Payment Details:

Cheque / D.D. Number	Bank Name	Date	Amount

Signature of the Applicant/
Company's Seal & Date

* NOTE:

- Duly filled forms should be posted/ faxed or e-mail to Librarian and/or the address mentioned above.
- Postal Charges are as applicable. The publication cost mentioned is subjected to change without prior notice.
- Payment can be made by Cheque/ D.D. in favor of 'VASANTDADA SUGAR INSTITUTE' payable at Pune. Cash payment will be accepted at VSI office only in office time.
- In case of payment by Cheque/ D.D., book(s) will be delivered **By Regd. Post** on receipt of above order and after realization of cheque.
- Payments are also accepted by **RTGS/ NEFT Fund Transfer**. After successful transaction, notify the payment details by email/ fax/ SMS/ phone to the Librarian /Chief Accountant for immediate process.

CONTENTS

CHAPTER - 1: MAINTENANCE PRACTICES	1
1.0 Maintenance practices in Sugar Industry	1
1.1 General Practices	1
1.1.1 Breakdown maintenance	2
1.1.2 Design Stage Maintenance	3
1.1.3 Predictive Maintenance	3
1.1.4 Preventive maintenance	3
1.2 Maintenance System	4
1.2.1 Preventive maintenance	4
1.2.2 Corrective maintenance	4
1.3 Teamwork for maintenance	5
1.4 Controls on maintenance cost	5
1.4.1 Engineering control	5
1.4.2 Manpower and Planning	5
1.4.3 Budgetary controls	6
CHAPTER - 2: MAINTENANCE PROCEDURES	7
2.0 General Procedure	7
2.1 History/ record of Plant and Machinery	7
2.2 General Requirements of Maintenance	8
2.2.1 Sugar Mill Shut-down for Off-Seasonal Maintenance	8
2.2.2 Overhauling during the off-season	10
2.2.3 Frequency of overhauling/servicing	12
2.2.4 Machinery History Card/Sheet	12
2.2.5 Reduction in maintenance duration and cost	13
CHAPTER-3: MAINTENANCE PROCEDURES - MILLING PLANT	16
3.0 MILL HOUSE	16
3.1 OVERHAULING DURING OFF - SEASON	17
3.2 CANE WEIGHMENT	20
3.2.1 Basic Routine Maintenance	20

3.3	CANE UNLOADERS	21
3.3.1	Routine Preventive Maintenance	21
3.3.2	Planned Preventive Maintenance in off season	22
3.4	CANE FEEDER TABLE	23
3.4.1	Routine Preventive Maintenance in off season	24
3.4.2	Planned Preventive Maintenance	24
3.5	CANE CARRIERS	25
3.5.1	Routine Preventive Maintenance	25
3.5.2	Planned Preventive Maintenance in off season	25
3.5.3	Drive and slats overhauling	27
3.6	CANE PREPARATORY DEVICES - CANE KNIVES, FIBRIZER, SHREDDERS	27
3.6.1	Preventive Maintenance	28
3.6.2	Specific Maintenance of Fibrizer	30
3.6.3	General maintenance requirements	31
3.6.4	Do's & Don'ts for proper running of fibrizer	32
3.6.5	Commissioning the fibrizer	32
3.7	MAGNETIC TRAMP IRON SEPARATOR	33
3.7.1	Start-up and commissioning	33
3.7.2	Trouble shooting chart	34
3.8	MILLING PLANT	35
3.9	DONNELLY CHUTES	35
3.9.1	Planned Preventive Maintenance in off season	35
3.10	INTERMEDIATE CARRIERS	35
3.10.1	Routine Preventive Maintenance	35
3.10.2	Planned Preventive Maintenance	36
3.11	MILLING TANDEM	36
3.11.1	Preventive Maintenance	36
3.11.2	General Maintenance Procedure	40
3.11.3	Head stock (mill cheeks)	42

