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In-situ Atmospheric Intelligence for Hybrid Power Grids: Volume 8 (μ -Grid Energy and Power Scenario)

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In-situ Atmospheric Intelligence for Hybrid Power Grids: Volume 8 (μ -Grid Energy and Power Scenario)

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1. Introduction

The thesis for the Artificial Intelligence for Hybridized Power Grid (AIHPG)¹⁻⁵ is that optimized tactical power distribution for an isolated grid is strengthened by analyzing and exploiting atmospheric intelligence. Optimal energy management of a hybridized power grid is a multivariate challenge, impacted by time, space, and the environment. By understanding these interactions, we can optimize our energy network's generation, distribution, storage, or transmission. The future of military operations will rely on efficient and effective hybridized tactical power, to include traditional generation and storage assets such as diesel generators and electrochemical batteries, as well as nontraditional generation such as nuclear, solar, wind, and/or alternative forms of renewable energy and power generation. Optimal energy and power (E&P) management will provide greater resiliency, adaptability, and flexibility, permitting the warfighter to reduce cognitive burdens and maximize military operations.

This report presents a US Army–relevant scenario developed for use within the AIHPG testbed. The intent of this research was to develop a set of dynamic scenarios that could emulate the chaotic and dynamic operational environments related to a standard Forward Operating Base (FOB) or Combat Outpost (COP) E&P requirements and capabilities. Incorrect operation or control of an energy network will degrade warfighter capabilities and reduce mission effectiveness and efficiency, leading to energy-constrained or contested operations. By developing more chaotic and dynamic load scenarios, operational knowledge can be developed, which will provide added capabilities or functionalities for current and future warfighters.

The primary intent of this report is to document the investigation and its corresponding conclusions. The report is organized as follows. Section 2 describes the primary need to understand the individual μ -grid E&P-based capabilities. Section 3 presents a general description of the event schedule, followed by a general description of the equipment list in Section 4. A detailed description of the model components and each military shelter configuration are given in Sections 5 and 6, respectively. Section 7 defines μ grid's E&P scenarios. Results for the standard COP E&P scenario and the limited resupply COP E&P scenario are described in Sections 8 and 9, respectively. Finally, Section 10 describes the conclusions and future work.

2. Background

In June 1941, the German military invaded the Soviet Union, requiring substantial amounts of military personnel and operational resources. The campaign was relatively uneventful for the first couple of months as German forces pushed through the Soviet Union commanding all operational domains until they ultimately reached the gates of Moscow. The German military forces remained for a period of time, before being driven back to defend their capital city of Berlin. The German advances were effectively stalled because their resupply logistics were strained or substantially delayed, in part due the local atmospheric conditions. This situation resulted in the German military being unequipped for prolonged operations. The ill-timed vulnerability can be reduced to a common single point of failure, namely, a lack of available energy. Whether past, current, or future military operations, the lack of energy capabilities can significantly impact military operations, leading to energy-constrained or contested operations that will reduce survivability, mobility, security, or lethality of military operations. It should also be noted that German military was combating a near-peer adversary with similar albeit inferior capabilities bolstered by vast amounts of military personnel, which enabled the Soviets to outlast the Germans in a war of attrition.

Consider the future of modern military warfare in which military personnel are forwardly deployed with advanced combat capabilities supported by air, land, sea, space, and cyber assets, operating subject to finite energy generation, storage, or transmission resources. Such a battlespace is expected to be further complicated by the fact that the next active military engagement is to be with a near-peer adversary who will possess similar advanced military capabilities or resources. All future military engagements are expected to be contested or constrained by energy availability, which will further be exasperated by the fact that military operations are expected to utilize additional advanced unmanned and manned assets all reliant on, and competing for, limited energy resources.

Based on this future vision, a set of MATLAB/*Simulink*-based components were developed to model the E&P capabilities of a COP or FOB. This report features two separate but similar (E&P-based) scenarios: 1) a fully staffed and operational brigade-sized COP required for long-term occupation and 2) a brigade-sized COP. The latter scenario includes three phases. Phase 1 begins as inoperable. Over a set

duration, the COP is constructed into a fully operational COP, at which point the COP runs for a 2-week period (Phase 2). At the conclusion of the 2-week period, the COP is deconstructed (Phase 3). During the 2-week operational phase, the COP has limited or no resupply capabilities. The second scenario is intended to emulate a future military operational theater in which small self-contained energy networks are continuously constructed, operated, and deconstructed to command and conquer geographic regions that effectively allow military operations to be conducted safely and securely at the tactical edge, effectively and efficiently commanding future military engagements.

There are two primary features for the μ -Grid E&P Scenario model: a US Army-relevant set of events and a US Army-relevant equipment set. These are described in Sections 3 and 4, respectively.

3. Event Schedule

One of two primary features for the μ -Grid E&P Scenario model was the US Army-relevant set of events. These events were used to define the event schedule, which directly impacted the energy generation, storage, dissipation, and transmission of model components. Twenty-two different events were defined: Normal Operations, Meal Preparations (Prep), Meal, Laundry Wash Cycle, Laundry Dryer Cycle, Shower, Briefing, Tactical Resupply, Reduced Signature Operations, Patrol, Patrol with Intermittent Contact, Patrol with Sustained Contact, Patrol Request Quick Response Force (QRF), Mobility Maneuver, Silent Watch, Standby, Insertion/Extraction, Overwatch, Maintenance, Buildup, Breakdown, and Deconstructed. Each of the 22 events are listed in Table 1. Events triggered occupancy changes, which changed the active number of electrical components. In this way, there was a tight coupling between the assigned events and assigned electrical equipment. In other words, any change to the assigned events lead to a change in the μ -grid electrical energy usage.

