SUBJECT **CHILLER PLANT, UTILITY ANNEX, LC-39, KSC**

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PURPOSE

This instruction establishes the operating instructions for startup, operation, and shutdown of the refrigeration plant, including the cooling tower, chiller system, control and monitor panels at the Utility Annex, LC-39, KSC. This process is documented per the Base Operations and Spaceport Services (BOSS) Performance Work Statement (PWS) section 3.2.4.2.1

SCOPE AND APPLICABILITY

This instruction applies to BOSS FSEU HVAC personnel certified for and assigned to Chiller Plant operation at the Utility Annex, K6-0947.

PROCESS

1. CHILLER PLANT OVERVIEW

1.1. Description

The Utility Annex Chiller Plant provides chilled water at a nominal temperature of 42 degrees F for air conditioning at the VAB, LCC, OPF1, OPF 2, OPF 3, TPSF, PCC, OSB-I, VABR, LES, MFF, OSB-II, K6-1246, K6-1446K, Logistics and CRCA facilities.

1.2. Location

The Chiller Plant, building K6-0947, is located adjacent to K6-0848, the VAB, in the LC-39 area of KSC.

1.3. Specifications

The Utility Annex Chiller Plant houses five centrifugal 2,500-ton YORK water chillers with Chiller 4 equipped with an additional 846 HP compressor (Chiller 4.5) piped in parallel to provide a 1100-ton cooling capacity option when needed. Chillers 1 & 5 utilize solid-state reduced voltage motor starters (Soft-Starters) to reduce motor inrush current to a level that will permit starting on emergency generator power. Note: Chillers 1, 5, 4.5 are available. Chiller 3 is inoperable. Chillers 2 and 4 are not electrically connected.

The pumping system consists of five 75 HP centrifugal pumps available for primary water loop circulation through the chillers and four 150 HP variable speed pumps to provide the requisite flow to the campus loop. Providing condenser water to the water-cooled chillers is a four-cell concrete cooling tower with four 300 HP vertical turbine pumps rated at 7500 gpm each. The tower stacks contain 24 foot diameter, 6-blade fans driven by 100 HP motors through double-reduction right angle gearboxes to a final speed of approximately 135 RPM.

2. SAFETY INFORMATION

2.1. **Specific Hazards**

2.1.1. OPERATIONAL HAZARDS

- High noise level during chiller operation [hearing protection required per SHP-P-0095 (Noise and Hearing Conservation) when chillers are operating].

2.1.2. PERSONAL HAZARDS

- Loud noise.
- Dropped or falling heavy objects.
- Overhead falling debris or bumping hazards.
- Rotating machinery.

2.2. **Safety Equipment**

2.2.1. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personnel performing the operation shall wear the following PPE as indicated:

- Hearing Protection (ear muffs, ear plugs, or both as required) - any time the noise level is anticipated to be at or above 82 dB, or any time noise levels preclude normal conversational speech thereby requiring personnel to shout, or becomes objectionable to an individual, or any time high pressure gas above 150 psi is vented to atmosphere.
- Footwear - low-heeled, closed toe, nonporous shoes made of leather or equivalent, with soles heavy enough and of appropriate composition to provide adequate foot protection in accordance with all commodity material safety data sheets (MSDS) and work environment. Safety toe shoes are recommended for all operations and are required for all operations where a hazard to the feet may exist from falling or dropped heavy objects.
- Eye/Face protection – goggles and face shield, chemical resistant - during operations involving acids, caustics, or other corrosive fluids.
- Hardhat with chin strap - any time there is a hazard to the head from falling debris, such as when a task is being performed with an overhead, open-type structure above the work area or the work area is congested with bumping hazards. The chin strap is required to be used when working on elevated surfaces.
- Body harness and lanyard - required for all identified fall hazards.
- Gloves, chemical, rubber or neoprene - when handling dangerous chemicals.
- When not operating, personnel shall wear personal protective equipment (PPE) as directed by supervision.

2.2.2. NON-PERSONAL PROTECTIVE EQUIPMENT

- Eyewash
- Safety shower

CAUTION: *When performing duties involving the handling of, or possible exposure to, strong chemicals such as bromine or battery acid ensure the above equipment is present nearby and operational. If not available, notify supervision before proceeding with the operation.*

- Fire extinguisher – 12 locations throughout the plant

3. SUPPORT REQUIREMENTS

3.1. Operating Personnel

NOTE: *Supervision will ensure that personnel are properly trained and qualified. Ensure HVAC technicians are certified in the handling of refrigerants to the EPA section 608 standards for Universal Certification category. Supervision is responsible for the safety of both personnel and equipment and shall ensure operations are performed safely according to approved procedures.*

- A/C Mechanic/Operator - 1

3.2. Operating Equipment And Materials

- Tools, Air Conditioning, Mechanic
- Tools And Test Equipment, Electrician
- Daily log – Chillers, KSC form 26-181
- Laptop Computer
- Cloths, Wiping

3.3. Operating Organization Instructions

- For routine nonhazardous industrial operations, verify a pre-operations briefing has been given at least once per shift by supervision or designated personnel that discusses objectives of tasks to be performed, safety aspects of each, potential hazards, outages and lockout/tagout requirements, communication means/interfaces, and contingency responses.
- A pre-operations briefing and walk down shall be conducted prior to commencement of launch support activity and during non-launch periods if more than one performing organization is required to work simultaneously at a job site on the same system. Documentation of the briefing is not required.
- Personnel performing this instruction shall ensure that system and component cleanliness is maintained at all times during the performance of this instruction.
- A safety representative is not required for safety surveillance of this operation.

- Report equipment/system failures or anomalies according to SMA-P-0016 (Event and Near Miss Reporting).
- Measuring and monitoring devices used to demonstrate conformance of products and/or service to specified requirements shall be in current calibration.

4. OPERATIONS INSTRUCTIONS

4.1. Plant Configuration

- Water Chillers - One, Two or Three Chillers as required by heat load

NOTE: *Because SS-829 is now a single-ended lineup, when THREE chiller operation is requested console operators will be carefully monitoring feeder current for overload condition and may request load shedding or deny a third chiller start altogether.*

- Primary Chilled Water Pumps - two pumps for first operating chiller, and one additional pump for each chiller brought on line, or as required.
- Secondary Chilled Water Pumps - two or three pumps (as required)
- Condenser Water Pumps - one, two, or three (as required)
- Cooling Tower Fans - one through four fans automatically cycled as required by the heat load
- Chilled Water Make-Up Pumps - one jockey and two main
- Pumps automatically cycled on pressure control.

4.2. Notifications

- Before starting any chiller, the Utility Annex plant operator or supervisor shall contact the HVAC Console (JBAC).
- Notification of users of the OPFs, VAB and LCC is required if a significant change in load, plant capacity, plant configuration, or developing anomalies occur.

