A P P E N D I X

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Cyber-Physical Attack Recovery Procedures Template

Soft copy of these forms (fully editable with fillable fields) is available for download from www.apress.com/9781484220641.

**<<Company Name>>**

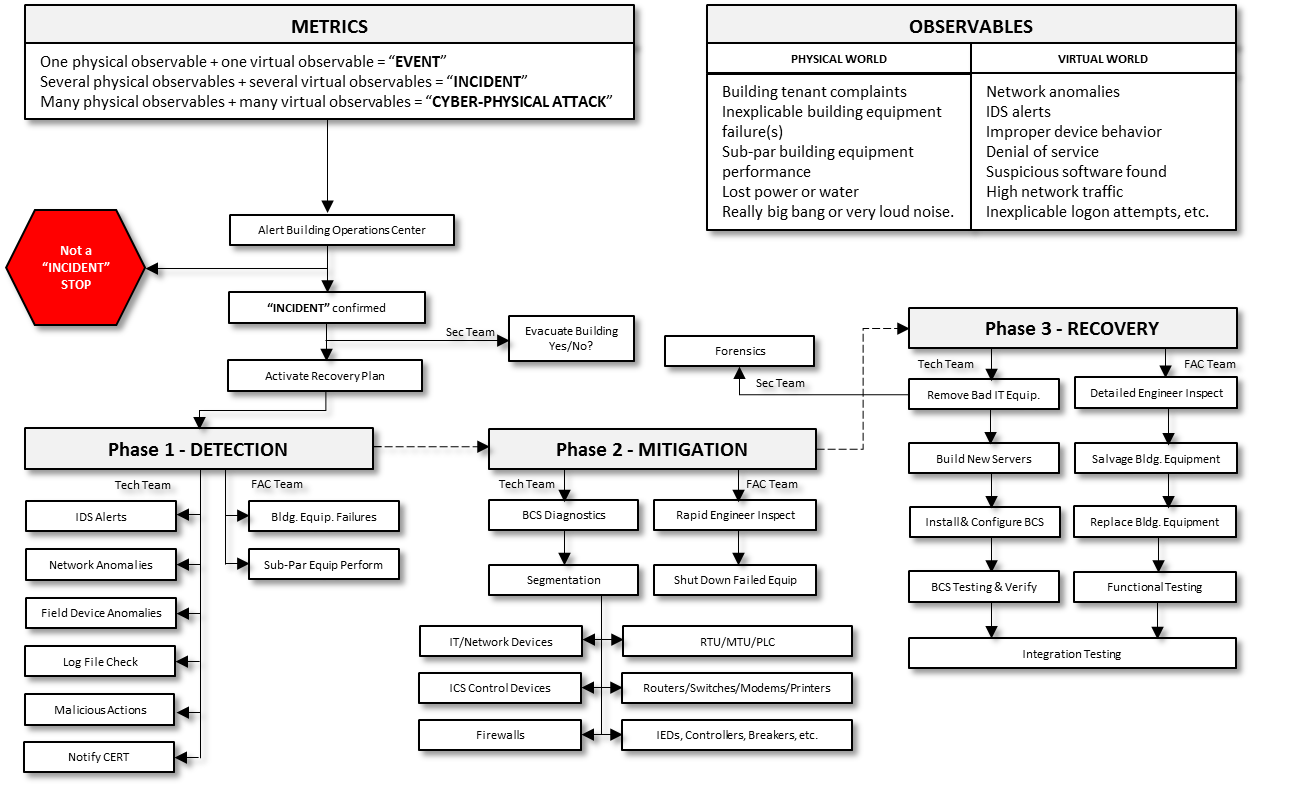
**<<Facility Name>>**

**<<Date>>**

The Cyber-Physical Attack Recovery Procedures provide guidance when responding to a cyber-attack on the Building Controls System and documenting the nature and scope of the cyber-attack. The Recovery Procedures Template consists of **Checklists** and **Functional Performance Tests** to assist the Incident Response Team to restore normal building operations in a pre-determined sequence, based on mission prioritization.

One Checklist shall be filled out specifically for each piece of equipment (e.g. AHU-1, AHU-2, AHU-3, … etc.) and the Functional Performance Tests include normal operating parameters (e.g. 40 psig, 40 to 95 deg F) based on information collected during initial installation and/or during equipment commissioning, for comparison with current readings. Some Checklists will require you to attach drawings indicating the location of important switches, valves and gages to be checked, as well as equipment shut-down and start-up, and Sequence of Operation instructions. Checklists may also list dependencies and related functions that make up the service such as water and power; how those dependencies interrelate; and the tools, procedures, and personnel necessary to restore the particular equipment or service to normal operation.

The following flow chart should give you a general idea of the recovery process.



# START HERE

These are the steps taken when a cyber-physical event occurs. The person who discovers the event will call the Building Operations Office. The sources should be provided with a contact procedure and contact list. Sources requiring contact information may be:

|  |  |
| --- | --- |
| Person discovering the event should call: | |
| Whom to Call | Telephone Number |
| Helpdesk |  |
| Building Operations Office |  |
| Security Office |  |
| IT Support Office |  |
| Whichever office is contacted first shall contact the other offices. | |

Enter telephone numbers and post the info where staff can see it.

|  |  |
| --- | --- |
| The office alerted of the event will log: | |
| Name of the caller |  |
| Time of the call |  |
| Contact information about the caller |  |
| Caller physical location |  |
| The nature of the event |  |
| How was the event detected? |  |
| What equipment or persons were involved? |  |
| Location of equipment or persons involved |  |

The facilities office staff member who receives the call will contact the Recovery Procedures Coordinator using both email and phone messages while being sure other appropriate backup personnel and designated managers are contacted.

|  |  |
| --- | --- |
| The staff member could possibly add the following: | |
| Is the equipment affected mission critical? |  |
| What is the severity of the potential impact? |  |
| Name of equipment being targeted, along with operating system, IP address, and location. |  |
| IP address and any information about the origin of the attack. |  |

The Incident Response Team will meet and determine a response strategy.

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| --- | --- |
| Incident Response Team Initial Meeting/Discussion | |
| Is the event real or perceived? |  |
| Is the event still in progress? |  |
| What equipment or system is threatened and how critical is it? |  |
| What is the impact on the building should the attack succeed? Minimal, serious, or critical? |  |
| Where is the equipment located physically and on the BCS network? |  |
| Is the event inside the trusted network? |  |
| Is the response urgent? |  |
| Can the event be quickly contained? |  |
| Will the response alert the attacker and do we care? |  |
| What type of event is this? | virus, worm, intrusion, abuse, damage |

**CREATE** a new Event Ticket for each call. There will be many.

## EVENT TICKET

|  |  |
| --- | --- |
| Work Order #: | Government Work Order #: |
| Work Order Type: | Customer Ref #: |
| Report Date: | Work Order Status: |
| Building: | Asset Worked On: |
| Additional Location Information: | |
| Customer Request: | |
| Conditions Found: | |
| Actions Taken: | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Status: |  | | Date: |  |
| Date: | Technician Name | Start Time | Stop Time | Regular Hours | OT Hours |
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| Part # | Description | | Quantity | Unit Cost | Total Cost |
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| Supply Rep Name | | Technician Name/ Date Received | | Supervisor Approval for High Value Items | |
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|  | | | | | |
| Customer Signature & Date Completed | | | Customer Rating | | |
|  | | |  | | |
| Technician Signature & Date Completed | | | Customer Comment | | |
|  | | |  | | |
| QC Inspector Signature & Date Completed | | | QC Comment | | |
|  | | |  | | |

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| --- | --- |
| **Event Category.** Event will be categorized into the highest applicable level of one of the following categories (Pick One): | |
| Event Category | Description |
| One | A threat to life safety or the public |
| Two | A threat to sensitive buildings or utilities |
| Three | A threat to computer systems |
| Four | A disruption of building mission or services |

## 

## INCIDENT RESPONSE TEAM

Incident Response Team members will use the checklists and perform the Functional Performance Tests specified herein in the order specified in the Equipment Restoration Priority List. IRT members sign off after each test. Incident Response Team members will establish and follow one of the following procedures basing their response on the incident assessment:

1. Worm response procedure
2. Virus response procedure
3. System failure procedure
4. Active intrusion response procedure - Is critical data at risk?
5. Inactive Intrusion response procedure
6. System abuse procedure
7. Property theft response procedure
8. Website denial of service response procedure
9. Database or file denial of service response procedure
10. Spyware response procedure.

The Incident Response Team may create additional procedures which are not foreseen in this document. If there is no applicable procedure in place, the team must document what was done and later establish a procedure for the incident.

Incident Response Team members will use forensic techniques, including reviewing system logs, looking for gaps in logs, reviewing intrusion detection logs, and interviewing witnesses and the incident victim to determine how the incident was caused. Only authorized personnel should be performing interviews or examining evidence, and the authorized personnel may vary by situation and the organization.

Upon management approval, the changes will be implemented.

Incident Response Team members will restore the affected building controls system(s) to the uninfected state. They may do any or more of the following:

1. Reinstall the affected building controls system(s) from scratch and restore data from backups if necessary. Preserve evidence before doing this.
2. Make ALL users change ALL passwords.
3. Be sure the building controls system has been hardened by turning off or uninstalling unused services.
4. Be sure the building controls system is fully patched.
5. Be sure real time virus protection and intrusion detection is running.
6. Be sure the building controls system is logging the correct events and to the proper level.

**Documentation** - The following shall be documented:

1. How the incident was discovered.
2. The category of the incident.
3. How the incident occurred, whether through email, firewall, etc.
4. Where the attack came from, such as IP addresses and other related information.
5. What the recovery plan was.
6. What was done in response?
7. Whether the recovery procedures were effective.

**Evidence Preservation** - make copies of logs, email, and other communication. Keep lists of witnesses. Keep evidence as long as necessary to complete prosecution and beyond in case of an appeal.

**Notify proper external agencies** - notify the police and other appropriate agencies if prosecution of the intruder is possible. Add contact numbers here.

**Notify proper external agencies**

|  |  |
| --- | --- |
| **Agency** | **Contact** |
| Dept. of Homeland Security | 877-776-7585 [ICS-CERT@HQ.DHS.GOV](mailto:ICS-CERT@HQ.DHS.GOV) |
| FBI – Cyber Division - CyWatch | 855-292-3937 [TCIU@IC.FBI.GOV](mailto:TCIU@IC.FBI.GOV) |
| **National Security Agency**  (Industry)  (Government) | 410-854-6091 [BAO@NSA.GOV](mailto:BAO@NSA.GOV)  410-854-4200 [IAD\_CCC@NSA.GOV](mailto:IAD_CCC@NSA.GOV) |
| Police |  |

**Assess damage and cost** - assess the damage to the organization and estimate both the equipment cost and the cost of the mitigation efforts.

## INCIDENT RESPONSE TEAM MEMBER LISTING

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Team Member Name | Cell Phone | Telephone | Time Called | E-mail |
| Management Team |  |  |  |  |
| Leader |  |  |  |  |
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| Facilities Team |  |  |  |  |
| Leader |  |  |  |  |
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| Tech Support Team |  |  |  |  |
| Leader |  |  |  |  |
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| Security Team |  |  |  |  |
| Leader |  |  |  |  |
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This list should be filled out and kept current.

## EQUIPMENT RECOVERY PRIORITY LIST

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| --- | --- |
| Equipment Recovery Priority List | |
| Priority | Description |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |

This list should be filled out and kept current.

## BCS NOTIFICATIONS REPORT

Below is a list of announced system vulnerabilities for the BCS network.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Announced BCS Vulnerabilities | | | | | |
| Bulletin ID or Name | Description | System Affected | Release Date | Resolved | Impact |
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## PATCH MANAGEMENT REPORT

Below is a list of installed and missing Service Packs on the BCS network.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Installed and Missing Service Packs | | | | | | | | |
| Bulletin ID or Name | Description | System Affected | Release Date | Severity | Lab Test Date | Patch Date | Complete Pending | Name of Tester |
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## VULNERABILITY ASSESSMENTS HISTORY

Types of Internal and External Vulnerability Tests

**White-Box Test Team**

Test team has complete access to the BCS network including network diagrams, hardware, operating system and application details. Knowledge of network allows targeting specific building equipment, applications and field devices.

**Grey-Box Test Team**

Test team simulates attack by a disgruntled employee. Test team has user level privileges and access permitted to the BCS network with certain security policies relaxed.

**Black-Box Test Team**

Test team has no prior knowledge of BCS network (except possibly a website URL or IP address). Test team attempts to break into the BCS network remotely.

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| --- | --- | --- | --- |
| Scan Date | Testing Team & Type | Company | Recommendations |
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**Vulnerability Test Types**

1. **External Vulnerability Scan** - Identify network-facing vulnerabilities (Monthly).
2. **Internal Vulnerability Scan** - Identify network-facing vulnerabilities (Quarterly).
3. **External Vulnerability Assessment** - Identify configuration and architecture vulnerabilities (Annual).
4. **Internal Vulnerability Assessment** - Identify network, client, configuration and physical vulnerabilities (Annual).
5. **Penetration Test** - Exploit any vulnerability to obtain access to building controls (Annual).

# PHASE 1 – DETECTION

## Observables

Historically, the primary reason many cyber-attacks went undetected for days, months or years is because most cyber-attacks steal information. In the past, cyber-attacks targeted an enterprise’s use of cyberspace for the purpose of disrupting, disabling, destroying, or maliciously controlling a computing environment/infrastructure; or destroying the integrity of the data or stealing controlled information. A cyber-physical attack on the other hand is a coordinated attack on vulnerable physical systems, making it much more difficult to conceal.

When anomalous behavior is observed such as multiple equipment failures, Intrusion Detection System alerts are sounded, or a catastrophic event occurs, the Incident Response Teams consult the **Event Diagnostics Table** to determine if the “event” is a possible cyber-physical attack. Incident Response Teams then consult the **Integrity Checks Table** to verify if a cyber-physical attack is underway. Incident Response Teams provide management with the facts necessary to make informed decisions regarding subsequent resumption and recovery activity.

**Real World Alerts**

As building managers, we are constantly monitoring building equipment in the physical world looking for clues that something is amiss. Problems like the inability of the HVAC to maintain building temperature at a comfortable level, or smoke billowing from a mechanical room are what I call – “Observables”. We actually *see, hear or smell* that something is wrong in *the real world*. Sometimes building occupant’s complaints tell us that something is wrong. We rely on electronic equipment to detect observables in the real world quickly. Things like automatic smoke detectors and fire alarms point out serious problems quickly since they are located throughout the building.

Observable events that tell us something is wrong in the **real world** include:

* Smoke
* Fire
* Leaks
* Smells
* Sounds
* Flashing red lights
* Multiple or frequent building occupant complaints
* Rooms too hot
* Rooms to cold
* Excessive energy use
* Equipment won’t turn on
* Equipment won’t turn off
* Explosions
* People passing out
* People vomiting
* ….. You get the idea.

