## Spare Parts:

Spare parts should be stored in a Con Edison owned storage space for emergency response and leak repair. At a minimum, the following parts should be kept in inventory:

- 2x 10 ft lengths of each size and type of pipe in the UDS
- 4x 90 degree elbow pieces in each size and type of pipe
- 4x replacement isolation valves in each size pipe
- 2x Replacement BTU meter
- 2x Replacement modulating valve or valve actuator of each pipe size and actuator type
- 2x Replacement ETS HX gaskets
- 2x Replacement gaskets or O-rings for any flanged connections of the UDS

## Identification of the Leak and Response:

Identify where the leak in the piping system is using the data from the SCADA system, the pipe leak detection system (requirement identified in the design drawings, specific system to be determined at time of submittal), and information from contractor-reported damage. In the event the leak cannot be identified, the emergency response crews should be instructed to survey UDS route to confirm no work is ongoing that could have damaged the UDS. Then start isolating segments of the UDS until the leak is found. The UDS will have isolation valves periodically installed throughout the system to assist with maintenance and repairs.

Con Edison should create a leak severity assessment to determine the level of the response. Minor leaks that are estimated to be below a 1.0 GPH threshold should trigger a “ticket”-based response which would be addressed during the next available day-shift. Major leaks over that threshold should trigger an immediate shutdown of the UTEN and isolation (automated as much as possible). The minimal scenario for automation would include shutting down the UDS circulating pumps and closing all automatic isolation/control valves. The SCADA system should be able to automatically call, text, or email Con Edison personnel to escalate any significant leak detected to escalate the issue and generate a rapid response. Notifications should be generated to the system participants: to inform of an outage, to identify potential areas of impact, and to request access by a maintenance response team of the impacted system participant. Once that

crew is dispatched, the area of the leak should be identified and any adjacent manual isolation valves closed to limit the extent of the leak.

## Repairs

Repairs should be made in accordance with the manufacturers repair instructions for the selected UDS pipe. Repair crews should be pre-selected or vetted and be familiar with the scope of the Rockefeller Center UTEN project.

After repairs, it will likely be necessary to replace and test the leak detection system, because in general leak detection systems rely on the conductivity of water to sense if the insulation on the exterior of the piping has gotten wet. Some leak detection systems use two wires running suspended within the piping insulation with voltage potential difference applied to the wires, and when the insulation between the wires gets wet, it creates a circuit and electrical current can flow. This current flow triggers the leak detection system alarm.

After repairs, it will also likely be necessary to re-perform some or all of the commissioning/start-up processes from commissioning and start-up. This would generally be:

1. Any repaired piping should be isolated as much as possible from the rest of the system and drained down already. After repairs, a pressure test should be performed on the repaired, isolated section of piping per the piping manufacturers' requirements. This pressure test should follow the pipe manufacturer's specified requirements, but it is generally performed at 1.5 times the working pressure of the system, for at least 2 hours.
2. After a successful pressure test, the isolated, empty section of piping should be re-filled with the working fluid, and all valves used to isolate the section should be slowly re-opened. For the Rockefeller Center UTEN's UDS, this is water with some chemical treatment to prevent rust, corrosion, and algal growth. If any air vents or air separators are available on the repaired section of piping, those should be used to vent air as the piping fills back up with water.
3. After re-filling the repaired section of piping, any remaining air should be evacuated from the network based on the same processes required in the commissioning process. This generally includes ramping up the pumps to maintain a minimum flow speed of at least 3 ft/s in the piping and running them at that speed for at least 4 hours, ensuring that any air vents or air separators are not isolated or plugged and can evacuate air from the network.

