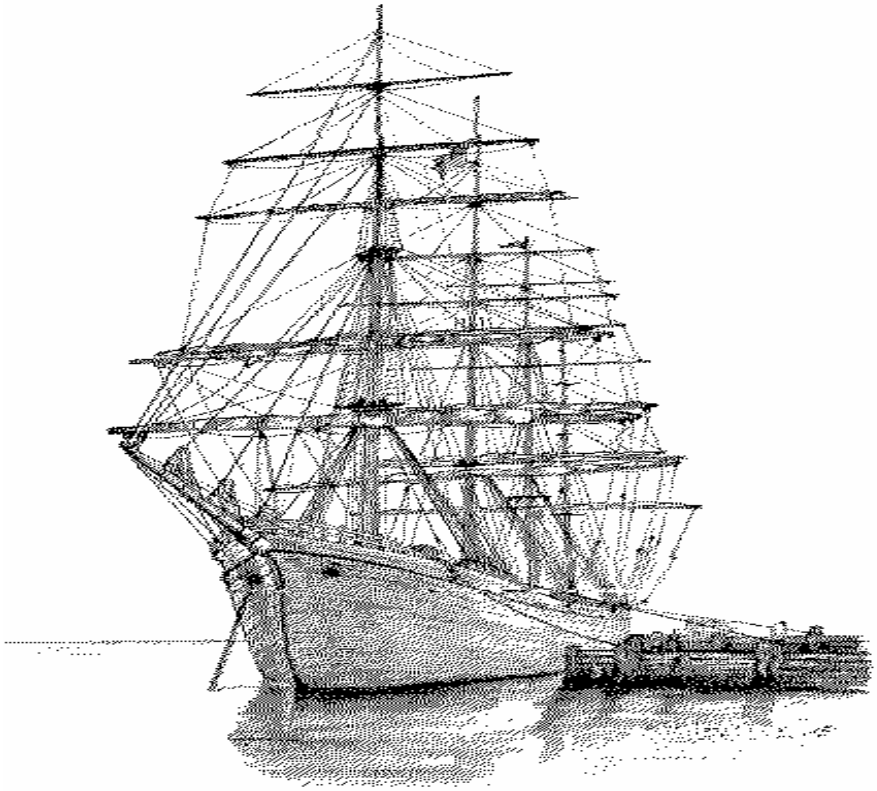
Industrial Assessment Center
Assessment Recommendation Code (ARC)



The ARC

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CAES
CENTER FOR ADVANCED ENERGY SYSTEMS

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy

Table of Contents

1. INTRODUCTION 1

2. ENERGY MANAGEMENT 2

2.1 Combustion Systems 2
2.11 FURNACES, OVENS & DIRECTLY FIRED OPERATIONS 2
2.111 Operations 2
2.112 Hardware 2
2.113 Maintenance 2
2.12 BOILERS 2
2.121 Operation 2
2.122 Hardware 2
2.123 Maintenance 2
2.124 Blowdown 3
2.13 FUEL SWITCHING 3
2.131 Electric to Fossil Fuel 3
2.132 Fossil Fuel to Electric 3
2.133 Alternate Fuel 3
2.139 Miscellaneous 3

2.2 Thermal Systems 4
2.21 STEAM 4
2.211 Traps 4
2.212 Condensate 4
2.213 Leaks and Insulation 4
2.214 Distillation 4
2.215 Maintenance 4
2.216 Operations 4
2.219 Miscellaneous 4
2.22 HEATING 5
2.221 Operation 5
2.222 Hardware 5
2.23 HEAT TREATING 5
2.231 General 5
2.24 HEAT RECOVERY 5
2.241 Flue Gas - Recuperation 5
2.242 Flue Gas - Other Uses 5
2.243 Heat Recovery from Specific Equipment 5
2.244 Other Process Waste Heat 6
2.249 Miscellaneous 6
2.25 HEAT CONTAINMENT 6
2.251 Insulation 6
2.252 Isolation 6
2.253 Infiltration 6
2.26 COOLING 7
2.261 Cooling Towers 7
2.262 Chillers and Refrigeration 7
2.269 Miscellaneous 7
2.27 DRYING 7
2.271 Use of Air 7

Table of Contents

2.3 Electrical Power 8
2.31 DEMAND MANAGEMENT 8
2.311 Thermal Energy Storage 8
2.212 *No Longer Used*
2.313 Scheduling 8
2.319 Miscellaneous 8
2.32 POWER FACTOR 8
2.321 General 8
2.33 GENERATION OF POWER 8
2.331 DC 8
2.332 AC 8
2.34 COGENERATION 9
2.341 General 9
2.35 TRANSMISSION 9
2.351 Transformers 9
2.352 Conductor Size 9

2.4 Motor Systems 10
2.41 MOTORS 10
2.411 Operation 10
2.413 Hardware 10
2.414 Motor System Drives 10
2.415 Motor Maintenance/Repair 10
2.42 AIR COMPRESSORS 10
2.422 Hardware 10
2.423 Operations 11
2.43 OTHER EQUIPMENT 11
2.431 Operations 11
2.432 Hardware 11

2.5 Industrial Design 12
2.51 SYSTEMS 12
2.511 Thermal 12
2.512 Mechanical 12
2.519 Miscellaneous 12

2.6 Operations 13
2.61 MAINTENANCE 13
2.612 General 13
2.62 EQUIPMENT CONTROL 13
2.621 Equipment Use Reduction 13
2.622 Equipment Scheduling 13
2.623 Equipment Automation 13
2.624 Load Reduction 13

Table of Contents

2.7 Building and Grounds 14
2.71 LIGHTING 14
2.711 Level 14
2.712 Operation 14
2.713 Controls 14
2.714 Hardware 14
2.72 SPACE CONDITIONING 14
2.721 Maintenance 14
2.722 Operation 14
2.723 Hardware - Heating / Cooling 15
2.724 Hardware - Air Circulation 15
2.725 Evaporation 15
2.726 Controls 15
2.727 Humidity Control 15
2.729 Miscellaneous 15
2.73 VENTILATION 15
2.731 General 15
2.74 BUILDING ENVELOPE 16
2.742 Solar Loading 16
2.744 Infiltration 16
2.749 Miscellaneous 16

2.8 Ancillary Costs 17
2.81 ADMINISTRATIVE 17
2.811 Utility Costs 17
2.812 Fiscal 17
2.82 SHIPPING, DISTRIBUTION, AND TRANSPORTATION 17
2.821 Shipping 17
2.822 Vehicles 17

2.9 Alternative Energy Usage 18
2.91 GENERAL 18
2.911 Solar 18
2.912 Wind Power 18
2.913 Hydrogen 18

Table of Contents

3. WASTE MINIMIZATION / POLLUTION PREVENTION 19

3.1 Operations 19
3.11 PROCEDURES 19
3.111 Process Specific 19
3.112 Material Application 19
3.113 Stripping.....19
3.114 Scheduling 19
3.115 Desulfurization / Slag Management.....19
3.116 Reduction / Elimination 19
3.117 Product Specifications 19
3.118 By-product Use 20
3.119 Miscellaneous 20
3.12 WASTE STREAM CONTAMINATION 20
3.122 Rinsing Strategies 20
3.124 Dragout Reduction.....20
3.129 Miscellaneous 20
3.13 CAD/CAM.....20

3.2 Equipment 21
3.21 GENERAL 21
3.211 Fault Tolerance 21
3.212 Painting Operations.....21
3.213 Process Specific Upgrades.....21
3.214 Tank Design.....21
3.216 System Monitoring.....21
3.217 Automation 21

3.3 Post Generation Treatment / Minimization 22
3.31 GENERAL 22
3.311 Neutralization.....22
3.312 Removal of Contaminants.....22
3.313 Material Concentration 22

3.4 Water Use 23
3.41 GENERAL 23
3.411 Close Cycle Water Use 23
3.413 Water Quality.....23
3.414 Water Treatment 23
3.415 Reduction 23

3.5 Recycling.....24
3.51 LIQUID WASTE.....24
3.511 Oil 24
3.512 Ink 24
3.513 White Water.....24
3.514 Miscellaneous 24
3.52 SOLID WASTE 24
3.521 General.....24
3.522 Sand 24
3.524 Metals.....25
3.53 OTHER MATERIALS.....25
3.531 General 25

Table of Contents

3.6 Waste Disposal 25
3.61 GENERAL 25
3.611 Sludge Maintenance 25
3.612 Combustion of Waste Products 25
3.619 Miscellaneous 25

3.7 Maintenance 26
3.71 CLEANING / DEGREASING 26
3.711 Mechanical Cleaning 26
3.712 Reduction of Cleaning 26
3.713 Rag Use 26
3.714 Preventive Maintenance 26
3.719 Miscellaneous 26
3.72 SPILLAGE 27
3.721 Operations 27
3.722 Hardware 27
3.73 OTHER 27
3.731 Leak Reduction 27
3.739 Miscellaneous 27

3.8 Raw Materials 28
3.81 SOLVENTS 28
3.811 Use Reduction 28
3.812 Emission Reduction 28
3.813 Material Replacement 28
3.814 Solvent Recovery 28
3.82 OTHER SOLUTIONS 28
3.821 Water-Based Substitutes 28
3.822 Other Substitutes 29
3.83 SOLIDS 29
3.831 General 29

Table of Contents

4. DIRECT PRODUCTIVITY ENHANCEMENTS 30

4.1 Manufacturing Enhancements 30
4.11 BOTTLENECK REDUCTION 30
4.12 DEFECT REDUCTION 30
4.13 MATERIAL REDUCTION 30

4.2 Purchasing 31
4.21 RAW MATERIALS..... 31
4.22 ANCILLARY MATERIALS 31
4.23 CAPITAL 31

4.3 Inventory.....31
4.31 JUST IN TIME..... 31
4.32 OTHER INVENTORY CONTROLS.....31

4.4 Labor Optimization 32
4.42 PRACTICES / PROCEDURES 32
4.43 TRAINING 32
4.44 AUTOMATION..... 32
4.45 SCHEDULING 32
4.46 MAINTENANCE 32

4.5 Space Utilization.....33
4.51 FLOOR LAYOUT 33
4.52 RENTAL SPACE 33

4.6 Reduction of Downtime 33
4.61 MAINTENANCE..... 33
4.62 QUICK CHANGE..... 33
4.63 POWER CONDITIONING..... 33
4.64 ALARMS 33
4.65 OTHER EQUIPMENT.....34

4.7 Management Practices 34
4.71 TOTAL QUALITY MANAGEMENT..... 34
4.72 CERTIFICATIONS 34
4.73 MARKETING 34

4.8 Other Administrative Savings 34
4.81 TAXES..... 34
4.82 FEES.....34

APPLICATION CODES 35

Note: due to modifications to the coding systems, sections may not be numbered consecutively

1. Introduction

The database resulting from assessments carried out by Universities for the Department of Energy's Industrial Technology Program (ITP). This manual, developed for the Industrial Assessment Centers (IAC) contain a list of recommendations involving enhancements in energy efficiency, waste minimization and manufacturing productivity. In order to organize the data in a useful way, a coding system called the Assessment Recommendation Code (ARC) has been developed to list each recommendation.