**Virtual World Alerts**

Observable events that tell us something is wrong in the **virtual world** include:

* Out of disk space or significantly reduced free disk space
* Unusually high CPU usage
* Unauthorized creation of new user accounts
* Attempted or actual use of administrator-level accounts
* Locked-out accounts
* Accounts in use when the user is not at work
* Cleared log files
* Full log files with an unusually large number of events
* Disabled antivirus software and other security controls
* Unexpected patch changes
* Requests for information about the system (social engineering attempts)
* Unexpected system or building equipment shutdown
* Stoppage or displayed error messages on a web, database, or application server
* Filenames containing unusual characters or new or unexpected files and directories
* Auditing configuration changes logged on the host records, especially disabling of audit functionality
* A large number of bounced e-mails with suspicious content
* Unusual deviation from typical network traffic flows
* Erratic equipment behavior, especially when more than one device exhibits the same behavior
* Any apparent override of safety, backup, or failover systems
* Equipment, servers, or network traffic that has bursts of temporary high usage when the operational process itself is steady and predictable
* Unknown or unusual traffic from corporate or other network external to control systems network
* Unknown or unexpected firmware pulls or pushes
* Evidence of cyber-attack precursors such as active port scanning or account harvesting
* Unusual patterns of communication gathering technical or security information
* Phishing attacks
* Information about the BCS is exfiltrated or leaked
* Denial of service attack
* Data, file system, software or packets were altered
* Equipment configuration setpoints were altered at rest or in transit
* Unauthorized use of the BCS

**Intrusion Detection System Alerts**

Now, we also have to discover when something is going wrong in the “virtual world”. We do this by installing an Intrusion Detection System (IDS). An IDS is a hardware or software product that gathers and analyzes information from various areas within a building controls system (BCS) to identify possible security breaches, which include both intrusions (attacks from outside the organizations) and misuse (attacks from within the organizations.)

An IDS alerts us whenever it detects suspicious behavior such as any of these events:

* Unauthorized user logging in
* Virus or Trojan horse detected
* Rapid and/or continuous log-ins/log-outs
* Users logging into accounts outside of normal working hours
* Numerous failed log-in attempts
* User accounts attempting to escalate account privileges
* Suspicious software and/or configurations on a server or workstation
* Unusual system behavior
* Irregular process found
* Spontaneous reboots or screen saver change
* Unusually slow performance or usually active CPU
* CPU cycles up and cycles down for no apparent reason
* Intermittent loss of mouse or keyboard
* Configuration files changed without user or system administrator action in operating system
* Configuration changes to software made without user or system administrator action
* BCS unresponsive
* When an asset is communicating outside the bounds of the data flow baseline
* HMI, OPC, and controllers not synchronized
* Unexpected changes to instructions, function calls, commands, or alarm thresholds being sent from HMI or OPC to controllers
* HMI or OPC not updating after operator made changes to instructions, commands, or alarm thresholds
* Expected changes to controllers are not appearing on controllers
* An irregular vendor patch coming from an external source, or unexpected source, to a device within the BCS
* A device on the BCS is communicating with an undocumented, unauthorized, or unknown IP address
* A device other than authorized devices is sending field controller traffic to a BCS device
* Traffic coming or going to an unknown device
* A BCS field controller is communicating with an unknown device
* A BCS device has expanded its communications to other devices within the BCS

As you can see, there are many “Observables” in the real world and the virtual world that tell us something is going on that we need to explore. Most alerts are not malicious and are due to authorized events or can otherwise be explained:

* Was maintenance performed on the system or a software update installed recently?
* Did the equipment simply malfunction?
* Did the equipment lose network connectivity (outside the building)?
* Was a new BCS device installed?
* Was a BCS device reconfigured? Was it reconfigured correctly?
* Other authorized events are causing excessive network traffic.
* Was an old process removed from the BCS?
* User error.

*IF* an event is detected *AND* it cannot be explained, then we are compelled to perform integrity checks on EVERY server, workstation, router, network switch, firewall, controller, all printers and peripherals.

*WHEN* an event is detected that may be a cyber-physical attack, an Event Ticket is created and the appropriate Incident Response Team is called upon to investigate.

## EVENT DIAGNOSTICS TABLE

|  |  |
| --- | --- |
| Check | Anomalous Behavior Observables |
|  | Unusually heavy BCS network traffic |
|  | Out of disk space or significantly reduced free disk space |
|  | Unusually high CPU usage |
|  | Creation of new user accounts |
|  | Attempted or actual use of administrator-level accounts |
|  | Locked-out accounts |
|  | Accounts in use when the user is not at work |
|  | Cleared log files |
|  | Full log files with an unusually large number of events |
|  | Antivirus or IDS alerts |
|  | Disabled antivirus software and other security controls |
|  | Unexpected patch changes |
|  | Machines or intelligent field devices connecting to outside IP addresses |
|  | Requests for information about the system (social engineering attempts) |
|  | Unexpected changes in configuration settings |
|  | Unexpected system shutdown |
|  | Stoppage or displayed error messages on a web, database, or application server |
|  | Unusually slow access to hosts on the network |
|  | Filenames containing unusual characters or new or unexpected files and directories |
|  | Auditing configuration changes logged on the host records, disabling auditing function |
|  | A large number of bounced e-mails with suspicious content |
|  | Unusual deviation from typical network traffic flows |
|  | Erratic building equipment behavior, more than one device exhibits the same behavior |
|  | Any apparent override of safety, backup, or failover systems |
|  | Equipment, servers, or network traffic that has bursts of temporary high usage when the operational process itself is steady and predictable. |
|  | Unknown or unusual traffic from corporate or other network external to BCS |
|  | Unknown or unexpected firmware pulls or pushes |
|  | Loss of building utilities (electricity, water, gas, sewer equipment failure) |
|  | Very large number of complaints from building tenants |
|  | Failure of multiple types of building equipment simultaneously |
|  | Very high energy usage |
|  | Obviously erroneous readings in BCS displays |
|  | Discovery that system safety devices have been disabled |
|  | Equipment running during the wrong season of the year |

## MASTER LIST OF DEFICIENCIES

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| **Equipment** | **Deficiency** |
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## DECISION TIME

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| --- | --- | --- | --- | --- | --- |
| **DECISION POINT** |  | **ACTIONS** | |  | **CATEGORY** |
| 1. Cyber “event” is discovered by IDS or unexpected equipment failure | 2. Event is confirmed to be “Incident” | 3. Recovery Procedures activated | 4. Alarm sounds | 5. Building evacuated | Initiation |
| 2. If no, then | 3. Recovery Procedures is not activated | 4. Return to normal operations | 5. Evaluate response | Determination |
| 6. Determine scope of incident and assess damage after building access is allowed | 7. If small scope with no to minimal damage, then | 8. Repair and begin clean up | 9. Return to normal operations | 10. Notify management and tenants of situation | Short Evacuation  May Be Required |
| 7. Moderate to large scope or moderate to severe damage, then | 8. Activate alternate site | 9. Activate Incident Recovery Team | 10. Notify  management and tenants of situation | Moderate to  Severe Damage to  Building or  Infrastructure |
| 11. Assess damage | 12. If damage is moderate and will be able to return in 30 days or less | 13. Complete repairs as necessary while operating at alternate site | 14. Return to building | 15. Return to normal operations | Moderate Severe  Damage to Building or  Infrastructure |
| 12. If more than 30 days expected for repairs, locate to new building | 13. Order supplies and equipment | 14. Set up and operate at new facility while completing repairs | 15. Return to normal operations | Severe Damage to  Building or  Infrastructure |
| 12. If total loss, locate to new facility | 13. Rebuild | 14. Set up at new facility while completing repairs | 15. Return to normal operations |  |

# PHASE 2 – MITIGATION

## Mitigation and Segmentation

* The Incident Response Team’s first priority is to isolate any compromised devices and protect the building and personnel through segmentation. The segmentation must be based on a predetermined strategy taking into account specific equipment and building mission realities. After this step is complete, the Incident Response Teams ensure that local control has been achieved.
* The Facilities Incident Response Team conducts a preliminary Rapid Inspection of incident impact, known injuries, extent of damage, and disruption to building services and operations.
* The Incident Response Team informs the Recovery Procedures Coordinator who determines if or when access to the facility will be allowed.
* The Recovery Procedures Coordinator establishes and organizes a management control center and headquarters for the recovery operations.
* The Recovery Procedures Coordinator implements procedures necessary to mobilize operations, support and department relocation as well as employee and external individuals and organizations notification before, during, and after relocation.
* The Recovery Procedures Coordinator notifies and appraises management of the situation.

## Buildi**n**g Equipment Damage Assessments

The Facilities Incident Recovery Team starts their damage assessment with a Rapid Inspection of all building equipment and systems and uses checklists to make sure they cover every possible anomaly. The FAC Team jots down the dial readings at the equipment for comparison with the BCS display readings. They check the equipment for out of range setpoints and ensure that equipment is working properly.

It is important to note that merely looking at the BCS display is a waste of time as those readings are probably false. A hacker will have a hard time spoofing a mechanical pressure gage on a steam line or fuel train. The FAC Team looks for low water levels, low fuel levels, leaks, squeaks, squeals, vibration and odd smells (such as overheating or burning oil). They check fan belts, motors, pumps and fans to make sure they are operating. They confirm that things like the basin heater in the cooling tower is not on during summer months. Basically, they are physically looking for things that are odd or unexpected.

If they suspect a cyber-physical attack is underway and it appears like the equipment is in the process of damaging itself, the FAC Team will immediately shut that piece of equipment down manually and ensure the equipment cannot be turned back on by the BCS. The FAC Team will lock-out the equipment until the BCS has been examined carefully by the Tech Team.

The FAC Team prepares a list of salvageable equipment and makes a preliminary assessment listing equipment that can be repaired, equipment that cannot be repaired, and equipment that does not require repair. Once they know which equipment was targeted, the FAC Team begins to assemble the manuals, drawings, parts lists and equipment documentation so they can begin the repair or replacement process.

At this point the FAC Team reports to the Recovery Procedures Coordinator with a preliminary estimate of the damage found and an educated estimate of the amount of time needed to effect repairs. Repairs that can be done in a matter of days are separated from those that will take months. The FAC Team also prepares a preliminary cost estimate for approval prior to commencing with requisition of replacement units.

One valuable tool that may be overlooked by management is the fact that although equipment has been damaged, sometimes a workaround can be pressed into service to partially restore service to allow continued occupation of the facility. For example, if the hot water boiler was damaged beyond repair in the summertime, is hot water heating a priority. Granted the HVAC system is designed to use reheat coils to optimize the temperature to a given space. Without hot water heating, the maintenance crew can temper the conditioning by raising the temperature of the chilled water circulating throughout the building. Instead of cooling the water to 48 degrees, simply circulate 56 degree water throughout. Some spaces will be a little warmer than usual, but the majority of the building will be comfortable.

Of course, it would be difficult to operate the building without potable water, but tanker trucks can deliver potable water as a temporary measure. And, in a crisis situation, the ideal is to have working toilets in the building but at a time of war, Portajohns may be all you can get.

The important thing is to start thinking about workarounds because you will need them. Add workarounds to the planning process and start and plan to use them. If there is no convenient outside connection to hook up a potable water truck or a portable water tank, perhaps now would be a good time to install one (in a secure location).

## BCS Network Integrity Checks

The IRT Tech Team begins by reviewing processes to identify malicious activity and anomalous symptoms (not attributed to hardware or software malfunctions). The Tech Team performs integrity checks using the procedures developed specifically for your building to identify malicious cyber activity. The Tech Team reviews host log files looking for unauthorized user account activity or user account changes. They verify network communications compared to the baseline and check the Registry on all servers and workstations looking for changes or anomalies. If a server or workstation is unresponsive, the Tech Team boots the machine from a Rescue CD and uses tools to identify any problems. The Tech Team checks the routers, switch and firewalls to determine if running configuration, startup configuration or operating system files have been modified and they check the devices for a rootkit.

The Tech Team verifies the network data flow compared to the baseline. They review the firewall log file looking for anomalies. They check the IDS configuration files, rules, operating system, firmware and log files to see if they have been modified. They also determine if the communications coming from the originating IP address should be communicating with the destination machines.

The Tech Team identifies the communications path between devices they are investigating and NetFlows. They will observe the data flow for anomalous traffic including ports, protocols and services not included in the Baseline Data Flow Table. They will document the originating asset and destination asset’s IP address.

## Server/Workstation Process Checks

The Tech Team will check servers and workstation log file looking for unauthorized activity. They check for processes that do not appear to be legitimate. This includes processes that have no icon or name, are unsigned Microsoft images, reside in the Windows directory, include unfamiliar URLs, communicate with unknown IP address or host suspicious DLL or services hiding as a DLL instead of a process.

The log review looks for unusual user activity, unfamiliar file names, unusually full log files or total cleared log files, unexpected configuration changes, unexpected system halts and reboots, file names with unusual characters and unexpected remote communications. The Tech Team captures the machine’s network status and stores it to a file. They then compare the network communications with the expected communications for that machine.

If the machine is unresponsive, the team does a “hard” reboot on the machine with the Rescue CD in the drive. They then perform diagnostics on the machine to determine if there is a good Master Boot Record, is there a problem with the memory, is there a hardware error and do the files appear accessible?

## BCS INTEGRITY CHECKS

|  |  |  |
| --- | --- | --- |
| Check | Device Integrity | Description |
|  | Computer Unresponsive | **BOOT** from Rescue CD, use tools to uncover problems. |
|  | Software Processes | **REVIEW** processes to identify malicious activity. Includes data base servers, control servers, HMIs, OPCs, master terminal units (MTUs), and engineering workstations. |
|  | Log Files | **REVIEW** database servers, HMIs, control server, engineering workstations, OPCs, MTUs and firewall log files for anomalies. |
|  | Registry | **IDENTIFY** changes and anomalies in the registry. |
|  | Rootkit | **CHECK** devices for a rootkit. |
|  | Network Communications | **VERIFY** network communications to the expected communications based on baseline. **VERIFY** data flow, and compare to baseline. |
|  | Unauthorized User Activity | **REVIEW** host log files for user account changes. |
|  | Firewalls | **DETERMINE** if configuration files, access control lists, operating system have been modified. **REVIEW** log file for anomalies or if log files have been modified. |
|  | Switches and Routers | **DETERMINE** if startup configuration, running configuration or operating system files have been modified. |
|  | Controllers | **VERIFY** the operating system, configuration files, and firmware against baseline. Includes PLCs, Intelligent electronic devices and remote terminal units. |
|  | Intrusion Detection System IDS Alerts – Inbound ICS Protocol | **DETERMINE** if IDS configuration files, rules, operating system, firmware, or log files have been modified. **DETERMINE** if the communications coming from the originating IP address should be communicating with the destination device. |
|  | Peripherals and Other Network Devices | **DETERMINE** if device has configuration files, operating systems and whether they have been modified. |

## BUILDING CONTROLS SYSTEM INFORMATION

|  |  |
| --- | --- |
| Date Updated |  |
| Unique Application ID |  |
| Application Name |  |
| Owner (e.g., Department, etc.) |  |
| Custodian (e.g., departmental IT staff, vendor) |  |
| Description |  |
| User Base/Scope |  |
| Business Function |  |
| Data Classification |  |
| Criticality |  |
| Date of Last Business Impact Analysis (BIA) |  |
| Operating System |  |
| Asset Tag |  |
| Serial Number |  |
| Licensing Information |  |
| Vendor (or, internally developed) |  |
| Maintenance Contract Expires |  |
| Maintenance Contact |  |
| Current Instances (e.g., production and test, test only, production only) |  |
| Program Language (s) |  |
| Internet Accessible |  |
| Requires own server |  |
| Desktop Data Storage (e.g., what files/configuration are required if app allows or requires storage of data on workstations) |  |
| External File Requirements |  |
| Domain Information |  |
| Service Account (s) |  |
| Storage Requirements |  |
| Seats/Units |  |
| Load Balancing |  |
| License Requirements |  |
| Protocol Requirements |  |
| Port Requirements |  |
| Network Requirements |  |
| IP Address/Range |  |
| Minimum Client Requirements |  |
| Encryption Requirements |  |
| Third Party Requirements (e.g., applications or software required) |  |
| Code Libraries |  |
| Known Bottlenecks |  |
| Batch Processing Details (e.g., scheduled tasks, duration, subtasks, etc.) |  |
| Backup Software |  |
| Backup Type |  |
| Backup Frequency/Schedule |  |
| Media |  |
| Offsite Storage Location |  |
| Generations Offsite |  |
| Source Code Backed Up? |  |
| Additional Details |  |
| Maintenance Window Details |  |
| Vendor /Internal contact information |  |
| Recovery Point Objective (RPO) |  |
| Recovery Time Objective (RTO) |  |
| Priority |  |
| Additional Details |  |
| Supporting Documentation Location |  |
| Additional Details |  |
| Application is dependent on the following hardware resources: |  |
| Other Processes dependent on this application: |  |
| Applications/services etc. dependent on this resource: |  |
| Applications/services etc. this resource is dependent on: |  |

This list should be filled out and kept current.

