Introduction

Chapters 2 through 16 describe the process equipment available in ICARUS’ systems. The chapters are organized as the equipment appears in the systems:

- Liquid and gas equipment
- Solids handling Equipment
- Off-site and packaged systems.

Process Equipment Categories

ICARUS’ process equipment is divided into the following categories. Each category is assigned an item symbol for identification purposes.

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<th>Description</th>
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List of Process Equipment

The following is a list of process equipment by chapter and category. The process equipment descriptions in chapters 2 through 16 include some of the entry fields for defining process equipment. The descriptions include the minimum and maximum values and the defaults. Default values appear between asterisks (*).

Chapter 2: Agitators

- Agitators (AG)
  - FIXED PROP Fixed propeller gear motor type agitator
  - PORT-PROP Portable propeller agitator
  - DIRECT Portable direct drive agitator
  - GEAR DRIVE Portable gear drive agitator
  - MECH-SEAL Agitator, mechanical seal, variable diameter
  - ANCHOR Fixed mount, gear drive, anchor, stuffing box
  - PULP STOCK Pulp stock agitator

- Agitated Tanks (AT)
  - MIXER Agitated tank - enclosed
  - REACTOR Agitated tank - enclosed, jacketed
  - OPEN TOP Agitated tank - open top
  - FLOCK-CELL Floatation machine
  - COND-CELL Floatation conditioning cell
  - MACH-PULP On machine pulper
  - OFF-MACH Off machine pulper

- Blenders (BL)
  - BLENDER Rotary drum blender
  - ROTARY Rotary double-cone blender

- Kneaders (K)
  - STATIONARY Stationary upright double-arm kneader
  - TILTING Tilting double-arm kneader
  - VAC-TILTING Vacuum tilting double-arm kneader

- Mixers (MX)
  - FIXED PROP Fixed propeller gear motor type mixer
  - PORT-PROP Portable propeller mixer
  - SIGMA Double-arm sigma blade mixer
  - SPIRAL RIB Spiral ribbon mixer
  - EXTRUDER Cylinder type extruder with variable drive
  - MULLER EXT Muller type extruder mixer
  - PAN Pan mixer
  - TWO-ROLL Two-roll mixer
  - STATIC Static mixer
Chapter 3: Compressors

• Air Compressors (AC)
  - CENTRIF-M Centrifugal air compressor with motor
  - CENTRIF-T Centrifugal air compressor with turbine
  - RECIP-GAS Reciprocating air compressor with gas engine
  - RECIP-MOTR Reciprocating air compressor with motor
  - SINGLE 1-S Single reciprocating air compressor - 1 stage
  - SINGLE 2-S Single reciprocating air compressor - 2 stage

• Gas Compressors (GC)
  - CENTRIF Centrifugal compressor - horizontal
  - CENTRIF-IG Centrifugal - integrated gear
  - RECIP-GAS Reciprocating compressor - integral gas engine
  - RECIP-MOTR Reciprocating compressor

• Fans, Blowers (FN)
  - PROPELLER Propeller fan
  - VANEAXIAL Vaneaxial fan
  - CENTRIF Centrifugal fan
  - ROT-BLOWER General purpose blower
  - CENT-TURBO Heavy duty, low noise blower

Chapter 4: Drivers

• Electrical Motors (MOT)
  - OPEN Open drip-proof induction motor
  - SYNCHRON Synchronous motor
  - ENCLOSED Totally enclosed induction motor
  - EXP-PROOF Explosion-proof (Class I Division I, hazardous)
  - VARY-SPEED TEFC motor with variable speed drive

• Turbines (TUR)
  - GAS Gas turbine with combustion chamber
  - CONDENSING Steam turbine driver, condensing type
  - NON-COND Steam turbine driver, non-condensing
Chapter 5: Heat Transfer

- **Heat Exchangers (HE)**
  - FLOAT-HEAD  Floating head shell and tube exchanger
  - FIXED-T-S  Fixed tube sheet shell and tube exchanger
  - AIR COOLER  Air cooling, free standing or rack-mounted
  - U-TUBE  U-tube shell and tube exchanger
  - PRE-ENGR  Pre-engineered (standard) U-tube exchanger
  - CROSS BORE  Cross-bore (all graphite) heat exchanger
  - SHELL+TUBE  Graphite tube/CS shell heat exchanger
  - FIN TUBE  Finned double pipe heat exchanger
  - HEATER-STM  Bare pipe immersion coil-heating/cooling
  - SUC-HEATER  Tank suction
  - HEATER-ELC  Electric immersion tank heater
  - JACKETED  Double pipe heat exchanger
  - SPIRAL PLT  Spiral plate heat exchanger
  - ONE SCREW  Thermascrew (Reitz) single screw conveyor
  - TWO SCREW  Twin screw agitated/jacketed heat exchanger
  - WASTE HEAT  Waste heat boiler
  - PLAT+FRAM  Plate and frame heat exchanger