4.3. General Warnings

- Verify no electrical storm is within five miles of an electrical switching operation in an outside or unprotected area. When lightning protection plan (LPP), Phase II, is initiated during an operation, stop operation and seek shelter immediately until the LPP has been terminated.
- Hearing protection must be worn any time the noise level is anticipated to be at or above 85 dB, or any time noise levels preclude normal conversational speech thereby requiring personnel to shout, or becomes objectionable to an individual.
- Poor housekeeping sets the stage for accidents and fire. Keep operational areas free of litter, debris, solvents, oils, and other combustibles that may become accident or fire hazards.
- When working at heights with inadequate safeguards against falling, wear approved body harness with lanyard attached to an approved attachment point/anchoring device (handrail is not an acceptable attachment point).

- Before servicing or doing maintenance on machines, equipment, or pressurized systems where release of stored energy or unexpected startup of the machines or equipment could cause injury to you or other employees, perform lockout/tagout per SHP-P-0147 [Hazardous Energy Control (Lockout/Tagout)].

5. PLANT STARTUP AFTER AN EXTENDED OUTAGE

5.1. Cooling Tower Startup Preparations

- Verify electrical insulation resistance test (5 Megohms minimum) has been performed on condenser water pump motors (4160V) following cell/tower outage.
- Verify electrical insulation resistance test (1 Megohm minimum) has been performed on the cooling tower fan motors (460V) determined to have been idle in excess of 120 hours.
- Verify cooling tower basins contain required amount of water, headers are filled, and any trapped air is exhausted. Verify that the sluice gates are open between cells 1-4.
- Verify automatic fill valve operation via manipulating the level sensing floats.
- Verify valves on discharge side of condenser water pumps are open.
- Open return header valves on cells to be placed into operation.
- At SS829 A/B, verify that the starter of the condenser pump(s) to be operated is racked in and the green "ready" light is illuminated.
- On cooling tower fans to be operated, verify "Hand-Off-Auto" switches (on MCCs 1-4) are in the "Auto" position, and circuit breakers are in the "ON" position.
- Verify oil level is within tolerance on condenser pump motors and fan gear boxes to be operated.
- Verify condenser water overpressure switches (located at the Northwest corner of the Utility Annex equipment room) are closed.
- During cold weather operation, verify that the cooling tower bypass control system is functional by observing bypass valve flow (valve will start opening below 78 degrees F; full open at 74 degrees F).
- Verify bypass - valve controller operation/position on the pneumatic indicator gauge (located on the control room console module 4). At +3 psi, the valve begins to open; at +15 psi, the valve is full open.

5.2. Establishing Control Power

- On lighting panel "E" (at southwest corner of caged area under the mezzanine), verify CB-5 and CB-7 are on.
- On power panel "BPP" (located in the center aisle of chiller equipment room), verify CB-37/39 is on and that the electrical disconnect located directly behind "BPP" is on.

- In the control room behind module #2, locate double-throw disconnect and verify that it is positioned to select power from either panel "E" CB-5 or panel "BPP" CB-37.
- Locate mini load center next to the double-throw disconnect and verify that all circuit breakers are on.
- In control room on south wall, verify that control console "UPS" unit selector switches are set to "ON" and "UPS".

5.3. Chilled Water Makeup System Preparation

- At MCC3, cubicle B2 (CHW M/U Pump 1):
  - Verify circuit breaker is on.
  - Verify "Hand-Off-Auto" switch is in the "Auto" position.
- At MCC1, cubicle A4 (CHW M/U Pump 2):
  - Verify circuit breaker is on.
  - Verify "Hand-Off-Auto" switch is in the "Auto" position.
  - Position Lead-Lag pump selector switch to pump 2 or 3.
- At MCC1, cubicle B5 (CHW M/U pump 3):
  - Verify circuit breaker is on.
  - Verify "Hand-Off-Auto" switch is in "Auto" position.
- Verify the expansion tank is valved into the main chilled water loop.
- Verify that individual makeup pump valves are open.
- At the chilled water makeup pumps (Northwest corner of Utility Annex equipment room), verify manual disconnect switches above the pumps are in "Up" or "On" position for all three makeup pumps.
- Verify that the bypass switch on the new makeup control panel is in the "Auto" position.
- Verify makeup pump control system is reset.
- Verify pressure on the chilled water expansion tank is between 105-110 psi. Gradually adjust the GN2 regulator as required to obtain the proper reading. During recovery from a total outage, coordinate expansion tank fill and GN2 pressurization. Excess nitrogen pressure can be relieved through a ball valve behind tank to outside.
- At the chilled water expansion tank, verify water level in sight glass is indicating mid-level.

5.4. Chilled Water Primary Pump Startup Preparations

- Verify valves on all suction and discharge of Primary pumps are open.
- Verify 12" common Primary pump header valves are all open.
- For the Primary chilled water pump to be operated, verify breaker is racked "In" and that the disconnect/starter ready light is on. Verify selector switch on starter is in the "On" position.

5.5. Chilled Water Secondary Pump Startup Preparations

- Verify valves on all suction and discharge of Secondary pumps are open.
- In the "VFD room 1028A", verify power indications on pump controllers.
- Verify selector switch on Secondary pump controller is in the "VFD" position.

5.6. Chillers 1 & 5 Startup Preparations

NOTE: *Each chiller control panel is equipped with an uninterruptible power source (UPS) to preclude chillers from tripping off-line during brief interruptions in the 480 VAC distribution system. These units are capable of supplying the necessary control voltage for the chiller units for several minutes.*

- If for any reason it becomes necessary to secure the chiller control power, proceed as follows:
  - Secure CB2 (the lower of the two circuit breakers located in the left hand compartment of the chiller control panel).
  - Secure the "UPS" units per manufacturer's instruction.
  - Verify all indicating lamps and the fluorescent panel lighting have extinguished along with all the led indicators.
  - If required, secure CB6 (the upper of the two circuit breakers located in the left hand chiller panel compartment). This breaker provides the power for the oil sump heaters and the pre-lube pump motor.

- To restore chiller control power, proceed as follows:
  - Turn CB2 back on (bottom breaker).
  - Reactivate the "UPS" unit per manufacturer's instructions.
  - Turn CB6 back on (top breaker).