## BCS SERVER DETAILS

|  |  |
| --- | --- |
| Date Updated |  |
| Unique Hardware ID |  |
| Hardware Name |  |
| Rack location |  |
| Custodian (e.g., department IT staff, vendor) |  |
| User Base/Scope |  |
| Description |  |
| Hardware Make/Model (e.g., Dell PowerEdge R200) |  |
| Hardware Type |  |
| Data Classification |  |
| Criticality |  |
| Recovery Time Objective (RTO) |  |
| Date of Last Business Impact Analysis (BIA) |  |
| Location (e.g., building & room) |  |
| Rack ID (if applicable) |  |
| Asset Tag |  |
| Serial Number |  |
| Model Number |  |
| Vendor |  |
| Warranty Expires |  |
| Maintenance Contact |  |
| BTU (cooling requirements) |  |
| KVA (power consumption rate) |  |
| Processor (# and type) |  |

This list should be filled out and kept current.

## BUILDING INSPECTION

|  |  |
| --- | --- |
| Who Does the Inspection? | Facilities Engineers, Architects, Structural, Mechanical and Electrical Engineers, Security Officer, Safety Officer, City or County Building, Health and Fire Inspectors. |
| What Do They Inspect? | General property inspection and collection of records and if necessary, information needed to repair or replace damaged equipment. A **Rapid Inspection** is followed by a detailed **Engineering Inspection**. Engineers will inspect building columns, walls, ceilings, roof, masonry, windows and doors for obvious hazards. They will also inspect stairs and elevators for safety hazards. Stuck doors and sagging ceilings can be indicators of structural weakness. |
| Why Are They Doing the Inspection? | To identify damage in the building and reduce or permanently eliminate future risk to lives and property. Inspectors will take photographs and document the damage for reporting purposes and planning building repairs. |
| When Do They Do the Inspection? | Inspections are conducted immediately after the incident as soon as building is accessible and/or when allowed entry by local officials. |
| What is the Result of the Inspection? | Obtain the local permits, certificates of occupancy, and any other required documentation to demonstrate compliance with local building/zoning/life safety regulations. |
| What if the building does not pass inspection? | Develop a project plan and obtain necessary funding and approvals for building restoration and repairs. If the building is a complete loss, develop a plan to replace the building. |

|  |  |
| --- | --- |
| Agency | Contact Information |
| City Building Department |  |
| Dept. of Public Works |  |
| Fire Department |  |
| Emergency Management |  |
| CERT |  |
| FEMA |  |
| Electric Utility Company |  |
| Natural Gas Utility Company |  |
| Water and Sewer Utility |  |

## 

## EQUIPMENT OR SERVICE FAILURE REPORT

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Building: | |  | | Date: | | Report No.: | | |  | |
| Area affected and phenomenon or condition failure: | | | | Partial Failure | | | | Complete Failure | | |
|  | | | | | | | | | | |
| Mode of Discovery: | Alarm | | Rounds/ Inspection | | Abnormal Equip Operation | | Occupant Complaint | | | Preventive Maintenance |
| Description of equipment or services that failed: | | | | | | | | | | |
|  | | | | | | | | | | |
| Emergency or temporary measures and containment actions: | | | | | | | | | | |
|  | | | | | | | | | | |
| Final or subsequent repairs: | | | | | | | | | | |
|  | | | | | | | | | | |
| Repaired by: | | |  | | | | | | | |
| Defect: | Open | | Closed | | | | | | | |
|  | | | | | | | | | | |
| Remedial Action Required: | | | | | | | | | | |
|  | Yes  No | | | | | | | | | |
| Describe: | | | | | | | | | | |
|  | | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | | Maintenance personnel on duty at time of incident: | | |  |  | |  |  | |  |  | |
|  |
| Findings and Conclusions: |
|  |
| Was this a cyber-attack? |

|  |
| --- |
| Explain: |

## DAMAGE ASSESSMENT ACTIVITIES

|  |  |  |
| --- | --- | --- |
| **Building:** | **Location:** | **Date:** |

Utilizing the following checklist as a guideline, survey the building and systems to assess damage.

|  |  |
| --- | --- |
| **Building** | **NOTES:** |
| Exterior |  |
| Interior |  |
| Walls |  |
| Ceiling |  |
| Floor |  |
| Controls |  |
| Electrical |  |
| UPS |  |
| Transformers |  |
| Emergency/Building |  |
| HVAC |  |
| Air Handling |  |
| Air Conditioning |  |
| Fire Suppression |  |
| Building Operations Center |  |
| Servers |  |
| External Disk Drives |  |
| Tape Backup |  |
| Network Cabling |  |
| Communications |  |
| Workstations |  |
| Other Equipment |  |
| Tape Media |  |
| Spare Parts |  |
| Documentation |  |

|  |
| --- |
| Participants: |
|  |

|  |  |
| --- | --- |
| Is the area safe for employees or vendors to work in? | |
|  | |
| Can equipment under examination function, and if so, at what percent of normal capacity? | |
|  | |
| What must be done to recover damaged equipment? | |
|  | |
| How long will it take to repair or replace the damaged equipment? | |
|  | |
| Using the damage assessment, determine the estimated time to recover based on the following guidelines. | |
| **Level I - Minimal damage** to facility and/or equipment. Estimated time to complete repairs is less than 4 hours.  **Level II - Moderate damage** to facility and/or equipment. Estimated time to complete repairs is between 4 hours and 2 business days.  **Level III - Extensive damage** to facility and/or equipment. Estimated time to complete repairs is greater than 2 business days. | |
|  | Identify equipment or spare parts which are immediately salvageable or in need of repair. |
|  | Verbally notify the Management Team of survey, assessment of damage, estimated time to recover. |
|  | Document findings from the survey and damage assessment. |
|  | Attend the recovery briefing to apprise Incident Recovery Team members of findings. |
|  | A log is prepared and maintained to record all salvageable equipment and its disposition and location. |

## RAPID INSPECTION CHECKLISTS

Use the checklists on the following pages to document the condition of building equipment after a rapid inspection and describe the extent of damage found on the following table.

### COOLING TOWER

### Rapid Inspection Checklist

**Cooling Tower No.: CT-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | 2 way Makeup water. |
|  | 2 way Blowdown to drain. |
|  | 2 way CWR and CWS isolation valve. |
|  | Cooling tower fan VFD. |
|  | 2 way Bypass Valve on CWR condenser. |
|  | Vibration Cutout Switch. |
|  | Pressure ports and flow sensors |
|  | Temperature sensing wells |
|  | Electrical |
|  | Tower fan drive |
| ☐ | Motor fan rotation |
| ☐ | System interlocks functional |
| ☐ | Power available to tower disconnect |
| ☐ | Power available to electric sump heater |
|  | Controls |
| ☐ | Makeup control valve shutoff |

1. Activate cooling tower fan start using control system command. This should first start the condenser water pump, establish flow, delay fan start to equalize flow in distribution basis and sump.
2. After chiller startup, control system should modulate bypass valve and two-speed fan motor to maintain condenser water set point. Verify function of bypass valve under varying loads.
3. Verify cooling tower interlock with chiller.
4. Verify makeup water float valve is functioning.
5. Activate chemical treatment feed valve, verify makeup of chemical treatment system, pump and controls.
6. Stop all building cooling equipment so that cooling tower pumps stop. Observe tower for at least 15 minutes and verify no overflow occurs.
7. Start cooling tower pumps in hand mode and observe pumps for air binding/cavitation.

Modify for your specific building.

### BOILER OR PRESSURE VESSEL

### Rapid Inspection Checklist

**Boiler No.: BR-1**

|  |  |  |
| --- | --- | --- |
| Check | Physical Inspection | |
|  | Inspect access doors are operable and sealed. | |
|  | Verify boiler water level. | |
|  | Check that all stack dampers are open. | |
|  | Examine the boiler furnace for foreign material. | |
|  | Check the furnace and flue passes for fuel accumulation. | |
|  | Make sure the manual fuel valves are open. | |
|  | Check all ventilation and combustion air openings and louvers are clean and free of debris. | |
|  | Verify operation of all operating and limit controls, interlocks and gage | |
|  | Monitor main flame. | |
|  | Boiler Fuel | |
|  | Fuel is available to boiler. | |
|  | Check fuel pressure. | |
|  | Check fuel throughput. | |
|  | Electrical | |
|  | Power available to unit disconnect. | |
|  | Power available to unit control panel. | |
|  | Check flame signal. | |
|  | Check automatic safety shutoff. | |
|  | Check trip circuit for proper operation. | |
|  | Coils |
|  | Check supply water temperature. |
|  | Check flue gas temperature |
|  | Controls |
|  | Control valves operable. |
|  | Control actuators operable. |
|  | Dampers operable. |
|  | Damper actuators operable. |
|  | Check 02 valve. |
|  | Check gas fuel volume. |
|  | Air Measuring Stations operational. |
|  | Check feed water pump operation. |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Filters are not clogged or blocked. |
|  | Boiler fully operational. |

### BOILER VISUAL INSPECTION

### ****Cyber Attack Tree****

|  |  |
| --- | --- |
| How adversary can attack boilers | |
|  | Power failure - the entire system is de-energized, closing all automatic valves and halting all boiler operations. |
|  | Low water switch opens, BCS thinks there is insufficient water in the boiler. |
|  | External gas-supply shut-off valve is closed so BCS thinks a low gas condition results. |
|  | High gas pressure switch opens, the BCS thinks burner operation is interrupted and the boiler locks out. |
|  | BCS thinks boiler water has exceeded both the operating and high-limit temperature the high limit switch opens, and the boiler will remain locked out until the water high limit switch is manually reset. |
|  | **FLAME ERROR** - BCS thinks there is a flame failure, the main fuel valves are de-energized and a manual reset lockout occurs. |
|  | **BLOCKED FLUE** error code sent indicating the high exhaust back pressure switch has tripped. |
| ☐ | **AIR SWITCH NOT OPEN** or **AIR SWITCH NOT CLOSED** error codes so BCS thinks there is improper airflow through the boiler. |

Begin by looking for evidence of bulges, cracks or other deformities. Check for cracked glass on gages and bent pointers on meters. Check draft, manifold pressure and combustion. Observe condition of flame. Flame should not impinge on furnace walls. Test the low water fuel cutoffs for proper sequencing and operation. Blow down the boiler. Check water column or glass gage. Observe operation of condensate or vacuum pumps. Check operation of chemical feed pots and feed pumps. Test flame detection devices and associated automatic fuel cutoff valves. Inspect condensate return valves radiators and traps. Blow down strainers. Inspect fuel supply systems and piping in boilers. Replace cartridges for in-line oil filters. Check safety valves and test with tri-level.

Inspect burner assembly. Clean, check and adjust electrodes. If the boiler is equipped with an air-to-fuel ratio control system, ensure the control system is operating in accordance with the manufacturers specifications. Inspect control equipment for proper sequencing and operation.

Check expansion tank and air eliminator equipment. Check breaching and stack for tightness.

### BOILER OR PRESSURE VESSEL

**Boiler No.:** **BR-1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HOT WATER SYSTEM CHECKLIST | | | | | | | | | | | | | | |
| Building: |  | | Location: | | |  | | | Job Number: | |  | | | |
| Equipment: |  | | Hot Water Loop: | | |  | | | | |  | | | |
| Test Equipment: |  | | | | | Tested By: | |  | | | | | | |
| Boiler Name: | | | Boiler Function: | | | | | Boiler Type: | | | Capacity: | | | |
|  | | |  | | | | |  | | |  | | | |
| Boiler Manufacturer: | | | Model No. | | | | | Serial No. | | | MAWP: | | | |
|  | | |  | | | | |  | | |  | | | |
| VISUAL AND MECHANICAL INSPECTION | | | | | | | | | | | | | |
| Internal Inspection | | SAT | | UNSAT | | | Operational | | | SAT | | UNSAT | |
| Combustion Chamber | |  | |  | | | Gas Boilers | | | | | | |
| Brickwork | |  | |  | | | Start in low Fire | | |  | |  | |
| Insulation | |  | |  | | | Loss of Combustion Air | | |  | |  | |
| Elec/Mech Interlocks | |  | |  | | | Low Gas Pressure | | |  | |  | |
| Fire/Water Tubes | |  | |  | | | High Gas Pressure | | |  | |  | |
| Burner Nozzle | |  | |  | | | Fuel Oil Burners | | | | | | |
| Steam Drum | |  | |  | | | Start in Low Fire | | |  | |  | |
| Stack/Flue | |  | |  | | | Loss of Combustion Air | | |  | |  | |
| Blow off Valve | |  | |  | | | Loss of Atomizing Air | | |  | |  | |
| External Inspection | | | | | | | Low Oil Pressure | | |  | | |  |
| Programmer | |  | | |  | | Burner Straw Switch (if applicable) | | |  | | |  |
| Low Water/Fuel Cutouts | |  | | |  | | Proximity Switch (if applicable) | | |  | | |  |
| Water Column | |  | | |  | | All Boilers | | | | | | |
| Pressure Gage | |  | | |  | | Flame Sensor | | |  | | |  |
| Review Record Logs (weekly/month) | |  | | |  | | Low Water Cut Off (left/right) | | |  | | |  |
| Condensing Neutralizer Installed | |  | | |  | | Feed Pump/Recirculating Pump | | |  | | |  |
|  | |  | | |  | | Normal Trip | | |  | | |  |
| Hydrostatic Test | |  | | |  | | Flame Pattern Inspection | | |  | | |  |
| Backflow Preventer | |  | | |  | | Water Treatment | | |  | | |  |
|  | |  | | |  | | High Trip | | |  | | |  |
| Date of last Combustion Tuning | |  | | | | | Emergency Stop | | |  | | |  |
| Date of last waterside inspection | |  | | | | | Combustion Tuning | | |  | | |  |
| Date of last 150% Strength Hydro | |  | | | | | Combustion (Air/Fuel) Control System | | |  | | |  |
|  | |  | | | | | Test Relief Valve Under Pressure | | |  | | |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Boiler Efficiency | | | | | | |
|  | Oxygen % | CO ppm | CO2% | SO2 ppm | NO ppm | Stack Temp. |
| Gas Fired |  |  |  |  |  |  |
| Oil Fired |  |  |  |  |  |  |
|  | | | | | | |
| Burner Assy. | Model | BTU Range | S/N | Programmer | | |
|  |  |  |  |  | | |
|  | | | | | | |
|  | Manufacturer | Size | PSI | BTU/Hr | | |
| Safety/Relief Valve |  |  |  |  | | |
| Gage |  |  |  |  | | |
| Inspector: |  | | | | | |
|  | | | | Certification Expires: |  | |

Fill out one form for each boiler. Modify for your specific building.