The list is assembled and is maintained by the Center for Advanced Energy Systems at Rutgers, the State University of New Jersey. The majority of the recommendations for increased energy efficiency come, in some part, from the list presented in the early Department of Commerce Guidebook (EPIC)[1]. The recommendations for waste reduction used, in part, a list assembled by Professor Richard J. Jendrucko, Thomas N. Coleman and Todd M. Thomas of the University of Tennessee and their contribution is gratefully acknowledged. The productivity recommendations are taken from the Industrial Productivity Training Manual, Rutgers University, Dr. Michael Muller, Dr. David Briggs, and Mr. Donald Kasten.

Most recommendations can be collected into groups that focus either on the same system or on the same general strategy for enhancement. Attempts were made to dev

elop a coding scheme, which would be consistent along either one of these lines, but neither approach proved satisfactory. The resulting organization of recommendations has been done in an "expert system" fashion. Therefore, the code has been assembled to best collect recommendations, which would be considered together by an experienced professional. For example, recommendations for energy savings for air compressors (a system) are grouped. In a similar fashion, recommendations for waste heat recovery (a strategy) are collected together.

A coding system like this will change frequently as new technologies and strategies reach the manufacturing floor. **Therefore it is important that the database version being used match the ARC code version.**

The ARC consists of a code as follows:

X.YYYY.Z

The first number, "X" is the recommendation type. Examples are 2 for energy savings, 3 for waste reduction, 4 for productivity. The second four numbers, "YYYY", detail the strategy being employed. The final number, "Z" is the application of the strategy, indicating whether the recommendation impacts the process, the building and grounds, or other application.

[1]Energy Conservation Program Guide For Industry and Commerce; National Bureau of Standards Handbook 115; US. Government Printing Office, Washington, 1974

2. Energy Management

2.1 Combustion Systems

2.11 FURNACES, OVENS & DIRECTLY FIRED OPERATIONS

2.111 Operations

2.1111 CONTROL PRESSURE ON STEAMER OPERATIONS
2.1112 HEAT OIL TO PROPER TEMPERATURE FOR GOOD ATOMIZATION
2.1113 REDUCE COMBUSTION AIR FLOW TO OPTIMUM
2.1114 LIMIT AND CONTROL SECONDARY COMBUSTION AIR IN FURNACE
2.1115 ELIMINATE COMBUSTIBLE GAS IN FLUE GAS
2.1116 IMPROVE COMBUSTION CONTROL CAPABILITY
2.1117 RELOCATE OVEN / FURNACE TO MORE EFFICIENT LOCATION

2.112 Hardware

2.1121 USE INSULATION IN FURNACES TO FACILITATE HEATING / COOLING
2.1122 RE-SIZE CHARGING OPENINGS OR ADD A MOVABLE DOOR ON EQUIPMENT
2.1123 INSTALL AUTOMATIC STACK DAMPER
2.1124 REPLACE DIRECT FIRED EQUIPMENT WITH STEAM HEAT
2.1125 CONVERT TO OXY-FUEL BURNERS

2.113 Maintenance

2.1131 REPAIR FAULTY INSULATION IN FURNACES, BOILERS, ETC
2.1132 REPAIR FAULTY LOUVERS AND DAMPERS
2.1133 ADJUST BURNERS FOR EFFICIENT OPERATION
2.1134 ELIMINATE LEAKS IN COMBUSTIBLE GAS LINES
2.1135 REPAIR FURNACES AND OVEN DOORS SO THAT THEY SEAL EFFICIENTLY

2.12 BOILERS

2.121 Operation

2.1211 MOVE BOILER TO MORE EFFICIENT LOCATION
2.1212 OPERATE BOILERS ON HIGH FIRE SETTING
2.1213 DIRECT WARMEST AIR TO COMBUSTION INTAKE

2.122 Hardware

2.1221 REPLACE OBSOLETE BURNERS WITH MORE EFFICIENT ONES
2.1222 INSTALL TURBULATORS
2.1223 INSTALL SMALLER BOILER (INCREASE HIGH FIRE DUTY CYCLE)
2.1224 REPLACE BOILER

2.123 Maintenance

2.1231 ESTABLISH BURNER MAINTENANCE SCHEDULE FOR BOILERS
2.1232 KEEP BOILER TUBES CLEAN
2.1233 ANALYZE FLUE GAS FOR PROPER AIR/FUEL RATIO

2.124 Blowdown

2.1241	REDUCE EXCESSIVE BOILER BLOWDOWN
2.1242	MINIMIZE BOILER BLOWDOWN WITH BETTER FEEDWATER TREATMENT
2.1243	USE HEAT FROM BOILER BLOWDOWN TO PREHEAT BOILER FEED WATER

2.13 FUEL SWITCHING

2.131 Electric to Fossil Fuel

2.1311	REPLACE ELECTRICALLY-OPERATED EQUIPMENT WITH FOSSIL FUEL EQUIPMENT

2.132 Fossil Fuel to Electric

2.1321	REPLACE FOSSIL FUEL EQUIPMENT WITH ELECTRICAL EQUIPMENT
2.1322	USE ELECTRIC HEAT IN PLACE OF FOSSIL FUEL HEATING SYSTEM
2.1323	REPLACE GAS-FIRED ABSORPTION AIR CONDITIONERS WITH ELECTRIC UNITS

2.133 Alternate Fuel

2.1331	BURN A LESS EXPENSIVE GRADE OF FUEL
2.1332	CONVERT COMBUSTION EQUIPMENT TO BURN NATURAL GAS
2.1333	CONVERT COMBUSTION EQUIPMENT TO BURN OIL
2.1334	CONVERT OIL OR GAS BURNERS TO COMBUSTION OF COAL
2.1335	REPLACE GASOLINE WITH DIESEL, LPG, OR NATURAL GAS
2.1336	INSTALL EQUIPMENT TO UTILIZE WASTE FUEL

2.139 Miscellaneous

2.1391	REPLACE PURCHASED STEAM WITH ELECTRIC HEATING
2.1392	REPLACE PURCHASED STEAM WITH OTHER ENERGY SOURCE
2.1393	USE STEAM SPARGING OR INJECTIONS IN PLACE OF INDIRECT HEATING
2.1394	REPLACE STEAM JETS ON VACUUM SYSTEM WITH ELECTRIC MOTOR DRIVEN VACUUM PUMPS

2.2 Thermal Systems

2.21 STEAM

2.211 Traps

2.2111	INSTALL STEAM TRAP
2.2112	USE CORRECT SIZE STEAM TRAPS
2.2113	REPAIR OR REPLACE STEAM TRAPS
2.2114	SHUT OFF STEAM TRAPS ON SUPER HEATED STEAM LINES WHEN NOT IN USE

2.212 Condensate

2.2121	INCREASE AMOUNT OF CONDENSATE RETURNED
2.2122	INSTALL / REPAIR INSULATION ON CONDENSATE LINES
2.2123	INSULATE FEEDWATER TANK
2.2124	INSTALL DE-AERATOR IN PLACE OF CONDENSATE TANK
2.2125	REPLACE BAROMETRIC CONDENSERS WITH SURFACE CONDENSERS
2.2126	LOWER OPERATING PRESSURE OF CONDENSER (STEAM)
2.2127	FLASH CONDENSATE TO PRODUCE LOWER PRESSURE STEAM
2.2128	USE STEAM CONDENSATE FOR HOT WATER SUPPLY (NON-POTABLE)

2.213 Leaks and Insulation

2.2131	INSULATE STEAM / HOT WATER LINES
2.2132	REPAIR FAULTY INSULATION ON STEAM LINES
2.2133	REPAIR LEAKS IN LINES AND VALVES
2.2134	ELIMINATE LEAKS IN HIGH PRESSURE REDUCING STATIONS
2.2135	REPAIR AND ELIMINATE STEAM LEAKS

2.214 Distillation

2.2141	OPERATE DISTILLATION COLUMNS EFFICIENTLY
2.2142	UPGRADE DISTILLATION HARDWARE

2.215 Maintenance

2.2151	CLEAN STEAM COILS IN PROCESSING TANKS
2.2152	MAINTAIN STEAM JETS USED FOR VACUUM SYSTEM
2.2153	CLOSE OFF UNNEEDED STEAM LINES

2.216 Operations

2.2161	OPTIMIZE OPERATION OF MULTI-STAGE VACUUM STEAM JETS
2.2162	REDUCE EXCESS STEAM BLEEDING
2.2163	USE MINIMUM STEAM OPERATING PRESSURE
2.2164	TURN OFF STEAM TRACING DURING MILD WEATHER
2.2165	SUBSTITUTE AIR FOR STEAM TO ATOMIZE OIL

2.219 Miscellaneous

2.2191	SUBSTITUTE HOT PROCESS FLUIDS FOR STEAM
2.2192	USE HEAT EXCHANGE FLUIDS INSTEAD OF STEAM IN PIPELINE TRACING SYSTEMS

2.22 HEATING

2.221 Operation

2.2211	USE OPTIMUM TEMPERATURE
2.2212	USE MINIMUM SAFE OVEN VENTILATION

2.222 Hardware

2.2221	USE IMMERSION HEATING IN TANKS, MELTING POTS, ETC
2.2222	CONVERT LIQUID HEATERS FROM UNDERFIRING TO IMMERSION OR SUBMERSION HEATING
2.2223	ENHANCE SENSITIVITY OF TEMPERATURE CONTROL AND CUTOFF

2.23 HEAT TREATING

2.231 General

2.2311	HEAT TREAT PARTS ONLY TO REQUIRED SPECIFICATIONS OR STANDARDS
2.2312	MINIMIZE NON-ESSENTIAL MATERIAL IN HEAT TREATMENT PROCESS
2.2313	USE BATCH FIRING WITH KILN "FURNITURE" SPECIFICALLY DESIGNED
2.2314	REPLACE HEAT TREATING OVEN WITH MORE EFFICIENT UNIT

