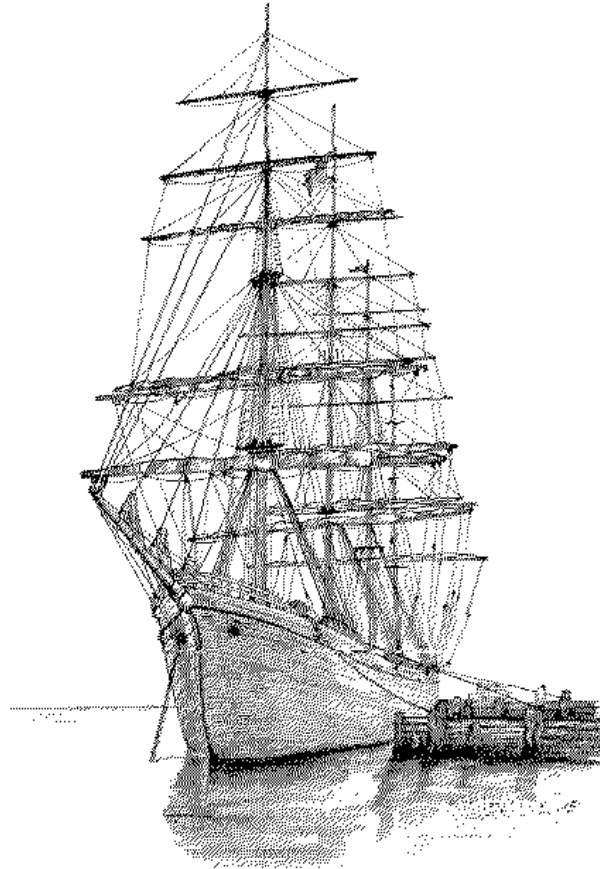

THE STATE UNIVERSITY OF NEW JERSEY

RUTGERS

Center for Advanced Energy Systems



The ARC

Assessment Recommendation Code System
for the DOE Industrial Assessment Center Database

Version 10.0

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Table of Contents

| | |
|--|----------|
| 1. Introduction..... | 1 |
| 2. Energy Management..... | 2 |
| 2.1 Combustion Systems..... | 2 |
| 2.11 FURNACES, OVENS & DIRECT 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 Fossil 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 |
| 2.3 | Electrical Power | 8 |
| 2.31 | Demand Management | 8 |
| 2.311 | Thermal Energy Storage..... | 8 |
| 2.312 | 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 |
| 2.412 | Hardware | 10 |
| 2.413 | Motor System Drives | 10 |
| 2.414 | Motor Maintenance/Repair | 10 |
| 2.42 | Air Compressors | 10 |
| 2.421 | Operations | 10 |
| 2.422 | Hardware..... | 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 |
| 2.611 | 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 |
| 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 |
| | SPACE CONDITIONING (continued) | 15 |
| 2.722 | Operation..... | 15 |
| 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 | 16 |
| 2.731 | General | 16 |
| 2.74 | Building Envelope | 16 |
| 2.741 | Solar Loading | 16 |
| 2.742 | 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 |
| 2.914 | Biofuels | 18 |
| 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 | Byproduct Use..... | 20 |
| 3.119 | Miscellaneous..... | 20 |
| 3.12 | Waste Stream contamination | 21 |
| 3.121 | Rinsing Strategies..... | 21 |
| 3.122 | Drag-out Reduction..... | 21 |
| 3.129 | Miscellaneous..... | 21 |
| 3.13 | CAD/CAM..... | 21 |
| 3.131 | General | 21 |
| 3.2 | Equipment..... | 22 |
| 3.21 | General..... | 22 |
| 3.211 | Fault Tolerance..... | 22 |
| 3.212 | Painting Operations..... | 22 |
| 3.213 | Process Specific Upgrades | 22 |
| 3.214 | Tank Design | 22 |
| 3.215 | System Monitoring..... | 22 |
| 3.216 | Automation..... | 22 |
| 3.3 | Post Generation Treatment / Minimization | 23 |
| 3.31 | General..... | 23 |
| 3.311 | Neutralization..... | 23 |
| 3.312 | Removal of Contaminants..... | 23 |
| 3.313 | Material Concentration..... | 23 |
| 3.4 | Water Use..... | 24 |
| 3.41 | General..... | 24 |
| 3.411 | Close Cycle Water Use | 24 |
| 3.412 | Water Quality | 24 |
| 3.413 | Water Treatment..... | 24 |
| 3.414 | Reduction | 24 |
| 3.5 | Recycling | 25 |
| 3.51 | Liquid Waste..... | 25 |
| 3.511 | Oil..... | 25 |
| 3.512 | Ink | 25 |
| 3.513 | White Water | 25 |
| 3.519 | Miscellaneous..... | 25 |
| 3.52 | Solid Waste | 25 |
| 3.521 | General | 25 |
| 3.522 | Sand..... | 25 |
| 3.523 | Metals..... | 26 |
| 3.53 | Other MATERIALS..... | 26 |
| 3.531 | General | 26 |