Table 1 Brigades-sized COP scenario event schedule

Event identifier	Event names	Event no.
A	Normal Operations	0
B	Meal Prep	1
C	Meal	2
D	Laundry Wash Cycle	3
E	Laundry Dryer Cycle	4
F	Shower	5
G	Briefing	6
H	Tactical Resupply	7
I	Reduced Signature Operations	8
J	Patrol	9
K	Patrol Intermittent Contact	10
L	Patrol Sustained Contact	11
M	Patrol Requests QRF	12
N	Mobility Maneuver	13
O	Silent Watch	14
P	Standby	15
Q	Insertion Extraction	16
R	Overwatch	17
S	Maintenance	18
T	Buildup	19
U	Breakdown	20
V	Deconstructed	21

4. Equipment List

The second of two primary features for the μ -Grid E&P Scenario model were the US Army–relevant set of representable government-furnished equipment (GFE), which was assigned to each individual shelter. Twenty-two different components were included in the model: specialized equipment, desktop computer, televisions (TVs), game console, shop lights, fans, laptop computer, cell phone, projector, refrigerator, freezer, oven, warmer, microwave, heaters, water heater, hot plate, dishwasher, clothes washer, clothes dryers, heating ventilation and air conditioning (HVAC) (also known as environmental control units [ECUs]), and a military-style shelter to contain the aforementioned equipment. The complete list of components is provided in Table 2.

Table 2 Brigade-sized COP scenario equipment list

Component	Assigned shelter	Section	Appendix
Specialized electrical equipment	Any	5.1	A.1
Desktop computer	Any		A.2
TVs	Any		A.3
Game console	Any		A.4
Shop lights	Any		A.5
Fans	Any		A.6
Laptop computer	Any		A.7
Cell phone	Any		A.8
Projector	Any		A.9
Microwave	Any		A.10
Heaters	Any		A.11
Hot plate	Any		A.12
Refrigerator	Any	5.2	A.13
Freezer	Any		A.14
Oven	Any		A.15
Warmer	Any		A.16
Water heater	Any		A.17
Dishwasher	Any	5.3	A.18
Clothes washer	Any		A.19
Clothes dryer	Any		A.20
ECU	Any	5.4	...
Shelter	...	5.5	...

5. Model Components

The μ -Grid E&P Scenario had 20 different representable GFE items that were housed within the various military structures termed shelters, which could also possess HVACs or ECUs intended to regulate the internal temperature of the shelter. Of the 22 different components, there were five separate modeling techniques used to define the equipment, including 1) the occupancy-dependent equipment, 2) the thermal-dependent equipment, 3) the thermal-dependent structure, 4) the lookup-table-based equipment, and 5) the condition-based thermal-dependent equipment. Each of the five separate modeling techniques are described in greater detail within the subsequent sections.

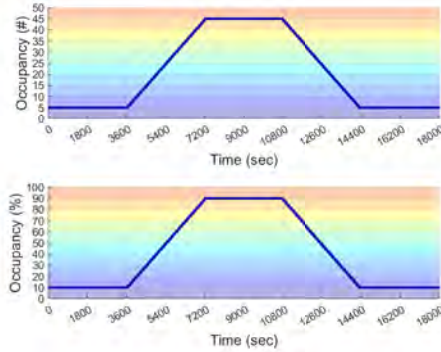
5.1 Occupancy Dependent Equipment

Of the 22 possible equipment defined within the μ -Grid E&P Scenario, 12 were modeled using the occupancy dependent equipment modeling technique including specialized electrical equipment, desktop computer, TVs, game console, shop lights, fans, laptop computer, cell phone, projector, microwave, heaters, and hot plate. Each of the aforementioned electrical equipment is considered to be an electrical load in which energy consumption is dictated based on the shelter occupancy. There are two separate E&P-based settings for the electrical equipment: the continuous use power consumption P_{cnt} and the discontinuous use power consumption P_{dis} . If the equipment is in use, the electrical component will consume power equivalent to its continuous use power consumption rating. Conversely, if the equipment is not in use, the electrical component will consume power equivalent to its discontinuous use power consumption rating. As the occupancy of a shelter changes the electrical load will change based on the shelter's occupancy. As an example, assume that a single military-type shelter contains five specialized electrical equipment, desktop computers, TVs, game consoles, shop lights, fans, laptop computers, cell phones, projectors, microwaves, heaters, and hot plates, the actual number of components within each shelter are defined in Appendix A.21. Further assume that the capacity of the shelter is that of 50 occupants, where the continuous and discontinuous use power consumption P_{cnt} and P_{dis} for each of the 12 components are defined as shown in Table 3, actual values used to generate the simulation results may vary and values used within the simulation results are defined within the appropriate Appendix. As shown in Fig. 1a, by changing the occupancy, the individual piece of electrical equipment power and energy consumed is also changed as seen in Fig. 1b. Each individual electrical equipment will consume $N_{use}P_{cnt} + (N_{eq} - N_{use})P_{dis}$ watts of power, based on the logic provided in Eq. 1.

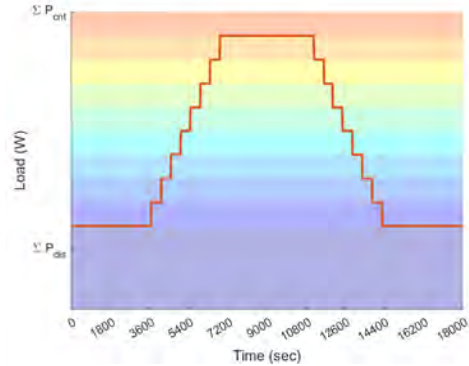
$$N_{use} = \begin{cases} 5 & \left(\frac{4}{5} < \frac{Occupancy}{50} \leq 1 \right) \\ 4 & \left(\frac{3}{5} < \frac{Occupancy}{50} \leq \frac{4}{5} \right) \\ 3 & \left(\frac{2}{5} < \frac{Occupancy}{50} \leq \frac{3}{5} \right) \\ 2 & \left(\frac{1}{5} < \frac{Occupancy}{50} \leq \frac{2}{5} \right) \\ 1 & \left(0 < \frac{Occupancy}{50} \leq \frac{1}{5} \right) \\ 0 & Occupancy = 0 \end{cases} \quad (1)$$