3.11.4	Mill rollers and journal bearings	43
3.11.5	Hydraulic ram	45
3.11.6	Crown Pinions	46
3.11.7	Square couplings and rope coupling	47
3.11.8	Trash and Scraper plate	48
3.11.9	Mill alignment and Setting of mills	48
3.11.10	Preparing the mills for service	54
3.11.11	Lubrication chart	56
3.12	DRIVE TURBINES (MILL AND FIBRIZER)	57
3.12.1	Routine Preventive Maintenance	57
3.12.2	Planned Preventive Maintenance	57
3.12.3	Off-season maintenance	58
3.12.4	Causes and remedies	58
3.12.5	Alignment of Turbine	59
3.13	ENCLOSED HELICAL(High and low Speed) AND PLANETARY GEARBOX	59
3.13.1	Routine Preventive Maintenance	59
3.13.2	Anti-rust Painting and Preservation	60
3.13.3	Coupling alignment	60
3.13.4	Dismantling the gear	61
3.13.5	Replacing and assembling of rotary shaft seals and gear unit	61
3.13.6	Lubrication and Flushing procedure	62
3.13.7	Requirement of check-up's at different stages	63
3.14	MILL HOUSE (EOT) CRANE AND HOISTS	64
3.14.1	Maintenance check list	64
3.14.2	Lubrication	66
3.14.3	Operating Do's and Don'ts	67
3.14.4	Trouble shooting chart	68
3.14.5	Hoisting practices	69
3.14.6	Electro Hydraulic Thruster Brake	69
3.14.7	Standard operation procedure for mill	72

3.15	DETAILS OF GENERAL RUNNING WORKS AND ACTION REQUIRED	75
3.15.1	Better housing keeping	75
3.15.2	Condition monitoring	75
3.15.3	Overhauling during cleaning day	76
3.15.4	Manpower requirement - training and development	76
CHAPTER-4: MAINTENANCE PROCEDURES - PROCESS HOUSE		77
4.0.1	Maintenance procedures of Process (Bolling) House	77
4.0.2	Off - season Maintenance Details	77
4.0.3	Maintenance work list	77
4.1	JUICE AND WATER WEIGHING SCALE	78
4.1.1	Testing	79
4.2	PHOSPHORIC ACID PREPARATION AND DOSING SYSTEM	80
4.3	JUICE HEATERS	80
4.3.1	Routine maintenance	80
4.3.2	Shift Maintenance Check list	81
4.3.3	Scheduled Cleaning of evaporators / Scheduled Stoppages	81
4.4	Off-season Maintenance	82
4.4.5	Major Renewal Parts	82
4.4.6	Major Inspections	82
4.4.7	Testing of Juice Heater	83
4.4.8	Tube Cleaning Procedure and schedule	85
4.4.9	Trouble shooting	87
4.5	MOL PREPARATION STATION (LIME PREPARATION & MIXING TANK)	89
4.5.1	Lime slacker	89
4.5.2	Vibro Screen	89
4.5.3	MOL storage tanks with stirrer	89
4.5.4	MOL Pumps	90
4.6	SULPHUR BURNER STATION	90
4.6.1	Maintenance of sulphur station equipment	90
4.6.2	Air compressor	91

4.7	JUICE SULPHITER	91
4.7.1	Off-season maintenance	91
4.8	CLARIFIER	92
4.8.1	Flash Tank	92
4.8.2	Clarifier	93
4.8.3	Testing of Clarifier	95
4.9	VACUUM FILTER STATION	95
4.9.1	Off-season maintenance	96
4.9.2	Bagacillo Blower	98
4.9.3	Cyclone separator	99
4.9.4	Mud mixture	99
4.10	EVAPORATORS	99
4.10.1	Chemical and mechanical cleaning	102
4.10.2	Methods of chemical cleaning	102
4.10.3	Soda boiling	103
4.10.4	Acid Boiling	103
4.10.5	Acid boiling with HCl	103
4.10.6	Acid boiling with Other chemicals	104
4.10.7	Steam cracking	105
4.10.8	Mechanical cleaning	105
4.10.9	Hydraulic Testing of Calandria	105
4.10.10	Time required for cleaning	106
4.10.11	Valve Grinding	106
4.10.12	Body cleaning and Testing	106
4.10.13	Water Testing of Evaporator set (Bodies)	107
4.10.14	Vacuum test of evaporator set	108
4.11	PANS	109
4.12	CONDENSERSE FOR EVAPORATOR AND PAN	110
4.13	CRYSTALLISERS	110
4.13.1	Massequite gutters from pans to crystallisers	110