| | | |
|-------|--|----|
| 3.6 | Waste Disposal..... | 26 |
| 3.61 | General..... | 26 |
| 3.611 | Sludge Maintenance | 26 |
| 3.612 | Combustion of Waste Products | 26 |
| 3.619 | Miscellaneous..... | 26 |
| 3.7 | Maintenance..... | 27 |
| 3.71 | Cleaning / Degreasing..... | 27 |
| 3.711 | Mechanical Cleaning..... | 27 |
| 3.712 | Reduction of Cleaning..... | 27 |
| 3.713 | Rag Use | 27 |
| 3.714 | Preventive Maintenance | 27 |
| 3.719 | Miscellaneous..... | 27 |
| 3.72 | Spillage | 28 |
| 3.721 | Operations | 28 |
| 3.722 | Hardware..... | 28 |
| 3.73 | Other | 28 |
| 3.731 | Leak Reduction | 28 |
| 3.739 | Miscellaneous..... | 28 |
| 3.8 | Raw Materials | 29 |
| 3.81 | Solvents..... | 29 |
| 3.811 | Use Reduction | 29 |
| 3.812 | Emission Reduction..... | 29 |
| 3.813 | Material Replacement..... | 29 |
| 3.814 | Solvent Recovery | 29 |
| 3.82 | other solutions..... | 29 |
| 3.821 | Water-Based Substitutes | 29 |
| 3.822 | Other Substitutes | 30 |
| 3.83 | Solids | 30 |
| 3.831 | General | 30 |
| 4. | Direct Productivity Enhancements | 31 |
| 4.1 | MANUFACTURING ENHANCEMENTS | 31 |
| 4.11 | Bottleneck Reduction..... | 31 |
| 4.12 | Defect Reduction | 31 |
| 4.13 | Material Reduction | 31 |
| 4.2 | Purchasing..... | 31 |
| 4.21 | Raw Materials..... | 31 |
| 4.22 | Ancillary Materials | 31 |
| 4.23 | Capital | 31 |
| 4.3 | Inventory | 32 |
| 4.31 | Just in Time | 32 |
| 4.32 | Other Inventory Controls..... | 32 |

| | |
|---------------------------------------|----|
| 4.4 Labor Optimization | 32 |
| 4.41 Practices / Procedures | 32 |
| 4.42 Training | 32 |
| 4.43 Automation | 32 |
| 4.44 Scheduling | 32 |
| 4.45 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..... | 33 |
| 4.7 Management practices | 33 |
| 4.71 Total Quality Management | 33 |
| 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

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, et al.

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 develop 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, etc. 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.

¹Energy 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 & DIRECT 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 WITH STEAM HEAT |
| 2.1125 | CONVERT TO OXYFUEL 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 |

BOILERS (continued)

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 BURNING 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 Fossil 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 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 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

HEAT RECOVERY (continued)

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, OR EXCHANGE HEAT WITH INCOMING 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 AIR WHICH COOLS PIECES FOR SPACE HEATING OR MAKE-UP AIR
- 2.2492 USE EXHAUST HEAT EXCHANGER TO PREHEAT 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 ISOLATE HOT EQUIPMENT FROM REFRIGERATED AREAS
- 2.2524 AVOID UNNECESSARY COOLING / HEATING OF PROCESS OR MATERIALS

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 OUTSIDE AIR FOR FREEZING
- 2.2695 USE HIGHEST TEMPERATURE FOR CHILLING OR COLD STORAGE
- 2.2696 UTILIZE POND OR LAKE AS A HEAT SINK
- 2.2697 USE CASCADE SYSTEM OF RECIRCULATING TO AVOID SUB-COOLING
- 2.2698 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 PEAK DEMAND PERIODS
- 2.3113 MAKE ICE DURING OFF PEAK HOURS FOR COOLING