Table 3 Assumed continuous and discontinuous use power consumption for the occupancy-dependent equipment as defined within this section

Component	Continuous use power consumption (W)	Discontinuous use power consumption (W)
Specialized electrical equipment	5000	625
Desktop computer	200	30
TVs	150	22.5
Game console	80.5	4.025
Shop lights	30	1.5
Fans	575	57.5
Laptop computer	75	7.5
Cell phone	5	0.25
Projector	675	65
Microwave	2100	105
Heaters	1500	15
Hot plate	200	10



(a) An example of the shelter occupancy trajectory



(b) Electrical power consumption trajectory

Fig. 1 An example of the time-varying shelter occupancy and the corresponding electrical power consumption

All parameters required to define the equipment can be found in Appendix A.1 through Appendix A.12.

5.2 Thermal-Dependent Equipment

Five of the 22 pieces of equipment were modeled using the thermal dependent modeling technique including 1) the refrigerator, 2) freezer, 3) oven, 4) warmer, and 5) water heater. Each of the five components is considered to have an electrical load, where its energy consumption is dictated by a lumped parameter thermal model. The lumped parameter thermal model for the refrigerator, freezer, oven, and warmer are provided in Fig. 2a, conversely the lumped parameter thermal model for the water heater is provided in Fig. 2b. Heat transfer rates are dictated by temperature differences and the temperature of the environment in which component is contained. A hysteresis controller was applied to maintain the desired internal temperature of the electrical component. The internal temperature of the thermal electrical systems was thermally maintained as define in Table 4.

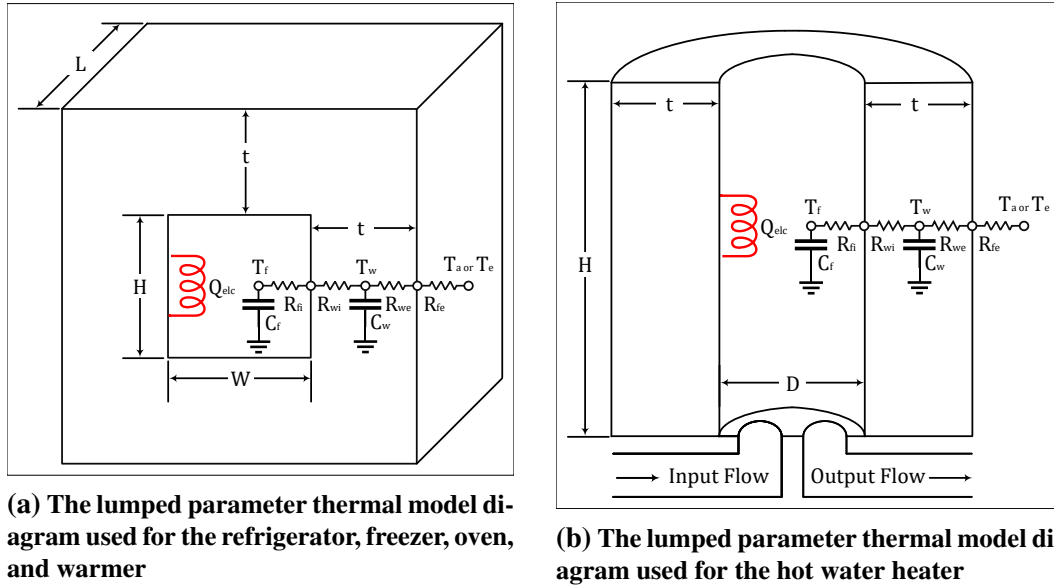


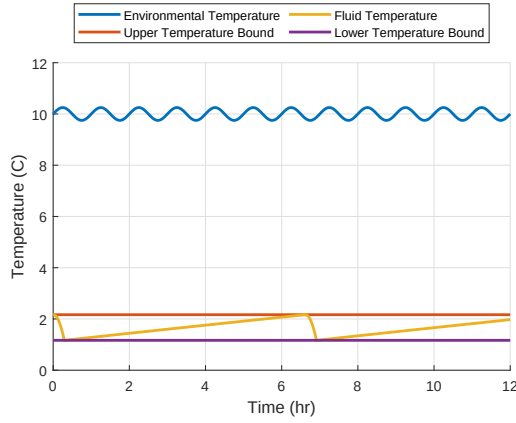
Fig. 2 The lumped parameter thermal model for the thermal-dependent equipment modeling technique

Table 4 Lower and upper temperature bound of the hysteresis controller

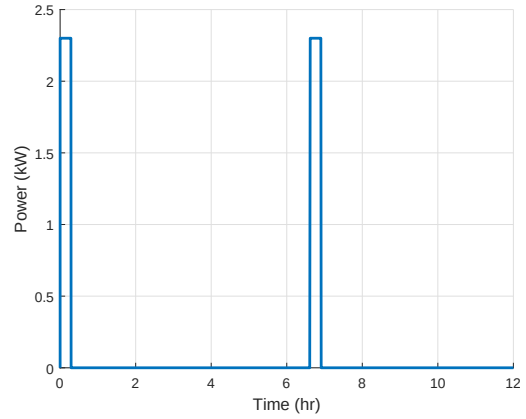
Component	Lower temperature bound (°C)	Upper temperature bound (°C)
Refrigerator	1.1667	2.1667
Freezer	-12.7	-11.7
Oven	171.47	181.67
Warmer	171.47	181.67
Water heater	47.89	49.87

The refrigerator and freezer thermal model and E&P consumption is based purely on the temperature control as it is agnostic of the events schedule. Both the oven and the warmer's thermal model and E&P consumption is based the Meal events. Finally, the water heater differs from the oven, warmer, freezer, and refrigerator. The water heater will periodically activate to maintain an internal fluid temperature in excess of 45 °C. When a shower event occurs, water at the internal temperature of the water heater is extracted and water at 10 °C is pumped back into the water heater at a rate 5% slower than the water consumption. Further, water consumption is dictated by the occupancy, as a result, the water heater's thermal model and E&P consumption are based on the temperature control and occupancy.