2.24 HEAT RECOVERY

2.241 Flue Gas - Recuperation

2.2411	USE WASTE HEAT FROM HOT FLUE GASES TO PREHEAT COMBUSTION AIR
2.2412	USE FLUE GAS HEAT TO PREHEAT BOILER FEEDWATER
2.2413	USE HOT FLUE GASES TO PREHEAT WASTES FOR INCINERATOR BOILER

2.242 Flue Gas - Other Uses

2.2421	INSTALL WASTE HEAT BOILER TO PROVIDE DIRECT POWER
2.2422	USE WASTE HEAT FROM HOT FLUE GASES TO GENERATE STEAM
2.2423	INSTALL WASTE HEAT BOILER TO PRODUCE STEAM
2.2424	USE HEAT IN FLUE GASES TO PREHEAT PRODUCTS OR MATERIALS
2.2425	USE FLUE GASES TO HEAT PROCESS OR SERVICE WATER
2.2426	USE WASTE HEAT FROM FLUE GASES TO HEAT SPACE CONDITIONING AIR
2.2427	USE WASTE HEAT FROM HOT FLUE GASES TO PREHEAT INCOMING FLUIDS
2.2428	USE FLUE GASES IN RADIANT HEATER FOR SPACE HEATING, OVENS, ETC

2.243 Heat Recovery from Specific Equipment

2.2431	RECOVER HEAT FROM TRANSFORMERS
2.2432	RECOVER HEAT FROM OVEN EXHAUST / KILNS
2.2433	RECOVER HEAT FROM ENGINE EXHAUSTS
2.2434	RECOVER HEAT FROM AIR COMPRESSOR
2.2435	RECOVER HEAT FROM COMPRESSED AIR DRYERS
2.2436	RECOVER HEAT FROM REFRIGERATION CONDENSERS
2.2437	RECOVER WASTE HEAT FROM EQUIPMENT

2.244 Other Process Waste Heat

2.2441	PREHEAT BOILER MAKEUP WATER WITH WASTE PROCESS HEAT
2.2442	PREHEAT COMBUSTION AIR WITH WASTE HEAT
2.2443	RE-USE OR RECYCLE HOT OR COLD PROCESS EXHAUST AIR
2.2444	USE HOT PROCESS FLUIDS TO PREHEAT INCOMING PROCESS FLUIDS
2.2445	RECOVER HEAT FROM EXHAUSTED STEAM
2.2446	RECOVER HEAT FROM HOT WASTE WATER
2.2447	HEAT WATER WITH EXHAUST HEAT

2.249 Miscellaneous

2.2491	USE COOLING AIR WHICH COOLS HOT WORK PIECES FOR SPACE HEATING
2.2492	USE “HEAT WHEEL” OR OTHER HEAT EXCHANGER TO CROSS-EXCHANGE BUILDING EXHAUST AIR WITH MAKE-UP AIR
2.2493	USE RECOVERED HEAT FROM LIGHTING FIXTURES FOR USEFUL PURPOSE
2.2494	RECOVER HEAT IN DOMESTIC HOT WATER GOING TO DRAIN
2.2495	USE EXHAUST HEAT FROM BUILDING FOR SNOW AND ICE REMOVAL
2.2496	HEAT SERVICE HOT WATER WITH AIR CONDITIONING EQUIPMENT

2.25 HEAT CONTAINMENT

2.251 Insulation

2.2511	INSULATE BARE EQUIPMENT
2.2512	INCREASE INSULATION THICKNESS
2.2513	COVER OPEN TANKS WITH FLOATING INSULATION
2.2514	COVER OPEN TANKS
2.2515	USE OPTIMUM THICKNESS INSULATION
2.2516	USE ECONOMIC THICKNESS OF INSULATION FOR LOW TEMPERATURES

2.252 Isolation

2.2521	ISOLATE STEAM LINES TO AVOID HEATING AIR CONDITIONED AREAS
2.2522	ISOLATE HOT OR COLD EQUIPMENT
2.2523	REDUCE INFILTRATION; ISOLATE HOT EQUIPMENT FROM REFRIGERATED AREAS
2.2524	AVOID COOLING OF PROCESS STREAMS OR MATERIALS THAT MUST SUBSEQUENTLY BE HEATED
2.2525	ELIMINATE COOLING OF PROCESS STREAMS WHICH SUBSEQUENTLY MUST BE HEATED AND VICE VERSA

2.253 Infiltration

2.2531	RE-SIZE CHARGING OPENINGS OR ADD MOVABLE COVER OR DOOR
2.2532	USE ONLY AMOUNT OF AIR NECESSARY TO PREVENT EXPLOSION HAZARD
2.2533	REPLACE AIR CURTAIN DOORS WITH SOLID DOORS

2.26 COOLING

2.261 Cooling Towers

2.2611	MODERATE COOLING TOWER OUTLET TEMPERATURE
2.2612	USE COOLING TOWER WATER INSTEAD OF REFRIGERATION
2.2613	USE ANTIFREEZE IN COOLING TOWERS TO ALLOW WINTER USE
2.2614	USE COOLING TOWER OR ECONOMIZER TO REPLACE CHILLER COOLING
2.2615	CLEAN CONDENSER TUBES

2.262 Chillers and Refrigeration

2.2621	MODIFY REFRIGERATION SYSTEM TO OPERATE AT A LOWER PRESSURE
2.2622	REPLACE EXISTING CHILLER WITH HIGH EFFICIENCY MODEL
2.2623	MINIMIZE CONDENSER COOLING WATER TEMPERATURE
2.2624	USE COLD WASTE WATER TO COOL CHILLER FEED WATER
2.2625	CHILL WATER TO THE HIGHEST TEMPERATURE POSSIBLE
2.2626	AVOID FROST FORMATION ON EVAPORATORS
2.2627	USE MULTIPLE-EFFECT EVAPORATORS
2.2628	UTILIZE A LESS EXPENSIVE COOLING METHOD

2.269 Miscellaneous

2.2691	SHUT OFF COOLING IF COLD OUTSIDE AIR WILL COOL PROCESS
2.2692	USE OUTSIDE COLD WATER SOURCE AS A SUPPLY OF COOLING WATER
2.2693	USE WASTE HEAT STEAM FOR ABSORPTION REFRIGERATION
2.2694	USE HIGHEST TEMPERATURE FOR CHILLING OR COLD STORAGE
2.2695	USE CASCADE SYSTEM OF RECIRCULATING DURING COLD WEATHER TO AVOID SUB-COOLING
2.2696	USE EXCESS COLD PROCESS FLUID FOR INDUSTRIAL COOLING NEEDS

2.27 DRYING

2.271 Use of Air

2.2711	UTILIZE OUTSIDE AIR INSTEAD OF CONDITIONED AIR FOR DRYING

2.3 Electrical Power

2.31 DEMAND MANAGEMENT

2.311 Thermal Energy Storage

2.3111	HEAT WATER DURING OFF-PEAK PERIODS AND STORE FOR LATER USE
2.3112	STORE HEATED / COOLED WATER FOR USE DURING PEAK DEMAND PERIODS
2.3113	MAKE ICE DURING OFF PEAK HOURS FOR COOLING

2.312 No Longer Used

2.313 Scheduling

2.3131	RESCHEDULE PLANT OPERATIONS OR REDUCE LOAD TO AVOID PEAKS
2.3132	RECHARGE BATTERIES ON DURING OFF-PEAK DEMAND PERIODS
2.3133	CONSIDER THREE OR FOUR DAYS AROUND-THE-CLOCK OPERATION RATHER THAN ONE OR TWO SHIFTS PER DAY
2.3134	SHIFT FROM DAYTIME TO NIGHTTIME OPERATION
2.3135	SCHEDULE ROUTINE MAINTENANCE DURING NON-OPERATING PERIODS
2.3136	OVERLAP CUSTODIAL SERVICES WITH NORMAL DAY HOURS
2.3137	USE POWER DURING OFF-PEAK PERIODS

2.319 Miscellaneous

2.3191	USE DEMAND CONTROLLER OR LOAD SHEDDER
2.3192	USE FOSSIL FUEL POWERED GENERATOR DURING PEAK DEMAND PERIODS

2.32 POWER FACTOR

2.321 General

2.3211	USE POWER FACTOR CONTROLLERS
2.3212	OPTIMIZE PLANT POWER FACTOR

2.33 GENERATION OF POWER

2.331 DC

2.3311	REPLACE DC EQUIPMENT WITH AC EQUIPMENT
2.3312	INSTALL EFFICIENT RECTIFIERS

2.332 AC

2.3321	USE STEAM PRESSURE REDUCTION TO GENERATE POWER
2.3322	USE EXISTING DAM TO GENERATE ELECTRICITY

2.34 COGENERATION

2.341 General

2.3411	REPLACE ELECTRIC MOTORS WITH BACK PRESSURE STEAM TURBINES AND USE EXHAUST STEAM FOR PROCESS HEAT
2.3412	USE WASTE HEAT TO PRODUCE STEAM TO DRIVE A STEAM TURBINE-GENERATOR
2.3413	BURN FOSSIL FUEL TO PRODUCE STEAM TO DRIVE A STEAM TURBINE-GENERATOR AND USE STEAM EXHAUST FOR HEAT
2.3414	BURN WASTE TO PRODUCE STEAM TO DRIVE A STEAM TURBINE GENERATOR SET AND USE STEAM EXHAUST FOR HEAT
2.3415	USE A FOSSIL FUEL ENGINE TO COGENERATE ELECTRICITY OR MOTIVE POWER; AND UTILIZE HEAT
2.3416	USE COMBINED CYCLE GAS TURBINE GENERATOR SETS WITH WASTE HEAT BOILERS CONNECTED TO TURBINE EXHAUST
2.3417	USE WASTE HEAT WITH A CLOSED-CYCLE GAS TURBINE-GENERATOR SET TO COGENERATE ELECTRICITY AND HEAT

2.35 TRANSMISSION

2.351 Transformers

2.3511	USE PLANT OWNED TRANSFORMERS OR LEASE TRANSFORMERS
2.3512	DE-ENERGIZE EXCESS TRANSFORMER CAPACITY
2.3513	CONSIDER POWER LOSS AS WELL AS INITIAL LOADS AND LOAD GROWTH IN DOWN-SIZING TRANSFORMERS