CAUTION: *480 Volt ac 3-Phase power must be provided to the input of the 3-position transfer switches and the step-down transformers located to the rear of the chiller control panel and be available to CB6 at least 24 hours prior to starting the chillers so that oil heaters can bring the oil temperature up to the minimum setpoint of 115º f and maintain it within this limit.*

- At the selected chiller:

NOTE: *At this time soft start and across-the-line functionality is unknown. Seek engineering guidance.*

NOTE: *Chillers 1 and 5 are equipped with medium-voltage soft-starters. Normally these chillers shall be operated in "Soft-Start" mode. This will require the mode selector switch in the "Motortronics soft-starter" cabinet (in the West electrical room) to be in the "S/S" position. In this mode, the chiller motor will require approximately fifteen (15) seconds for synchronization and commencement of loading. For across-the-line starting, the "Motortronics" mode selector switch shall be placed into the "ATL" position and the motor will synchronize in approximately 3-4 seconds, and may then be loaded.*

  - Verify control power disconnect transfer switch arm (located behind each chiller control panel) is either in primary (bottom) or emergency (top) position.
  - Verify circuit breakers CB2 and CB6 (for Chiller 5; CB2, CB5, and CB6), located in the left hand compartment of the chiller control panel, are in the "On" position.
  - Verify hot gas bypass valve is closed.
  - Verify oil level is visible in speed increaser sight glass and compressor sump.
  - Verify manual CHW cooling line valves to gear box and compressor oil cooler are open.
  - Verify oil levels are visible in sight glasses for motor drive end bearing and motor exciter end bearing.
- At selected chiller control panel:
  - Verify that the CONTROL POWER and STOP indicating lamps are illuminated.
  - Verify chilled water setpoint thumbwheel switch is set to 42 degrees.
  - Verify vane selector switch is set to "Manual".
  - Set manual vane pressure to 4 psig via the manual pneumatic regulator as indicated by the manual gauge located above the regulator.
  - Verify Auxiliary oil pump selector switch is set to "Auto" (New Step
  - On Chiller #5 verify Gearbox oil pump selector switch is set to "Auto").
  - Verify compressor oil temperature is greater than 115 degrees F.
- Inside left hand compartment of chiller control panel:
  - Verify only green lights are illuminated on PLC processor.
  - Verify the PLC output cards' swing arms are in the "Up" position and mated with the cards.

5.7. Pneumatic control system

- Verify GN2 pressure is 175 to 200 pounds per square inch gauge (psig) via LED indicator on control room console, Module 4, upper panel.

5.8. Verification Of Secondary Control Set Points In PLC

- The system set points are dynamic entities and will not be fixed by this document. The set points will be adjusted by the system engineers as operational requirements change. (The Secondary chilled water pumps in the "Auto" mode respond to the lowest differential pressure in the four monitored facilities, and the VFDs are modulated accordingly.)

6. CHILLER STARTUP

6.1. Cooling Tower

- Select cooling tower cells to be operated. Verify discharge and return valves are open. Ensure that the pneumatically-operated return valve is also open. Verify the isolation sluice gates are open between cells 1-4.
- On control room console, Module 5, position cooling tower fan switches for selected cells to "On".

***NOTE**: The fan switch made be run in "Auto" position if the condenser water pump on that cell is also running. The "Auto" position will allow the fan to cycle in response to changes in the temperature of the condenser supply water at predetermined setpoints.*

CAUTION: *Ensure condenser water system is free of air. Verify automatic air vent valves located at high points in the condenser water piping are operating as water is circulated through the chiller condenser.*

6.2. Selected Chiller:

- Verify chain-operated isolation valve on Condenser water return line is open.
- Verify chain-operated isolation valve on Chilled water supply is opened.

***NOTE**: Chillers 1 and 2 share a common chain-operated valve upstream of the primary pumps. Chillers 3 and 4 also share a common chain-operated isolation valve upstream of the primary pumps. Chiller 5 has a dedicated Chilled water chain-operated valve located downstream of the chiller.*

- On the control room console, Module 5, position "Control power on-off" switch for the selected chiller to "On".
- Open chiller Condenser water control valve as follows:
  - Chiller 4.5 and 5: In the West blue master local control panel (MLCP), facing the transfer isle, place the selected chiller's condenser pneumatic control valve to the "Open" position.
  - Chiller 1 On the East blue pneumatic control panel, turn the selected chiller's Condenser water control switch to the "Open" position. (It will return to the center position when released).
- On the East blue pneumatic control panel, turn the selected chiller valve control potentiometers fully clockwise to provide chilled water flow through the selected chiller. When Primary pumps are operating flow rate will be displayed on LED above dial (typically 5000-6500 gpm for Chillers 1, 2 and 4; for Chiller 5: 6000-7500 gpm as needed).

6.3. **Start Pumps**

- On the Primary/Secondary pump controller cabinet, perform the following:
  - Turn on secondary pumps per section 7.0 and operate in Automatic mode. Verify pump operation via cabinet indicating lights.
  - For the selected Primary chilled water pumps, turn the "On/Off" switch to "On" and verify pump operation via control panel indicating lights.
- Start the selected Condenser pumps by placing the "Off/On" selector switches on the control console to "On" and momentarily pressing and holding the "Start" buttons until the green "Run" indicating lamps are illuminated.

6.4. **Start Chiller (1 or 5)**

6.4.1. Notify the HVAC Console (JBAC) of intent to start chiller.

6.4.2. On the control room console, Module 5, place the 4160 enable "Off-On" switch for the selected chiller to the "On" position.

6.4.3. At the chiller control cabinet:

- Verify the following lights are illuminated:
  - Chilled Water Flow
  - Ready
  - Control Power
  - Stop
- If "Emergency Stop" or "Anti-recycle" light is illuminated, push the respective reset button to extinguish lights.
- Ensure the following:
  - Auxiliary oil pump switch is in the "Auto" position.
  - Vane selector switch is in the "Manual" position.
  - Maximum vane pressure is 4 psig.
  - Chiller 5 gearbox oil pump “Auto” Depress chiller Start button.

***NOTE**: Within 30 seconds of start initiation, the chiller drive motor will go into rotation and synchronization.*

NOTE: Chiller 5 may be different. Seek engineering direction

- Following synchronization, manually load chiller to 165 amps.
- On the chiller control panel, verify:
  - The auxiliary oil pump indicator lamp is illuminated (the lamp will extinguish after 100 seconds).
  - "Stop" indication lamp is extinguished and the "Run" indication lamp is illuminated.

- Compressor oil pressure is greater than 60 psig.
- "Chilled Water Flow" lamp remains illuminated.

***NOTE**: With 3 chiller operation, always operate a minimum of 2 condenser water pumps.*

- Once the "Manual" and "Auto" vane pressure indicating gauges are within reasonable balance, and the CHWS temperature is within +/- 1.5 degrees F of setpoint, place the vane control selector switch to "Auto".

6.4.4. Proceed with normal operation as follows:

***NOTE**: The required readings will be logged hourly on a log sheet and compared with normal readings to determine any anomalies*.