### CHILLED WATER SYSTEM

### Rapid Inspection Checklist

**Chiller No.: CH-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Inspect access doors are operable and sealed. |
|  | Verify refrigerant level. |
|  | Check chilled water pump, flow and control valve. |
|  | Check for closed shutoff valves. |
|  | Check sensors, controllers, and set point, actuator/positioners. |
|  | Check filters and fans. |
|  | Check controls, switches, starters and disconnects. |
|  | Check expansion tank and air separator. |
|  | Check safeties and interlocks to fire protection system. |
|  | Inspect for oil leaks and check oil level. |
|  | Check pH of chilled water |
|  | Check pH of condenser water |
|  | Inspect purge unit operation. |
|  | Sample condenser water. |
|  | Inspect V-belts (vapor compression chillers). |
|  | Sample lithium bromide for testing (absorption chillers only). |
|  | Electrical |
|  | Power available to unit disconnect. |
|  | Power available to unit control panel. |
|  | Check refrigerant heaters. |
|  | Check power supply. |
|  | Controls |
|  | Control valves operable. |
|  | Control actuators operable. |
|  | Check Program Logic Controller. |
|  | Damper actuators operable. |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Filters are not clogged or blocked. |
|  | Chillers fully operational. |

### CHILLER VISUAL INSPECTION

### ****Cyber Attack Tree****

|  |  |
| --- | --- |
| How adversary can attack chillers | |
|  | Low pressure trip - BCS thinks refrigerant is low, low or no water flow; clogged water filter or screen. |
|  | High pressure trip - BCS thinks water-cooled condenser has poor or no flow; air-cooled condenser is blocked with debris or has a fan not working; or that the chilled water tank temperature is too high. |
|  | Oil failure trip - BCS thinks either low superheat or low oil. |
|  | Freezestat - BCS thinks poor water flow, or that the thermostat is set too low. |
|  | Blown fuses or starter trips - BCS over-amped motor, compressor or wires. |
|  | System not reaching thermostat setpoint - BCS thinks evaporator is iced up. |
|  | Proof of flow - BCS thinks either flow or pressure switches in water circuit are suffering from low or no flow, water filter is blocked or water valve shut off. |

1. Begin by looking for indicators or codes that come up on the diagnostic readouts
2. Make a visual inspection of the electrical panel, water piping, and pump tank system.
3. Look for obvious problems such as burned or broken wires, water pump not running, water valves shut off, and improper system water temperature.
4. Is the chiller running and not cooling, or not running at all?
5. Is the pump circulating water? What is the water temperature?
6. If the chiller isn’t running, check the high voltage circuits.
7. Does the chiller have power? Check all the fuses.
8. Start at the power side of the control transformer and check wire by wire. Trace the power wire from safety to safety.
9. Check the water flow switch and the freezestat control.
10. Strap temperature probes on the suction, discharge, and liquid lines.
11. Watch all the pressures, temperatures and amperages.

### CHILLED WATER SYSTEM CHECKLIST

**Chiller No.: CH-1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Building: |  | Location: |  | | | Job Number: |  |
| Equipment: |  | Cooling Water Loop: |  | | | |  |
| Test Equipment: |  | | Tested By: | |  | | |
| Chiller Manufacturer: | | Model No. | | Serial No. | | | BTU Rating: |
|  | |  | |  | | |  |
| Pump Manufacturer: | | Model No. | | Serial No. | | | Rated Flow: |
|  | |  | |  | | |  |
| HP @ RPM |  | Rated NPSH |  | | | Rated Pressure |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| VISUAL AND MECHANICAL INSPECTION | | | | | |
|  | | CONDITION |  | | CONDITION |
| Exterior of Equipment |  |  | Equipment Identification |  |  |
| Completeness of Assembly |  |  | Bracing |  |  |
| Equipment Rotation |  |  | Labeling and Tagging |  |  |
| Elec/Mech Interlocks |  |  | Safety Interlocks |  |  |
| Instruments |  |  | Working Space |  |  |
| Proper Grounding |  |  | Anchorage |  |  |
| Proper Insulation |  |  | System Flushed and Cleaned |  |  |
| Tightness of Bolts |  |  | Compare to Drawings |  |  |
| Proper Lubrication |  |  | Control System |  |  |
| Refrigerant Installed |  |  | Water Treatment Installed |  |  |

CONDITION: A-ACCEPTABLE; R-NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C- CORRECTED; NA-NOT APPLICABLE

|  |  |  |
| --- | --- | --- |
| **CALIBRATION AND SETPOINT** | | |
|  | DESCRIPTION | NOTES |
| Sensors | Pressure, temperature and condition sensors checked OK |  |
| Controllers | Control system interfaces with BCS |  |
| Actuators | Exercise annually for valve control |  |
| Relief Valves Checked | Exercise annually for valve operation limits |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HYDRONIC SYSTEM TESTS | | | | | |
|  | Operating Mode | Temperature | Pressure | Flows | Levels |
| Chiller |  |  |  |  |  |
| Pump |  |  |  |  |  |
| Hydrostatic Test |  |  |  |  |  |
| Balance Test |  |  |  |  |  |
| Cooling Coil Number |  |  |  |  |  |
| Expansion Tank/Air Separator |  |  |  |  |  |
| Control Valves |  |  |  |  |  |
| System test | Performed Annually |  |  |  |  |
| Notes: | | | | | |
|  | | | | | |

### AIR HANDLING UNIT CHECKLIST

### Rapid Inspection Checklist

**AIR HANDLER No.: AHU-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Inspect access doors are operable and sealed. |
|  | Condensate drainage is unobstructed. (Verify drainage by pouring a cup of water into drain pan.) |
|  | Check fan belt operation and adjustment. |
|  | **Electrical** |
|  | Power available to unit disconnect. |
|  | Power available to unit control panel. |
|  | Proper motor rotation verified. |
|  | Verify that power is stable at proper voltage. |
|  | UV light is fully operational. |
|  | **Coils** |
|  | Chilled water piping properly connected. |
|  | Hot water piping properly connected. |
|  | **Controls** |
|  | Control valves operable. |
|  | Control actuators operable. |
|  | Dampers operable. |
|  | Damper actuators operable. |
|  | Verify proper operation of duct static pressure sensor. |
|  | Fan air volume controller operable. |
|  | Air Measuring Stations operational. |
|  | Air handler controls system operational. |
|  | **Testing, Adjusting, and Balancing (TAB)** |
|  | Filters are not clogged or blocked. |

Fill out one form for each air handling unit. Modify for your specific building.

### AIR HANDLING UNIT VISUAL INSPECTION

### ****Cyber Attack Tree****

**AIR HANDLER No.: AHU-1**

1. Begin by looking for indicators or codes that come up on the diagnostic readouts.
2. Is the system low in airflow?
3. Check parameters such as pressure, power, speed, elevation, and temperature.
4. Check actual airflow compared to the desired airflow.
5. Document test measurements and their locations.
6. Check all driveline components such as bearings, couplings, v-belts, and motors.
7. Ensure that the fan wheel is properly aligned with the inlet bell and housing, is free to turn, and turns in the right direction.
8. Check the fan and system for any obstructions, build-up, leaks, or missing parts
9. Run the fan at full speed, verifying that it’s running close to the design speed.
10. Check that the fan is running smoothly and that the bearings aren’t running hot.
11. Make sure the fan isn’t overloading the motor.

Air handlers are controlled by the BCS which has the ability to turn the system’s fans on or off, and open and close the dampers. Verify the BCS configuration setpoints and time clock, to ensure that it’s giving the fan the correct command to operate, and is opening and closing the appropriate dampers.

Air handlers have variable frequency drives that adjust the fan speeds based on static pressure in the ductwork. When a VFD isn’t receiving a signal from the BCS, it will either default to its minimum speed, or its high speed.

### COMPUTER ROOM AIR CONDITIONER

### Rapid Inspection Checklist

**CRAC No.: CR-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Inspect access doors are operable and sealed. |
|  | Condensate drainage is unobstructed. (Verify drainage by pouring a cup of water into drain pan.) |
|  | Check fan belt operation and adjustment. |
|  | Electrical |
|  | Power available to unit disconnect. |
|  | Proper motor rotation verified. |
|  | Proper motor rotation verified. |
|  | Verify that power is stable at proper voltage. |
|  | Coils/Humidifier |
|  | Chilled water piping properly connected. |
|  | Hot water piping properly connected. |
|  | Controls |
|  | Control valves operable. |
|  | Unit control system operable and verified. |
|  | Verify proper operation of thermostat. |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | CRAC unit is operating properly. |

### PUMP - PRIMARY CHILLED WATER

### Rapid Inspection Checklist

**Pump No.: PCHW-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Piping system inspected. |
|  | Electrical |
|  | Power available to pump disconnect. |
|  | Pump rotation verified. |
|  | Control system interlocks functional. |
|  | VFD operation verified (where applicable). |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Pressure/temperature gauges operating. |

#### Pump Control Questions

1. What causes the pump to initially start?
2. What causes the pump to cycle?
3. How is capacity controlled?
4. What is the differential pressure control point?
5. Is there is a lead/lag strategy?
6. Are pumps staged?

### PUMP - SECONDARY CHILLED WATER

### Rapid Inspection Checklist

**Pump No.: SCHW-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Piping system inspected. |
|  | Electrical |
|  | Power available to pump disconnect. |
|  | Pump rotation verified. |
|  | Control system interlocks functional. |
|  | VFD operation verified (where applicable). |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Pressure/temperature gauges operating. |

#### Pump Control Questions

1. What causes the pump to initially start?
2. What causes the pump to cycle?
3. How is capacity controlled?
4. What is the differential pressure control point?
5. Is there is a lead/lag strategy?
6. Are pumps staged?

### PUMP - PRIMARY DOMESTIC HOT WATER

### Rapid Inspection Checklist

**Pump No.: PDHW-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Piping system inspected. |
|  | Electrical |
|  | Power available to pump disconnect. |
|  | Pump rotation verified. |
|  | Control system interlocks functional. |
|  | VFD operation verified (where applicable). |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Pressure/temperature gauges operating. |

#### Pump Control Questions

1. What causes the pump to initially start?
2. What causes the pump to cycle?
3. How is capacity controlled?
4. What is the differential pressure control point?
5. Is there is a lead/lag strategy?
6. Are pumps staged?

### PUMP - SECONDARY DOMESTIC HOT WATER

### Rapid Inspection Checklist

**Pump No.: SDHW-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Piping system inspected. |
|  | Electrical |
|  | Power available to pump disconnect. |
|  | Pump rotation verified. |
|  | Control system interlocks functional. |
|  | VFD operation verified (where applicable). |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Pressure/temperature gauges operating. |

**Pump Control Questions**

1. What causes the pump to initially start?
2. What causes the pump to cycle?
3. How is capacity controlled?
4. What is the differential pressure control point?
5. Is there is a lead/lag strategy?
6. Are pumps staged?

### FAN COIL UNIT

### Rapid Inspection Checklist

**Fan Coil Unit No.: FCU-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Inspect access doors are operable and sealed. |
|  | Condensate drainage is unobstructed. |
|  | Check fan belt operation and adjustment. |
|  | Electrical |
|  | Power available to unit disconnect. |
|  | Power available to unit control panel. |
|  | Proper motor rotation verified. |
|  | Verify that power is stable at proper voltage. |
|  | Coils |
|  | Chilled water piping properly connected. |
|  | Hot water piping properly connected. |
|  | Controls |
|  | Control valves operable. |
|  | Control actuators operable. |
|  | Verify proper operation of thermostat. |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Pressure/temperature gauges operating. |

Fill out one form for each fan coil unit. Modify for your specific building

### DIESEL BACKUP GENERATOR

### Rapid Inspection Checklist

**Generator No.: DG-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Access doors are operable and sealed. |
|  | Recovery system ductwork is unobstructed and clean. |
|  | Recovery system wheel operational. |
|  | Cooling system is operating properly. |
|  | Electrical |
|  | Power available to unit disconnect. |
|  | Power available to unit control panel. |
|  | Proper engine rotation verified. |
|  | Verify that power is stable at proper voltage. |
|  | Generator Fuel |
|  | Fuel is available to generator. |
|  | Diesel fuel is not contaminated. |
|  | Controls |
|  | Engine control properly programmed. |
|  | Control dampers/actuators operable. |
|  | Outside Air Flow Measurement Arrays operable. |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Filters removed and replaced. |

### DIESEL SYSTEM CHECKLIST

**Generator No.: DG-1**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DIESEL SYSTEM CHECKLIST | | | | | | | | | | | |
| Building: |  | | Location: | |  | | | | | Job Number: |  |
| Equipment: |  | | System Designation: | | | |  | | | |  |
| Test Equipment: |  | | | | Tested By: | | |  | | | |
| Pump Manufacturer: | | | Model No. | | | | | | | Serial No. | Flow Rating gpm: |
|  | | |  | | | | | | |  |  |
| Type: | | | HP @ RPM | | | | | | | Pressure Rating psig: | |
|  | | |  | | | | | | |  | |
| Heater Manufacturer: | | | Model No. | | | | | | | Serial No. | Flow Rating gpm: |
|  | | |  | | | | | | |  |  |
| Cooler Manufacturer: | | | Model No. | | | | | | | Serial No. | Flow Rating gpm: |
|  | | |  | | | | | | |  |  |
| VISUAL AND MECHANICAL INSPECTION | | | | | | | | | | | |
|  | | | | CONDITION | |  | | | | | CONDITION |
| Exterior of Equipment | |  | |  | | Equipment Identification | | |  | |  |
| Completeness of Assembly | |  | |  | | Bracing | | |  | |  |
| Equipment Rotation | |  | |  | | Labeling and Tagging | | |  | |  |
| Elec/Mech Interlocks | |  | |  | | Safety Interlocks | | |  | |  |
| Instruments | |  | |  | | Working Space | | |  | |  |
| Proper Grounding | |  | |  | | Anchorage | | |  | |  |
| Proper Insulation | |  | |  | | Leaks | | |  | |  |
| Tightness of Bolts | |  | |  | | Compare to Drawings | | |  | |  |
| Proper Lubrication | |  | |  | | Control System | | |  | |  |

CONDITION: A-ACCEPTABLE; R-NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C- CORRECTED; NA-NOT APPLICABLE

|  |  |  |
| --- | --- | --- |
| CALIBRATION AND SETPOINT | | |
|  | DESCRIPTION | NOTES |
| Sensors | Main tank levels are consistent with sensor readings |  |
| Controllers | Main tank controllers indicate all conditions normal |  |
| Actuators | NA |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HYDRONIC SYSTEM TESTS | | | | | |
|  | Operating Mode | Temperature | Pressure | Flows | Levels |
| Pump |  |  |  |  |  |
| Heater |  |  |  |  |  |
| Cooler |  |  |  |  |  |
| Engine |  |  |  |  |  |
| Hydrostatic Test |  |  |  |  |  |
| System test | Performed Annually |  |  |  |  |
| Notes: | | | | | |