The resulting response of the hysteresis controller the resulting E&P consumption for the refrigerator, freezer, oven, warmer, and water heater are shown in Figs. 3, 4, 5, 6, and 7, respectively. As shown in Figs. 3 and 4, the upper temperature bound triggers activation of the component to cool the internal fluid, while the lower temperature bound triggers deactivation of the component until the upper temperature bound is violated. Conversely, as shown in Figs. 5 through 7, the upper temperature bound triggers deactivation of the component to heat the internal fluid temperature, while the lower temperature bound triggers activation of the component until the upper temperature bound is breached.

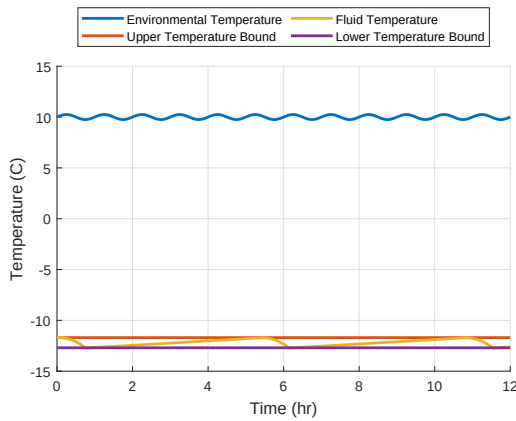


(a) The temperature controller response for the refrigerator

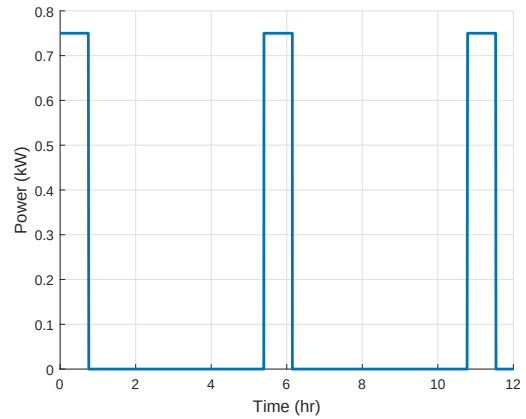


(b) The E&P consumption of the refrigerator

Fig. 3 An example of the time-varying shelter temperature profile and the corresponding electrical power consumption for the refrigerator

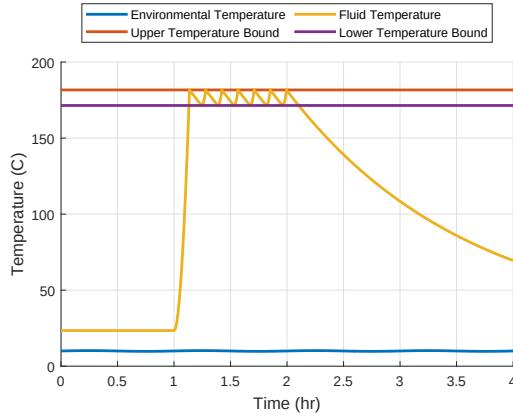


(a) The temperature controller response for the freezer

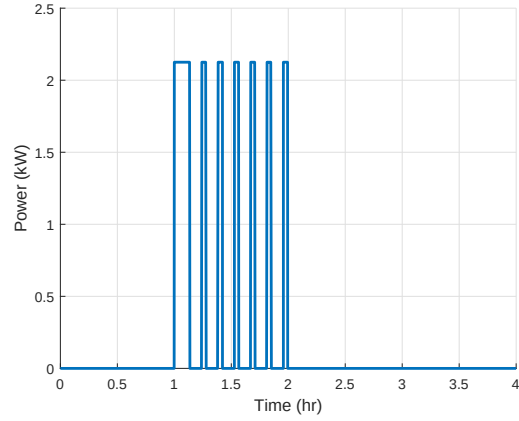


(b) The E&P consumption of the freezer

Fig. 4 An example of the time-varying shelter temperature profile and the corresponding electrical power consumption for the freezer

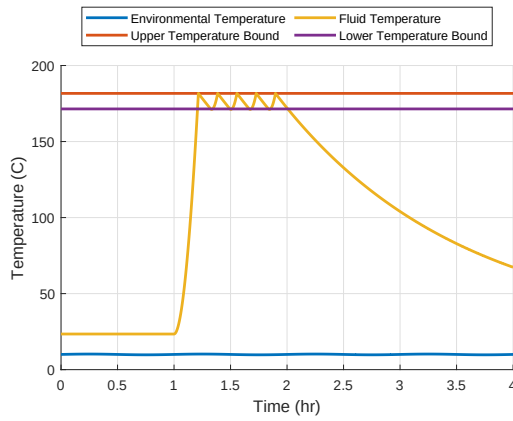


(a) The temperature controller response for the oven

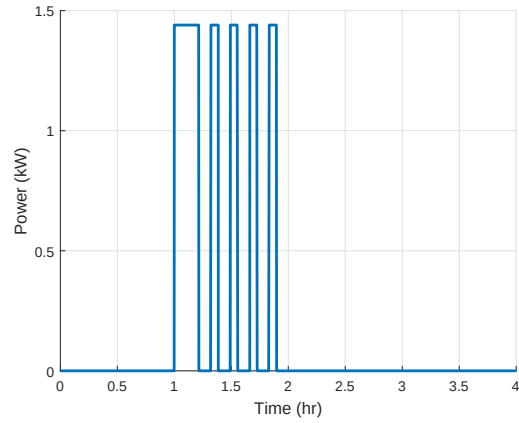


(b) The E&P consumption of the oven

Fig. 5 An example of the time-varying shelter temperature profile and the corresponding electrical power consumption for the oven