- **Reboilers (RB)**
  - KETTLE  Kettle type reboiler with floating head
  - U-TUBE  U-tube kettle type reboiler
  - THERMOSIPH  Thermosiphon type reboiler

- **Furnaces, Project Heaters (FU)**
  - HEATER  A-frame type process furnace
  - BOX  Box type process furnace
  - PYROLYSIS  Pyrolysis unit
  - REFORMER  Box type reformer, without catalyst
  - VERTICAL  Vertical cylindrical process furnace

Chapter 6: Packing, Linings

- **Packing, Linings (PAK, LIN)**
  - PACKING  Packing, variety of vessel packings
  - ACID BRICK  Acid brick lining
  - MONOLITHIC  Castable, refractory or gunned mix
  - OTHER  Lining - other than acid brick, monolithic
Chapter 7: Pumps

- Centrifugal Pumps (CP)
  - API 610 API 610 pump (single or multi-stage)
  - ANSI Standard ANSI single stage pump
  - ANSI PLAST Plastic ANSI single stage pump
  - GEN-SERV General service pump
  - CENTRIF Centrifugal single or multi-stage pump
  - AXIAL FLOW Axial flow vertical pump
  - TURBINE Vertical sump pump - turbine impeller
  - API 610-IL API 610 in line pump
  - IN LINE General service in line pump
  - PULP STOCK Low consistency stock pump
  - MAG DRIVE Standard ANSI magnetic drive pump
  - CANNED Canned motor pump

- Gear Pumps (GP)
  - GEAR Standard external gear rotary pump
  - CANNED RTR Canned rotary gear pump
  - MECH-SEAL Mechanical seal gear pump

- Piston, Other Positive Displacement Pumps (P)
  - SIMPLEX Reciprocating simplex pump - steam driver
  - DUPLEX Reciprocating duplex pump - steam driver
  - TRIPLEX Triplex (plunger) pump - motor driver
  - DIAPHRAGM Diaphragm pump - TFE type
  - SLURRY Slurry pump
  - ROTARY Rotary (sliding vanes) pump
  - RECIP-MOTR Reciprocating positive displacement plunger pump
  - HD STOCK High density stock pump

Chapter 8: Towers, Columns

- Double Diameter Towers (DDT)
  - PACKED Packed double-diameter tower
  - TRAYED Trayed double-diameter tower

- Single Diameter Towers (TW)
  - PACKED Packed tower
  - TRAYED Trayed tower
  - TRAY STACK Tray stack for tray tower
  - DC HE TW Direct contact heat exchanger tower
  - TS ADSORB Dual vessel temperature swing adsorber
Chapter 9: Vacuum Systems

- Condensers (C)
  - BAROMETRIC  Barometric condenser

- Ejectors (EJ)
  - SINGLE STG  One stage ejector non-condensing
  - TWO STAGE  Two stage ejector with one condenser
  - 2 STAGE  Two stage ejector non-condensing
  - 4 STAGE B  Four stage ejector with two condensers
  - 4 STAGE  Four stage ejector with one condenser
  - 5 STAGE B  Five stage ejector with one condenser

- Vacuum Pumps (VP)
  - WATER-SEAL  Water-sealed vacuum pump
  - MECHANICAL  Mechanical oil-sealed vacuum pump
  - MECH-BOOST  Mechanical booster vacuum pump

Chapter 10: Vessels

- Horizontal Tanks (HT)
  - MULTI WALL  Multi-wall horizontal drum
  - HORIZ-DRUM  Horizontal drum
  - JACKETED  Jacketed horizontal drum

- Vertical Tanks (VT)
  - CYLINDER  Vertical process vessel
  - MULTI WALL  Multi-wall vertical process vessel
  - JACKETED  Jacketed vertical process vessel
  - SPHERE  Sphere - pressure or vacuum storage
  - SPHEROID  Spheroid - pressure or vacuum storage
  - STORAGE  Flat bottom storage tank, optional roof
  - CRYOGENIC  Cryogenic storage tank
  - PLAST TANK  Plastic storage tank (FRP or Haveg)
  - WOOD TANK  Wooden storage tank
  - GAS HOLDER  Low pressure gas storage vessel
  - CONE BTM  Cone bottom storage bin
  - LIVE BTM  Live bottom storage bin
  - CHEST-REC  Rectangular concrete tile chest
  - CHEST-CYL  Cylindrical concrete tile chest
  - CHEST-MTL  Metal tile chest
Chapter 11: Crushers, Mills and Stock Treatment