2.352 Conductor Size

2.3521	REDUCE LOAD ON ELECTRICAL CONDUCTOR TO REDUCE HEATING LOSSES
2.3522	INCREASE ELECTRICAL CONDUCTOR SIZE TO REDUCE DISTRIBUTION LOSSES

2.4 Motor Systems

2.41 MOTORS

2.411 Operation

2.4111	UTILIZE ENERGY-EFFICIENT BELTS AND OTHER IMPROVED MECHANISMS
2.4112	INSTALL SOFT-START TO ELIMINATE NUISANCE TRIPS
2.4113	INSTALL MOTOR VOLTAGE CONTROLLER ON LIGHTLY LOADED MOTORS

2.413 Hardware

2.4131	REPLACE OVER-SIZE MOTORS AND PUMPS WITH OPTIMUM SIZE
2.4132	SIZE ELECTRIC MOTORS FOR PEAK OPERATING EFFICIENCY
2.4133	USE MOST EFFICIENT TYPE OF ELECTRIC MOTORS
2.4134	REPLACE ELECTRIC MOTOR WITH FOSSIL FUEL ENGINE

2.414 Motor System Drives

2.4141	USE MULTIPLE SPEED MOTORS OR AFD FOR VARIABLE PUMP, BLOWER AND COMPRESSOR LOADS
2.4142	USE ADJUSTABLE FREQUENCY DRIVE TO REPLACE MOTOR-GENERATOR SET
2.4143	USE ADJUSTABLE FREQUENCY DRIVE TO REPLACE THROTTLING SYSTEM
2.4144	USE ADJUSTABLE FREQUENCY DRIVE TO REPLACE MECHANICAL DRIVE
2.4145	INSTALL ISOLATION TRANSFORMER ON ADJUSTABLE FREQUENCY DRIVE

2.415 Motor Maintenance/Repair

2.4151	DEVELOP A REPAIR/REPLACE POLICY
2.4152	USE ONLY CERTIFIED MOTOR REPAIR SHOPS
2.4153	AVOID EMERGENCY REWIND OF MOTORS
2.4154	AVOID REWINDING MOTORS MORE THAN TWICE
2.4155	STANDARDIZE MOTOR INVENTORY
2.4156	ESTABLISH A PREVENTATIVE MAINTENANCE PROGRAM
2.4157	ESTABLISH A PREDICTIVE MAINTENANCE PROGRAM

2.42 AIR COMPRESSORS

2.422 Hardware

2.4221	INSTALL COMPRESSOR AIR INTAKES IN COOLEST LOCATIONS
2.4222	INSTALL ADEQUATE DRYERS ON AIR LINES TO ELIMINATE BLOWDOWN
2.4223	INSTALL DIRECT ACTING UNITS IN PLACE OF COMPRESSED AIR PRESSURE SYSTEM IN SAFETY SYSTEM
2.4224	UPGRADE CONTROLS ON COMPRESSORS
2.4225	INSTALL COMMON HEADER ON COMPRESSORS
2.4226	USE / PURCHASE OPTIMUM SIZED COMPRESSOR
2.4227	USE COMPRESSOR AIR FILTERS

Air Compressors (continued)

2.423 Operations

2.4231	REDUCE THE PRESSURE OF COMPRESSED AIR TO THE MINIMUM REQUIRED
2.4232	ELIMINATE OR REDUCE COMPRESSED AIR USED FOR COOLING, AGITATING LIQUIDS, MOVING PRODUCT, OR DRYING
2.4233	ELIMINATE PERMANENTLY THE USE OF COMPRESSED AIR
2.4234	COOL COMPRESSOR AIR INTAKE WITH HEAT EXCHANGER
2.4235	REMOVE OR CLOSE OFF UNNEEDED COMPRESSED AIR LINES
2.4236	ELIMINATE LEAKS IN INERT GAS AND COMPRESSED AIR LINES/ VALVES
2.4237	SUBSTITUTE COMPRESSED AIR COOLING WITH WATER OR AIR COOLING
2.4238	DO NOT USE COMPRESSED AIR FOR PERSONAL COOLING

2.43 OTHER EQUIPMENT

2.431 Operations

2.4311	RECOVER MECHANICAL ENERGY
2.4312	IMPROVE LUBRICATION PRACTICES
2.4313	PROVIDE PROPER MAINTENANCE / OF MOTOR DRIVEN EQUIPMENT
2.4314	USE SYNTHETIC LUBRICANT

2.432 Hardware

2.4321	UPGRADE OBSOLETE EQUIPMENT
2.4322	USE OR REPLACE WITH ENERGY EFFICIENT SUBSTITUTES
2.4323	USE OPTIMUM SIZE AND CAPACITY EQUIPMENT
2.4324	REPLACE HYDRAULIC / PNEUMATIC EQUIPMENT WITH ELECTRIC EQUIPMENT
2.4325	UPGRADE CONVEYORS

2.5 Industrial Design

2.51 SYSTEMS

2.511 Thermal

2.5111	CONVERT FROM INDIRECT TO DIRECT FIRED SYSTEMS
2.5112	USE CONTINUOUS EQUIPMENT WHICH RETAINS PROCESS HEATING CONVEYORS WITHIN THE HEATED CHAMBER
2.5113	USE DIRECT FLAME IMPINGEMENT OR INFRARED PROCESSING FOR CHAMBER TYPE HEATING
2.5114	USE SHAFT TYPE FURNACES FOR PREHEATING INCOMING MATERIAL
2.5115	REPOSITION OVEN WALLS TO REDUCE HEATED SPACE
2.5116	USE EXCESS COLD PROCESS FLUID FOR INDUSTRIAL COOLING NEEDS
2.5117	CONVERT TO INDIRECT TEMPERATURE CONTROL SYSTEM

2.512 Mechanical

2.5121	REDESIGN FLOW TO MINIMIZE MASS TRANSFER LENGTH
2.5122	REPLACE HIGH RESISTANCE DUCTS, PIPES, AND FITTINGS
2.5123	REDUCE FLUID FLOW RATES
2.5124	USE GRAVITY FEEDS WHEREVER POSSIBLE
2.5125	SIZE AIR HANDLING GRILLS/ DUCT/S COILS TO MINIMIZE AIR RESISTANCE

2.519 Miscellaneous

2.5191	MODIFY DYE BECK
2.5192	MODIFY TEXTILE DRYERS
2.5193	CONVERT FROM BATCH TO CONTINUOUS OPERATION
2.5194	REDESIGN PROCESS
2.5195	CHANGE PRODUCT DESIGN TO REDUCE ENERGY REQUIREMENTS
2.5196	USE SMALL NUMBER OF HIGH OUTPUT UNITS INSTEAD OF MANY SMALL INEFFICIENT UNITS
2.5197	AVOID ELECTRICALLY-POWERED ANIMATED DISPLAYS

2.6 Operations

2.61 MAINTENANCE

2.612 General

2.6121	REDUCE HOT WATER TEMPERATURE TO THE MINIMUM REQUIRED
2.6122	ADJUST VENTS TO MINIMIZE ENERGY USE
2.6123	REMOVE UNNEEDED SERVICE LINES TO ELIMINATE POTENTIAL LEAKS
2.6124	ESTABLISH EQUIPMENT MAINTENANCE SCHEDULE
2.6125	KEEP EQUIPMENT CLEAN
2.6126	KEEP SOLID FUELS / RAW MATERIALS DRY
2.6127	MAINTAIN AIR FILTERS BY CLEANING OR REPLACEMENT

2.62 EQUIPMENT CONTROL

2.621 Equipment Use Reduction

2.6211	CONSERVE ENERGY BY EFFICIENT USE OF VENDING MACHINES
2.6212	TURN OFF EQUIPMENT DURING BREAKS, REDUCE OPERATING TIME
2.6213	TURN OFF STEAM / HOT WATER LINES LEADING TO SPACE HEATING UNITS
2.6214	SHUT OFF PILOTS IN STANDBY EQUIPMENT
2.6215	SHUT OFF AIR CONDITIONING IN WINTER HEATING SEASON
2.6216	SHUT OFF COOLING WATER WHEN NOT REQUIRED
2.6217	SHUT OFF ALL LABORATORY FUME HOODS WHEN NOT IN USE
2.6218	TURN OFF EQUIPMENT WHEN NOT IN USE

2.622 Equipment Scheduling

2.6221	USE MOST EFFICIENT EQUIPMENT AT IT'S MAXIMUM CAPACITY AND LESS EFFICIENT EQUIPMENT ONLY WHEN NECESSARY
2.6222	USE DRYING OVEN (BATCH TYPE) ON ALTERNATE DAYS OR OTHER OPTIMUM SCHEDULE TO RUN EQUIPMENT WITH FULL LOADS
2.6223	SCHEDULE USE OF ELEVATORS TO CONSERVE ENERGY
2.6224	SCHEDULE BAKING TIMES OF SMALL AND LARGE COMPONENTS
2.6225	ELIMINATE THIRD SHIFT

2.623 Equipment Automation

2.6231	UTILIZE CONTROLS TO OPERATE EQUIPMENT ONLY WHEN NEEDED
2.6232	INSTALL SET-BACK TIMERS

2.624 Load Reduction

2.6241	REDUCE TEMPERATURE OF PROCESS EQUIPMENT WHEN ON STANDBY
2.6242	MINIMIZE OPERATION OF EQUIPMENT MAINTAINED IN STANDBY CONDITION

2.7 Building and Grounds

2.71 LIGHTING

2.711 Level

2.7111	REDUCE ILLUMINATION TO MINIMUM NECESSARY LEVELS
2.7112	REDUCE EXTERIOR ILLUMINATION TO MINIMUM SAFE LEVEL

2.712 Operation

2.7121	UTILIZE DAYLIGHT WHENEVER POSSIBLE IN LIEU OF ARTIFICIAL LIGHT
2.7122	DISCONNECT BALLASTS
2.7123	KEEP LAMPS AND REFLECTORS CLEAN
2.7124	MAKE A PRACTICE OF TURNING OFF LIGHTS WHEN NOT NEEDED

2.713 Controls

2.7131	ADD AREA LIGHTING SWITCHES
2.7132	INSTALL TIMERS ON LIGHT SWITCHES IN LITTLE USED AREAS
2.7133	USE SEPARATE SWITCHES ON PERIMETER LIGHTING WHICH MAY BE TURNED OFF WHEN NATURAL LIGHT IS AVAILABLE
2.7134	USE PHOTOCELL CONTROLS
2.7135	INSTALL OCCUPANCY SENSORS