4.13.2	Air cooled crystallisers and seed crystallisers	110
4.13.3	Water cooled crystalliser	110
4.13.4	Vacuum crystallisers	111
4.13.5	Vertical Crystallisers	111
4.14	CENTRIFUGAL STATION	111
4.14.1	Batch type machines	112
4.14.2	Continuous type machines	113
4.14.3	Pug mills and magma mixers	113
4.15	SUGAR HANDLING EQUIPMENT	113
4.15.1	Grass hoppers	113
4.15.2	Sugar elevator	113
4.15.3	Sugar graders	114
4.15.4	Sugar bag weighing and conveying	114
4.16	SPRAY POND	114
4.17	COOLING TOWER	114
CHAPTER-5 : MAINTENANCE PROCEDURE - STEAM GENERATION PLANT		116
5.1	RECOMMENDED MAINTENANCE PRACTICES	116
5.2	PREVENTIVE MAINTENANCE	116
5.2.1	Preventive maintenance program for spares	116
5.3	CONDITION BASED MAINTENANCE	117
5.3.1	Daily Checks	118
5.3.2	Monthly Checks	120
5.3.3	Boiler annual maintenance and overhaul	120
5.3.4	Annual overhaul	120
5.4	SHUTDOWN AND COOLING THE BOILER	120
5.4.1	Inspection after cooling	120
5.4.2	Steam Drum	121
5.4.3	Operational Checks	121
5.4.4	Prior to annual shutdown	122
5.4.5	Annual inspection	122

5.4.6	Headers	123
5.4.7	Annual	123
5.4.8	Every five (05) years	123
5.4.9	Furnace	124
5.4.10	Prior to annual shutdown	125
5.4.11	Annually	125
5.4.12	Every 5 years	126
5.4.13	Super heater	126
5.4.14	Economiser	127
5.4.15	Penthouse	128
5.4.16	Plenum hopper	129
5.5	FLUES, DUCTS AND DAMPERS	129
5.5.1	Flues	130
5.5.2	Ducts	130
5.5.3	Dampers	130
5.5.4	Expansion joints	131
5.5.5	Supports	131
5.6	REFRACTORY AND INSULATION	133
5.7	VALVES	133
5.7.1	Safety valves	134
5.7.2	Boiler valves	135
5.8	WATER LEVEL INDICATORS AND DEAERATOR	136
5.8.1	Water Level Indicators	136
5.8.2	Deaerator - Maintenance and inspection	137
5.9	SOOT BLOWERS	138
5.9.1	Long retractable soot (LRS) blowers	138
5.9.2	Rotary soot blowers	140
5.10	FANS	142
5.10.1	Operational Checks	142
5.10.2	Preventive maintenance program for fans	142
5.10.3	Fan and auxiliaries	144

5.11	MAINTENANCE PROCEDURE FOR ELECTROSTATIC PRECIPITATOR	149
5.12	MAINTENANCE PROCEDURE FOR FUEL HANDLING SYSTEM	152
5.12.1	Bagasse belt conveyer	152
5.12.2	Maintenance procedure for bagasse slat conveyer	152
5.12.3	Maintenance procedure for coal handling system	153
5.13	HP HEATER MAINTENANCE INSTRUCTIONS	154
5.14	TRAVELLING GRATE	159
5.14.1	Operational checks	160
5.14.2	During short shut down	160
5.14.3	Annual maintenance	161
5.15	TUBE FAILURES	161
5.15.1	Tube failure investigation / analysis method	162
5.15.2	Objectives of failure investigation	162
5.15.3	Failure analysis	163
5.15.4	Tests to be carried out at lab	165
5.16	DATA COLLECTION ON WATER CHEMISTRY	165
5.17	BOILER PRESERVATION PROCEDURE	165
5.17.1	Dry Storage	166
5.17.2	Wet storage	167
5.17.3	Nitrogen blanket	168
5.17.4	Protection of external surfaces	168
5.18	WATER WASHING PROCEDURE OF ECONOMISER	169
5.18.1	Water Requirement	169
5.18.2	Preparation for Water Washing	170
5.19	REFRACTORY DRYOUT	171
5.19.1	Pre-requisites	171
5.20	ALKALI BOIL-OUT	172
5.20.1	Quantity of Chemicals for one Alkali Boil out	173
5.20.2	Procedures	173
5.20.3	Completion and Post boil-out operation	175