- **Crushers (CR)**
  - CONE: Cone crusher - secondary crushing
  - GYRATORY: Gyratory - primary and secondary crushing
  - ECCENTRIC: Overhead eccentric jaw crusher
  - JAW: Swing jaw crusher
  - ROTARY: Rotary crusher
  - S-ROLL-LT: Single roll crusher - light duty
  - S-ROLL-MED: Single roll crusher - medium duty
  - S-ROLL-HVY: Single roll crusher - heavy duty
  - SAWTOOTH: Sawtooth roller crusher
  - REV-HAMR: Reversible hammermill
  - HAMMER-MED: Non-reversible hammermill, medium hard material
  - SWING-HAMR: Non-reversible hammermill, hard material
  - BRADFORD: Bradford (rotary) breaker
  - S-IMPACT: Single rotor impact breaker
  - PULVERIZER: Pulverizer - crushing soft material
  - ROLL RING: Ring granulator

- **Flakers (FL)**
  - DRUM: Rotary drum flaker

- **Mills (M)**
  - ATTRITION: Attrition mill
  - AUTOGEOUS: Autogenous mill
  - BALL MILL: Ball mill with initial ball charge
  - ROD MILL: Rod mill with initial rod charge
  - MIKRO-PULV: Mikro-pulverizer
  - ROLLER: Roller mill
  - ROD-CHARGR: Rod charger for rod mill

- **Stock Treatment (ST)**
  - REFINER: Double disk refiner
  - DEFLAKE-DK: Plate or tackle type deflaker
  - DEFLAKE-CN: Conical type deflaker

Chapter 12: Drying Systems

- **Crystallizers (CRY)**
  - BATCH VAC: Batch vacuum crystallizer
  - MECHANICAL: Mechanical scraped-surface crystallizer
  - OSLO: Oslo growth type crystallizer

- **Evaporators (E)**
  - FALL-FILM: Agitated falling film evaporator
  - FORCED CIR: Forced circulation evaporator
  - LONG TUBE: Long tube rising film evaporator
  - LONG-VERT: Long tube vertical evaporator
  - STAND-VERT: Standard vertical tube evaporator
  - STAND-HOR: Standard horizontal tube evaporator

- **Wiped Film Evaporators (WFE)**
  - THIN FILM: Agitated thin film evaporator
  - WFE-SYSTEM: Agitated thin film evaporator - package system
• Air Dryers (AD)
  - AIR DRYER Dual tower desiccant air dryer

• Dryers (D)
  - ATMOS-TRAY Atmospheric tray batch dryer
  - VAC-TRAY Vacuum tray batch dryer
  - PAN Agitated pan batch dryer
  - SPRAY Continuous spray drying system

• Drum Dryers (DD)
  - SINGLE ATM Single atmospheric drum dryer
  - DOUBLE ATM Double atmospheric drum dryer
  - SINGLE VAC Single vacuum rotary drum dryer

• Rotary Dryers (RD)
  - DIRECT Direct rotary dryer
  - INDIRECT Indirect rotary dryer
  - JAC-VACUUM Jacketed rotary vacuum dryer
  - VACUUM Conical rotary vacuum dryer

• Tray Drying Systems (TDS)
  - ATM-SYSTEM Atmospheric tray dryer
  - VACUUM Vacuum tray dryer
  - TURBO Turbo tray drying system
  - VAC-SYSTEM Vacuum tray dryer with condenser

Chapter 13: Solids Conveying

• Conveyors (CO)
  - OPEN BELT Belt conveyor - open
  - CLOSED-BLT Belt conveyor - covered
  - APRON Apron conveyor - pans on endless chain
  - PNEUMATIC Pneumatic conveying system
  - ROLLER Roller conveyor (non-motorized)
  - SCREW Screw conveyor in a U-shaped trough
  - VIBRATING Vibrating conveyor with inclined trough
  - CENT-BKT-L Elevator-spaced bucket
  - CONT-BKT-L Elevator-continuous bucket

• Cranes (CE)
  - BRIDGE-CRN Traveling bridge crane
  - HOIST Hoist with track beam

• Elevators, Lifts (EL)
  - FREIGHT Freight elevator
  - PASSENGER Passenger elevator

• Feeders (FE)
  - BELT Volumetric belt feeder
  - BIN-ACTVTR Bin activator
  - ROTARY Rotary feeder
  - VIBRATING Vibrating feeder
  - WT-LOSS Loss-in-weight feeder
Chapter 1: Introduction to Process Equipment

• Hoists (HO)
  - HOIST 5-speed electric hoist - motorized trolley
  - 1 SPEED 1-speed electric hoist - no trolley
  - 5 SPEED 5-speed electric hoist - no trolley
  - HAND GT Hand hoist - manual pull chain trolley
  - HAND PT Hand hoist - manual trolley
  - HAND NT Hand hoist - no trolley