### LUBE OIL SYSTEM

### Rapid Inspection Checklist

**Lube Oil System No.: LO-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Access doors are operable and sealed. |
|  | Recovery system ductwork is unobstructed and clean. |
|  | Recovery system wheel operational. |
|  | Cooling system is operating properly. |
|  | **Electrical** |
|  | Power available to unit disconnect. |
|  | Power available to unit control panel. |
|  | Proper engine rotation verified. |
|  | Verify that power is stable at proper voltage. |
|  | **Lube Oil** |
|  | Lube oil is available. |
|  | Lube oil is not contaminated. |
|  | **Controls** |
|  | Engine control properly programmed. |
|  | Control dampers/actuators operable. |
|  | Outside Air Flow Measurement Arrays operable. |
|  | **Testing, Adjusting, and Balancing (TAB)** |
|  | Filters removed and replaced. |
|  | TAB report approved. |

### LUBE OIL SYSTEM CHECKLIST

**Lube Oil System No.: LO-1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| LUBE OIL SYSTEM CHECKLIST | | | | | | |
| Building: |  | Location: |  | | Job Number: |  |
| Equipment: |  | System Designation: |  | | |  |
| Test Equipment: |  | | Tested By: |  | | |
| Pump Manufacturer: | | Model No. | | | Serial No. | Flow Rating gpm: |
|  | |  | | |  |  |
| Type: | | HP @ RPM | | | Pressure Rating psig: | |
|  | |  | | |  | |
| Heater Manufacturer: | | Model No. | | | Serial No. | Flow Rating gpm: |
|  | |  | | |  |  |
| Cooler Manufacturer: | | Model No. | | | Serial No. | Flow Rating gpm: |
|  | |  | | |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| VISUAL AND MECHANICAL INSPECTION | | | | | |
|  | | CONDITION |  | | **CONDITION** |
| Exterior of Equipment |  |  | Equipment Identification |  |  |
| Completeness of Assembly |  |  | Bracing |  |  |
| Equipment Rotation |  |  | Labeling and Tagging |  |  |
| Elec/Mech Interlocks |  |  | Safety Interlocks |  |  |
| Instruments |  |  | Working Space |  |  |
| Proper Grounding |  |  | Anchorage |  |  |
| Proper Insulation |  |  | Leaks |  |  |
| Tightness of Bolts |  |  | Compare to Drawings |  |  |
| Proper Lubrication |  |  | Control System |  |  |

CONDITION: A-ACCEPTABLE; R-NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C- CORRECTED; NA-NOT APPLICABLE

|  |  |  |
| --- | --- | --- |
| CALIBRATION AND SETPOINT | | |
|  | DESCRIPTION | NOTES |
| Sensors | Main tank levels are consistent with sensor readings |  |
| Controllers | Main tank controllers indicate all conditions normal |  |
| Actuators | NA |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HYDRONIC SYSTEM TESTS | | | | | |
|  | **Operating Mode** | **Temperature** | **Pressure** | **Flows** | **Levels** |
| **Pump** |  |  |  |  |  |
| **Heater** |  |  |  |  |  |
| **Cooler** |  |  |  |  |  |
| **Engine** |  |  |  |  |  |
| **Hydrostatic Test** |  |  |  |  |  |
| **System test** | Performed Annually |  |  |  |  |
| **Notes:** | | | | | |

### VENTILATION SYSTEM CHECKLIST

### Rapid Inspection Checklist

**Ventilation System No.: V-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Fan belt operating and adjusted. |
|  | Electrical |
|  | Power available to fan disconnect. |
|  | Proper motor rotation verified. |
|  | Verify that power is stable at proper voltage. |
|  | Controls |
|  | Control interlocks properly operating. |
|  | Control interlocks operable. |
|  | Dampers/actuators properly operating. |
|  | Dampers/actuators operable. |
|  | Verify proper operation of thermostat. |
|  | Testing, Adjusting, and Balancing (TAB) |
|  | Exhaust fan operating properly. |

Fill out one form for each ventilation system. Modify for your specific building.

### VENTILATION SYSTEM

### Rapid Inspection Checklist

**Ventilation System No.: V-1**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| VENTILATION SYSTEM CHECKLIST | | | | | | | | | | |
| Building: |  | | Location: | |  | | Job Number: | |  | |
| Equipment: | |  | | | Air Loop Designation: | | |  | | |
| Test Equipment: | |  | | | Tested By: | | |  | | |
| Fan Manufacturer: | | | | Model No. | | Serial No. | | | | Rated Flow cfm: |
|  | | | |  | |  | | | |  |
| Fan Type: | | | | HP @ RPM | | Rated Pressure psig: | | | | |
|  | | | |  | |  | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| VISUAL AND MECHANICAL INSPECTION | | | | | |
|  | | CONDITION |  | | CONDITION |
| Exterior of Equipment |  |  | Equipment Identification |  |  |
| Completeness of Assembly |  |  | Bracing |  |  |
| Equipment Rotation |  |  | Labeling and Tagging |  |  |
| Elec/Mech Interlocks |  |  | Safety Interlocks |  |  |
| Instruments |  |  | Working Space |  |  |
| Proper Grounding |  |  | Anchorage |  |  |
| Proper Insulation |  |  | Leaks |  |  |
| Tightness of Bolts |  |  | Compare to Drawings |  |  |
| Proper Lubrication |  |  | Control System |  |  |
| Condensate Drip Pans |  |  | Filters |  |  |

CONDITION: A-ACCEPTABLE; R-NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C- CORRECTED; NA-NOT APPLICABLE

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HYDRONIC SYSTEM TESTS | | | | | |
|  | Operating Mode | Temperature | Pressure | Flows | Levels |
| Chiller |  |  |  |  |  |
| Pump |  |  |  |  |  |
| Hydrostatic Test |  |  |  |  |  |
| Balance Test |  |  |  |  |  |
| Cooling Coil Number |  |  |  |  |  |
| Expansion Tank/Air Separator |  |  |  |  |  |
| Control Valves |  |  |  |  |  |
| System Test | Performed Annually |  |  |  |  |
| Notes: | | | | | |
|  | | | | | |

|  |  |  |
| --- | --- | --- |
| CALIBRATION AND SETPOINT | | |
|  | DESCRIPTION | NOTES |
| Sensors | Checked sensors with standard |  |
| Controllers | Cycled controllers for response |  |
| Actuators | Checked full operation from fully open to fully closed |  |
| Fire Dampers Checked | Actuated fire dampers. Checked for proper operation |  |
| Smoke Dampers Checked | Actuated smoke dampers. Checked for proper operation |  |

Fill out one form for each piece of ventilation equipment. Modify for your specific building.

### ELECTRICAL SWITCHGEAR INSPECTION

### Cyber Attack Tree

|  |  |
| --- | --- |
| How adversary can attack electrical switchgear | |
|  | Send invalid disconnect messages to meters. |
|  | Compromised head end. |
|  | Blocked DR messages. |
|  | Improper DRAS configuration causes inappropriate DR messages. |
|  | Spurious trip parameters added trips unit offline. |
|  | Equipment tripped offline thru vendor remote connection. |
|  | Improper firewall rule configuration allows direct access from another network. |
|  | Adversary sends DR message that cause services to send “last gasp” or “self-test failed” messages direct to devices. |
|  | Meter reconfigured via optical port. |
|  | Flood communications channel with other messages prevent legitimate DR messages from being received and transmitted. |
|  | Modify DRAS configuration to send DR messages at incorrect times or to incorrect devices. |
|  | Manufactures an artificial cascade to trigger Blackout through sequential tripping of select feeders and components causing automated tripping due to power and voltage fluctuations. |
|  | Stop flow of wireless communications between devices. |
|  | Overwhelm alarm processing capability by sending unnecessary alarms. |

### ELECTRICAL SWITCHGEAR CHECKLIST

### Rapid Inspection Checklist

**Switchgear No.: S-1**

|  |  |
| --- | --- |
| Check | Physical Inspection |
|  | Check nameplate information. |
|  | Inspect covers, panels and doors. |
|  | Check for smooth and proper movement of racking mechanisms, shutter, rollers, rails and guides. |
|  | Check alignment of primary and secondary contacts. |
|  | Check operation of mechanical interlocks. |
|  | Electrical |
|  | Check phasing connection of busbar. |
|  | Perform mechanical check and visual inspection for breaker. |
|  | Perform electrical check and visual inspection for transformers. |
|  | Perform mechanical check and visual inspection on disconnect switches. |

Fill out one form for each piece of equipment. Modify for your specific building.

### REPAIR WORK ORDER LISTING

|  |  |  |  |
| --- | --- | --- | --- |
| Priority | Task Number | Summary | Estimated Completion Date |
|  |  |  |  |
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### RESTART OPERATING CONDITIONS

### Reassessment

Repaired equipment shall be reassessed by comparing current conditions with normal operating conditions. A report shall be prepared with recommendations when building can be reoccupied.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Conditioned Space Temperature | | | | | | |
| Operating Range: |  | to |  | deg F. Current Conditions: |  | deg F. |
| Unconditioned Space Temperature | | | | | | |
| Operating Range: |  | to |  | deg F. Current Conditions: |  | deg F. |
| Duct Temperature | | | | | | |
| Operating Range: |  | to |  | deg F. Current Conditions: |  | deg F. |
| Outside Air Temperature | | | | | | |
| Operating Range: |  | to |  | deg F. Current Conditions: |  | deg F. |
| High Temperature Hot Water | | | | | | |
| Operating Range: |  | to |  | deg F. Current Conditions: |  | deg F. |
| Chilled Water | | | | | | |
| Operating Range: |  | to |  | deg F. Current Conditions: |  | deg F. |
| Heating Hot Water | | | | | | |
| Operating Range: |  | to |  | deg F. Current Conditions: |  | deg F. |

### BUILDING CONTROLS POINT-TO-POINT CHECKS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **HVAC** | | | | | | | | | | |
| **Building:** |  | | | **Equipment:** | | | | | **Date:** |  |
| **Point** | | | **Output** | | | | **Input** | | **Accept** | **Comment** |
| **Description** | | **Name** | **DO** | **AI 0%** | **AI 50%** | **AI 100%** | **DI** | **AI** | **Y/N** |  |
|  | |  |  |  |  |  |  |  |  |  |
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| **Checked By:** | | | X \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | **Date:** |  |
| **Verified By:** | | | X \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | **Date:** |  |

### OTHER EQUIPMENT TO BE CHECKED

|  |  |
| --- | --- |
| System | Description |
| Fire Detection System |  |
| Parking Controls System | Has been done before. British airport garage was hacked, preventing parking controls from allowing autos to enter garage causing flight delays. |
| Traffic Barriers |  |
| Elevators |  |
| Fire Pump |  |
| Smoke Evac System |  |
| Lighting Controls |  |
| Security Systems |  |
| CCTV |  |
| Access Control System |  |
| Storm Drainage System |  |
| Incinerators |  |
| Fire Sprinkler System |  |
| Domestic Hot Water System |  |
| Cable TV System |  |
| Public Address System |  |
| Energy Recovery Systems |  |
| Solar Energy System |  |
| Medium Voltage Electrical Distribution System |  |
| Low Voltage Electrical Distribution System |  |
| Electric Power Monitoring System |  |
| Duress Alarm Systems |  |
| Sewerage Pump System |  |
| Wastewater Pump System |  |
| Storm Drainage Utilities |  |
| Sanitary Sewerage Utilities |  |
| Door Locking System |  |

# PHASE 3 - RECOVERY

Effective recovery after a cyber-physical attack requires ensuring that new reintegration devices will not be re-infected. The only way to avoid this problem is to verify that each device on the network is clean of any cyber incident remnants. All devices in the network should be replaced or re-flashed with known, good firm/software to provide confidence that re-infection will not occur.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Task No. | Prior Task | Description | IRT Team | Est. Start | Est. Finish |
|  |  | **RESTART** undamaged equip – manual control | FAC |  |  |
|  |  | **PURCHASE** new building equipment | FAC |  |  |
|  |  | **INSTALL** new building equipment | FAC |  |  |
|  |  | **RUN** new equip - manual mode | FAC |  |  |
|  |  | **RECEIVE** new BCS IT equipment | Tech |  |  |
|  |  | **INSTALL** BCS software from vendor CD-ROMs | Tech |  |  |
|  |  | **INSTALL** new BCS servers | Tech |  |  |
|  |  | **BOOT** the BCS servers | Tech |  |  |
|  |  | **TEST** operating system | Tech |  |  |
|  |  | **TEST** network | Tech |  |  |
|  |  | **TEST** BCS | Tech |  |  |
|  |  | **CONNECT** bldg equip to new BCS | MGMT/FAC/Tech |  |  |
|  |  | **TEST** BCS with bldg equipment | MGMT/FAC/Tech |  |  |
|  |  | **ADVISE** upper management | MGMT |  |  |
|  |  | **REASSESS** the situation | MGMT |  |  |
|  |  | **SCHEDULE** move dates for tenant return | MGMT/FAC/Tech |  |  |
|  |  | **ESTABLISH** new building operating schedule | MGMT/FAC/Tech |  |  |
|  |  | **MOVE** tenants back to building | MGMT |  |  |
|  |  | **RESUME** normal operations | MGMT/FAC/Tech |  |  |
|  |  | **MONITOR** help desk for tenant concerns | MGMT/FAC/Tech |  |  |
|  |  | **PREPARE** media statements | MGMT/SEC |  |  |
|  |  | **PREPARE** after-action report | MGMT/FAC/Tech |  |  |
|  |  | **UPDATE** Recovery Procedure w/Lessons Learned | MGMT/FAC/Tech |  |  |

## RECOVERY EVENT RECORDING FORM

1. Key events during the recovery phase must be recorded.
2. Separate form should be prepared for every major piece of equipment affected.
3. Event log shall be maintained by the Recovery Procedures Coordinator.
4. Event log should be started at the announcement of a cyber-physical attack and a copy of the log passed on to the Incident Recovery Teams once the initial dangers have been controlled.
5. The following event log should be completed to record all key events during the recovery phase.