4. After completing the fill procedure, the VFDs and other control devices should be set back to automatic control by the SCADA.
5. The standard recommended chemical treatment additives for hydronic networks (at their recommended levels of dilution) are typically safe to be disposed of via the municipal sewer system however the Safety Data Sheets, which will be found stored in the Energy Center, will dictate the required clean-up and remediation process.

| Owned by ConEd? | Can UTEN Function? | Failure | Type | Possible Method of Detection | Result | Implication | Procedure to Restore Service |
|---|---|---|---|---|---|---|---|
| Y | Y* | UDS Pumps | Electrical, mechanical | CTs, dP sensor, VFD alarm relay, etc. | If there is a catastrophic failure of multiple pumps, loss of flow in UDS and in all ETS HX | UDS pump set use a N+1 design. Any individual pump's failure will result in a backup pump starting up with little to no detectable impact. Failure of multiple pumps would result in loss of flow in UDS, means that ETS heat exchangers are not transferring heat, and any heat pumps using UTEN will trip if they are not shut down. Failure of multiple pumps is extremely unlikely and would be indicative of a much larger system-wide issue or failure. | In the event of a single pump failure, service will be maintained automatically. The out-of-service pump will require diagnostic and repair. Once complete, automatic control can be selected at its associated variable frequency drive and it will sequence into operation according to the rotational schedule identified for those pumps.<br>In the event of a catastrophic failure impacting both pumps, the procedure would remain much the same. The UTEN customers will need to be notified. Backup heating should be automatically sequenced as described elsewhere in this document. If a partial system drawin-down is required to service the pumps, the refill procedure would need to be followed to repressure and eliminate air from the system. |
| N | N | 30 Rockefeller Center Central Plant Condenser Pumps | Electrical, mechanical | Interface with 30 Rock Central Plant BMS | If there is a catastrophic failure of multiple pumps, loss of flow in cooling tower loop and in TER ETS HX | 30 Rockefeller Center's Central Plant has N+2 design for it's condenser pumps so any individual pump's failure will result in a backup pump starting up with little to no detectable impact. Loss of flow in cooling towers/condenser loop at 30 Rock would be catastrophic failure of a critical system (very unlikely). There would be no heat available from TER, and all customer heat pump's will need to be disabled. Customer side heating will come from their personal steam backup. | Temperature and/or differential pressure sensors will be able to detect once TER condenser water pump service is restored. This should be confirmed via a to-be-developed communication protocol between the TER and the utility. Once TER pressure is reestablished, the TEN's pumps can sequence back to maintain the system differential pressure and customers notified that service is resumed. |
| N | Y* | New ETS Condenser Water Pumps | Electrical, mechanical | CTs, dP sensor, VFD alarm relay, etc. | If there is a catastrophic failure of multiple pumps, loss of flow in TER ETS HX | In the instance of failure of the new condensor water pump installed for flow through the TER ETS, the bypass around this pump will be opened and flow will be dependent on the existing N+2 condenser water pumps set in the energy center to direct flow through the ETS. Pump calculations are still being analyzed to confirm that the energy center pumps will be able to direct sufficient flow to the TER ETS in all heat demand scenarios. | Temperature and/or differential pressure sensors will be able to detect once TER condenser water transfer pump service is restored. This should be confirmed via a to-be-developed communication protocol between the TER and the utility. Once TER pressure is reestablished, the TEN's pumps can sequence back to maintain the system differential pressure and customers notified that service is resumed. |