(a) The temperature controller response for the warmer



(b) The E&P consumption of the warmer

Fig. 6 An example of the time-varying shelter temperature profile and the corresponding electrical power consumption for the warmer

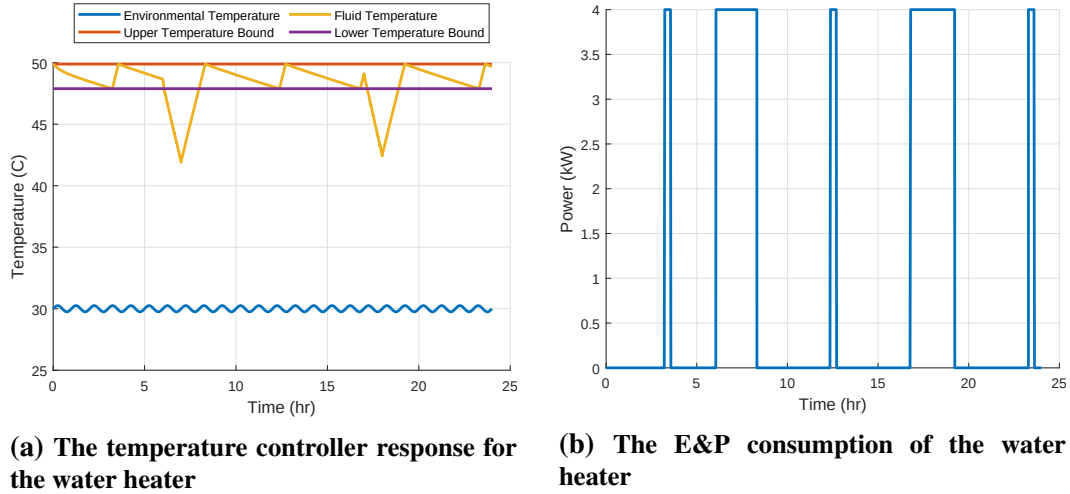


Fig. 7 An example of the time-varying shelter temperature profile and the corresponding electrical power consumption for the water heater

All parameters required to define the five electrical systems are defined in Appendix A.13 through Appendix A.17.

5.3 Lookup Table Based Equipment

Three of the 22 pieces of equipment were modeled using the occupancy-dependent modeling technique, and these were the dishwasher, clothes washer, and clothes dryer.

The electrical power/energy consumption of this equipment are based on a National Renewable Energy Laboratory (NREL)⁶ data set. The electrical load for each of the components are contained in a repeating sequence that repeats roughly every hour and a quarter for the dishwasher, and 38 min for the clothes washer and clothes dryer. The usage of the dishwasher is based on the Meal event, conversely the usage of the clothes washer and clothes dryer are based on the Clothes Washing and Clothes Drying events. Assuming that the Meal event, Clothes Washing event, and Clothes Drying event occur twice daily from 0600 through 0830 and from 1700 through 1930 as shown in Fig. 8, the dishwasher, clothes washer, and clothes dryer will then consume E&P as shown Figs. 9, 10, and 11, respectively.