2.312 Scheduling

- 2.3121 RESCHEDULE PLANT OPERATIONS OR REDUCE LOAD TO AVOID PEAKS
- 2.3122 RECHARGE BATTERIES DURING OFF-PEAK DEMAND PERIODS
- 2.3123 CONSIDER SHORTER WORK WEEK WITH THREE SHIFT OPERATION
- 2.3124 SHIFT FROM DAYTIME TO NIGHTTIME OPERATION
- 2.3125 SCHEDULE ROUTINE MAINTENANCE DURING NON-OPERATING PERIODS
- 2.3126 OVERLAP CUSTODIAL SERVICES WITH NORMAL DAY HOURS
- 2.3127 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
- 2.3323 INSTALL EMISSIONS CONTROLS TO INCREASE CAPACITY

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
- 2.3417 USE WASTE HEAT WITH A CLOSED-CYCLE GAS TURBINE-GENERATOR SET

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 NUISANSE TRIPS
- 2.4113 INSTALL MOTOR VOLTAGE CONTROLLER ON LIGHTLY LOADED MOTORS

2.412 Hardware

- 2.4121 REPLACE OVER-SIZE MOTORS AND PUMPS WITH OPTIMUM SIZE
- 2.4122 SIZE ELECTRIC MOTORS FOR PEAK OPERATING EFFICIENCY
- 2.4123 USE MOST EFFICIENT TYPE OF ELECTRIC MOTORS
- 2.4124 REPLACE ELECTRIC MOTOR WITH FOSSIL FUEL ENGINE

2.413 Motor System Drives

- 2.4131 USE MULTIPLE SPEED MOTORS OR ADJUSTABLE FREQUENCY DRIVE (AFD) FOR VARIALBE PUMP, BLOWER AND COMPRESSOR LOADS
- 2.4132 USE AFD TO REPLACE MOTOR-GENERATOR SET
- 2.4133 USE AFD TO REPLACE THROTTLING SYSTEM
- 2.4134 USE ADF TO REPLACE MECHANICAL DRIVE
- 2.4135 INSTALL ISOLATION TRANFORMER ON AFD

2.414 Motor Maintenance/Repair

- 2.4141 DEVELOP A REPAIR/REPLACE POLICY
- 2.4142 USE ONLY CERTIFIED MOTOR REPAIR SHOPS
- 2.4143 AVOID EMERGENCY REWIND OF MOTORS
- 2.4144 AVOID REWINDING MOTORS MORE THAN TWICE
- 2.4145 STANDARDIZE MOTOR INVENTORY
- 2.4146 ESTABLISH A PREVENTATIVE MAINTENANCE PROGRAM
- 2.4157 ESTABLISH A PREDICTIVE MAINTENANCE PROGRAM

2.42 AIR COMPRESSORS

2.421 Operations

- 2.4211 REDUCE THE PRESSURE OF COMPRESSED AIR TO THE MINIMUM REQUIRED
- 2.4212 ELIMINATE OR REDUCE COMPRESSED AIR USED FOR COOLING, AGITATING LIQUIDS, MOVING PRODUCT, OR DRYING
- 2.4213 ELIMINATE PERMANENTLY THE USE OF COMPRESSED AIR
- 2.4214 COOL COMPRESSOR AIR INTAKE WITH HEAT EXCHANGER
- 2.4215 REMOVE OR CLOSE OFF UNNEEDED COMPRESSED AIR LINES
- 2.4216 ELIMINATE LEAKS IN INERT GAS AND COMPRESSED AIR LINES / VALVES
- 2.4217 SUBSTITUTE COMPRESSED AIR COOLING WITH WATER OR AIR COOLING
- 2.4218 DO NOT USE COMPRESSED AIR FOR PERSONAL COOLING

AIR COMPRESSORS (continued)

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

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 / DUCTS 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 REPLACE SMALLER UNITS WITH FEWER LARGE HIGH EFFICIENCY UNITS
- 2.5197 AVOID ELECTRICALLY-POWERED ANIMATED DISPLAYS

2.6 Operations

2.61 MAINTENANCE

2.611 General

| | |
|--------|--|
| 2.6111 | REDUCE HOT WATER TEMPERATURE TO THE MINIMUM REQUIRED |
| 2.6112 | USE COLD WATER FOR CLEANUP WHENEVER POSSIBLE |
| 2.6113 | ADJUST VENTS TO MINIMIZE ENERGY USE |
| 2.6114 | REMOVE UNNEEDED SERVICE LINES TO ELIMINATE POTENTIAL LEAKS |
| 2.6115 | CALIBRATE THE SENSORS CONTROLLING LOUVERS AND DAMPERS |
| 2.6116 | ESTABLISH EQUIPMENT MAINTENANCE SCHEDULE |
| 2.6117 | KEEP EQUIPMENT CLEAN |
| 2.6118 | KEEP SOLID FUELS / RAW MATERIALS DRY |
| 2.6119 | 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 |
| 2.6226 | MAINTAIN FILTRATION TO MINIMIZE AIR RESISTANCE |