|  |  |
| --- | --- |
| Description of Cyber-Physical Attack: | |
| Recovery Start Date: |  |
| Equipment and systems affected: | |

|  |  |  |  |
| --- | --- | --- | --- |
| Recovery Start Date | Work Complete Date | Resources Involved | Person in Charge |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## BUILDING CONTROLS SYSTEM

|  |  |
| --- | --- |
| The following Recovery and Reintegration checklists apply to all devices on the BCS network: | |
| Servers | |
| Workstations | |
| Routers/Switches/Modems/Printers | |
| Remote Terminal Units (RTU)/MTU/PLC | |
| IEDs; Controllers, Breakers, Switches, Re-closers, Regulators | |
| Human-Machine Interface (HMI) | |
| Firewalls | |
| Media Converters (Serial to Fiber, Serial to Ethernet) | |
|  | |
| **BCS Recovery** | |
|  | **DOCUMENT** steps taken during recovery procedures for forensic analysis of the cyber incident and possible use as evidence later on. |
|  | **MAINTAIN** primary power (if possible) to the BCS device until an image can be saved of the onboard memory. |
|  | **SAVE** an image of any hard drive(s) and volatile memory (if possible) for forensic analysis. This may require a reboot. **CAPTURE** volatile memory first, and then image the drive. |
|  | **REMOVE and REPLACE** the affected BCS device. |
|  | **DO NOT** **REIMAGE** any devices. Reimaging the affected device drive(s) will destroy forensic evidence of the cyber incident. |
|  | **VERIFY** the latest operating system, software, and firmware patches are installed on the device. **INSTALL** updates prior to reintegration in the BCS. |
|  | **UPDATE** passwords on all BCS devices (including seldom used obscure modules). |
|  | **UPDATE** the antivirus software and intrusion detection software and **RUN** a full system scan. |

|  |  |
| --- | --- |
| **BCS Reintegration** | |
|  | **DO NOT** **RECONNECT** the device to other devices in the network until each device in the affected network layer or affected sub-system has been recovered per these procedures. |
|  | **VERIFY** that each device in the isolated layer or sub-system has been properly recovered. **CONSULT** the cyber incident records to confirm that *Recovery* has been performed on these devices prior to reintegration on the BCS network. |
|  | When each device in the layer or sub-system has been properly recovered and documented, **RECONNECT** all of the devices. |
|  | **DO NOT** **RECONNECT** to the enterprise network. |
|  | **VERIFY** that the forensics specialists have eliminated cyber incident artifacts using detection tools (IDS, Log Review, NMap, Netstat, Wireshark, etc) and documented the results. |
|  | **MONITOR** the BCS for anomalous BEHAVIOR. |
|  | If anomalous behavior is still evident, **REPEAT** the detection procedures and/or mitigation procedures as necessary. |
|  | When the layer or sub-system is operating without evidence of the cyber incident, and the Recovery Procedures Coordinator gives approval, **RECONNECT** the isolated layer or sub-system to the BCS. |
|  | **MONITOR** the system for anomalous behavior. |
|  | If anomalous behavior is still evident, **REPEAT** the detection procedures and/or mitigation procedures as necessary. |
|  | **SUBMIT** all records of recovery actions to the Recovery Procedures Coordinator. |
|  | **RETURN** to Routine Monitoring of the network. |

**CUSTOMIZE** form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

## BUILDING CONTROLS SYSTEM FIELD TEST

All point-to-point testing of end field devices through proper input/output to graphic and operator interface shall be completed and approved.

All field calibration shall be completed and approved.

Detailed functional tests shall verify that the system adheres to the Sequence of Operation.

All alarm limits shall be completed and approved.

All schedule start/stops and system setpoints shall be entered, operating and approved.

**General:** Adjust, calibrate, measure, program, configure, set the time schedules, and ensure that the systems function as specified in the Sequence of Operations.

**Systems Check:** An item by item check shall be performed for each HVAC system.

**Step 1** - **System Inspection:** With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, it shall be verified that power and main air are available where required and that all output devices are in their failsafe and normal positions. Each local display panel and each M&C Client shall be inspected to verify that all displays indicate shutdown conditions.

**Step 2** - **Calibration Accuracy Check:** A two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter shall be performed by comparing the value from the test instrument to the corresponding SNVT. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensor accuracy. The calibration of the test instruments shall be traceable to National Institute of Standards and Technology standards. The first check point shall be with the HVAC system in unoccupied mode with fan hand-off-auto switches in the OFF position, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-DDC system readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

**Step 3** - **Actuator Range Check:** With the system running, a signal shall be applied to each actuator through the DDC Hardware controller. Proper operation of the actuators and positioners for all actuated devices shall be verified and the signal levels shall be recorded for the extreme positions of each device. The signal shall be varied over its full range, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, it shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

## BOILER OR PRESSURE VESSEL

## ****Functional Performance Test****

|  |  |
| --- | --- |
|  | Incident Response Team shall inspect, restart and verify proper operation of boilers including the following (IRT to sign off each item): |
|  | **OBSERVE** the burner flame to identify combustion problems. |
|  | Before lighting a boiler, always **PURGE** the furnace thoroughly. This is particularly important if oil has spilled into the furnace. The purge will evacuate the inventory of unburned gases until the concentration is below the explosive limits. |
|  | **VERIFY** that the water treatment system is operating properly, producing boiler feedwater for the temperatures and pressures involved. |
|  | **NEVER** under any circumstance disable a low water trip. |
|  | **VERIFY** that the water leaving the deaerator is free of oxygen, that the deaerator is operated at the proper pressure, and that the storage tank water is at saturation temperature. A continuous vent from the deaerator is necessary to **DISCHARGE** non-condensable gases. |
|  | Continuously **MONITOR** the quality of condensate coming back from the process to enable the diversion of the condensate in the event of a catastrophic process equipment failure. |
|  | **NEVER** blowdown a furnace wall header while the boiler is operating. |
|  | **ALWAYS** ensure that the steam drum vent valve is opened whenever the boiler pressure is less than 5 psig. |
|  | The boiler’s warm-up curve should be strictly followed. The standard warm-up curve for a typical boiler is not to increase the boiler water temperature over 100°F per hour. It is not unusual for a continuous minimum fire to exceed this maximum warm-up rate. During start-up, the burner must be intermittently fired to **ENSURE** that this rate is not exceeded. |
|  | If necessary, **DRAIN** and flush the boiler, open all handholes and manholes, clean and remove soot and scale from the firesides. |
|  | **INSTALL** new gaskets, **REPLACE** all handhole and manhole covers, **REFILL** boiler and **PERFORM** a hydrostatic test, if required. |
|  | **DISASSEMBLE** the low water cutoff and water feeding devices, clean, recondition and reassemble them. Leak **TEST** all fuel safety shutoff valves. |

Fill out one form for each boiler.

## CHILLED WATER SYSTEM

## Functional Performance Test

**Chiller No.: CH-1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Incident Response Team shall inspect, restart and verify proper operation of chillers including the following (IRT to sign off each item): | | | | | | | | | |
|  | **START** the building air handling units in order to provide a cooling load for the chiller. | | | | | | | | |
|  | **SWITCH** system to “warm-up” mode in order to open all supply ducts, where VAV boxes may be present, and set fan powered box coils to full heat. | | | | | | | | |
|  | **OPERATE** boilers or use outside air to provide cooling load in building depending upon the outside air temperature and the design conditions to be simulated. | | | | | | | | |
| **RECORD** chiller inlet/outlet pressure readings and compare to chiller design conditions, Test and Balance Report and chiller manufacturer’s performance data. | | | | | | | | | |
|  | | | | | | | | | |
|  |  | Chilled water flow | | |  | | | | gpm |
|  |  | DESIGN | | TEST & BAL | | FULL PERF TEST | | ACTUAL | |
| Chiller Inlet Pressure (psig) | |  | |  | |  | |  | |
| Chiller Outlet Pressure (psig) | |  | |  | |  | |  | |
|  | | | | | | | | | |
| **RECORD** chilled water supply and return temperature readings and compare to readout on chiller control panel. | | | | | | | | | |
|  | | | DISPLAYED | | | | ACTUAL | | |
| Chilled Water Supply Temp (°F) | | |  | | | |  | | |
| Chilled Water Return Temp (°F) | | |  | | | |  | | |
|  | | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **RECORD** for chiller: amperage each phase, voltage phase to phase, voltage phase to ground, and power factor | | | | | |
|  | PHASE 1 |  | PHASE 2 |  | PHASE 3 |
| Amperage |  |  |  |  |  |
| Voltage |  |  |  |  |  |
| Voltage |  | | |
| Voltage to Ground |  |  |  |  |  |
| Power Factor |  | | | | |
| KW (use PMT) |  | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **RECORD** for chilled water pump: amperage each phase, voltage phase to phase, voltage phase to ground, and power factor. | | | | | |
|  | PHASE 1 |  | PHASE 2 |  | PHASE 3 |
| Amperage |  |  |  |  |  |
| Voltage |  |  |  |  |  |
| Voltage |  | | |
| Voltage to Ground |  |  |  |  |  |
| Power Factor |  | | | | |
| KW (use PMT) |  | | | | |
|  | | | | | |
| **RECORD** the following information: | | | | | |
| Ambient outside air DB temperature (°F): | | | | |  |
| Entering chilled water temperature (°F): | | | | |  |
| Leaving chilled water temperature (°F): | | | | |  |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

Confirm energy performance over load range. Chiller should run one hour before performing load tests.

## AIR HANDLING UNIT

## Functional Performance Test

**AIR HANDLER No.: AHU-1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Incident Response Team shall inspect, restart and verify proper operation of air handling unit including the following (IRT to sign off each item): | | | | | | | | | | | | | | | | | | | |
|  | | **ENSURE** a slight negative pressure exists on inboard side of outside air dampers throughout the operation of the dampers. **MODULATE** OA, RA, and EA dampers from fully open to fully closed positions. | | | | | | | | | | | | | | | | | |
| The following shall be **VERIFIED** supply and return fans (where applicable) operating mode is initiated: | | | | | | | | | | | | | | | | | | | |
|  | | (1)  All dampers in **NORMAL** position prior to fan start. | | | | | | | | | | | | | | | | | |
|  | | (2)  All valves in **NORMAL** position prior to fan start. | | | | | | | | | | | | | | | | | |
|  | | (3)  System safeties allow start if safety conditions are met. | | | | | | | | | | | | | | | | | |
|  | | (4)  VAV fan controller shall “**SOFT-START**" fan. | | | | | | | | | | | | | | | | | |
|  | | (5)  **MODULATE** all VAV boxes to minimum air flow and verify that the static pressure does not exceed the high static pressure shutdown setpoint. | | | | | | | | | | | | | | | | | |
|  | | (6)  Return all VAV boxes to **AUTO**. | | | | | | | | | | | | | | | | | |
| Occupied mode of operation - economizer de-energized. | | | | | | | | | | | | | | | | | | | |
|  | | (1)  Outside air damper at **MINIMUM** position. | | | | | | | | | | | | | | | | | |
|  | | (2)  Make sure the return air damper is **OPEN**. | | | | | | | | | | | | | | | | | |
|  | | (3)  Relief air damper at **MINIMUM** position. | | | | | | | | | | | | | | | | | |
|  | | (4)  Chilled water control valve **MODULATING** to maintain leaving air temperature set point. | | | | | | | | | | | | | | | | | |
| SETPOINT | | | | |  | | | deg F. | | | | Actual | | | |  | | | deg F. |
|  | Fan VAV controller receiving signal from duct static pressure sensor and **MODULATING** fan to maintain supply duct static pressure set point. | | | | | | | | | | | | | | | | | | |
| SETPOINT | | | | |  | | | inches-wg | | | | Actual | | | |  | | | inches-wg |
| Occupied mode of operation - economizer energized. | | | | | | | | | | | | | | | | | | | |
|  | (1)  Outside air damper **MODULATED** to maintain mixed air temperature set point. | | | | | | | | | | | | | | | | | | |
| SETPOINT | | | | |  | | | deg F. | | | | Actual | | | |  | | | deg F. |
| Outside air damper position | | | | | | | |  | | | | | | | | percent | | | |
|  | (2)  Relief air damper **MODULATES** with outside air damper per sequence of operation. | | | | | | | | | | | | | | | | | | |
| Relief air damper position | | | | | | | |  | | | | | | | | percent | | | |
|  | (3)  Chilled water control valve **MODULATING** to maintain leaving air temperature set point. | | | | | | | | | | | | | | | | | | |
| SETPOINT | | | | |  | | | deg F. | | | | Actual | | | |  | | | deg F. |
|  | (4)  Hot water control valve **MODULATING** to maintain leaving air temperature set point. | | | | | | | | | | | | | | | | | | |
| SETPOINT | | |  | | | deg F. | | | | Actual | | | |  | | | deg F. | | |
|  | (5)  Fan VAV controller receives signal from duct static pressure sensor and **MODULATES** fan to maintain supply duct static pressure set point. | | | | | | | | | | | | | | | | | | |
| SETPOINT | | | |  | | | inches-wg | | | | Actual | | | |  | | | inches-wg | |
| Unoccupied mode of operation. | | | | | | | | | | | | | | | | | | | |
|  | (1)  **OBSERVE** fan starts when space temperature calls for heating or cooling. | | | | | | | | | | | | | | | | | | |
| Note: This does not apply to series boxes. | | | | | | | | | | | | | | | | | | | |
|  | (2)  All dampers in **NORMAL** position. | | | | | | | | | | | | | | | | | | |
|  | (3)  **VERIFY** space temp is maintained as specified in sequence of operation. | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | | |
| The following shall be **VERIFIED** when the supply and return fans (where applicable) off mode is initiated: | | | | | | | | | | | | | | | | | | | |
|  | (1)  All dampers in **NORMAL** position. | | | | | | | | | | | | | | | | | | |
|  | (2)  All valves in **NORMAL** position. | | | | | | | | | | | | | | | | | | |
|  | (3)  Fan **DE-ENERGIZES**. | | | | | | | | | | | | | | | | | | |
| **VERIFY** the chilled water coil control valve operation by setting all VAV's to maximum and minimum cooling. | | | | | | | | | | | | | | | | | | | |
| **Max** Cooling Supply air temp: | | | | | | | | |  | | deg F, | | **VERIFY** cooling valve operation | | | | | | |
| **Min** Cooling Supply air temp: | | | | | | | | |  | | deg F, | | **VERIFY** cooling valve operation | | | | | | |
|  | **VERIFY** safety shut down initiated by low temperature protection thermostat. | | | | | | | | | | | | | | | | | | |
|  | **VERIFY** occupancy schedule is programmed into time clock/UMCS. | | | | | | | | | | | | | | | | | | |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

## COMPUTER ROOM AIR CONDITIONER

## ****Functional Performance Test****

**CRAC No.: CR-1**

|  |  |
| --- | --- |
| Incident Response Team shall inspect, restart and verify proper operation of computer room unit in accordance with specification including the following:(IRT to sign off each item): | |
|  | System safeties allow start if safety conditions are met. |
|  | **VERIFY** cooling and heating operation by varying thermostat set point from space set point to space set point plus 10 degrees, space set point minus 10 degrees, and returning to space set point. |
|  | **VERIFY** humidifier operation by varying humidistat set point from space set point to space set point plus 20 percent RH, and returning to space set point. |
|  | **VERIFY** that airflow is within tolerance. |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

Fill out one form for each CRAC unit.