- Verify that the chilled water expansion tank maintains a water level between the indicator notches on the sight glass.
- Verify a chilled water expansion tank pressure of 105-110 psi. Adjust the GN2 regulator as required to maintain said pressure.
- Verify an operating chiller motor current of 150 to 270 amps for Chiller 1 and 110 to 240 amps for Chiller 5.
- Verify a condenser refrigerant pressure of 75 to 135 psi (140 psi cutoff).
- Verify an evaporator refrigerant pressure of 30 to 40 psi (27 psi cutoff).
- Verify chilled water make-up controls are not tripped.
- Verify a leaving (supply) chilled water temperature of 42 +/- 2 degrees F (36 degrees cutoff).
  - If the automatic temperature controller cannot maintain the chilled water temperature within the required range, switch to manual mode of vane control by first adjusting the manual vane pressure regulator to obtain a manual gauge reading identical to that of the "Auto" gauge and then selecting manual mode of operation. Proceed with manual temperature control to maintain the leaving chilled water temperature within the required range.

***NOTE**: If step above fails to bring the leaving chilled water to within the desired range and the temperature continues to drop below 40 degrees F, proceed with hot gas bypass.*

- Adjust hot gas bypass pneumatic control for 1/4 opening of hot gas bypass valve. Allow the chiller to stabilize. Manually fine tune the adjustment until 40 degree F chilled water temperature is obtained to maintain a minimum of 150 amps (Chiller 1). Adjust hot gas bypass on Chiller 5 to maintain a minimum of 115 amps. Under hot gas bypass operations, maintain the leaving chilled water temperature to a minimum of 40 degrees F.

6.5. **Start Chiller 4.5**

- Notify the HVAC Console (JBAC) of intent to start chiller.

NOTE: *Because SS-829 is now a single-ended lineup, when THREE chiller operation is requested console operators will be carefully monitoring feeder current for overload condition and may request load shedding or deny a third chiller start altogether.*

- Verify that the "Optiview" control panel is powered up via observation of the graphic display panel. Place Chiller 4.5 "On-Off" switch (White) on control console, Module 5, to the "On" position.
- Ensure that oil cooling chilled water is available to the chiller.
- Place the refrigerant selector switch on the left-hand side of the "Optiview" control panel to the "4.5" position.
- Place the chiller selector switch on chiller 4 control cabinet right-hand door to the "4.5" position.
- Ensure that an adequate volume of chilled and condenser water is available to place chiller 4.5 on-line.
- Open condenser and chilled water valves to chiller 4.
- Verify a minimum of 3000 gpm of chilled water flow via the LED display on Chiller 4 control cabinet.
- Initiate chiller 4.5 start via the control switch on the "Optiview" control panel.
- Monitor chiller parameters on the graphic display panel to verify correct chiller start and consequent loading.
- Continue with normal plant operations.

7. CHILLER SHUTDOWN

NOTE*: The nominal chilled water temperature leaving the Plant shall be maintained at 42 degrees F, +/- 2 F. It is acceptable for the temperature to exceed 44 degrees F for up to 15 minutes during scheduled equipment changeover.*

- On chillers designated to remain on-line, adjust manual gauge pressure to equal auto pressure gauge, then switch to manual vane operation.
- At the selected chiller control panel, depress the "stop" button.

NOTE*: Chiller 4.5 shut down is accomplished by initiating "Soft Stop" of the chiller via the "Optiview" control panel, and securing the chiller unit.*

- If two condenser water pumps are operating, secure one pump at this time, if only one chiller remains on line.
- Verify auxiliary oil pump indicating lamp remains illuminated for the duration of coastdown.
- Verify "Stop" indicator lamp is illuminated.
- Close the Chilled and Condenser water valves to the chiller at the pneumatic valve control panel.
- On the control room Primary control panel, place the selected chilled water primary pump "On-Off" switch to the "Off" position.
- At the operating chillers:

- Adjust the manual vane pressure regulator to obtain when the chilled water temperature has stabilized.
- Verify that both the "auto" and "manual" vane pressure indicator gauges are indicating approximately the same pressure.
- Position the "Auto-Manual" vane selector switch to "Auto."

***NOTE**: With two chiller operation, if the head pressure exceeds 125 psig, a second condenser pump shall be placed on-line.*

- Continue normal operations per section 6.4.4.

8. CHILLED WATER PUMP SWITCHOVER

8.1. Primary Chilled Water Pump Switchover

- Verify 12" common primary pump header valves are all open.
- On the primary pump to be started, turn the on/off switch on the primary control panel to "On".
- Verify primary pump pilot light is on.
- On the pump to be secured, turn the on/off switch to "Off".

8.2. Secondary Chilled Water Pump Switchover - Automatic Mode - VFD

- Verify the mode indication on the DTAM+ general status screen reads control mode: VFD (select system status, select general status, read control mode: "VFD").
- Verify the DTAM+ pump sequence mode is not set for automatic alternation: disable (select system setup, select sequence setup, select alternator enable, enter disable).
- Verify secondary pump HOA switch for all pumps to be enabled are in the "auto" position.
- Verify secondary pumps 1-4 bypass control is in the "VFD".
- Verify secondary pumps 1-4 auto mode pilot lights are on.
- On the DTAM+, select the pumps that are to be operated (select system setup, select sequence setup, select fixed sequence select, enter desired fixed sequence of the secondary pumps).
- Verify that the remaining on-line secondary pump(s) accelerate in accordance with the PID speed reference setpoint to try to maintain the load pressure setpoint.
- Verify that the selected secondary pump starts after the add pump delay timer times out, accelerates in accordance with the add pump accel setpoint, and all operating secondary pumps reach the same speed to maintain the load pressure setpoint.

9. CONDENSER WATER PUMP SWITCHOVER

- Open return and supply valves as required. Ensure all sluice gates are open.
- On the control room console, turn the selected CW pump "on/off" switch to "On" and press the "Start" button momentarily.
- Verify pump start, by "Run" lamp illumination on master console.
- Place the "on/off" switch serving pump to be secured to the "Off" position.

10. COLD WEATHER – LOW LOAD OPERATION

***WARNING**: Ensure that Chiller 5 hot gas bypass selector switch is in "Manual" position.*

- If chilled water temperature leaving the evaporator drifts below 40 degrees f and the automatic temperature controller (PLC) cannot stabilize the temperature, switch to manual vane control and attempt to manually stabilize leaving chilled water temperature.
- If chilled water leaving temperature continues to fall despite action taken above or if chiller operating amperage drops below 130 amperes, adjust hot gas bypass valve to open hot gas bypass 1/4 open. Allow the chiller to stabilize. Fine tune pneumatic adjustment until 40 degree water is obtained.
- Open hot gas valve further to increase chilled water leaving temperature or close hot gas valve to obtain desired chilled water leaving temperature with a minimum of 165 amperes. Return vane control to "automatic" mode of control.
- Maintain chilled water leaving temperature using hot gas while in this mode until there is sufficient load to operate with hot gas valve fully closed. Do not reset control point until hot gas valve is completely closed.

