The ARC
Assessment Recommendation Code System for the DOE Industrial Assessment Center Database
Version 10.0
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4.72 Certifications
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4.82 Fees

Application Codes
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.

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

2.2112 Condensate

2.21121 INCREASE AMOUNT OF CONDENSATE RETURNED
2.21122 INSTALL / REPAIR INSULATION ON CONDENSATE LINES
2.21123 INSULATE FEEDWATER TANK
2.21124 INSTALL DE-AERATOR IN PLACE OF CONDENSATE TANK
2.21125 REPLACE BAROMETRIC CONDENSERS WITH SURFACE CONDENSERS
2.21126 LOWER OPERATING PRESSURE OF CONDENSER (STEAM)
2.21127 FLASH CONDENSATE TO PRODUCE LOWER PRESSURE STEAM
2.21128 USE STEAM CONDENSATE FOR HOT WATER SUPPLY (NON-POTABLE)

2.2113 Leaks and Insulation

2.21131 INSULATE STEAM / HOT WATER LINES
2.21132 REPAIR FAULTY INSULATION ON STEAM LINES
2.21133 REPAIR LEAKS IN LINES AND VALVES
2.21134 ELIMINATE LEAKS IN HIGH PRESSURE REDUCING STATIONS
2.21135 REPAIR AND ELIMINATE STEAM LEAKS

2.2114 Distillation

2.21141 OPERATE DISTILLATION COLUMNS EFFICIENTLY
2.21142 UPGRADE DISTILLATION HARDWARE

2.2115 Maintenance

2.21151 CLEAN STEAM COILS IN PROCESSING TANKS
2.21152 MAINTAIN STEAM JETS USED FOR VACUUM SYSTEM
2.21153 CLOSE OFF UNNEEDED STEAM LINES

2.2116 Operations

2.21161 OPTIMIZE OPERATION OF MULTI-STAGE VACUUM STEAM JETS
2.21162 REDUCE EXCESS STEAM BLEEDING
2.21163 USE MINIMUM STEAM OPERATING PRESSURE
2.21164 TURN OFF STEAM TRACING DURING MILDE WEATHER
2.21165 SUBSTITUTE AIR FOR STEAM TO ATOMIZE OIL

2.2119 Miscellaneous

2.21191 SUBSTITUTE HOT PROCESS FLUIDS FOR STEAM
2.21192 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

IAC Assessment Recommendation Code System 10.0  7
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 NUISANCE 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 VARIABLE 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 AFD TO REPLACE MECHANICAL DRIVE
- 2.4135 INSTALL ISOLATION TRANSFORMER 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
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 RINSE 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 BOOTH 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
3.2162 USE AN AUTOMATIC PLATE PROCESSOR
3.2163 USE AUTOMATIC CLEANING EQUIPMENT
3.2164 CONVERT TO ROBOTIC PAINTING
3.2165 AUTOMATE INK KEY SETTING SYSTEM
3.2166 AUTOMATE INK MIXING
3.2167 USE AUTOMATIC INK LEVELERS
3.2168 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, FLOTAION 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
3.4150 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 PALLEY RECYCLING COMPANY
3.5317 SELL / OFFER BYPRODUCT AS ANIMAL FEED
3.5318 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 TEFLO 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
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 CONTINUOUS 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 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:

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