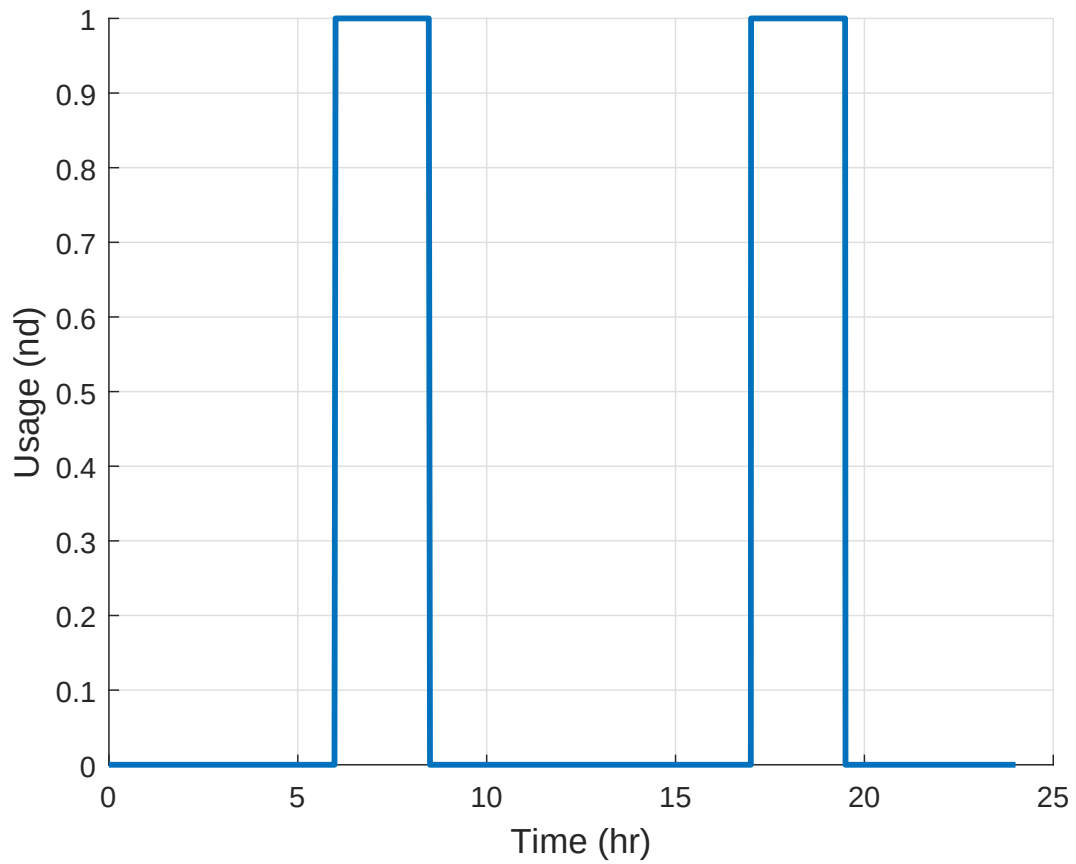


Fig. 8 An example usage profile in which the Meal event, Clothes Washing event, and Clothes Drying event occur twice daily from 0600 through 0830 and from 1700 through 1930