## COOLING TOWER

## Functional Performance Test

**Cooling Tower No.: CT-1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Incident Response Team shall inspect, restart and verify proper operation of cooling towers including the following (IRT to sign off each item): | | | | | | |
|  | **START** the building air handling units in order to provide a cooling load. | | | | | |
|  | **SWITCH** system to “warm-up” mode in order to open all supply ducts, where VAV boxes may be present, and set fan powered box coils to full heat. | | | | | |
|  | **OPERATE** boilers or use outside air to provide cooling load in building depending upon the outside air temperature and the design conditions to be simulated. | | | | | |
| **RECORD** CWS Header and CWR Header temperature readings and compare to cooling tower design conditions, Test and Balance Report and manufacturer’s performance data. | | | | | | |
|  | | | | | | |
|  |  | Water Flow Rate | |  | | gpm |
|  | | | | | | |
| **RECORD** cooling tower water supply and return temperature readings and compare to readout on cooling tower control panel. | | | | | | |
|  | | | DISPLAYED | | ACTUAL | |
| Cooling Water Supply Header Temp (°F) | | |  | |  | |
| Cooling Water Return Header Temp (°F) | | |  | |  | |
| Entering Wet Bulb Temp (°F) | | |  | |  | |
|  | | | | | | |

**CUSTOMIZE** form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

|  |  |
| --- | --- |
| Ambient Air Conditions |  |
| Dry Bulb (°F) |  |
| Wet Bulb (°F) |  |
| Relative Humidity (%) |  |
| Conditions at Cooling Tower Exit |  |
| Dry Bulb (°F) |  |
| Wet Bulb (°F) |  |
| Relative Humidity (%) |  |

## PUMP - PRIMARY CHILLED WATER

## ****Functional Performance Test****

**Pump No.: PCHW-1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| IRT shall demonstrate operation of pumps in accordance with specifications including the following: **ACTIVATE** pump start using control system commands. | | | | | | | |
|  | **VERIFY** correct operation in: | | | | | | |
| HAND | |  | | OFF |  | AUTO |  |
|  | **VERIFY** pressure drop across strainer: | | | | | | |
|  | | | Strainer inlet pressure | | |  | psig |
|  | | | Strainer outlet pressure | | |  | psig |
|  | **VERIFY** pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report and pump design conditions. | | | | | | |
|  | | DESIGN | |  | TAB |  | ACTUAL |
| Pump inlet pressure psig | |  | |  |  |
| Pump outlet pressure psig | |  | |  |  |
|  | **OPERATE** pump at shutoff and at 100 percent of designed flow when all components are in full flow.  **PLOT** test readings on pump curve and compare results against readings taken from flow measuring devices. | | | | | | |
|  | | | | SHUTOFF |  | 100 PERCENT |  |
|  | Pump inlet pressure psig | | |  |  |  |
|  | Pump outlet pressure psig | | |  |  |  |
|  | Pump flow rate gpm | | |  |  |  |
|  | | | | | SETPOINT |  | |
|  | Differential Pressure Transmitter | | | |  |  | |
|  | For variable speed pumps, **OPERATE** pump at shutoff (shutoff to be done in manual on variable speed drive at the minimum rpm that the system is being controlled at) and at minimum flow or when all components are in full by-pass. **PLOT** test readings on pump curve and compare results against readings taken from flow measuring devices. | | | | | | |
|  | | | | SHUTOFF |  | 100 PERCENT |  |
|  | Pump inlet pressure psig | | |  |  |  |
|  | Pump outlet pressure psig | | |  |  |  |
|  | Pump flow rate gpm | | |  |  |  |
|  | | | | | SETPOINT |  |  |
|  | Differential Pressure Transmitter | | | |  |  | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **MEASURE** motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions. **COMPARE** amperage to nameplate FLA. | | | | | |
| Full flow: | | | | | |
| Nameplate FLA |  |  | | | |
| Amperage Phase 1 |  | Phase 2 |  | Phase 3 |  |
| Voltage Ph1-Ph2 |  | Ph1-Ph3 |  | Ph2-Ph3 |  |
| Voltage Ph1-gnd |  | Ph2-gnd |  | Ph3-gnd |  |
| Minimum flow: | | | | | |
| Amperage Phase 1 |  | Phase 2 |  | Phase 3 |  |
| Voltage Ph1-Ph2 |  | Ph1-Ph3 |  | Ph2-Ph3 |  |
| Voltage Ph1-gnd |  | Ph2-gnd |  | Ph3-gnd |  |
| Note any unusual noise. | | | | | |
|  | | | | | |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

## PUMP - SECONDARY CHILLED WATER

## ****Functional Performance Test****

**Pump No.: SCHW-1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| IRT shall demonstrate operation of pumps in accordance with specifications including the following: **ACTIVATE** pump start using control system commands. | | | | | | | |
|  | **VERIFY** correct operation in: | | | | | | |
| HAND | |  | | OFF |  | AUTO |  |
|  | **VERIFY** pressure drop across strainer: | | | | | | |
|  | | | Strainer inlet pressure | | |  | psig |
|  | | | Strainer outlet pressure | | |  | psig |
|  | **VERIFY** pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report and pump design conditions. | | | | | | |
|  | | DESIGN | |  | TAB |  | ACTUAL |
| Pump inlet pressure psig | |  | |  |  |
| Pump outlet pressure psig | |  | |  |  |
|  | **OPERATE** pump at shutoff and at 100 percent of designed flow when all components are in full flow.  **PLOT** test readings on pump curve and compare results against readings taken from flow measuring devices. | | | | | | |
|  | | | | SHUTOFF |  | 100 PERCENT |  |
|  | Pump inlet pressure psig | | |  |  |  |
|  | Pump outlet pressure psig | | |  |  |  |
|  | Pump flow rate gpm | | |  |  |  |
|  | | | | | SETPOINT |  | |
|  | Differential Pressure Transmitter | | | |  |  | |
|  | For variable speed pumps, **OPERATE** pump at shutoff (shutoff to be done in manual on variable speed drive at the minimum rpm that the system is being controlled at) and at minimum flow or when all components are in full by-pass. **PLOT** test readings on pump curve and compare results against readings taken from flow measuring devices. | | | | | | |
|  | | | | SHUTOFF |  | 100 PERCENT |  |
|  | Pump inlet pressure psig | | |  |  |  |
|  | Pump outlet pressure psig | | |  |  |  |
|  | Pump flow rate gpm | | |  |  |  |
|  | | | | | SETPOINT |  |  |
|  | Differential Pressure Transmitter | | | |  |  | |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **MEASURE** motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions. **COMPARE** amperage to nameplate FLA. | | | | | |
| Full flow: | | | | | |
| Nameplate FLA |  |  | | | |
| Amperage Phase 1 |  | Phase 2 |  | Phase 3 |  |
| Voltage Ph1-Ph2 |  | Ph1-Ph3 |  | Ph2-Ph3 |  |
| Voltage Ph1-gnd |  | Ph2-gnd |  | Ph3-gnd |  |
| Minimum flow: | | | | | |
| Amperage Phase 1 |  | Phase 2 |  | Phase 3 |  |
| Voltage Ph1-Ph2 |  | Ph1-Ph3 |  | Ph2-Ph3 |  |
| Voltage Ph1-gnd |  | Ph2-gnd |  | Ph3-gnd |  |
| Note any unusual noise. | | | | | |
|  | | | | | |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

## PUMP - PRIMARY DOMESTIC HOT WATER

## ****Functional Performance Test****

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| IRT shall demonstrate operation of pumps in accordance with specifications including the following: **ACTIVATE** pump start using control system commands. | | | | | | | |
|  | **VERIFY** correct operation in: | | | | | | |
| HAND | |  | | OFF |  | AUTO |  |
|  | **VERIFY** pressure drop across strainer: | | | | | | |
|  | | | Strainer inlet pressure | | |  | psig |
|  | | | Strainer outlet pressure | | |  | psig |
|  | **VERIFY** pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report and pump design conditions. | | | | | | |
|  | | DESIGN | |  | TAB |  | ACTUAL |
| Pump inlet pressure psig | |  | |  |  |  |
| Pump outlet pressure psig | |  | |  |  |  |
|  | **OPERATE** pump at shutoff and at 100 percent of designed flow when all components are in full flow.  **PLOT** test readings on pump curve and compare results against readings taken from flow measuring devices. | | | | | | |
|  | | | | SHUTOFF |  | 100 PERCENT |  |
|  | Pump inlet pressure psig | | |  |  |  |
|  | Pump outlet pressure psig | | |  |  |  |
|  | Pump flow rate gpm | | |  |  |  |
|  | | | | | SETPOINT |  | |
|  | Differential Pressure Transmitter | | | |  |  | |
|  | For variable speed pumps, **OPERATE** pump at shutoff (shutoff to be done in manual on variable speed drive at the minimum rpm that the system is being controlled at) and at minimum flow or when all components are in full by-pass. **PLOT** test readings on pump curve and compare results against readings taken from flow measuring devices. | | | | | | |
|  | | | | SHUTOFF |  | 100 PERCENT |  |
|  | Pump inlet pressure psig | | |  |  |  |
|  | Pump outlet pressure psig | | |  |  |  |
|  | Pump flow rate gpm | | |  |  |  |
|  | | | | | SETPOINT |  |  |
|  | Differential Pressure Transmitter | | | |  |  | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **MEASURE** motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions. **COMPARE** amperage to nameplate FLA. | | | | | |
| Full flow: | | | | | |
| Nameplate FLA |  |  | | | |
| Amperage Phase 1 |  | Phase 2 |  | Phase 3 |  |
| Voltage Ph1-Ph2 |  | Ph1-Ph3 |  | Ph2-Ph3 |  |
| Voltage Ph1-gnd |  | Ph2-gnd |  | Ph3-gnd |  |
| Minimum flow: | | | | | |
| Amperage Phase 1 |  | Phase 2 |  | Phase 3 |  |
| Voltage Ph1-Ph2 |  | Ph1-Ph3 |  | Ph2-Ph3 |  |
| Voltage Ph1-gnd |  | Ph2-gnd |  | Ph3-gnd |  |
| Note any unusual noise. | | | | | |
|  | | | | | |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

## PUMP - SECONDARY DOMESTIC HOT WATER

## ****Functional Performance Test****

**Pump No.: SDHW-1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| IRT shall demonstrate operation of pumps in accordance with specifications including the following: **ACTIVATE** pump start using control system commands. | | | | | | | |
|  | **VERIFY** correct operation in: | | | | | | |
| HAND | |  | | OFF |  | AUTO |  |
|  | **VERIFY** pressure drop across strainer: | | | | | | |
|  | | | Strainer inlet pressure | | |  | psig |
|  | | | Strainer outlet pressure | | |  | psig |
|  | **VERIFY** pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report and pump design conditions. | | | | | | |
|  | | DESIGN | |  | TAB |  | ACTUAL |
| Pump inlet pressure psig | |  | |  |  |
| Pump outlet pressure psig | |  | |  |  |
|  | **OPERATE** pump at shutoff and at 100 percent of designed flow when all components are in full flow. **PLOT** test readings on pump curve and compare results against readings taken from flow measuring devices. | | | | | | |
|  | | | | SHUTOFF |  | 100 PERCENT |  |
|  | Pump inlet pressure psig | | |  |  |  |
|  | Pump outlet pressure psig | | |  |  |  |
|  | Pump flow rate gpm | | |  |  |  |
|  | | | | | SETPOINT |  | |
|  | Differential Pressure Transmitter | | | |  |  | |
|  | For variable speed pumps, **OPERATE** pump at shutoff (shutoff to be done in manual on variable speed drive at the minimum rpm that the system is being controlled at) and at minimum flow or when all components are in full by-pass. **PLOT** test readings on pump curve and compare results against readings taken from flow measuring devices. | | | | | | |
|  | | | | SHUTOFF |  | 100 PERCENT |  |
|  | Pump inlet pressure psig | | |  |  |  |
|  | Pump outlet pressure psig | | |  |  |  |
|  | Pump flow rate gpm | | |  |  |  |
|  | | | | | SETPOINT |  |  |
|  | Differential Pressure Transmitter | | | |  |  | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **MEASURE** motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions. **COMPARE** amperage to nameplate FLA. | | | | | |
| Full flow: | | | | | |
| Nameplate FLA |  |  | | | |
| Amperage Phase 1 |  | Phase 2 |  | Phase 3 |  |
| Voltage Ph1-Ph2 |  | Ph1-Ph3 |  | Ph2-Ph3 |  |
| Voltage Ph1-gnd |  | Ph2-gnd |  | Ph3-gnd |  |
| Minimum flow: | | | | | |
| Amperage Phase 1 |  | Phase 2 |  | Phase 3 |  |
| Voltage Ph1-Ph2 |  | Ph1-Ph3 |  | Ph2-Ph3 |  |
| Voltage Ph1-gnd |  | Ph2-gnd |  | Ph3-gnd |  |
| Note any unusual noise. | | | | | |
|  | | | | | |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

## FAN COIL UNIT

## Functional Performance Test

**Fan Coil Unit No.: FCU-1**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IRT shall demonstrate operation of selected fan coils in accordance with specifications including the following: | | | | | | | | | | |
|  | Cooling only fan coils: **VERIFY** fan coil unit response to room temp set point adjustment. | | | | | | | | | |
|  |  | | | **CHECK** blower fan airflow | | | | |  | cfm |
|  |  | | | **CHECK** cooling coil water flow | | | | |  | gpm |
|  | **VERIFY** proper operation of cooling water control valve. | | | | | | | | | |
|  | **CHECK** cooling mode inlet air temperature | | | | | | | |  | deg F |
|  | **CHECK** cooling mode outlet air temperature | | | | | | | |  | deg F |
|  | **MEASURE** coil sensible capacity and compare to design: | | | | | | | | | |
|  | ACTUAL | |  | | | BTU/hr | | DESIGN |  | BTU/hr |
|  | Cooling/heating fan coils: **VERIFY** fan coil unit response to room temp set point adjustment | | | | | | | | | |
|  | **CHECK** blower fan airflow. | | | | | | | |  | cfm |
|  | **CHECK** cooling coil water flow. | | | | | | | |  | gpm |
|  | **VERIFY** proper operation of cooling water control valve. | | | | | | | | | |
|  | **CHECK** cooling mode inlet air temperature. | | | | | | | |  | deg F |
|  | **CHECK** cooling mode outlet air temperature. | | | | | | | |  | deg F |
|  | **MEASURE** cooling coil sensible capacity and compare to design: | | | | | | | | | |
|  | ACTUAL |  | | | BTU/hr | | DESIGN | |  | BTU/hr |
|  | **CHECK** heating coil water flow. | | | | | | | |  | gpm |
|  | **VERIFY** proper operation of heating water control valve. | | | | | | | | | |
|  | **CHECK** heating mode inlet air temperature. | | | | | | | |  | deg F |
|  | **CHECK** heating mode outlet air temperature. | | | | | | | |  | deg F |
|  | **MEASURE** heating coil capacity and compare to design: | | | | | | | | | |
|  | ACTUAL |  | | | BTU/hr | | DESIGN | |  | BTU/hr |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

Fill out one form for each fan coil unit.