5.21	STEAM BLOWING	175
5.21.1	Pre-requisites	175
5.21.3	Procedure	177
5.21.4	Precautions	177
5.22	FLOATING OF SAFETY VALVE	178
5.22.1	Procedure	178
5.23	TROUBLE SHOOTING CHART FOR BOILER	179
5.24	EMERGENCY BOILER PROCEDURES	181
5.24.1	Low water level	181
5.24.2	High water level	182
5.24.3	Furnace puffing & back firing	182
5.24.4	Superheater temperature increases rapidly	183
5.24.5	Boiler implosions / Collapses	183
5.25	WINDOW PATCH WELDING	183
5.25.1	Preparation	184
5.25.2	Welding	184
5.25.3	Testing	184
5.26	GENERAL PRINCIPAL OF WELD REPAIRS	184
5.26.1	Furnace and boiler tubes	184
5.26.2	Weld repair of small cracks in tube	185
5.26.3	Plugging tubes in drums & headers	185
5.26.4	Replacement of sections of tubes	187
5.26.5	Removing tubes from drums, headers & tube plates	187
5.27	CALCULATION OF BOILER EFFICIENCY	188
5.27.1	Calculation of boiler efficiency (bagasse fired boiler)	190
5.27.2	Steam to fuel ratio (s/f)	191
CHAPTER-6: MAINTENANCE PROCEDURES - POWER GENERATION PLANT		193
6.1	STEAM TURBINE	193
6.1.1	Steam Turbines (General) Maintenance practices	193
6.1.2	Preventive Maintenance	195

6.1.3	Type of Overhaul / Repair	196
6.1.4	Minor Overhaul	197
6.1.5	Major overhaul	198
6.2	Maintenance of auxiliaries	201
6.2.1	Checking the Bearings	201
6.2.2	Checking and Tightening of Screws	204
6.2.3	Inspection and Cleaning of the flow part	205
6.2.4	Cleaning and grinding of flanges sealing "Metal to Metal"	206
6.2.5	Check of Alignment of Rotors in Couplings	207
6.2.6	Inspection of the Rotor	209
6.2.7	Lubricating Oil System Maintenance	214
6.2.8	Adjustment and maintenance of draining devices	218
6.2.9	Tightness Measurement	219
6.2.10	HP Hydraulic System	219
6.2.11	Speed Sensors	220
6.2.12	Emergency Stop flap, Control valves and Control extraction	221
6.2.13	Non-return extraction flaps air operated part	222
6.2.14	Re-Assembly of turbine set	222
6.2.15	Trouble shooting	224
6.2.16	Power House Check points	228
6.2.17	Miscellaneous work	229
6.3	TURBINE GEARBOX	230
6.3.1	Preventive maintenance	230
6.3.2	Rust prevention procedure for storage of more than one year at site	233
6.3.3	Lubrication	234
6.3.4	Gear Inspection	234
6.3.5	Interpretation of Tooth Contact	235
6.3.6	Gear Condition Assessment	236
6.3.7	Bearing Inspection / condition Assessment	237

6.3.8	Bearing Removal and Re-assembling Procedure	237
6.3.9	Re-assembly	238
6.3.10	Trouble Shooting	239
6.4	RECOMMENDED BEARING COOLING WATER AND ITS ANALYSIS	241
6.5	RECOMMENDED STEAM PURITY	242
6.5.1	Steam Purity - Limits:	242
6.6	PREPARATION FOR RUNNING AND ROUTINE CHECKS	243
CHAPTER-7: MAINTENANCE PROCEDURES - BALANCE OF PLANT (MECH.)		245
7.1	PUMPS	245
7.1.1	Preventive Maintenance	245
7.1.2	Overhauling and maintenance of pumps	245
7.1.3	Piping	248
7.1.4	Foundations	248
7.1.5	Chart for trouble shooting in pumps	248
7.2	FANS, BLOWERS AND AIR COMPRESSORS	251
7.2.1	Fans Blowers and compressors	251
7.2.2	Fan Efficiencies	252
7.2.3	Different types of fans, their characteristics and typical applications	252
7.2.4	System characteristics	253
7.2.5	Fan characteristics	253
7.2.6	System characteristics and fan curves	254
7.2.7	Fan laws or Affinity laws	255
7.2.8	Impeller inlet seal clearances	255
7.2.9	Change in pulley dimensions	255
7.2.10	Fan performance assessment	256
7.2.11	Energy saving opportunities	258
7.3.	COOLING TOWER	258
7.3.1.	Trouble Shooting	259
7.3.2.	Maintenance tips	261
7.3.3.	Cooling Tower Cleaning and Preventive Maintenance	262
7.3.4.	FRP fans in cooling towers/humidification plants	262