11. PLANT RECOVERY EMERGENCY RESPONSE CHECKLIST

LOSS OF CHILLER/S

Refer to Scrolling Alarm display at Chiller and Alarm screen of SCADA for help in determining cause of Chiller shutdown. (Note: Some safety shutdown events may not be reported to the chiller or SCADA)

- If cause can be readily corrected, take corrective actions (see examples below) and restart dropped Chiller/s.
  - Contact HVAC console, JBAC (7-2723): inform them of loss of Chiller/s.
  - Request permission to restart Chiller/s
  - Verify all required pumps are in operation.
  - Primary CHW, Secondary CHW, Condenser Water Pumps
  - Verify water flows through Chiller/s.
  - Wait for 5 minute Coast Down delay to expire (timer displayed on main SCADA screen).

- Press Reset buttons on Chiller control panel and verify blue READY light is lit.
  - Continue with normal startup of Chiller/s per section 6.4.
  - Notify the HVAC Console (JBAC) that Utility Annex chiller is back on line.
  - Continue with normal operations per section 6.4.4.

- If cause cannot be readily corrected, take action to start alternate Chiller/s.
  - Contact HVAC console, JBAC (7-2723): inform them of loss of Chiller/s.
  - Request permission to start alternate Chiller/s
  - Verify all required pumps are in operation.
  - Primary CHW, Secondary CHW, Condenser Water Pumps
  - Enable Control and 4160 power switches on console for Chiller/s to be started.
  - Open Chilled Water and Condenser Water valves on Chiller/s to be started.
  - Close Chilled Water and Condenser Water valves on failed Chiller/s.
  - Press Reset buttons on Chiller control panel and verify blue READY light is lit.
    - Continue with normal startup of Chiller/s per section 6.4.
    - Notify the HVAC Console (JBAC) that Utility Annex chiller is back on line.
    - Continue with normal operations per section 6.4.4.
    - Request WON to troubleshoot failed chiller.

- Examples of readily corrected events leading to Chiller shutdown along with suggested actions to take.

  - Chiller shutdown due to power bump. (Call HVAC console for power status)
  - Chiller ***CHW Flow*** shutdown due to loss of a Primary CHW pump. (Start alternate pump/s)
  - Chiller ***Condenser Refrigerant Pressure*** shutdown due to loss of a Condenser Water pump. A second alarm, ***Low Condenser Flow***, may also be displayed. (Start alternate pump/s)

Other Chiller shutdown events such as ***Low Oil pressure, High Oil temperature*** or ***Motor Protective Relay*** trips will likely require more time to investigate before chiller can be restarted. An alternate chiller should be started in these cases.

12. POWER FAILURE RECOVERY, CHILLERS

NOTE: Power analysis must be performed in reference to new soft starts

WARNING: *Always notify the HVAC Console (JBAC) to request permission to start a chiller. HVAC Console will coordinate with Power Console to determine if power is being provided by the Emergency Power Plant and will deny request to startup chillers or allow only Chiller #1 or #5 to be started.* (See Appendix A).

- Ensure that the oil sump temperature is at least 115 degrees F prior to starting any chiller.
- Reset "Anti-Recycle" and "Emergency Stop" lights by pressing the associated reset buttons, if required.
- Reset chilled water make-up pump controller.
- Proceed with chiller startup per section 6.4.

13. NITROGEN/COMPRESSED AIR SWITCHOVER

***NOTE**: Pneumatic pressure is used throughout the Condenser water, Chilled water and HTHW systems to operate valve actuators, vane actuators and to provide a blanket in the expansion tanks. The normal source of this pressure is Nitrogen provided from the VAB system and backed up by an MSU at the Northeast outside corner of the Plant. The Plant's compressed air system can also provide a backup source of pressure in the event of prolonged loss of the Nitrogen sources.*

***CAUTION**: The compressed air from the Plant is neither dried nor filtered and its use should be limited to prevent contamination within the pneumatic controls.*

13.1. Nitrogen to Compressed Air

- At air/nitrogen switchover station 1, close red valve and open blue valve.
- At air/nitrogen switchover station 2, close red valve, and open blue valve.

13.2. Compressed Air to Nitrogen

Warning Note: Blanket on HTHW EXT Tank Cannot Be Maintained with Comp Air secure boilers

- At air/nitrogen switchover station 1, open red valve and close blue valve.
- At air/nitrogen switchover station 2, open red valve, and close blue valve.

14. PLANT CHWS HIGH TEMPERATURE ALARM (2 CHILLER OPERATION)

- Monitor plant CHWS temperature.
- Verify operating chillers are producing at maximum output.
- Verify chilled water pumps are operating.
- Verify two condenser water pumps and associated cooling tower fans are running.

- When CHWS reaches 42 degrees with a temperature difference of 10 degrees, immediately start a third chiller per section 6.4.

15. PLANT CHWS LOW TEMPERATURE ALARM (3 CHILLER OPERATION)

- Monitor plant CHWS temperature. If temperature reaches 38 degrees, immediately secure one chiller per section 7.0.

NOTE: *Water chiller low temperature alarm will initiate at 36 degrees and chiller shutoff will occur automatically at 34 degrees.*

16. PLANT CHWS LOW TEMPERATURE ALARM (2 CHILLER OPERATION)

- Monitor plant CHWS temperature. If temperature reaches 38 degrees, immediately manually unload chiller until stable operations at 42 degrees CHWS temperature are achieved.

NOTE: *If chillers are* operating in the surge range due to low load, secure one chiller.

- Return vanes to auto after balancing load between chillers.

17. POST-OPERATIONS INSTRUCTIONS

- All logs in SETI
- Document all hardware and software problems.

APPENDIX A: SPECIAL INSTRUCTIONS FOR LOSS OF UTILITY POWER

1. TEMPORARY LOSS OF UTILITY POWER TO THE CHILLER PLANT

NOTE: *In the event of power bumps or short term loss of utility power, the following steps shall be followed following recovery of utility power.*

- Request permission to restart from HVAC Console (JBAC).
- Restart equipment per section 6.4.
- Notify HVAC Console (JBAC) that restart is complete.
- Fill in SETI log, recording all details and times.
- Resume normal operations per section 6.4.4.