2.714 Hardware

2.7141	LOWER LIGHT FIXTURES IN HIGH CEILING AREAS
2.7142	UTILIZE HIGHER EFFICIENCY LAMPS AND/OR BALLASTS
2.7143	USE MORE EFFICIENT LIGHT SOURCE
2.7144	INSTALL SPECTRAL REFLECTORS / DELAMP
2.7145	INSTALL SKYLIGHTS

2.72 SPACE CONDITIONING

2.721 Maintenance

2.7211	CLEAN AND MAINTAIN REFRIGERANT CONDENSERS AND TOWERS
2.7212	INSTALL OR UPGRADE INSULATION ON HVAC DISTRIBUTION SYSTEMS

2.722 Operation

2.7221	LOWER TEMPERATURE DURING THE WINTER SEASON AND VICE-VERSA
2.7222	AIR CONDITION ONLY SPACE IN USE
2.7223	CONDITION SMALLEST SPACE NECESSARY
2.7224	REDUCE SPACE CONDITIONING DURING NON-WORKING HOURS
2.7225	CLOSE OUTDOOR AIR DAMPERS DURING WARM-UP / COOL-DOWN PERIODS
2.7226	USE COMPUTER PROGRAMS TO OPTIMIZE HVAC PERFORMANCE
2.7227	USE WATER ON AIR CONDITIONING EXCHANGER
2.7228	AVOID INTRODUCING HOT, HUMID, OR DIRTY AIR INTO HVAC SYSTEM

2.723 Hardware - Heating / Cooling

2.7231	USE RADIANT HEATER FOR SPOT HEATING
2.7232	REPLACE EXISTING HVAC UNIT WITH HIGH EFFICIENCY MODEL
2.7233	USE PROPERLY DESIGNED AND SIZED HVAC EQUIPMENT
2.7234	USE HEAT PUMP FOR SPACE CONDITIONING
2.7235	INSTALL FOSSIL FUEL MAKE-UP AIR UNIT

2.724 Hardware - Air Circulation

2.7241	INSTALL OUTSIDE AIR DAMPER / ECONOMIZER ON HVAC UNIT
2.7242	CHANGE ZONE REHEAT COILS TO VARIABLE AIR VOLUME BOXES
2.7243	IMPROVE AIR CIRCULATION WITH DESTRATIFICATION FANS / OTHER METHODS
2.7244	REVISE SMOKE CLEANUP FROM OPERATIONS
2.7245	USE DIRECT AIR SUPPLY TO EXHAUST HOODS

2.725 Evaporation

2.7251	REDUCE AIR CONDITIONING LOAD BY EVAPORATING WATER FROM ROOF
2.7252	UTILIZE AN EVAPORATIVE AIR PRE-COOLER OR OTHER HEAT EXCHANGER IN AC SYSTEM

2.726 Controls

2.7261	INSTALL TIMERS AND/OR THERMOSTATS
2.7262	SEPARATE CONTROLS OF AIR HANDLERS FROM AC/ HEATING SYSTEMS
2.7263	LOWER COMPRESSOR PRESSURE THROUGH A/C SYSTEM MODIFICATION
2.7264	INTERLOCK HEATING AND AIR CONDITIONING SYSTEMS TO PREVENT SIMULTANEOUS OPERATION

2.727 Humidity Control

2.7271	REPLACE ELECTRIC REHEAT WITH HEAT PIPES
2.7272	INSTALL HEAT PIPES / RAISE COOLING SETPOINT
2.7273	INSTALL DESICCANT HUMIDITY CONTROL SYSTEM

2.729 Miscellaneous

2.7291	RESCHEDULE AND REARRANGE MULTIPLE-SOURCE HEATING SYSTEMS
2.7292	LOWER CEILING TO REDUCE CONDITIONED SPACE
2.7293	MODIFY SPRINKLER SYSTEM TO REDUCE HEATING REQUIREMENTS

2.73 VENTILATION

2.731 General

2.7311	VENTILATION SYSTEM TO SHUT OFF WHEN ROOM IS NOT IN USE
2.7312	MINIMIZE USE OF OUTSIDE MAKE-UP AIR FOR VENTILATION EXCEPT WHEN USED FOR ECONOMIZER CYCLE
2.7313	RECYCLE AIR FOR HEATING, VENTILATION AND AIR CONDITIONING
2.7314	REDUCE VENTILATION AIR
2.7315	REDUCE BUILDING VENTILATION AIR TO MINIMUM SAFE LEVELS
2.7316	CENTRALIZE CONTROL OF EXHAUST FANS TO ENSURE THEIR SHUTDOWN, OR ESTABLISH PROGRAM TO ENSURE MANUAL SHUTDOWN

2.74 BUILDING ENVELOPE

2.742 Solar Loading

2.7421	REDUCE GLAZED AREAS IN BUILDINGS
2.7422	PLANT TREES OR SHRUBS NEAR WINDOWS TO SHIELD FROM SUNLIGHT
2.7423	REDUCE HEAT GAIN BY WINDOW TINTING
2.7424	SHADE WINDOWS FROM SUMMER SUN
2.7425	CLEAN OR COLOR ROOF TO REDUCE SOLAR LOAD

2.744 Infiltration

2.7441	REPLACE BROKEN WINDOWS AND/OR WINDOW SASH
2.7442	KEEP DOORS AND WINDOWS SHUT WHEN NOT ON USE
2.7443	AIR SEALS AROUND TRUCK LOADING DOCK DOORS
2.7444	CLOSE HOLES AND OPENINGS IN BUILDING SUCH AS BROKEN WINDOWS
2.7445	INSTALL WEATHER STRIPPING ON WINDOWS AND DOORS
2.7446	UTILIZE SENSORS CONTROLLING ROOF AND WALL OPENINGS
2.7447	INSTALL VINYL STRIP / HIGH SPEED / AIR CURTAIN DOORS

2.749 Miscellaneous

2.7491	INSULATE GLAZING, WALLS, CEILINGS, AND ROOFS
2.7492	USE PROPER THICKNESS OF INSULATION ON BUILDING ENVELOPE
2.7493	USE DOUBLE OR TRIPLE GLAZED WINDOWS TO MAINTAIN HIGHER RELATIVE HUMIDITY AND TO REDUCE HEAT LOSSES
2.7494	INSTALL STORM WINDOWS AND DOORS
2.7495	INSTALL REPLACEMENT DOORS
2.7496	INSTALL PARTITIONS TO REDUCE SIZE OF CONDITIONED SPACE

2.8 Ancillary Costs

2.81 ADMINISTRATIVE

2.811 Utility Costs

2.8111	CHECK FOR ACCURACY OF UTILITY METERS
2.8112	COMBINE UTILITY METERS
2.8113	PURCHASE GAS DIRECTLY FROM A CONTRACT GAS SUPPLIER
2.8114	CHANGE RATE SCHEDULES OR OTHER CHANGES IN UTILITY SERVICE
2.8115	BASE UTILITY CHARGES ON USAGE RATHER THAN AREA OCCUPIED
2.8116	CHECK FOR ACCURACY OF POWER METER

2.812 Fiscal

2.8121	APPLY FOR TAX-FREE STATUS FOR ENERGY PURCHASES
2.8122	USE UTILITY CONTROLLED POWER MANAGEMENT
2.8123	PAY UTILITY BILLS ON TIME

2.82 SHIPPING, DISTRIBUTION, AND TRANSPORTATION

2.821 Shipping

2.8211	CONSOLIDATE FREIGHT SHIPMENTS AND/OR DELIVERIES
2.8212	REDUCE DELIVERY SCHEDULES

2.822 Vehicles

2.8221	CONSIDER INTERMEDIATE OR ECONOMY SIZE AUTOS / TRUCKS
2.8222	SIZE TRUCKS TO JOB
2.8223	ADD AIR SHIELDS TO TRUCKS TO INCREASE FUEL MILEAGE
2.8224	SHUT DOWN TRUCK ENGINES WHILE LOADING, UNLOADING, OR WAITING
2.8225	SCHEDULE REGULAR MAINTENANCE TO MAINTAIN TRUCK ENGINES
2.8226	INCREASE EFFICIENCY OF TRUCKS
2.8227	ADJUST / MAINTAIN FORK LIFT TRUCKS FOR MOST EFFICIENT OPERATION

2.9 Alternative Energy Usage

2.91 GENERAL

2.911 Solar

2.9111 USE SOLAR HEAT TO HEAT MAKE-UP AIR
2.9112 USE SOLAR HEAT TO HEAT WATER
2.9113 USE SOLAR HEAT FOR HEAT

2.912 Wind Power

2.9121 INSTALL WIND POWERED ELECTRIC GENERATOR

2.913 Hydrogen

2.9131 INSTALL FUEL CELL TO UTILITZE WASTE HYDROGEN

3. Waste Minimization / Pollution Prevention

3.1 Operations

3.11 PROCEDURES

3.111 Process Specific

3.1111	COVER INK CONTAINERS WHEN NOT IN USE
3.1112	USE DEDICATED PRESSES FOR EACH COLOR
3.1113	USE GLASS MARBLES TO RAISE FLUID LEVELS OF CHEMICALS
3.1114	REUSE HIGH FERROUS METAL DUST AS RAW MATERIAL
3.1115	ORDER PAINT PIGMENTS IN PASTE FORM INSTEAD OF DRY POWDER TO ELIMINATE HAZARDOUS DUST WASTE
3.1116	REPAIR / UPGRADE GRATE CONVEYORS TO MINIMIZE LOSS OF COAL FINES

3.112 Material Application

3.1121	USE MORE EFFICIENT ADHESIVE APPLICATORS
3.1122	SWITCH FROM AUTOMATIC TO HAND APPLICATION

3.113 Stripping

3.1131	USE MECHANICAL STRIPPING METHODS
3.1132	USE CRYOGENIC STRIPPING

3.114 Scheduling

3.1141	SCHEDULE JOBS TO MINIMIZE THE NEED FOR CLEANUP (COLORS)
3.1142	SCHEDULE PRODUCTION RUNS TO MINIMIZE COLOR CHANGES

3.115 Desulfurization / Slag Management

3.1151	TREAT DESULFURIZATION SLAG IN A DEEP QUENCH TANK INSTEAD OF SPRAYING WATER ONTO AN OPEN PILE TO REDUCE AIR EMISSIONS
3.1152	USE HIGH QUALITY SCRAP (LOW SULFUR) TO REDUCE HAZARDOUS SLUDGE GENERATION
3.1153	ALTER PRODUCT REQUIREMENTS TO ELIMINATE UNNECESSARY USE OF DESULFURIZING AGENT (CALCIUM CARBIDE)
3.1154	USE AN ALTERNATIVE DESULFURIZING AGENT TO ELIMINATE HAZARDOUS SLAG FORMATION