7.4.	COMPRESSOR	263
7.4.1.	Preventive Maintenance - Compressor	263
7.4.2.	Trouble shooting for air compressors	265
7.4.3.	Tips for compressor maintenance	268
7.5	VALVES	269
7.5.1	Preventive Maintenance of valves	269
7.5.2.	Daily Inspection	269
7.5.3.	Troubleshooting	270
7.5.4.	Periodic Inspection	271
7.6	GEARS AND GEARBOXES	271
7.6.1	Trouble shooting	272
7.6.2.	Tips to minimise downtime whilst ensuring gearbox a long life	275
7.7.	BALL AND ROLLER BEARING	276
7.7.1	Cleaning, removal and assembly	277
7.7.2	Trouble shooting	280
7.7.3	White metal bearing radial and axial clearances	281
7.8	V - BELTS	281
7.8.1	Alignment and Belt tension	281
7.8.2	Wear	282
7.8.3.	V-Belt Drive Installation	282
7.8.4.	V- belt Trouble shooting	283
7.8.5.	Flat belts	284
7.9	CHAINS	285
7.9.1	Power transmission chains	285
7.9.2	Alignment and slack	285
7.9.3.	Roller Chain - maintenance and inspection	286
7.9.4.	Inspection Roller chain/Sprocket	287
7.9.5.	Roller Chain Trouble shooting	289
7.9.6.	Carrier chain check points.	290

7.10	COUPLINGS	291
7.10.1	Types of coupling	291
7.10.2	Causes of flexible coupling failures	295
7.10.3	Troubleshooting	296
7.11	LUBRICATION	297
7.11.1	Purpose of lubrication	297
7.11.2	Oil and Grease	298
7.11.3	Greasing Tips	299
7.11.4	Lubrication Inspections	299
7.11.5	Advantages of automatic lubrication	299
7.11.6	Advantages of centralized lubrication systems	300
7.12	VIBRATIONS CAUSES AND REMEDIES	300
7.12.1	Causes of vibrations	300
7.12.2	Vibration limits	302
7.12.3	Overloading of the driver	303
7.12.4	Vibration severity chart for vibration displacement	303
7.12.5	Limiting amplitude Vs Frequency chart.	304
7.12.6	Displacement - time plot of damped system	305
7.12.7	Machinery vibration signature	305
7.12.8	RMS values of vibration signal.	306
7.13.	WELDING PRACTICES & WELDING MATERIAL	306
7.13.1.	Information about Welding Technology	306
7.13.2	Method of Welding	307
7.13.3	Selection of Electrodes	307
7.13.4	Mechanism of Welding	308
7.13.5	Identification of the Electrodes	308
7.13.6	Selection of Correct Size of an Electrode:	310
7.13.7	Conservation and Storage of Electrodes	310
7.13.8	Cast Iron Welding	310
7.13.9	General / Special Welding Electrodes	311

7.13.10	Electrodes used for surface hardening	312
7.13.11	Roller Arcing Electrodes	313
7.13.12	Equivalent Electrodes used In Sugar Factory Maintenance	313
CHAPTER-8: MAINTENANCE PROCEDURES - BALANCE OF PLANT (ELE.)		315
8.1	INDUCTION MOTOR	315
8.1.1	Routine Preventive Maintenance	315
8.1.2	Planned Preventive Maintenance	317
8.1.3	Failure Cause	318
8.1.4	General points of electrical maintenance of Induction motor	320
8.1.5	Termination Practices	323
8.2	ALTERNATOR / TURBO GENERATOR (TG) SET	330
8.2.1	Precaution	330
8.2.2	Testing Procedure	331
8.2.3	Auxiliary Panels	331
8.2.4	Trouble Shooting at TG Set	331
8.2.5	Interfacing with Grid	333
8.2.6	General problems during operation and their Suggestions / Remedies	333
8.2.7	Requirements	335
8.3	TRANSFORMER	335
8.3.1	Testing	336
8.3.2	Maintenance of auxiliaries	336
8.3.3	Maintenance Schedule	339
8.3.4	Trouble -Shooting	341
8.4	SWITCH YARD EQUIPMENTS	342
8.4.1	Current transformers & Potential transformer	342
8.4.2	Isolators	343
8.4.3	Lightening Arrestor	343
8.4.4	Circuit - breaker	343
APPENDIX I - REFERENCES		344
APPENDIX II - ABBREVIATIONS AND ACRONYMS		345