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 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 CLEAN SKYLIGHTS
- 2.7123 DISCONNECT BALLASTS
- 2.7124 KEEP LAMPS AND REFLECTORS CLEAN
- 2.7125 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 INSTALL 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

SPACE CONDITIONING (continued)

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 SPRAY WATER ON AIR CONDITIONER CONDENSER
- 2.7228 DIRECT HOT EXHAUST AIR OUTDOORS IN SUMMER
- 2.7229 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 INSTALL DRY SPRINKLER SYSTEM TO REDUCE HEATING REQUIREMENTS

2.73 VENTILATION

2.731 General

- 2.7311 SHUT OFF VENTILATION SYSTEM WHEN ROOM IS NOT IN USE
- 2.7312 MINIMIZE USE OF OUTSIDE MAKE-UP AIR FOR VENTILATION
- 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

2.741 Solar Loading

- 2.7411 REDUCE GLAZED AREAS IN BUILDINGS
- 2.7412 PLANT TREES OR SHRUBS NEAR WINDOWS TO SHIELD FROM SUNLIGHT
- 2.7413 REDUCE HEAT GAIN BY WINDOW TINTING
- 2.7414 SHADE WINDOWS FROM SUMMER SUN
- 2.7415 CLEAN OR COLOR ROOF TO REDUCE SOLAR LOAD

2.742 Infiltration

- 2.7421 REPLACE BROKEN WINDOWS AND/OR WINDOW SASH
- 2.7422 KEEP DOORS AND WINDOWS SHUT WHEN NOT IN USE
- 2.7423 KEEP LOADING DOCK DOORS CLOSED WHEN NOT IN USE
- 2.7424 INSTALL AIR SEALS AROUND TRUCK LOADING DOCK DOORS
- 2.7425 CLOSE HOLES AND OPENINGS IN BUILDING SUCH AS BROKEN WINDOWS
- 2.7426 INSTALL WEATHER STRIPPING ON WINDOWS AND DOORS
- 2.7427 ELIMINATE UNUSED ROOF OPENINGS
- 2.7428 UTILIZE SENSORS CONTROLLING ROOF AND WALL OPENINGS
- 2.7429 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
- 2.9114 USE SOLAR HEAT TO MAKE ELECTRICITY

2.912 Wind Power

- 2.9121 INSTALL WIND POWERED ELECTRIC GENERATOR

2.913 Hydrogen

- 2.9131 INSTALL HYDROGEN FUEL CELL

2.914 Biofuels

- 2.9141 INSTALL ANAEROBIC DIGESTER

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 TO THE BRIM TO REDUCE CONTACT WITH ATMOSPHERIC OXYGEN
- 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 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 Byproduct Use

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

3.119 Miscellaneous

- 3.1191 CHANGE PROCEDURES / EQUIPMENT / OPERATING CONDITIONS
- 3.1194 REDUCE SCRAP PRODUCTION
- 3.1195 CONVERT FROM BATCH OPERATION TO CONTINUOUS PROCESSING
- 3.1196 USE AUTOMATIC FLOW CONTROL
- 3.1197 USE SILHOUETTE ENTRY COVER TO REDUCE EVAPORATION AREA
- 3.1198 MONITOR SOLUTIONS TO MAINTAIN SOLUTION STRENGTH

3.12 WASTE STREAM CONTAMINATION

3.121 Rinsing Strategies

- 3.1211 USE REACTIVE RINSING
- 3.1212 REDUCE WATER USE WITH COUNTER CURRENT RINSING
- 3.1213 USE FOG NOZZLES / SPRAY RINSING INSTEAD OF IMMERSION RINSING
- 3.1214 MECHANICALLY AND AIR AGITATE RINSE TANKS FOR COMPLETE MIXING
- 3.1215 USE A STILL RINSE AS THE INITIAL RINSING STAGE
- 3.1216 USE COUNTER CURRENT WASHING IN PHOTO PROCESSORS
- 3.1217 USE COUNTER CURRENT RINSING TO REDUCE RINSE WATER VOLUME
- 3.1218 USE REPLACEMENT CHEMICAL TO EXTEND LIFE OF ACID RINSE