| Owned by ConEd? | Can UTEN Function? | Failure | Type | Possible Method of Detection | Result | Implication | Procedure to Restore Service |
|---|---|---|---|---|---|---|---|
| N | Y | Tishman Speyer (600 5th ave & 1230 AOA combined) HVAC WSHP | Electrical, mechanical, fault | CTs, fault/alarm relay, BACnet interface, etc. | Loss of heat transfer between UDS and Customer distribution loops | Customer side heat pump failure will prevent the customer from utilizing the UTEN system for heating purposes. Without the necessary functioning equipment required to lift UDS supply to the proper temperature needed for building heating, this customer will have to switch to their existing steam service connections to heat the building side HW distribution loops until their HVAC heat pumps are back online.<br>The new customer side HW supply & return distribution pipes are being installed in series with these existing steam service connections and their steam to hot water heat exchangers to allow for seamless manual switchover in emergency scenarios. The setpoint of the steam heat exchanger can be staggered to be a few degrees lower than the supply from the UDS-fed system, resulting in a passive fail-safe. If the UDS-originated supply is unable to meet that setpoint, the backup heatsource will automatically enable.<br>In the scenario where a customer heat exchanger is offline, a bypass will open on the Con Ed owned UDS side of the heat pump, allowing the UDS to remain active and provide heating to remaining customers. The bypass will open via a differential pressure that will sense the pressure change that results from lack of flow through the customer heat pump. | Service availability by the TEN will remain unaffected. The amount of heat recovered and transferred will be reduced, impacting the control valves around the TER ETS automatically, however there will be no impact to normal system automatic operation. |
| N | Y | Rockefeller Group (1221 AOA) HVAC WSHP | Electrical, mechanical, fault | CTs, fault/alarm relay, BACnet interface, etc. | Loss of heat transfer between UDS and Customer distribution loops | Customer side heat pump failure will prevent the customer from utilizing the UTEN system for heating purposes. Without the necessary functioning equipment required to lift UDS supply to the proper temperature needed for building heating, this customer will have to switch to their existing steam service connections to heat the building side HW distribution loops until their HVAC heat pumps are back online. The new customer side HW supply & return distribution pipes are being installed in series with these existing steam service connections and their steam to hot water heat exchangers to allow for seamless manual switchover in emergency scenarios. In the scenario where a customer heat exchanger is offline, a bypass will open on the Con Ed owned UDS side of the heat pump, allowing the UDS to remain active and provide heating to remaining customers. The bypass will open via a differential pressure that will sense the pressure change that results from lack of flow through the customer heat pump. | Service availability by the TEN will remain unaffected. The amount of heat recovered and transferred will be reduced, impacting the control valves around the TER ETS automatically, however there will be no impact to normal system automatic operation. |
| N | Y | Rockefeller Group (1221 AOA) DHW WSHP | Electrical, mechanical, fault | CTs, fault/alarm relay, BACnet interface, etc. | Loss of heat transfer to/from intermediate loop | DHW heat pump failure will result in decreased need for heat from Thermal Energy Resource in heating season. No failure risk to the UTEN system. | Service availability by the TEN will remain unaffected. The amount of heat recovered and transferred will be reduced, impacting the control valves around the TER ETS automatically, however there will be no impact to normal system automatic operation. |