2. PROLONGED LOSS OF UTILITY POWER TO THE CHILLER PLANT

3. NOTE: POWER ANALYSIS MUST BE PERFORMED IN REFERENCE TO NEW SOFT STARTS

NOTE*: A non-catastrophic loss of plant is defined as a loss of utility power that does not preclude the on-duty operator from restarting the plant as soon as the C5 emergency power plant is on line and providing power to the Utility Annex priority bus (feeder 614 to SS-829B). The Power Console will analyze the EPP load and number of generators on line to determine if one of the Soft-Start chillers can be started.*

3.1. Configure Plant for Operation Off of Priority Bus

***NOTE: At this time only feeder A1 is fed from EPP, but after C5 project is complete then* 614 will be back to be fed from EPP.**

NOTE*: See Figure 1 below for a general diagram of UA power distribution to important chiller plant loads. Feeders 614 and A1 would be fed from the EPP during a prolonged Utility Power loss.*

- Contact the HVAC Console (JBAC) to verify with the Power Console that the C5 emergency power plant is ready to support Utility Annex emergency operation.
- Secure all boilers and associated support equipment.
- Secure primary chilled water pumps 3, 4, and 5.
- Secure air compressors 1 and 2.
- Secure condenser pumps 2 and 4.
- Secure cooling tower fans 1 and 2.
- Select air compressor cooling pump 1.
- Start primary chilled water pumps 1 and 2.
- Enable air compressors 3 and 4.
- Start condenser pump 1 or 3.

- Enable cooling tower fans 3 and 4.

***NOTE**: In the event that SS-829 does not have adequate support equipment operationally available to support the Soft-start equipped chiller units.*

- Open chilled and condenser water valves on Chiller 1 or 5.
- Request permission from HVAC Console (JBAC) to start the selected, Soft-Start equipped chiller on the priority bus. (HVAC Console will coordinate permission to do so with the Power console).
- Start the selected chiller unit.
- Continue to operate the plant in the Emergency mode until utility power is restored or as instructed by the HVAC Console (JBAC).

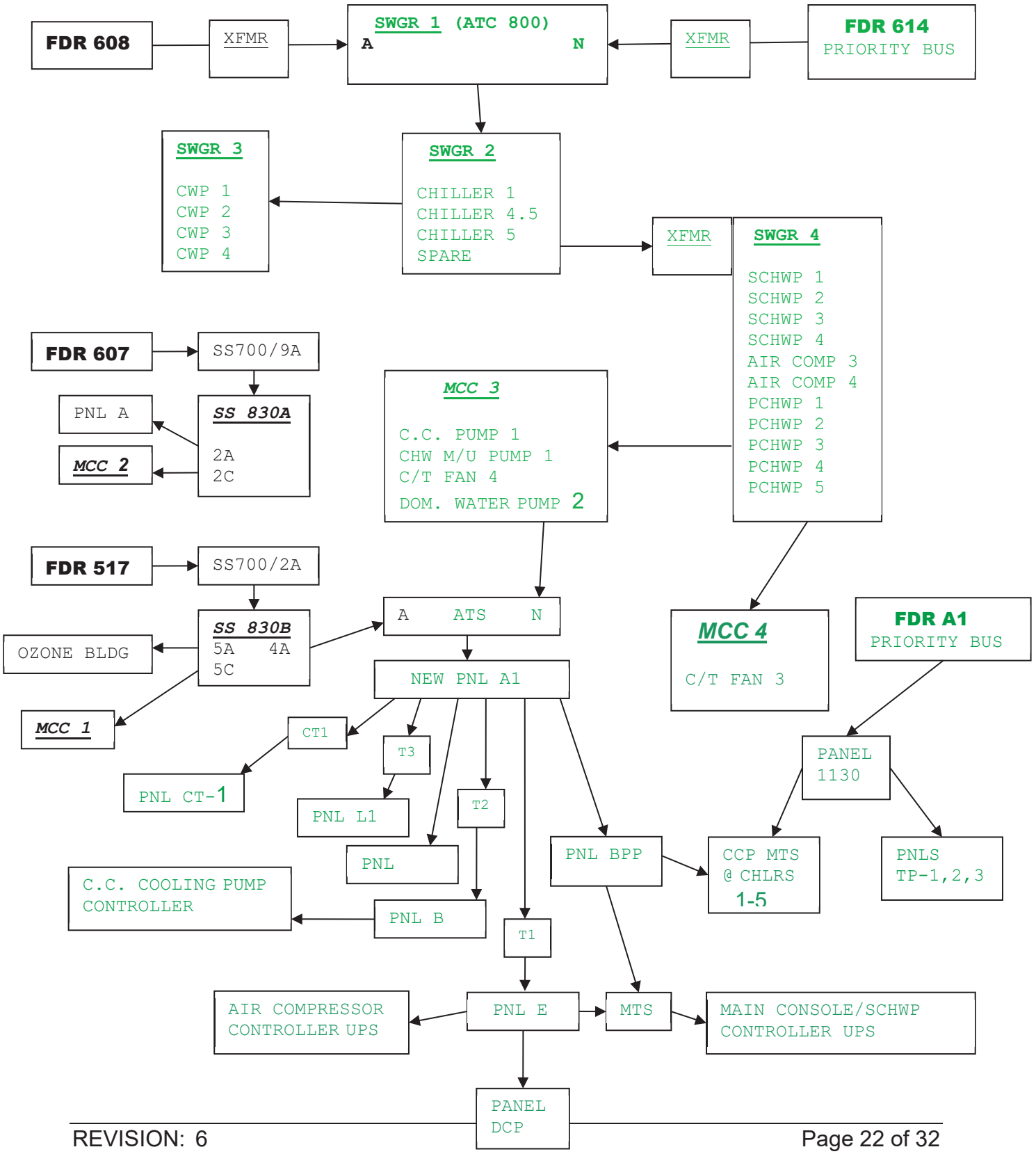
3.2. Restore Configuration for Operation off of Utility Power

***NOTE:** Because SS-829 is now a single-ended lineup, when THREE chiller operation is requested console operators will be carefully monitoring feeder current for overload condition and may request load shedding or deny a third chiller start altogether.*

- Following notification of utility power recovery by the HVAC Console (JBAC), proceed with the reconfiguration of the plant for normal operations.
- Fill in SETI log, recording all details and times.
- Resume normal operations per section 6.4.4.

Figure 1: Utility Annex Power Distribution Guide

Figure 1 - UA CHILLER PLANT POWER DISTRIBUTION FOR IMPORTANT LOADS



APPENDIX B: HURRICANE OPERATIONS

1. PLANT OPERATION FROM LAUNCH CONTROL CENTER

NOTE: *At the discretion of the Center Director, Plant personnel may be directed to evacuate to the LCC with the Plant configured for remote monitoring and operation of Chiller #1.*

1.1. CONFIGURE PLANT FOR REMOTE OPERATION

NOTE: *Modifications to the Medium Voltage switchgear in the North electrical room after hurricane Matthew have resulted in a single-ended lineup fed from an ATS with a Normal source of priority feeder 614. Only 3 Chillers were provided 4160V power (1, 4.5 and 5) and only Chiller 1 can be operated remotely from the LCC. All CHW and CW pumps will remain powered during remote Plant operations.*

a. ___ On manual transfer switch behind chiller control cabinet 1, ensure that "Panel BPP" is the selected source.
b. ___ Run Primary pumps 1 and additional pump for other chiller (4.5 or 5) if needed.
c. ___ Enable all condenser water pumps. Run 1 or 2 as needed for chillers.
d. ___ Enable air compressors 3 and 4 at PLC control cabinet.
e. ___ Place all cooling tower fans in "Auto" and ensure all tower cells are open.
f. ___ Run Chiller 1 and operate additional chillers as required for load.