## DIESEL BACKUP GENERATOR

## Functional Performance Test

**Generator No.: DG-1**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| IRT shall demonstrate operation of backup generators in accordance with specifications including the following: **START** equipment to provide energy source for building recovery. | | | | | |
|  | **VERIFY** backup generators are providing recoverable energy. | | | | |
|  | **VERIFY** recovery system senses available energy and activates. | | | | |
|  |  | DESIGN |  | ACTUAL |  |
|  | Primary inlet air temp |  | deg F |  | deg F |
|  | Primary outlet air temp |  | deg F |  | deg F |
|  | Primary flow rate |  | cfm |  | cfm |
|  | Secondary inlet air temp |  | deg F |  | deg F |
|  | Secondary outlet air temp |  | deg F |  | deg F |
|  | Secondary flow rate |  | cfm |  | cfm |
|  | Primary energy BTU/hr |  | BTU/hr |  | BTU/hr |
|  | Secondary energy BTU/hr |  | BTU/hr |  | BTU/hr |
|  | **VERIFY** switchgear senses available energy and activates. | | | | |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

## VENTILATION UNIT

## ****Functional Performance Test****

**Ventilation System No.: V-1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Incident Response Team shall inspect, restart and verify proper operation of air handling unit including the following (IRT to sign off each item): | | | | | | |
|  | **ENSURE** a slight negative pressure exists on inboard side of outside air dampers throughout the operation of the dampers. **MODULATE** OA, RA, and EA dampers from fully open to fully closed positions. | | | | | |
| The following shall be **VERIFIED** supply and return fans (where applicable) operating mode is initiated: | | | | | | |
|  | All dampers in **NORMAL** position prior to fan start. | | | | | |
|  | All valves in **NORMAL** position prior to fan start. | | | | | |
|  | System safeties allow start if safety conditions are met. | | | | | |
|  | VAV fan controller shall “**SOFT-START**" fan. | | | | | |
|  | **MODULATE** all VAV boxes to **MINIMUM** air flow and verify that the static pressure does not exceed the high static pressure shutdown setpoint. | | | | | |
|  | **RETURN** all VAV boxes to auto. | | | | | |
| **Occupied** mode of operation - economizer **DE-ENERGIZED**. | | | | | | |
|  | Outside air damper at **MINIMUM** position. | | | | | |
|  | Make sure the return air damper is **OPEN**. | | | | | |
|  | Relief air damper at **MINIMUM** position. | | | | | |
|  | Chilled water control valve **MODULATING** to maintain leaving air temperature set point. | | | | | |
|  | SETPOINT |  | deg F. | ACTUAL |  | deg F. |
|  | Fan VAV controller receiving signal from duct static pressure sensor and **MODULATING** fan to **MAINTAIN** supply duct static pressure set point. | | | | | |
|  | SETPOINT |  | inches-wg | ACTUAL |  | inches-wg |
| **Occupied** mode of operation - economizer **ENERGIZED**. | | | | | | |
|  | Outside air damper **MODULATED** to maintain mixed air temperature set point. | | | | | |
|  | SETPOINT |  | deg F. | ACTUAL |  | deg F. |
|  | Outside air damper position | |  | percent |  |  |
|  | Relief air damper **MODULATES** with outside air damper per sequence of operation. | | | | | |
|  | Relief air damper position | |  | percent |  |  |
|  | Chilled water control valve **MODULATING** to maintain leaving air temperature set point. | | | | | |
|  | SETPOINT |  | deg F. | ACTUAL |  | deg F. |
|  | Hot water control valve **MODULATING** to maintain leaving air temperature set point. | | | | | |
|  | SETPOINT |  | deg F. | ACTUAL |  | deg F. |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Fan VAV controller receives signal from duct static pressure sensor and modulates fan to **MAINTAIN** supply duct static pressure set point. | | | | | | | | |
|  | SETPOINT |  | inches-wg | | ACTUAL | |  | inches-wg |
| **Unoccupied** mode of operation | | | | | | | | |
|  | **OBSERVE** fan starts when space temperature calls for heating or cooling. | | | | | | | |
| Note: This does not apply to series boxes. | | | | | | | | |
|  | All dampers in **NORMAL** position. | | | | | | | |
|  | **VERIFY** space temp is maintained as specified in sequence of operation. | | | | | | | |
|  | The following shall be verified when the supply and return fans (where applicable) **OFF MODE** is initiated: | | | | | | | |
|  | All dampers in **NORMAL** position. | | | | | | | |
|  | All valves in **NORMAL** position. | | | | | | | |
|  | Fan **DE-ENERGIZES**. | | | | | | | |
|  | **VERIFY** the chilled water coil control valve operation by setting all VAV's to maximum and minimum cooling. | | | | | | | |
|  | Max Cooling Supply air temp: | | |  | | deg F, Verify cooling valve operation | | |
|  | Min Cooling Supply air temp: | | |  | | deg F, Verify cooling valve operation | | |
|  | **VERIFY** safety shut down initiated by low temperature protection thermostat. | | | | | | | |
|  | **VERIFY** occupancy schedule is programmed into time clock/UMCS. | | | | | | | |

Customize form for your specific building and verify the normal operating conditions when the recovery procedures are prepared.

## ELECTRICAL SWITCHGEAR CHECKLIST

## ****Functional Performance Test****

**Switchgear No.: S-1**

|  |  |  |
| --- | --- | --- |
| Incident Response Team shall inspect, restart and verify proper operation of electrical switchgear including the following (IRT to sign off each item): | | |
|  | **CHECK** for voltage imbalance. Maximum allowable is 2%. |  |
| Insulation Resistance Test | | |
|  | **INSPECT** to make sure surface dust and moisture has been removed from the component under test. | |
|  | **ENSURE** the component is isolated from other connected system, which may feedback to other components or circuits not under test. | |
|  | Voltage shall be **Applied** between one phase and other phases connected with ground, testing shall be repeated for other phases. | |
|  | The following shall be verified when the supply and return fans (where applicable) **OFF MODE** is initiated: | |
| High Voltage Test | | |
|  | **DETERMINE** the equipment is in proper condition to put back in service by performing the following tests: | |
|  | AC Hi-pot test for switchgear with leakage current indicator for overload protection. | |
|  | DC Hi-pot test for cables with leakage current indicator for overload protection. | |

## INTEGRATED SYSTEMS TEST: EMERGENCY POWER

|  |  |  |  |
| --- | --- | --- | --- |
| Building: |  | Date: |  |
| Participants | | | |
| Individual Name: | | Participation Role: | |
|  | |  | |
|  | |  | |
|  | |  | |
|  | |  | |
|  | | | |
| Date of Test |  | Weather |  |
| Date of Test |  | Weather |  |
| Date of Test |  | Weather |  |
| Date of Test |  | Weather |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Testing Procedures and Record | | | |
| Sequence of Operation | Pass | Fail | Comments |
| Example: Duct static maintained at set point. |  |  | Fire smoke damper is closed and needs to be open to provide air to the duct static sensor. |
|  |  |  |  |
|  |  |  |  |
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## INTEGRATED SYSTEMS TEST: EMERGENCY POWER

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Testing Procedures and Record | | | | | |
| Sequence of Operation | Pass | | Fail | | Comments |
| Chilled Water System | | | | | |
| Upon power failure **VERIFY** the following occurs: | | | | | |
| Chillers **SHUT DOWN**. After transfer of power, chillers **RESTART**. | | ☐ | |  |  |
| **VERIFY** chillers return to previous operation. | |  | |  |  |
| Pumps **MAINTAIN** operation. After transfer of power via open transition, pumps **RESTART**. | |  | |  |  |
| **VERIFY** pumps return to previous operation. | |  | |  |  |
| Load is **MAINTAINED**. | |  | |  |  |
| Temperatures **REMAIN** within operational range. | |  | |  |  |
| CHW Flows **REMAIN** within operational range. | |  | |  |  |
| Loss of power alarms are **TRIGGERED** at BCS for Chillers and Pumps | |  | |  |  |
| Condenser Water System | | | | | |
| Upon power failure **VERIFY** the following occurs: | | | | | |
| Cooling Towers **MAINTAIN** operation. After transfer of power via open transition, cooling towers **RESTART**. | |  | |  |  |
| **VERIFY** cooling towers return to previous operation. | |  | |  |  |
| Pumps **MAINTAIN** operation. After transfer of power via open transition, pumps **RESTART**. | |  | |  |  |
| **VERIFY** pumps return to previous operation. | |  | |  |  |
| Load is MAINTAINED. | |  | |  |  |
| Temperatures **REMAIN** within operational range. | |  | |  |  |
| CW Flows **REMAIN** within operational range. | |  | |  |  |

## INTEGRATED SYSTEMS TEST: EMERGENCY POWER

|  |  |  |  |
| --- | --- | --- | --- |
| Testing Procedures and Record | | | |
| Sequence of Operation | Pass | Fail | Comments |
| Loss of power alarms are **TRIGGERED** at BCS for Cooling towers and Pumps |  |  |  |
| Heating Water System | | | |
| Upon power failure **VERIFY** the following occurs: | | | |
| Boilers **MAINTAIN** operation. After transfer of power via open transition, cooling towers **RESTART**. |  |  |  |
| **VERIFY** Boilers return to previous operation. |  |  |  |
| Pumps **MAINTAIN** operation. After transfer of power via open transition, pumps **RESTART**. |  |  |  |
| **VERIFY** pumps return to previous operation. |  |  |  |
| Load is MAINTAINED. |  |  |  |
| Temperatures **REMAIN** within operational range. |  |  |  |
| CW Flows **REMAIN** within operational range. |  |  |  |
| Loss of power alarms are **TRIGGERED** at BCS for Boilers and Pumps |  |  |  |

## OPERATIONAL SECURITY LOG

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Date:  Time | Asset | Operator:  IP Address | Description | Action Taken | Results |
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## HVAC CONTROL SYSTEM DRAWINGS

The Design Drawing Legend indicates all symbols, abbreviations and acronyms.

## VALVE SCHEDULE

The valve schedule indicates each valve’s size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. The valve schedule contains actuator data of the force required to move and seal the valve.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Valve Schedule | | | | | | | |
| ID No | Size | Flow Kv | Pres Drop | Spring Rng | Pos Rng | Torq | Dim. & Clear |
|  |  |  |  |  |  |  |  |
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| Comments: | | | | | | | |

## DAMPER SCHEDULE

The damper schedule indicates each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The Damper Schedule indicates the AMCA 511 maximum leakage rate at the operating static-pressure differential.

|  |  |
| --- | --- |
| Damper Schedule | |
| ID No. | Location |
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## THERMOSTAT AND OCCUPANCY SENSOR SCHEDULE

The thermostat and occupancy sensor schedule indicate each area’s unique room identifier and control features and functions.

|  |  |
| --- | --- |
| Thermostat and Occupancy Sensor Schedule | |
| ID No. | Location |
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## BUILDING EQUIPMENT SCHEDULE

The equipment schedule indicates the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component installed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equipment Schedule | | | | |
| ID No | Descriptive Name | Manufacturer | Model Number | Part Number |
|  | Boiler |  |  |  |
|  | Chiller |  |  |  |
|  | Cooling Tower |  |  |  |
|  | Water Heater |  |  |  |
|  | Air Handling Unit |  |  |  |
|  | Pressure Vessel |  |  |  |
|  | Primary CW Pump |  |  |  |
|  | Second CW Pump |  |  |  |
|  | Primary HW Pump |  |  |  |
|  | Second HW Pump |  |  |  |
|  | Generator |  |  |  |
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## BUILDING OCCUPANCY SCHEDULE

The occupancy schedule indicates the seasonal building start time for building equipment to reach required building temperature and time equipment is set back to caretaker temperature.

|  |  |  |  |
| --- | --- | --- | --- |
| Occupancy Schedule | | | |
|  | HVAC Start/Stop Times | Office Lighting Times | Comments |
| Spring | | | |
| Sun |  |  | unoccupied |
| Mon | 0530 - 2200 | 0600 - 2200 | 74 deg F. 15% to 55% humidity |
| Tues | 0530 - 2200 | 0600 - 2200 | 74 deg F. 15% to 55% humidity |
| Wed | 0530 - 2200 | 0600 - 2200 | 74 deg F. 15% to 55% humidity |
| Thurs | 0530 - 2200 | 0600 - 2200 | 74 deg F. 15% to 55% humidity |
| Fri | 0530 - 2000 | 0600 - 2000 | 74 deg F. 15% to 55% humidity |
| Sat |  |  | unoccupied |
| Summer | | | |
| Sun |  |  |  |
| Mon |  |  |  |
| Tues |  |  |  |
| Wed |  |  |  |
| Thurs |  |  |  |
| Fri |  |  |  |
| Sat |  |  |  |
| Fall | | | |
| Sun |  |  |  |
| Mon |  |  |  |
| Tues |  |  |  |
| Wed |  |  |  |
| Thurs |  |  |  |
| Fri |  |  |  |
| Sat |  |  |  |

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| --- | --- | --- | --- |
| Winter | | | |
| Sun |  |  |  |
| Mon |  |  |  |
| Tues |  |  |  |
| Wed |  |  |  |
| Thurs |  |  |  |
| Fri |  |  |  |
| Sat |  |  |  |

## POINTS SCHEDULE

The Points Schedule drawing indicates Device address and NodeID, Input and Output SNVTs including SNVT Name, Type and Description, Hardware I/O, including Type (AI, AO, BI, BO) and Description.

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| Points Schedule | |
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## BUILDING CONTROL NETWORK RISER DIAGRAM

The Riser Diagram for all DDC Hardware, all Network Hardware, including network terminators shall be attached. It provides the unique identifier, common descriptive name, physical sequential order (previous and next device on the network), room identifier and location within a room.

## SEQUENCE OF OPERATION

The Sequence of Operation is unique to each building and should be readily available to the IRT. These can be found in the as-built drawings, original project specifications or manufacturer operating manuals. Attach a copy here.

|  |  |
| --- | --- |
| Sequence of Operation | |
| Attached | Operating and Maintenance Manuals |
|  | Boilers |
|  | Chillers |
|  | Cooling Towers |
|  | Domestic Hot Water Heaters |
|  | Air Handling Units |
|  | Pressure Vessels |
|  | Primary Chilled Water Pumps |
|  | Secondary Chilled Water Pumps |
|  | Primary Domestic Hot Water Pumps |
|  | Secondary Domestic Hot Water Pumps |
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## PERFORMANCE VERIFICATION TEST RESULTS

The Performance Verification Test is unique to each building and should be readily available to the IRT.

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| --- | --- |
| Performance Verification Test Results | |
| Attached | Description |
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## COMMISSIONING REPORT

The Commissioning Report is unique to each building and should be readily available to the IRT. The report includes checklists and functional test results that provide historical data that will be helpful for before and after comparison by the IRT.

## EQUIPMENT MAINTENANCE MANUALS

All equipment manufacturers supply operating manuals with their equipment. Unfortunately, many buildings do not have manuals and operating instructions available. These manuals may have either been lost or misplaced. It is the responsibility of the supervisor to obtain these publications and see that they are read, understood, followed and that hard copy is available in the Building Operations Center. Collect all manuals in one location.

|  |  |
| --- | --- |
| Equipment Manuals | |
| Available | Operating and Maintenance Manuals |
|  | Boilers |
|  | Chillers |
|  | Cooling Towers |
|  | Domestic Hot Water Heaters |
|  | Air Handling Units |
|  | Pressure Vessels |
|  | Primary Chilled Water Pumps |
|  | Secondary Chilled Water Pumps |
|  | Primary Domestic Hot Water Pumps |
|  | Secondary Domestic Hot Water Pumps |
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## LIST OF AUTHORIZED MAINTENANCE LAPTOPS

The Authorized Maintenance Laptop List may be unique to each building and should be readily available to the IRT. The list includes the date of the last virus scan for each. Authorized maintenance laptops MUST be stored in a secure location and only issued to vendors on site for use on site. When needed for more than one day, laptops shall be collected at the end of each day and locked away. Laptop shall be scanned for virus and malware prior to connection to the BCS every time. After use, vendor software shall be wiped and drive scanned prior to returning to storage.

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| Authorized Maintenance Laptop List | |
| Date of Last Virus Scan | Laptop Number |
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## VENDOR CONTACT LIST

This is a listing of all vendors and contractors that currently provide support or will provide support in a post-disaster environment. Additionally, any Service Level Agreements (SLAs) that have been executed and all subsequent modifications should be attached.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Vendor Contact List | | | | |
| Vendor | Equipment | Contact Name: | Telephone | Email |
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