3.116 Reduction / Elimination

3.1161	ELIMINATE/REDUCE AN OPERATION
3.1162	USE LESS WASTEFUL PACKAGING
3.1163	USE PLASTIC PALLETS INSTEAD OF WOOD

3.117 Product Specifications

3.1171	CHANGE PRODUCT SPECS
3.1172	REVISE RAW MATERIAL SPECS
3.1173	USE A DIFFERENT RAW MATERIAL
3.1174	USE A RECYCLED RAW MATERIAL

Procedures (continued)

3.118 By-product Use

3.1181 ELIMINATE A BY-PRODUCT
3.1182 MAKE A NEW BY-PRODUCT

3.119 Miscellaneous

3.1191 CHANGE PROCEDURES / EQUIPMENT / OPERATING CONDITIONS
3.1192 REDUCE SCRAP PRODUCTION
3.1193 CONVERT FROM BATCH OPERATION TO CONTINUOUS PROCESSING
3.1194 USE AUTOMATIC FLOW CONTROL
3.1195 USE SILHOUETTE ENTRY COVER TO REDUCE EVAPORATION AREA
3.1196 MONITOR SOLUTIONS TO MAINTAIN SOLUTION STRENGTH

3.12 WASTE STREAM CONTAMINATION

3.122 Rinsing Strategies

3.1221 USE REACTIVE RINSING
3.1222 REDUCE WATER USE WITH COUNTER CURRENT RINSING
3.1223 USE FOG NOZZLES / SPRAY RINSING INSTEAD OF IMMERSION RINSING
3.1224 MECHANICALLY AND AIR AGITATE RINSE TANKS FOR COMPLETE MIXING
3.1225 USE A STILL RINSE AS THE INITIAL RINSING STAGE
3.1226 USE COUNTER CURRENT WASHING IN PHOTO PROCESSORS
3.1227 USE COUNTER-CURRENT RINSING TO REDUCE RINSE WATER VOLUME (GRAVURE)

3.124 Dragout Reduction

3.1241 SLOW INSERTION / WITHDRAWAL OF PARTS FROM DEGREASING TANK
3.1242 ALLOW DRAINAGE BEFORE WITHDRAWING OBJECT
3.1243 PRE-INSPECT PARTS TO PREVENT DRAG-IN OF SOLVENTS / CLEANERS
3.1244 REDUCE SOLUTION DRAG-OUT TO PREVENT SOLUTION LOSS
3.1245 EXTEND SOLUTION LIFE BY MINIMIZING DRAG-IN
3.1246 LOWER THE CONCENTRATION OF PLATING BATHS
3.1247 USE DRAG-OUT REDUCTION METHODS (GRAVURE)-SEE SURFACE COATING

3.129 Miscellaneous

3.1291 ELIMINATE PRACTICE OF MIXING WASTE STREAMS
3.1292 DEVELOP SEGREGATED SEWER SYSTEMS
3.1293 SEPARATE TREATMENTS FOR EACH TYPE OF SOLUTION AND RECYCLE
3.1294 SEGREGATE SPENT SOLVENTS AND REUSE IN SUBSEQUENT WASHINGS
3.1295 USE SQUEEGEES TO PREVENT CHEMICAL CARRY-OVER
3.1296 AVOID CONTAMINATION OF SCRAP GLASS AND REUSE AS FEED STOCK

3.13 CAD/CAM

3.131 General

3.1311 OPTIMIZE DYE DESIGN

3.2 Equipment

3.21 GENERAL

3.211 Fault Tolerance

3.2111	INSTALL REDUNDANT EQUIPMENT TO AVOID LOSSES CAUSED BY EQUIPMENT FAILURE AND ROUTINE MAINTENANCE

3.212 Painting Operations

3.2121	CONVERT TO ELECTROSTATIC POWDER COATING
3.2122	CONVERT FROM WATER CURTAIN SPRAY BOOTHS TO A DRY SYSTEM
3.2123	CONVERT TO HIGH VOLUME LOW PRESSURE (HVLP) PAINT GUNS
3.2124	CONVERT TO AIR ASSISTED / AIRLESS PAINT GUNS

3.213 Process Specific Upgrades

3.2131	INSTALL MIXERS ON EACH CLEANING TANK
3.2132	INCREASE FREEBOARD SPACE / INSTALL CHILLERS ON VAPOR DEGREASERS
3.2133	ELIMINATE CHEMICAL ETCHING AND PLATING BY USING ALTERNATIVE PRINTING TECHNOLOGIES (PRE SENSITIZED LITHOGRAPHIC, PLASTIC OR PHOTO POLYMER, HOT METAL, OR FLEXOGRAPHIC)
3.2134	USE HIGH PURITY ANODES TO INCREASE SOLUTION LIFE
3.2135	EXTEND SOLUTION LIFE WITH FILTERING OR CARBONATE FREEZING
3.2136	USE "WASH-LESS" PROCESSING EQUIPMENT
3.2137	USE INDUCTION FURNACES INSTEAD OF ELECTRIC ARC OR CUPOLA FURNACES TO REDUCE DUST AND FUMES

3.214 Tank Design

3.2141	USE CYLINDRICAL TANKS WITH HEIGHT TO DIAMETER RATIOS CLOSE TO ONE TO REDUCE WETTED SURFACE
3.2142	USE TANKS WITH A CONICAL BOTTOM OUTLET SECTION TO REDUCE WASTE ASSOCIATED WITH THE INTERFACE OF TWO LIQUIDS

3.216 System Monitoring

3.2161	CLOSELY MONITOR CHEMICAL ADDITIONS TO INCREASE BATH LIFE
3.2162	INSTALL WEB BREAK DETECTORS TO PREVENT EXCESSIVE WASTE PAPER
3.2163	USE INK WATER RATIO SENSOR

3.217 Automation

3.2171	USE AN AUTOMATIC PLATE PROCESSOR
3.2172	USE AUTOMATIC CLEANING EQUIPMENT
3.2173	CONVERT TO ROBOTIC PAINTING
3.2174	AUTOMATE INK MIXING
3.2175	USE AUTOMATED PLATE BENDERS
3.2176	INCREASE USE OF AUTOMATION

3.3 Post Generation Treatment / Minimization

3.31 GENERAL

3.311 Neutralization

3.3111	ADJUST PH FOR NEUTRALIZATION
3.3112	UTILIZE OXIDATION/REDUCTION FOR NEUTRALIZATION
3.3113	USE OTHER METHODS FOR NEUTRALIZATION

3.312 Removal of Contaminants

3.3121	USE SCREENING, MAGNETIC SEPARATION TO REMOVE CONTAMINANTS
3.3122	USE FILTRATION, CENTRIFUGING TO REMOVE CONTAMINANTS
3.3123	USE DECANTING, FLOTATION TO REMOVE CONTAMINANTS
3.3124	USE CYCLONE SEPARATION TO REMOVE CONTAMINANTS
3.3125	USE DISTILLATION, EVAPORATION TO REMOVE CONTAMINANTS
3.3126	USE ABSORPTION, EXTRACTION TO REMOVE CONTAMINANTS
3.3127	USE ADSORPTION, ION EXCHANGE TO REMOVE CONTAMINANTS
3.3128	UTILIZE OTHER METHODS TO REMOVE CONTAMINANTS

3.313 Material Concentration

3.3131	USE EVAPORATION TO CONCENTRATE MATERIAL
3.3132	USE REVERSE OSMOSIS TO CONCENTRATE MATERIAL
3.3133	USE OTHER WASTE CONCENTRATION METHODS

3.4 Water Use

3.41 GENERAL

3.411 Close Cycle Water Use

3.4111	USE CLOSED CYCLE PROCESS TO MINIMIZE WASTE WATER PRODUCTION
3.4112	RECOVERY METALS FROM RINSE WATER (EVAP., ION EXCHANGE, RO, ELECTROLYSIS, ELECTRODIALYSIS) AND REUSE RINSE WATER
3.4113	TREAT AND REUSE RINSE WATERS
3.4114	REPLACE CITY WATER WITH RECYCLED WATER VIA COOLING TOWER
3.4115	RECOVER AND REUSE COOLING WATER
3.4116	METER RECYCLED WATER (TO REDUCE SEWER CHARGES)

3.413 Water Quality

3.4131	MINIMIZE CONTAMINATION OF WATER BEFORE TREATMENT
3.4132	USE DEIONIZED WATER IN UPSTREAM RINSE TANKS
3.4133	CLEAN FOULING FROM WATER LINES REGULARLY

3.414 Water Treatment

3.4141	REPLACE THE CHLORINATION STAGE WITH AN OXYGEN OR OZONE STAGE
3.4142	RECYCLE CHLORINATION STAGE PROCESS WATER
3.4143	USE WATER FROM THE WASHING SYSTEM IN THE CHLORINATION STAGE
3.4144	PERFORM HIGH CONSISTENCY GAS PHASE CHLORINATION
3.4145	USE MAGNETIC TECHNOLOGY TO TREAT WATER

3.415 Reduction

3.4151	MINIMIZE WATER USAGE
3.4152	CAREFULLY CONTROL WATER LEVEL IN MASS FINISHING EQUIPMENT
3.4153	USE COUNTER CURRENT RINSING TO REDUCE WASTE WATER
3.4154	ELIMINATE LEAKS IN WATER LINES AND VALVES
3.4155	SUB-METER / QUANTIFY WATER USE
3.4156	USE FLOW CONTROL VALVES ON EQUIPMENT TO OPTIMIZE WATER USE
3.4157	REPLACE WATER COOLING ON PROCESSES WITH AIR COOLING
3.4158	USE MINIMUM COOLING WATER TO BEARINGS
3.4159	REPLACE TREATED WATER WITH WELL / SURFACE WATER