1.2. EVACUATION

NOTE*: Prior to evacuating the plant during hurricane conditions, the operator shall take the following steps as time permits.*

g. ___
h. ___ Verify all Tower fans are in "Auto" and all cells are open.
i. ___ Ensure all Condenser water pumps are "enabled".
j. ___ Verify operation of Chiller 1 and other operating chillers.
k. ___ Ensure Air compressors 3 and 4 are selected.
l. ___ Verify vane control selector for Chiller 1 is in "Auto".
m. ___ Verify Secondary pumps are in "Auto".

Proceed to the designated fallback location at the LCC, room 1P9.

1.3. LAUNCH CONTROL CENTER REMOTE WORK STATION

n. ___ Access the work station assigned to the Utility Annex SCADA system by logging in.
o. ___ Commence monitoring and controlling of the plant's systems.

***NOTE**: In the event of a power interruption from FPL, and chillers shutdown as a result, some operational equipment will require a restart. The operator should proceed as follows:*

p. ___ Contact the HVAC Console (JBAC) to request status and permission to reset and restart Utility Annex equipment.
q. ___ Configure workstation for remote control.
r. ___ Issue an air compressor controller "Reset" command.
s. ___ ___ Verify Primary pumps 1 is running and secure any other operating Primary pump.
t. ___ Verify secondary pumps are running.
u. ___ Issue a "Start" command to condenser pump/s to be started. Verify pump start.
v. ___ Issue a "Reset" command for the chiller Anti-Recycle control.
w. ___ Issue a command to reset the Chilled Water Make-Up pump controller.
x. ___ Verify proper chilled water temperature set point on chiller.
y. ___ Issue "Start" command to chiller #1.

Note: if chiller 4.5 or chiller 5 were also operating, they cannot be restarted remotely. Securing the Primary pump for these chillers will be necessary to reduce the amount of water circulating through the dead chiller since the chilled water valves cannot be closed remotely. It may help to also operate only 1 Secondary pump by placing the other pumps in Maintenance,

- Allow for 30 seconds pre-lube/lube time delay and observe chiller soft-start and subsequent synchronization within 15-20 seconds by the inrush and stabilization of motor current. The motor current should settle down to less than 270 amps, typically around 160 amps. (In the unlikely event that the motor fails to synchronize, remains at or above 300 amps past the 30 second time limit and the soft-start control safeties fail to shut it down, issue a "Stop" command to the chiller by clicking on the "Stop" button in the chiller pop-up screen, then attempt a second restart on the chiller.)

***CAUTION:** A chiller that fails to synchronize or will not run below 300 amps after two attempts may have exciter and/or control issues that may lead to serious damage to the motor and electrical systems. Secure the chiller.*

- At this time the chiller will start loading via the vane opening indicated by an increasing vane air pressure, increasing motor current and decreasing chilled water discharge temperature towards its set point. Once the set point is reached, the vane air pressure and motor current will stabilize.

2. PLANT SHUTDOWN

NOTE: *At the discretion of the Center Director, BOSS personnel may be directed to secure the Chiller Plant. To prepare Plant for the possibility of water intrusion into North Electrical Room, Medium Voltage switchgear will be de-energized and covered. Other switchgear within the Plant will remain energized (SWGR 700) to provide power for lighting, motor heaters, etc.*

Secure running equipment

- Notify HVAC Console that Plant equipment is to be secured.

a. ___ Shutdown Chiller/s
b. ___ Shutdown Condenser Water Pump/s
c. ___ Shutdown Cooling Tower Fans – HOA switch to OFF
d. ___ Shutdown Air Compressors - HOA switch to OFF
e. ___ Secure cooling water circ pump for Air Compressors
f. ___ Secure Ozone Generators and Pumps.
g. ___ Secure Make-Up water pumps at control panel near PCHWP 3
h. ___ Shutdown Primary Pumps
i. ___ Shutdown Secondary Pumps — HOA switches to OFF
j. ___ Secure Boilers
k. ___ Secure Boiler Distribution Pumps and Circulation Pumps

Medium Voltage SWGR should now be clear for switching.

Prepare Plant for extended shutdown

l. ___ Secure nitrogen at CHW expansion tank and relieve blanket pressure
m. ___ Close Chilled Water isolation valves to VAB/LCC (Mezzanine)
n. ___ Secure nitrogen to HTHW expansion tank
o. ___ Verify heaters are operational on chiller sumps and motors

2.1. PLANT RESTART

Prepare Plant for Equipment startup

a. ___ Verify a Plant walkdown has been performed and any issues (water intrusion, structural damage, debris, etc.) that would prevent safe operation of the Plant have been discussed with HVAC and Electrical supervision and mitigated prior to beginning Plant startup.
b. ___ Test winding insulation (Meg) on motors suspected of water exposure or winding heater issues during shutdown.
c. ___ Verify all Pump, Air compressor and Fan controls are off.

Medium Voltage SWGR should now be clear for switching.

Restart Equipment

- Notify HVAC Console that Plant equipment is to be started.

d. ___ Verify ATS A1 transferred to MCC-3 source.
e. ___ Open Chilled Water isolation valves to VAB/LCC (Mezzanine)
f. ___ Start Make-Up water pumps/restore nitrogen blanket to CHW expansion tank
g. ___ Start Secondary Chilled Water pumps (Enable two pumps initially until loop has been cooled down)
h. ___ Open CHW and CW valves on Chiller/s
i. ___ Start Primary Pumps
j. ___ Start Condenser Water Pump/s
k. ___ Start Cooling Tower Fans as needed
l. ___ Notify console that chillers are to be started
m. ___ Start chiller/s
n. ___ Monitor level of CHW at expansion tank as loop cools
o. ___ Start cooling water circ pump for Air Compressors
p. ___ Start Air Compressors
q. ___ Start Boiler Distribution pumps and Circulation Pumps
r. ___ Restore nitrogen blanket to HTHW expansion tank
s. ___ Start boiler
t. ___ Restore Ozone system operation (purge generators as needed prior to startup)

APPENDIX Z: EMERGENCY INSTRUCTIONS

1. PLANT FIRE

- Evacuate the area.
- If exiting at the main entrance or West entrance, lift the clean plastic cover and press the red mushroom switch of the "Boiler/Fuel Shutoff Station".
- If fire department is not on-site, notify the appropriate control center (phone 911. If using a cell phone 867-7911).
- If requested by site commander, terminate plant operations:
  - Secure running chillers by shutting off "4160 Enable" and "Control Power" switches at control console.
  - Shut off Condenser water pumps at control console.
  - Shut off Primary and Secondary pumps at Secondary Pump Controller Cabinet.
  - Assist fire department personnel, if properly trained, as requested by the Fire Chief.
  - Notify supervision and proceed as directed.