3.122 Drag-out Reduction

- 3.1221 SLOW INSERTION / WITHDRAWAL OF PARTS FROM DEGREASING TANK
- 3.1222 ALLOW DRAINAGE BEFORE WITHDRAWING OBJECT
- 3.1223 PRE-INSPECT PARTS TO PREVENT DRAG-IN OF SOLVENTS / CLEANERS
- 3.1224 REDUCE SOLUTION DRAG-OUT TO PREVENT SOLUTION LOSS
- 3.1225 EXTEND SOLUTION LIFE BY MINIMIZING DRAG-IN
- 3.1226 PREVENT SOLUTION DRAG-OUT FROM UPSTREAM TANKS
- 3.1227 REDUCE DRAG-IN WITH BETTER RINSING TO INCREASE SOLUTION LIFE
- 3.1228 LOWER THE CONCENTRATION OF PLATING BATHS
- 3.1229 USE DRAG-OUT REDUCTION METHODS (GRAVURE)-SEE SURFACE COATING
- 3.1220 USE REPLACEMENT CHEMICAL TO REDUCE DRAG-OUT

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
- 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

3.215 System Monitoring

- 3.2151 CLOSELY MONITOR CHEMICAL ADDITIONS TO INCREASE BATH LIFE
- 3.2152 INSTALL WEB BREAK DETECTORS TO PREVENT EXCESSIVE WASTE PAPER
- 3.2153 USE INK WATER RATIO SENSOR

3.216 Automation

- 3.2161 USE ELECTRONIC IMAGING AND LASER PLATE MAKING
- 3.2165 USE AN AUTOMATIC PLATE PROCESSOR
- 3.2162 USE AUTOMATIC CLEANING EQUIPMENT
- 3.2163 CONVERT TO ROBOTIC PAINTING
- 3.2164 AUTOMATE INK KEY SETTING SYSTEM
- 3.2168 AUTOMATE INK MIXING
- 3.2166 USE AUTOMATIC INK LEVELERS
- 3.2167 USE AUTOMATED PLATE BENDERS
- 3.2169 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 RECOVER METALS FROM RINSE WATER 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)

3.412 Water Quality

- 3.4121 MINIMIZE CONTAMINATION OF WATER BEFORE TREATMENT
- 3.4122 USE DEIONIZED WATER IN UPSTREAM RINSE TANKS
- 3.4123 CLEAN FOULING FROM WATER LINES REGULARLY

3.413 Water Treatment

- 3.4131 REPLACE THE CHLORINATION STAGE WITH AN OXYGEN OR OZONE STAGE
- 3.4132 RECYCLE CHLORINATION STAGE PROCESS WATER
- 3.4133 USE WATER FROM THE WASHING SYSTEM IN THE CHLORINATION STAGE
- 3.4134 PERFORM HIGH CONSISTENCY GAS PHASE CHLORINATION
- 3.4135 USE MAGNETIC TECHNOLOGY TO TREAT WATER
- 3.4136 CHANGE METHOD OF DEIONIZED WATER PRODUCTION

3.414 Reduction

- 3.4141 MINIMIZE WATER USAGE
- 3.4142 CAREFULLY CONTROL WATER LEVEL IN MASS FINISHING EQUIPMENT
- 3.4143 USE COUNTER CURRENT RINSING TO REDUCE WASTE WATER
- 3.4144 ELIMINATE LEAKS IN WATER LINES AND VALVES
- 3.4145 METER / QUANTIFY WASTE WATER USE
- 3.4146 USE FLOW CONTROL VALVES ON EQUIPMENT TO OPTIMIZE WATER USE
- 3.4147 MINIMIZE WATER USE IN LAVATORIES WITH APPROPRIATE FIXTURES
- 3.4148 REPLACE WATER COOLING ON PROCESSES WITH AIR COOLING
- 3.4149 USE MINIMUM COOLING WATER TO BEARINGS
- 3.4140 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 |