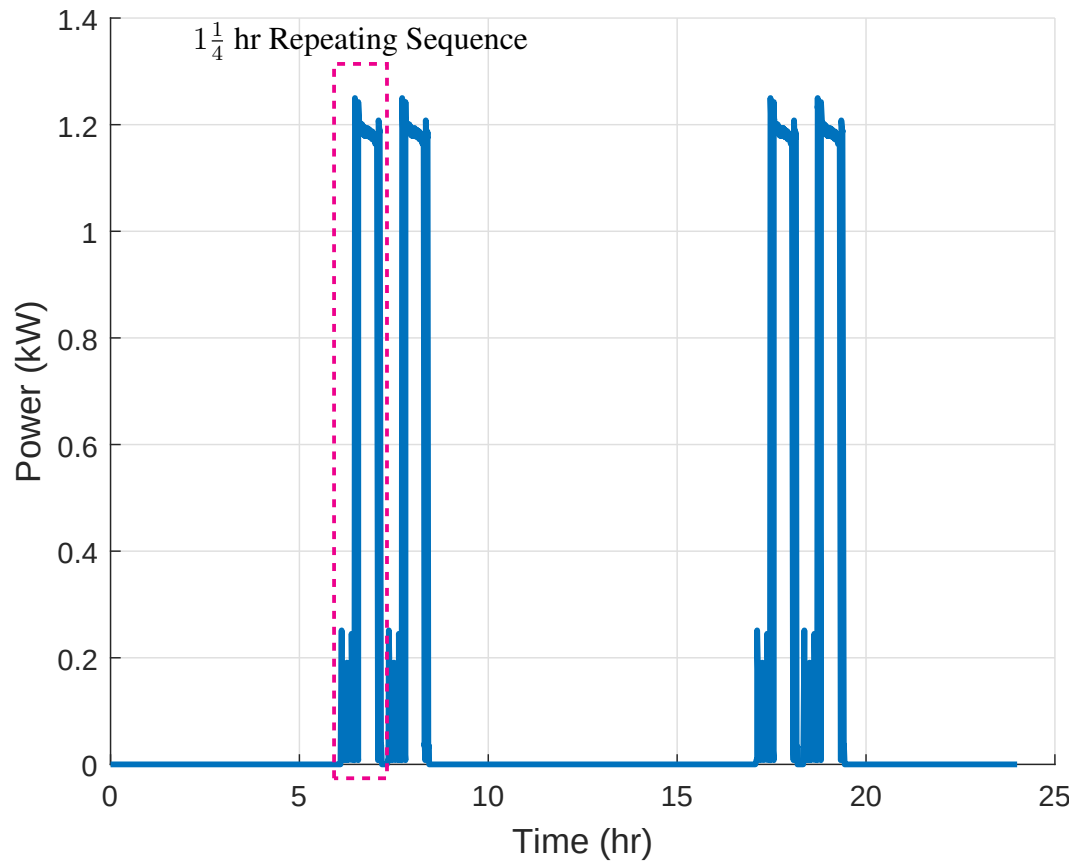


Fig. 9 The dishwasher electrical power consumption trajectory

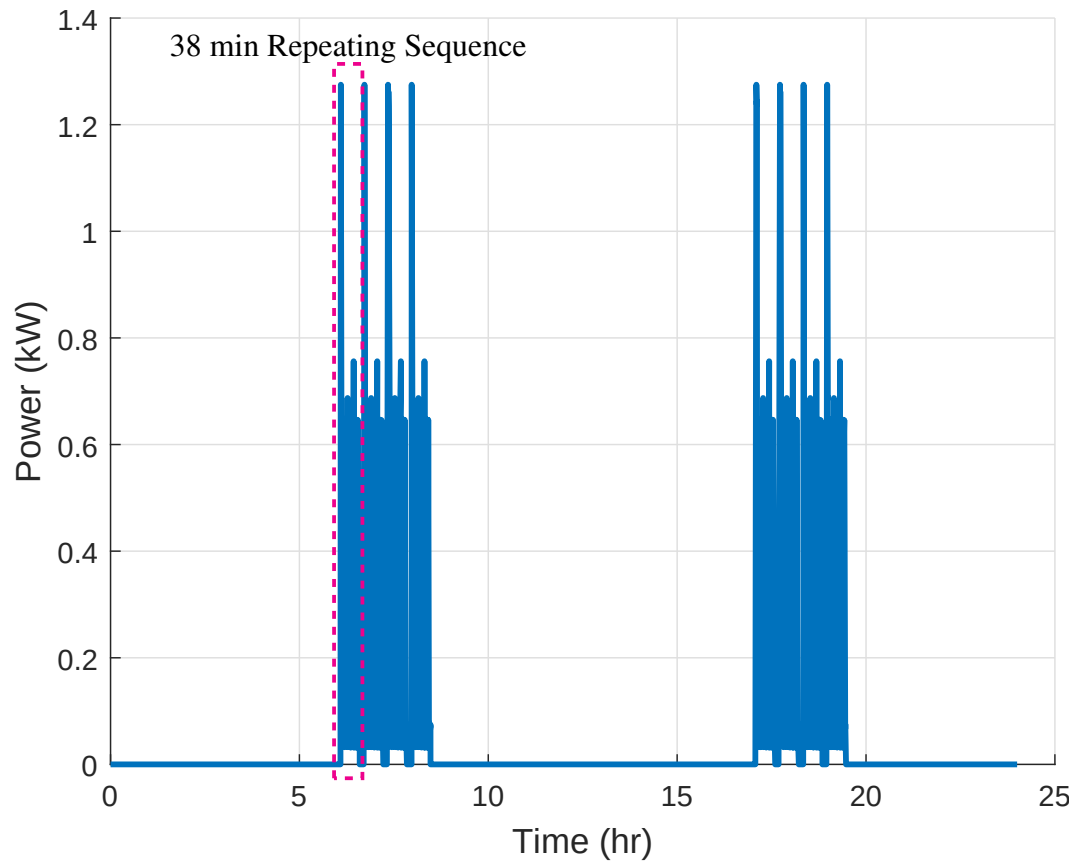


Fig. 10 The clothes washer electrical power consumption trajectory

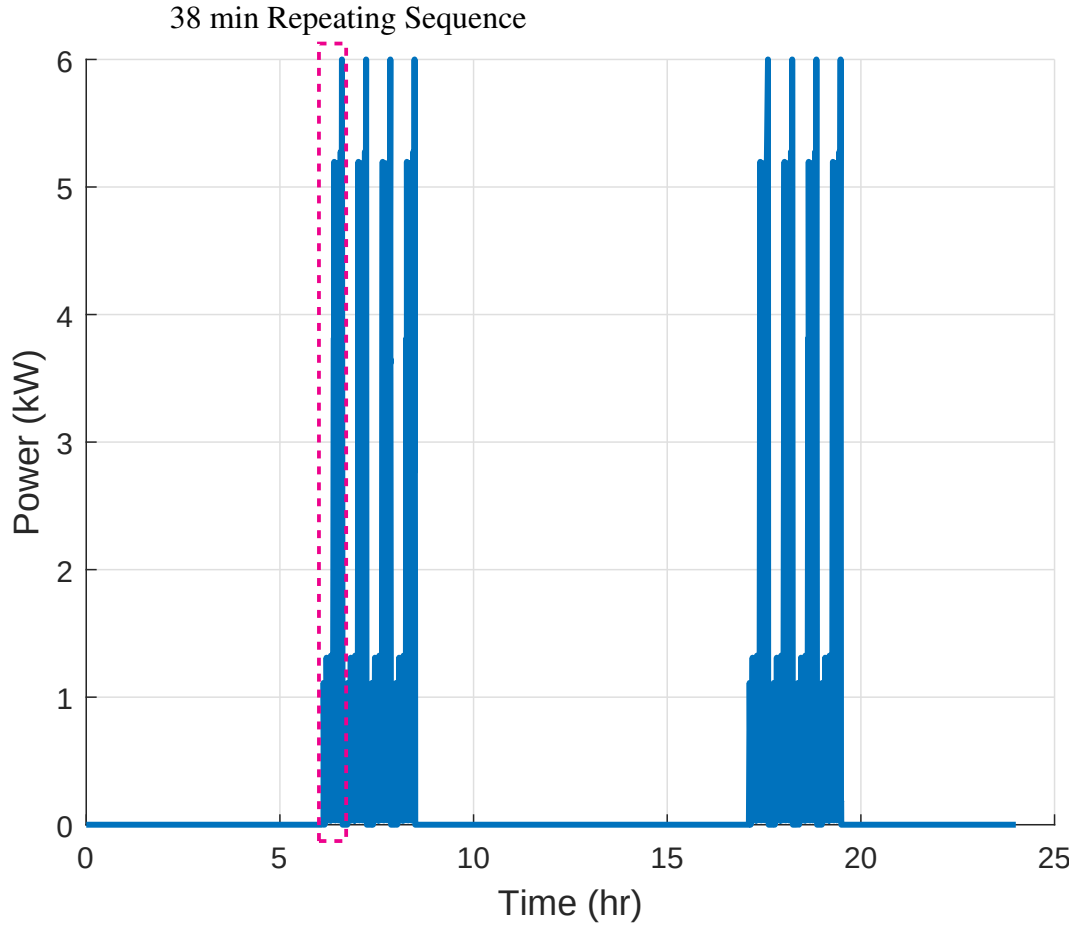


Fig. 11 The clothes dryer electrical power consumption trajectory

All parameters required to define these components are defined in Appendix A.18 through Appendix A.20.

5.4 Condition-Based Thermal-Dependent Equipment

An ECU is a specialized piece of electrical equipment that is designed to maintain the internal temperature of a shelter. The general physical characteristics of the ECU are based on commercially available information provided by HDT Global.⁷ The ECU was assumed to be capable of operating in two modes: an off state and an on state. If the ECU is on, there are three separate modes that the ECU can take: fan only, heating, or cooling. The heating and cooling modes will activate based on the internal temperature of the shelter. In this way, the ECU will maintain the desired shelter temperature. The ECU parameters are provided in Tables 5 through 9. The

ECU is designed to operate with a shelter model, and this the simulation performance is presented within the subsequent sections.

A Microsoft Excel spreadsheet, which supports 64-bit numeric quantities, was used to define the parameters used within the simulations. Data contained in the Microsoft Excel document will dictate the precision of the values as observed within the subsequent tables.