3.5 Recycling

3.51 LIQUID WASTE

3.511 Oil

3.5111	FILTER AND REUSE HYDRAULIC OIL
3.5112	REPROCESS SPENT OILS ON SITE FOR RE-USE
3.5113	SELL OIL TO RECYCLER

3.512 Ink

3.5121	RECYCLE WASTE INK AND CLEANUP SOLVENT

3.513 White Water

3.5131	RECYCLE WHITE WATER
3.5132	REUSE RICH WHITE WATER IN OTHER APPLICATIONS

3.514 Miscellaneous

3.5141	RECOVER DYE FROM WASTE WATERS
3.5142	TREAT AND REUSE EQUIPMENT CLEANING SOLUTIONS
3.5143	RETURN SPENT SOLUTIONS TO THE MANUFACTURER
3.5144	RECYCLE SPENT TANNING SOLUTION
3.5145	RECOVER AND REUSE SPENT ACID BATHS
3.5146	UTILIZE A CENTRAL COOLANT SYSTEM FOR CLEANING AND REUSE OF METAL WORKING FLUID

3.52 SOLID WASTE

3.521 General

3.5211	REUSE SCRAP GLASS AS FEED STOCK
3.5212	REGRIND, REUSE, OR SELL SCRAP PLASTIC PARTS
3.5213	REUSE SCRAP PRINTED PAPER FOR MAKE-READY
3.5214	AVOID CONTAMINATION OF FLASHING / REJECT S AND USE AS FEED STOCK
3.5215	AVOID CONTAMINATION OF END PIECES AND REUSE AS FEED STOCK
3.5216	RECYCLE NONFERROUS DUST
3.5217	REUSE / RECYCLE/ SELL PAPER PRODUCTS
3.5218	REUSE / RECYCLE/ SELL RUBBER PRODUCTS

3.522 Sand

3.5221	RECYCLE CASTING SAND
3.5222	USE SAND FOR OTHER PURPOSES (EG CONSTRUCTION FILL, COVER FOR MUNICIPAL LANDFILLS)

Solid Waste (continued)

3.524 Metals

3.5241	SELL USED PLATES TO AN ALUMINUM RECYCLER
3.5242	RECOVER METALS FROM SPENT SOLUTIONS AND RECYCLE
3.5243	RECYCLE FILM FOR SILVER RECOVERY
3.5244	RECOVER METALS FROM CASTING SAND
3.5245	SEPARATE AND RECYCLE SCRAP METAL TO FOUNDRY
3.5246	SEGREGATE METALS FOR SALE TO A RECYCLER
3.5247	SEPARATE IRON FROM SLAG AND REMELT

3.53 OTHER MATERIALS

3.531 General

3.5311	RECOVER AND REUSE WASTE MATERIAL
3.5312	SALVAGE AND RE-USE PROCESS WASTE
3.5313	INCREASE AMOUNT OF WASTE RECOVERED FOR RESALE
3.5314	USE IN-PROCESS RECYCLING WHENEVER POSSIBLE
3.5315	LEASE / PURCHASE BALER; SELL CARDBOARD TO RECYCLER
3.5316	CONTRACT A WOOD PALLET RECYCLING COMPANY
3.5317	SELL / OFFER BY-PRODUCT AS ANIMAL FEED
3.5318	RECYCLE FLUORESCENT LAMPS

3.6 Waste Disposal

3.61 GENERAL

3.611 Sludge Maintenance

3.6111	USE ALTERNATIVE FLOCCULENT TO MINIMIZE SLUDGE VOLUME
3.6112	USE FILTER AND DRYING OVEN TO REDUCE SLUDGE VOLUME
3.6113	REMOVE SLUDGE FROM TANKS ON A REGULAR BASIS
3.6114	USE PRECIPITATING AGENTS IN WASTE WATER TREATMENT THAT PRODUCE THE LEAST QUANTITY OF WASTE

3.612 Combustion of Waste Products

3.6121	BURN WASTE PAPER FOR HEAT
3.6122	INSTALL SOLID WASTE INCINERATOR FOR HEAT
3.6123	BURN WOOD BY-PRODUCTS FOR HEAT
3.6124	BURN WASTE OIL FOR HEAT
3.6125	SELL COMBUSTIBLE WASTE
3.6126	DIRECT WASTE GASSES TO BOILER COMBUSTION AIR

3.619 Miscellaneous

3.6191	RETURN SPENT SOLUTIONS TO THE MANUFACTURER
3.6192	USE A LESS EXPENSIVE METHOD OF WASTE REMOVAL
3.6193	INSTALL EQUIPMENT (e.g. COMPACTOR) TO REDUCE DISPOSAL COSTS
3.6194	SHIP HYDRAULIC OIL TO SECONDARY FUEL PROGRAM

3.7 Maintenance

3.71 CLEANING / DEGREASING

3.711 Mechanical Cleaning

3.7111	USE VACUUM FOR SPILL CLEANUP INSTEAD OF ABSORBENT
3.7112	USE SQUEEGEES, MOPS, AND VACUUMS FOR FLOOR CLEANING
3.7113	USE MECHANICAL WIPERS FOR CLEANING OF VESSELS
3.7114	USE SQUEEGEES TO RECOVER CLINGING PRODUCT PRIOR TO RINSING
3.7115	CLEAN LINES WITH “PIGS" INSTEAD OF SOLVENTS / SOLUTIONS

3.712 Reduction of Cleaning

3.7121	IMPROVE HANDLING PRACTICES
3.7122	MAXIMIZE PRODUCTION RUNS TO REDUCE CLEANING
3.7123	USE CONTINUOUS PROCESSING
3.7124	INSTALL DEDICATED MIXING EQUIPMENT TO OPTIMIZE REUSE OF USED RINSEATE AND TO PRECLUDE THE NEED FOR INTER-RUN CLEANING
3.7125	SHORTEN PAINT LINES AS MUCH AS POSSIBLE
3.7126	USE PEEL COATINGS ON RAW MATERIALS
3.7127	MINIMIZE PART CONTAMINATION BEFORE WASHING

3.713 Rag Use

3.7131	USE A RAG RECYCLE SERVICE
3.7132	REUSE RAGS UNTIL COMPLETELY SOILED
3.7133	USE RAGS SIZED FOR EACH JOB
3.7134	WASH AND REUSE RAGS ON-SITE
3.7135	MINIMIZE USE OF RAGS THROUGH WORKER TRAINING
3.7136	MARKET WASTE MATERIALS AS CLEAN-UP RAGS
3.7137	REPLACE CLOTH RAGS WITH PAPER TOWELS

3.714 Preventive Maintenance

3.7141	IMPROVE CLEANING EFFICIENCY BY MAINTAINING CLEANING SYSTEM
3.7142	USE CLEAN IN PLACE (CIP) SYSTEMS
3.7143	CLEAN EQUIPMENT IMMEDIATELY AFTER USE

3.719 Miscellaneous

3.7191	USE WATER BASED SPRAY ABRASIVES INSTEAD OF BAR ABRASIVES
3.7192	USE DRY CLEANING METHODS WHENEVER POSSIBLE
3.7193	USE HIGH PRESSURE WASH SYSTEMS
3.7194	USE DISPOSABLE LINERS IN TANKS
3.7195	USE TEFLON LINED TANKS
3.7196	USE RE-USABLE FILTERS
3.7197	USE ULTRASONIC CLEANING
3.7198	REDUCE / ELIMINATE USE OF DISPOSABLE PRODUCT

3.72 SPILLAGE

3.721 Operations

3.7211	MODIFY MATERIAL APPLICATION METHODS
3.7212	IMPROVED MATERIAL HANDLING (MIXING AND TRANSFER)
3.7213	USE MORE EFFICIENT SPRAY METHOD FOR GELCOAT APPLICATION
3.7214	REDUCE OR ELIMINATE WASTE
3.7215	AVOID INSERTING OVERSIZED OBJECT TO REDUCE PISTON EFFECT

3.722 Hardware

3.7221	IMPROVE PROCESS CONTROL TO PREVENT SPILLS OF MATERIAL
3.7222	MINIMIZE OVERFLOWS BY INSTALLING LEVEL CONTROLS
3.7223	INSTALL SHROUDING ON MACHINES TO PREVENT SPLASHING
3.7224	USE PUMPS AND PIPING TO DECREASE THE FREQUENCY OF SPILLAGE DURING MATERIAL TRANSFER

3.73 OTHER

3.731 Leak Reduction

3.7311	MAINTAIN MACHINES WITH TO REDUCE LEAKS
3.7312	IMPLEMENT A REGULAR MAINTENANCE PROGRAM TO REDUCE EMISSIONS FROM LEAKY VALVES AND PIPE FITTINGS
3.7313	ELIMINATE OXYGEN LOSS

3.739 Miscellaneous

3.7391	IMPLEMENT A MAINTENANCE PROGRAM TO KEEP RACKS AND TANKS FREE OF RUST, CRACKS, OR CORROSION
3.7392	APPLY A PROTECTIVE COATING TO RACKS AND TANKS
3.7393	IMPLEMENT A MACHINE AND COOLANT SUMP CLEANING PROGRAM TO MINIMIZE COOLANT CONTAMINATION

3.8 Raw Materials

3.81 SOLVENTS

3.811 Use Reduction

3.8111	MAINTAIN WATER SEPARATOR AND COMPLETELY DRY PARTS TO AVOID WATER CONTAMINATION OF SOLVENT
3.8112	USE DEIONIZED WATER FOR MAKE-UP AND RINSE WATER TO INCREASE SOLUTION LIFE
3.8113	PREVENT EXCESSIVE SOLVENT USAGE (OPERATOR TRAINING)
3.8114	AUTOMATE PAINT MIXING-USE COMPRESSED AIR BLOWOUT FOR LINE CLEANING PRIOR TO SOLVENT CLEANING
3.8115	REDUCE THE NUMBER OF PARTS WASHERS

3.812 Emission Reduction

3.8121	COVER CONTAINERS TO MINIMIZE EVAPORATIVE LOSSES
3.8122	USE TIGHT-FITTING LIDS ON MATERIAL CONTAINERS TO REDUCE VOC EMISSIONS
	USE TIGHT FITTING LIDS ON MATERIAL CONTAINERS TO REDUCE VOC EMISSION
3.8124	INSTALL FLOATING COVERS ON TANKS OF VOLATILE MATERIALS TO REDUCE EVAPORATION
3.8125	REMOVE ROLLERS FROM THE MACHINES AND CLEAN IN A CLOSED SOLVENT CLEANER
3.8126	USE FLUE GAS RECUPERATION TO REDUCE VOC