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|---|---|---|---|---|---|---|---|
| Y | Y | ETS Modulating Valve | Electrical, mechanical | Valve position feedback, relay, end switches | Loss of flow or inability to control flow at heat injection/rejection | Depends on location and if valve is partially open, fully closed, or fully open. This will also be affected by the detailed sequence of operation at each of these locations has been determined but will be optimized during system commissioning.<br>If the valve fails open at the EC ETS, flow can be controlled based on a combination of differential pressure, temperature, and pump speed. Service could be maintained. If that valve fails partially closed, again reduced system operation could be maintained. If that valve fails closed, the system wouldn't be able to recover any heat and the customers would have to default to their backup sources of heating. | A diagnostic and repair would need to be triggered immediately. Once the valve is restored to service, automatic TEN operation can resume. |
| Y | N* | Leak in ETS HX | Mechanical | UDS leak detection system, SCADA alarm | Reduced heat transfer from TER to UDS or UTEN shutdown depending on severity of leak. | Depends on severity of leak. The UTEN system can still function if there is only a small leak in the ETS HX, however it may not be able to operate at its full capacity. Repair of this leak or any large/significant leaks in the ETS HX that require immediate repair will result in a full shutdown of the UTEN system until repairs are complete. This will require customers to temporarily switch to their existing steam services for building heating requirements until the UTEN system is repaired and back online. Repairs for small/non-urgent leaks in the ETS HX can be strategically scheduled for periods of time when the UTEN system is offline (i.e. cooling season) to prevent interruptions to customers' UTEN services.<br>Detection of leaks can result from active monitoring of the system pressure / setting alarms when it drops below a nominal expected value along with the implementation of an active leak detection system as described in the above narrative. | See above description for a leak detection and restoration of service. |
| Y | Y* | Leak in UDS | Mechanical | UDS leak detection system, SCADA alarm | Reduced heat transfer in UTEN, loss of one customer from UTEN, or full loss of UTEN system depending on location of the leak | Depends on size and location of the leak. If on the supply piping, this can reduce the amount of heat transferred by UTEN. If the leak occurs on a specific customer side branch of the UDS, then that branch can be isolated during repairs to allow other customers to continue utilizing the UTEN system. For example, if a leak was detected on the 1221 AOA branch of the UDS, this branch can be isolated via one of the multiple sets of isolation valves along this line. This would allow 1230 AOA and 600 5th Ave to continue utilizing the UTEN system while repairs are completed on the 1221 AOA branch. If a leak is located on the short portion of Energy Center UDS piping before any customer take-offs, then the entire UTEN system will have to be taken offline to repair the leak. In this scenario the UTEN system will be temporarily disabled until the repair is complete and all customers will need to utilize their existing steam connections for building side heating needs. | See above description for a leak detection and restoration of service. |
| N | Y | Leak in Customer Piping | Mechanical | BMS alarms, SCADA alarm with direct pressure/temperature/valve positioning monitoring | Reduced load of UTEN, depending on size of the leak | Depends on size and location of the leak. If it requires a full shutdown of customer side equipment to repair, then a bypass will open on the Con Ed owned UDS side of the customer owned heat pump, allowing the UDS to remain active and provide heating to remaining customers. The bypass will open via a differential pressure that will sense the pressure change that results from lack of flow through the customer heat pump. | See above description for a leak detection and restoration of service. |

| Owned by ConEd? | Can UTEN Function? | Failure | Type | Possible Method of Detection | Result | Implication | Procedure to Restore Service |
|---|---|---|---|---|---|---|---|
| Y | N | Electrical Grid Outage | Electrical | Con Edison SCADA | No customer equipment using the UTEN will function | Currently there is no emergency heating backup options during full electrical grid outage for any of the Rockefeller Center UTEN customers. As such, no emergency heating backup as been designed into the UTEN system during a power outage scenario. UTEN will not be active during this time. | A more developed procedure to test electrical components for damage before resuming system operation would need to be developed by the system operator, based on the specific equipment installed and the manufacturer's recommendations for each piece of equipment. |
| Y | Y | ConEd SCADA Outage | Electrical | ConEdison SCADA | No communication from local control devices. | All system sequences of operation and programming should be installed on the local controllers primarily installed within the Energy Center. In the event of a communication failure between the local controllers and ConEd's supervisory SCADA, the system should continue to operate according to its programmed sequence of operation, however a communication failure will be noted in the ConEd supervisory SCADA. This should trigger a remote alarm and require a diagnostic, and possibly an in-person intervention to restore communication. This is not uncommon in remotely controlled networks. All devices used for data acquisition for points required to meet PSC metrics will be remotely installed within each of the customer locations. In the event of an outage impacting these, again, the overall system operation should remain unaffected for short (1-24 hours) periods of time, however a diagnostic and intervention should be triggered to restore communication. | This should trigger a service call to correct the communication error, however automatic operation will be maintained by the local controllers unless the utility decides otherwise. No procedure required. |
| **Note: A full list of alarms and corresponding devices is not available at this stage of design. This would need to be generated by the controls contractor following creation, submission, review, and approval of the specific system shop-drawings and submittals.** | | | | | | | |