• Scales (S)
  - BEAM SCALE Beam scale
  - BELT Conveyor belt scale
  - BENCH Bench scale - dial and beam
  - FULL-FRAME Full floor scale - dial and beam
  - SEMI-FRAME Semi frame floor scale - dial and beam
  - TANK SCALE Tank scale - weigh bridge and saddles
  - TRACK Track scale for rail cars
  - TRUCK Truck (lorry) scale

Chapter 14: Separation Equipment

• Centrifuges (CT)
  - ATM SUSPEN Atmospheric suspended basket centrifuge
  - BATCH-AUTO Auto batch filtering centrifuge
  - BATCH-BOTM Batch bottom - suspended centrifuge
  - TOP UNLOAD Batch top unload centrifuge
  - BOT-UNLOAD Batch bottom unload centrifuge
  - BATCH-TOP Batch top-suspended centrifuge
  - DISK High-speed disk centrifuge
  - RECIP-CONV Reciprocating conveyor centrifuge
  - SCROLL-CON Scroll conveyor centrifuge
  - SOLID BOWL Solid bowl centrifuge
  - SCREEN-BWL Screen bowl centrifuge
  - TUBULAR High-speed tubular centrifuge
  - VIBRATORY Vibrating screen centrifuge
  - INVERTING Inverting filter centrifuge

• Dust Collectors (DC)
  - CENTRF-PRE Centrifugal precipitator
  - CLOTH BAY Baghouse with motor shakers
  - CYCLONE Cyclone dust collector
  - MULT-CYCLO Multiple cyclone dust collector
  - ELC-H-VOLT High voltage electrical precipitator
  - ELC-L-VOLT Low voltage electrical precipitator
  - WASHERS Washer dust collector
  - PULSE SHKR Baghouse with injected pulsed air
• Filters (F)
  - CARTRIDGE: Cartridge filter (5 micron cotton)
  - LEAF-DRY: Pressure leaf-dry filter
  - LEAF-WET: Pressure leaf-wet filter
  - PLATE+FRAM: Plate and frame filter
  - ROTY-DISK: Rotary disk filter
  - ROTY-DRUM: Rotary drum filter
  - SEWAGE: Sewage filter
  - SPARKLER: Sparkler filter
  - TUBULAR: Tubular fabric filter (bank of 3)
  - SCROLL: Scroll discharge centrifugal filter
  - WHITESTOCK: White water filter - centrifugal screen

• Separation Equipment (SE)
  - WATER-CYCL: Water-only cyclone - mineral separation
  - OIL-WATER: Oil-water separator - API type
  - PULP STOCK: Pulp stock centrifugal cleaner

• Thickeners (T)
  - THICKENER: Thickener/clarifier

• Screens (VS)
  - ONE DECK: Single deck rectangular vibrating screen
  - TWO DECK: Double deck rectangular vibrating screen
  - THREE DECK: Triple deck rectangular vibrating screen
  - HUMMER: Hummer type screen for fine separation
  - SIFTER-1: Single deck circular vibrating screen
  - SIFTER-2: Double deck circular vibrating screen
  - SIFTER-3: Triple deck circular vibrating screen
  - PRESSURE: Pressure screen
  - LD STOCK: Low consistency stock pump
  - BAR: Mechanical bar screen

Chapter 15: Utility Service Systems

• Cooling Towers (CTW)
  - COOLING: Cooling tower, less pumps, field assembly
  - COOLING-WP: Cooling tower, complete, field assembly
  - PACKAGED: Packaged cooling tower, factory assembly

• Steam Boilers (STB)
  - BOILER: Packaged boiler unit
  - STM BOILER: Field erected boiler unit

• Heating Units (HU)
  - CYLINDER: Process heater type dowtherm unit

• Refrigeration Units (RU)
  - CENT-COMPR: Centrifugal compression refrigeration unit
  - MECHANICAL: Mechanical compression refrigeration unit

• Electrical Generators (EG)
  - PORTABLE: Portable electrical generator - diesel
  - TURBO-GEN: Electrical generator - steam turbine drive
• Water Treatment Systems (WTS)
  - DEMINERAL Two stage ion exchange water treatment
  - SOFTENING Hot lime, zeolite water treatment system
  - AERATOR Surface aerator

Chapter 16: Flares and Stacks

• Flares (FLR)
  - DERRICK Derrick-supported flare stack
  - GUYED Guyed flare stack
  - SELF-SUPP Self-supported flare stack
  - HORIZONTAL Horizontal ground flare
  - THRMOVX LC Recuperative thermal oxidizer
  - STORAGE Vapor control flare for storage/loading

• Stacks (STK)
  - STACK Stack without flare tip