3.813 Material Replacement

3.8131	USE WATER-BASED ADHESIVES
3.8132	USE LESS TOXIC AND VOLATILE SOLVENT SUBSTITUTES
3.8133	CONVERT TO AQUEOUS CLEANING
3.8134	USE WATER-BASED CUTTING FLUIDS TO ELIMINATE NEED FOR SOLVENT CLEANING
3.8135	USE LOW VOC OR WATER BASED PAINT
3.8136	SWITCH TO A SOLVENT THAT CAN BE CLEANED AND RE-USED
3.8137	USE SOY OR WATER-BASED INKS

3.814 Solvent Recovery

3.8141	REGENERATE CLEANING SOLVENT ON-SITE AND REUSE
3.8142	DISTILL CONTAMINATED SOLVENTS FOR REUSE
3.8143	RECYCLE CLEANING SOLVENT AND REUSE

3.82 OTHER SOLUTIONS

3.821 Water-Based Substitutes

3.8211	CONVERT TO AQUEOUS CLEANING SYSTEM
3.8212	USE WATER-BASED IMAGE PROCESSING CHEMICALS
3.8213	USE WATER BASED OR GREASELESS BINDERS TO INCREASE WHEEL LIFE
3.8214	USE WATER-BASED DEVELOPERS AND FINISHERS

3.822 Other Substitutes

3.8221	USE ALTERNATIVES FOR ACIDS / ALKALINE (WATER, STEAM, ABRASIVE)
3.8222	USE REACTIVE RINSING TO EXTEND BATH LIFE
3.8223	USE NON-PHENOLIC STRIPPERS TO REDUCE TOXICITY ASSOCIATED WITH PHENOL AND ACID ADDITIVES
3.8224	CONVERT TO LESS TOXIC HYDROCARBON CLEANERS
3.8225	REPLACE HEXAVALENT CHROMIUM SOLUTIONS WITH TRIVALENT SOLUTIONS
3.8226	USE CYANIDE FREE SOLUTIONS WHENEVER POSSIBLE
3.8227	REPLACE CADMIUM-BASED SOLUTIONS WITH ZINC SOLUTIONS
3.8228	REPLACE HEAVY METAL REAGENTS WITH NON-HAZARDOUS REAGENTS

3.83 SOLIDS

3.831 General

3.8311	USE SILVER FREE FILMS
3.8312	USE BUILDING MATERIALS WHICH REQUIRE LESS ENERGY TO PRODUCE
3.8313	ALTER RAW MATERIALS TO REDUCE AIR EMISSIONS
3.8314	PURCHASE HIGH MATERIALS IN RETURNABLE BULK CONTAINERS

4. Direct Productivity Enhancements

4.1 Manufacturing Enhancements

4.11 BOTTLENECK REDUCTION

4.1110	ADD EQUIPMENT/ OPERATORS TO REDUCE PRODUCTION BOTTLENECK
4.1120	REPLACE OLD MACHINE WITH NEW AUTOMATIC MULTI-STATION TOOL
4.1130	INSTALL REFRIGERATION SYSTEM TO COOL PRODUCT
4.1140	ADD/MODIFY EQUIPMENT TO IMPROVE DRYING PROCESS

4.12 DEFECT REDUCTION

4.1210	MAINTAIN CLEAN CONDITIONS BEFORE PAINTING
4.1220	DEVELOP STANDARD PROCEDURES TO IMPROVE INTERNAL YIELDS
4.1230	REDUCE DEFECTS BY REDUCING PRODUCT TIPPING
4.1240	INSTALL CONTINUOUS LUBRICATION EQUIPMENT
4.1250	MODIFY PROCESS TO REDUCE MATERIAL COSTS
4.1260	INSTALL SENSORS TO DETECT DEFECTS

4.13 MATERIAL REDUCTION

4.1310	MODIFY PROCESS TO REDUCE MATERIAL USE/COST
4.1320	PURCHASE NEW EQUIPMENT TO REDUCE MATERIAL USE / COST

4.2 Purchasing

4.21 RAW MATERIALS

4.2110	CONSIDER USE / PURCHASE OF BULK MATERIALS WHERE POSSIBLE
4.2120	ADOPT IN-HOUSE MATERIAL GENERATION
4.2130	PURCHASE MATERIAL FROM SUPPLIER IN CUSTOMIZED PACKAGING
4.2140	PURCHASE APPROPRIATELY SIZED MATERIAL

4.22 ANCILLARY MATERIALS

4.2210	USE ONLY AMOUNT OF PACKAGING MATERIAL NECESSARY
4.2220	PURCHASE RE-CONDITIONED MATERIAL INSTEAD OF NEW

4.23 CAPITAL

4.2310	PURCHASE EQUIPMENT INSTEAD OF LEASING
4.2320	LEASE EQUIPMENT INSTEAD OF PURCHASING

4.3 Inventory

4.31 JUST IN TIME

4.3110	SCHEDULE DELIVERIES ACCORDING TO DEMAND

4.32 OTHER INVENTORY CONTROLS

4.3210	OPTIMIZE PRODUCTION LOT SIZES AND INVENTORIES
4.3220	ELIMINATE OLD STOCK AND / OR MODIFY INVENTORY CONTROL
4.3230	OPTIMIZE LOT SIZES TO REDUCE INVENTORY CARRYING COSTS

4.4 Labor Optimization

4.42 PRACTICES / PROCEDURES

4.4210	MODIFY CURRENT INCENTIVE PROGRAM
4.4220	UTILIZE OUTSIDE CONTRACTING
4.4230	MOVE PRODUCT USING MECHANICAL MEANS
4.4240	IMPROVE SPACE COMFORT CONDITIONING
4.4250	ELIMINATE/REDUCE REDUNDANT INSPECTIONS
4.4260	MODIFY WORKLOAD

4.43 TRAINING

4.4310	TRAIN OPERATORS FOR MAXIMUM OPERATING EFFICIENCY
4.4320	CROSS-TRAIN PERSONNEL TO AVOID LOST TIME

4.44 AUTOMATION

4.4410	INSTALL AUTOMATIC PACKING EQUIPMENT
4.4420	INSTALL MAGAZINES FOR TEMPORARY STORAGE
4.4430	INSTALL AUTOMATIC BOILER FUEL FEED SYSTEM
4.4440	INSTALL SYSTEM TO COLLECT SCRAP
4.4450	INSTALL EQUIPMENT TO MOVE PRODUCT
4.4460	AUTOMATE FINISHING PROCESS
4.4470	AUTOMATE PAYROLL SYSTEM
4.4480	INSTALL AUTOMATIC PART STORAGE / RETREVAL SYSTEM

4.45 SCHEDULING

4.4510	ADD ADDITIONAL PRODUCTION SHIFT
4.4520	ELIMINATE SHIFT
4.4530	RESCHEDULE BREAKS TO ALLOW FOR CONTINUOUS PRODUCTION
4.4540	MODIFY STARTUP/SHUTDOWN TIMES

4.46 MAINTENANCE

4.4610	REMOVE HOT SLAG BEFORE IT HARDENS
4.4620	PROVIDE TRANSPORTATION FOR PERSONELL
4.4630	MODIFY FACILITY TO AVOID EXCESS MAINTENANCE COSTS

4.5 Space Utilization

4.51 FLOOR LAYOUT

4.5110	EXPAND OPERATIONS INTO UNUSED SPACE
4.5120	CONDENSE OPERATION INTO ONE BUILDING
4.5130	RE-ARRANGE EQUIPMENT LAYOUT TO REDUCE LABOR COSTS
4.5140	RE-ARRANGE EQUIPMENT LAYOUT TO REDUCE HANDLING COSTS
4.5150	INSTALL SHELVES / RACKS TO UTILIZE UNUSED SPACE

4.52 RENTAL SPACE

4.5210	CLEAR AND RENT EXISTING SPACE
4.5220	MODIFY STORAGE SPACE TO AVOID RENTAL OF A WAREHOUSE

4.6 Reduction of Downtime

4.61 MAINTENANCE

4.6110	BEGIN A PRACTICE OF PREDICTIVE / PREVENTATIVE MAINTENANCE
4.6120	CONTRACT OUT MAINTENANCE

4.62 QUICK CHANGE

4.6210	USE FIXTURES TO REDUCE MACHINE CHANGEOUT TIMES
4.6220	INSTALL ROTATING CAROUSELS TO REDUCE SET-UP TIMES
4.6230	EMPLOY MODULAR JIGS TO REDUCE PROCESS SET-UP TIME
4.6240	HIRE ADDITIONAL PERSONNEL TO REDUCE CHANGEOUT TIME
4.6250	DEVELOP STANDARD OPERATING PROCEDURES

4.63 POWER CONDITIONING

4.6310	INSTALL AN UNINTERUPTABLE POWER SUPPLY
4.6320	CHANGE OPERATING CONDITIONS

4.64 ALARMS

4.6410	ELIMINATE SHUTDOWNS OF CONTROLS DUE TO OVERHEATING
4.6420	INSTALL SENSORS TO DETECT AND AVOID JAMS

4.65 OTHER EQUIPMENT

4.6510	INSTALL BACK-UP EQUIPMENT
4.6520	REPLACE EXISTING EQUIPMENT WITH MORE SUITABLE SUBSTITUTES
4.6530	MAINTAIN/ENLARGE A STOCK OF SPARE PARTS

4.7 Management Practices

4.71 TOTAL QUALITY MANAGEMENT

4.7110	INITIATE A TOTAL QUALITY MANAGEMENT PROGRAM
4.7120	UTILIZE JOB COSTING SOFTWARE

4.72 CERTIFICATIONS

4.7210	INITIATE A PROGRAM TO ACQUIRE ISO CERTIFICATION

4.73 MARKETING

4.7310	ADVERTISE PRODUCT OR SERVICE

4.8 Other Administrative Savings

4.81 TAXES

4.8110	DEMOLISH OLD BUILDING TO REDUCE TAX AND INSURANCE BILLS
4.8120	APPLY FOR INVESTMENT INCENTIVES

4.82 FEES

4.8210	PAY BILLS ON TIME TO AVOID LATE FEES

Application Codes

A suffix is used with the Assessment Recommendation codes listed above in this manual to designate the general area of application of the recommendation. Therefore, a similar strategy applied to a space heating boiler or a process furnace would be distinguishable. The codes are:

Number	Application	Examples
1	Manufacturing Process	Process Heat Recovery, Variable Speed Drives on Process Equipment, Solvent Recovery
2	Process Support	Air Compressors, Steam, Nitrogen, Cogeneration
3	Building and Grounds	Lights, HVAC, Burn Waste for Heat
4	Administrative	Taxes, Inventory Control, Sale of Wastes