2. PERSONNEL INJURY

- If safe to do so, administer first aid to victim. If breathing has stopped, begin CPR (if certified to do so) and call appropriate control center (phone 911. If using a cell phone, 867-7911).
- If victim cannot be safely attended to, inform control center of the hazards so that proper departments/personnel can be dispatched.
- Notify supervision and proceed as directed.

3. CATASTROPHIC RELEASE OF REFRIGERANT

***NOTE**: The Utility Annex chillers operate on refrigerant R-134a with each chiller containing approximately 10,000 lbs of the refrigerant. The primary hazard associated with a release of the refrigerant is asphyxiation due to oxygen dilution. Inhalation of small amounts of R-134a does not damage respiratory organs, but high concentrations of the vapor can cause nervous system depression, narcosis, lethargy and anesthetic effects. The vapors will decompose upon exposure to high temperatures to form toxic and irritating compounds such as hydrofluoric acid, carbon monoxide and carbonyl fluoride.*

- During a major, uncontrollable release of refrigerant from a chiller system evacuate the plant.
- Notify appropriate control center (phone 911. If using a cell phone, 867-7911).
- Provide the following information:
  - Name
  - Company
  - Phone number
  - Location of incident
  - Type of incident
  - Casualties and injuries, if applicable
  - The need to notify the HVAC Console (JBAC), if required.
- Notify Test Conductor/Duty Officer.
- Stand by to assist emergency personnel.

4. CATASTROPHIC LOSS OF CHILLER PLANT

NOTE: *A catastrophic loss of plant is defined as a loss of utility/essential equipment within the plant or an act of god that precludes an immediate restart by the on-duty operator.*

- If incident is not a threat to personnel, safe equipment to prevent further damage.
- If the incident causing loss of plant is a threat to personnel, immediately evacuate the facility.
- Notify appropriate control center (phone 911. If using a cell phone, 867-7911).
- Provide the following information:
  - Name
  - Company
  - Phone number
  - Location of incident
  - Type of incident
  - Casualties and injuries, if applicable
  - The need to notify power coordinator, if required.
- Notify Test Conductor/Duty Officer.
- Stand by to assist emergency personnel.

RECORDS

Refer to procedure UTI-I-0006 for identification of records associated with operation of this Chiller Plant.

AFFECTED DIVISIONS/OFFICES

FSEU and OM&E
Program Management
Quality Safety and Environmental

MANAGEMENT ROLES AND RESPONSIBILITIES

BOSS Program Manager: Ensures BOSS compliance to the requirements stated in this procedure. Reviews and approves or disapproves waiver requests written against this standard.

Division Manager: Ensures compliance within the Division to the requirements stated in this procedure.

Department Manager: Ensures compliance at the Department level to the requirements stated in this procedure.
Assigned Primary Operator - HVAC Mechanic assigned to perform Operator duties at manned Chiller Plants.

REFERENCE DOCUMENTS

The following documents are referenced in this procedure:

Document Number	Title
FAM-I-0001	Hurricane Operations for KSC HVAC Plants
KSC Form 26-181	Daily log – Chillers
SHP-P-0095	Noise and Hearing Conservation
SHP-P-0147	Hazardous Energy Control (Lockout/Tagout)
SMA-P-0016	Event and Near Miss Reporting
UTI-I-0006	KSC CHILLER PLANT DAILY ROUTINE DUTIES INSTRUCTIONS

ADDITIONAL RESOURCES

Secondary PLC Control Manual SETI use procedures

The following documents are not referenced in this procedure, but are an added resource:

Document Number	Title
80KSC018C0017	Base Operations and Spaceport Services (BOSS) Contract
QMS-QP	BOSS Quality Plan
QMS-P-0001	Control of Documents
QMS-P-0002	Control of Records

ACRONYMS

BOSS Base Operations and Spaceport Services
CHW Chilled Water
CHWS Chilled Water Supply
FSEU Facilities/Systems/Equipment/Utilities
GN2 Gaseous Nitrogen
HOA Hand/Off/Auto
KSC Kennedy Space Center
LCC Launch Control Center – K6-0900
LED Light Emitting Diode
PLC Programmable Logic Controller
PWS Performance Work Statement
PSIG Pounds per Square Inch Gauge
SETI System Electronic Tie-In
VAB Vehicle Assembly Building
VFD Variable Frequency Drive

DEFINITIONS

DTAM+: Model designation of operator interface terminal consisting of an LCD display and key pad used to interface with Allen-Bradley controllers.

Optiview: Model designation of York's microprocessor based control system used on their centrifugal chiller. The operator interface contains an LCD graphic display and keypad.

PID: Control method utilizing loop feedback where the controller calculates a desired output from a weighted sum utilizing coefficients represented by Proportional, Integral and Derivative terms.

Soft Start: A starter that operates much like a VFD to limit the inrush current to motors by reducing the voltage at start up. After the motor has reached full speed the voltage controlling "stacks" are bypassed and full voltage is passed to motor. Used at the Utility Annex on Chillers #1 & #2 to permit starting their 2500 HP drive motors when the Emergency Power Plant is providing power.

Soft Stop: A device shut down scheme performed by a controller allowing for a gradual stop in an unloaded condition. Used on Chiller # 4.5.

Synchronization: An event occurring during start up on synchronous motors where the rotor "locks in step" with the rotating magnetic field of the stator.

REVISION RECORD

The following revisions have been applied to this document:

Revision Number	Change Description	Date
0	Initial Release of Procedure–based format of previous OMI I3067 Rev M-3	10/28/2015
1	Updated CHW temperature requirements and Plant Recovery section.	5/12/2016
2	Updated due to new electrical configuration	1/31/2017
3	Update to Appendix B, New hurricane operations	8/1/2017
4	Added notes in Sections 4, 6.5, and Appendix A to coordinate chiller start-up with the C3 power console.	10/25/17
5	Administrative change only. Document updated to remove branding of previous contract.	04/01/19
6	Updated to add BOSS header and Changes to Appendix B	10/23/20

DOCUMENT APPROVALS

Expired certificate

X Melquiades Lopez

Mike Lopez
Technical Manager, FSEU OM&E
Signed by: Melquiades Lopez (affiliate)

Expired certificate

X Michael Cassidy

Mike Cassidy
BOSS HVAC SE Lead
Signed by: Michael Cassidy (affiliate)