3.519 Miscellaneous

| | |
|--------|--|
| 3.5191 | RECOVER DYE FROM WASTE WATERS |
| 3.5192 | TREAT AND REUSE EQUIPMENT CLEANING SOLUTIONS |
| 3.5193 | RETURN SPENT SOLUTIONS TO THE MANUFACTURER |
| 3.5194 | RECYCLE SPENT TANNING SOLUTION |
| 3.5195 | RECOVER AND REUSE SPENT ACID BATHS |
| 3.5196 | UTILIZE A CENTRAL COOLANT SYSTEM FOR CLEANING AND REUSE OF METAL WORKING FLUID |
| 3.5197 | CHANGE OUT CLEANING SOLUTION WITH SELF REGENERATING SOLUTION |

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 CASTINGS AND REUSE 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 |

SOLID WASTE (continued)

3.523 Metals

| | |
|--------|---|
| 3.5231 | SELL USED PLATES TO AN ALUMINUM RECYCLER |
| 3.5232 | AVOID CONTAMINATION OF END PIECES AND REUSE AS FEED STOCK |
| 3.5233 | RECOVER METALS FROM SPENT SOLUTIONS AND RECYCLE |
| 3.5234 | RECYCLE PROCESSING BATHS FOR NICKEL RECOVERY |
| 3.5235 | RECYCLE FILM FOR SILVER RECOVERY |
| 3.5236 | RECOVER METALS FROM CASTING SAND |
| 3.5237 | SEPARATE AND RECYCLE SCRAP METAL TO FOUNDRY |
| 3.5238 | SEGREGATE METALS FOR SALE TO A RECYCLER |
| 3.5239 | 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 PALET RECYCLING COMPANY |
| 3.5137 | SELL / OFFER BYPRODUCT AS ANIMAL FEED |
| 3.5138 | RECYCLE FLOURESCENT LAMPS |

3.6 Waste Disposal

3.61 GENERAL

3.611 Sludge Maintenance

| | |
|--------|--|
| 3.6111 | USE ALTERNATIVE FLOCCULANT 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 |

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 (EG 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 ADHESIVE 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 SUBSTITUTE RE-USABLE ABSORBANT
- 3.7199 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 LIDS ON MATERIAL CONTAINERS TO REDUCE VOC EMISSIONS
- 3.8123 INSTALL FLOATING COVERS ON TANKS OF VOLATILE MATERIALS TO REDUCE EVAPORATION
- 3.8124 CLEAN MACHINE ROLLERS IN A CLOSED SOLVENT CLEANER
- 3.8125 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 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

OTHER SOLUTIONS (continued)

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 VOLUME MATERIALS IN RETURNABLE 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 PRODECURES 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

4.41 Practices / Procedures

4.4110 MODIFY CURRENT INCENTIVE PROGRAM
4.4120 UTILIZE OUTSIDE CONTRACTING
4.4130 MOVE PRODUCT USING MECHANICAL MEANS
4.4140 IMPROVE SPACE COMFORT CONDITIONING
4.4150 ELIMINATE / REDUCE REDUNDANT INSPECTIONS
4.4160 MODIFY WORKLOAD

4.42 Training

4.4210 TRAIN OPERATORS FOR MAXIMUM OPERATING EFFICIENCY
4.4220 CROSS-TRAIN PERSONNEL TO AVOID LOST TIME

4.43 Automation

4.4310 INSTALL AUTOMATIC PACKING EQUIPMENT
4.4320 INSTALL MAGAZINES FOR TEMPORARY STORAGE
4.4330 INSTALL AUTOMATIC BOILER FUEL FEED SYSTEM
4.4340 INSTALL SYSTEM TO COLLECT SCRAP
4.4350 INSTALL EQUIPMENT TO MOVE PRODUCT
4.4360 AUTOMATE FINISHING PROCESS
4.4370 AUTOMATE PAYROLL SYSTEM
4.4380 INSTALL AUTOMATIC PART STORAGE / RETREVAL SYSTEM

4.44 Scheduling

4.4410 OPTIMIZE LOT SIZES TO REDUCE INVENTORY CARRYING COSTS
4.4420 ADD ADDITIONAL PRODUCTION SHIFT
4.4430 ELIMINATE SHIFT
4.4440 RESCHEDULE BREAKS TO ALLOW FOR CONTINUIOUS PRODUCTION
4.4450 MODIFY STARTUP / SHUTDOWN TIMES

4.45 Maintenance

4.4510 REMOVE HOT SLAG BEFORE IT HARDENS
4.4520 PROVIDE TRANSPORTATION TO PERSONELL
4.4530 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 AN 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 |
| 4.6130 | ADD STORAGE TO COMPRESSED AIR SYSTEM |

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 UNINTERRUPTABLE 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 |

MANAGEMENT PRACTICES (continued)

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 |