Table 5 ECU parameters (part 1)

ECU requirement	Cooling volumetric flow rate	Cooling capacity	Cooling rated power	Cooling COP
(ton)	(m³ / h)	(kW)	(kW)	(nd)
20.00	6796.25	35.13	18.75	2.34
8.00	5437.00	28.10	15.00	1.87
6.00	3398.00	21.10	15.00	1.41
5.00	3398.00	17.60	15.00	1.17
3.00	1132.67	5.87	5.00	0.39

Table 6 ECU parameters (part 2)

Heating volumetric flow rate	Heating capacity	Heating rated power	Heating COP
(m³ / h)	(kW)	(kW)	(nd)
6796.25	16.88	18.75	1.13
5437.00	13.50	15.00	0.90
3398.00	12.00	15.00	0.80
3398.00	12.00	15.00	0.80
1132.67	4.00	5.00	0.27

Table 7 ECU parameters (part 3)

Fan volumetric flow rate (m³ / h)	Fan capacity (kW)	Fan rated power (kW)	Fan COP (nd)
6796.25	12.50	12.50	1.00
5437.00	10.00	10.00	1.00
3398.00	10.00	10.00	1.00
3398.00	10.00	10.00	1.00
1132.67	3.33	3.33	1.00

Table 8 ECU parameters (part 4)

Low-priority temperature offset (°C)	High-priority temperature offset (°C)	Transition time (h)	Offset (h)
2.00	1.00	6.00	4.00
2.00	1.00	6.00	4.00
2.00	1.00	6.00	4.00
2.00	1.00	6.00	4.00
2.00	1.00	6.00	4.00

Table 9 ECU parameters (part 5)

Temperature setpoint (°C)	Tier allocation (%)
20.00	[0 100 0]
20.00	[0 100 0]
20.00	[0 100 0]
20.00	[0 100 0]
20.00	[0 100 0]

5.5 Thermal-Dependent Military Structure

One of the 22 pieces of equipment were modeled using the condition-based thermal-dependent structure. This component is very similar to the thermal-dependent equipment modeling technique; the major difference is the military shelter itself is not

defined as an electrical equipment. Instead, it simply represents a physical structure that houses various types of electrical equipment.

Figures 12 and 13 are the thermal network for the shelters, whose interior space is thermally controlled using an ECU. There are many types of shelter configurations; each individual shelter configuration is discussed in greater detail within subsequent sections. The general physical characteristics of the shelter are based on commercially available information provided by Alaska Structure.⁸ Using the shelter configurations shown in Fig. 12 and the ECU parameters as shown in Section 5.4, the shelter and the ECU can be simulated, resulting in Figs. 14a and 14b.

A Microsoft Excel spreadsheet, which supports 64-bit numeric quantities, was used to define the parameters used within the simulations. Data contained in the Microsoft Excel document will dictate the precision of the values as observed within the subsequent tables.

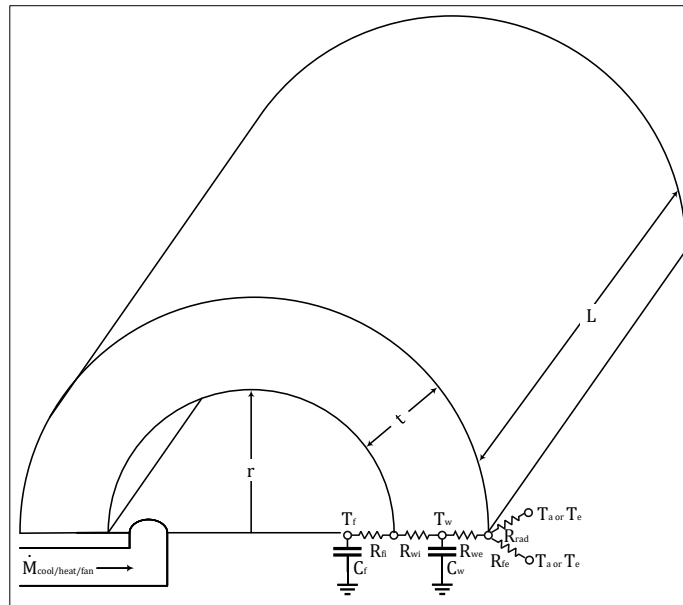


Fig. 12 The lumped parameter thermal model used to define the energy balance that emulates temperature control of the shelter in the shape of a half cylinder

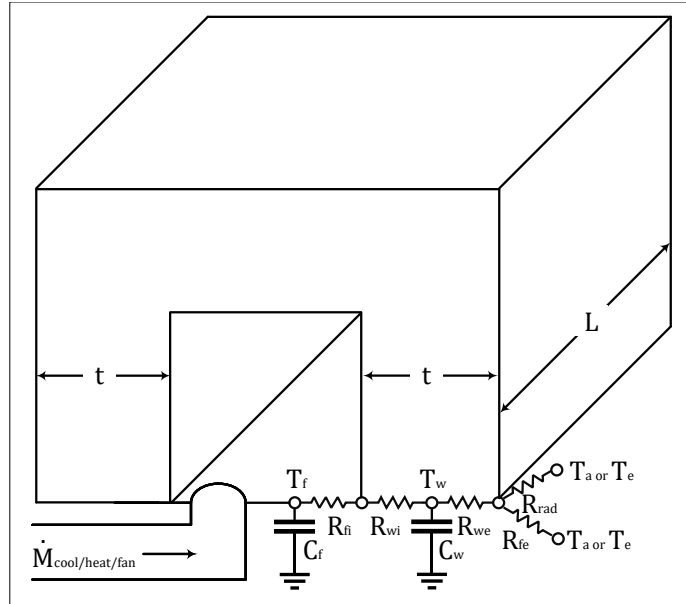


Fig. 13 The lumped parameter thermal model used to define the energy balance that emulates temperature control of the shelter in the shape of a rectangular prism

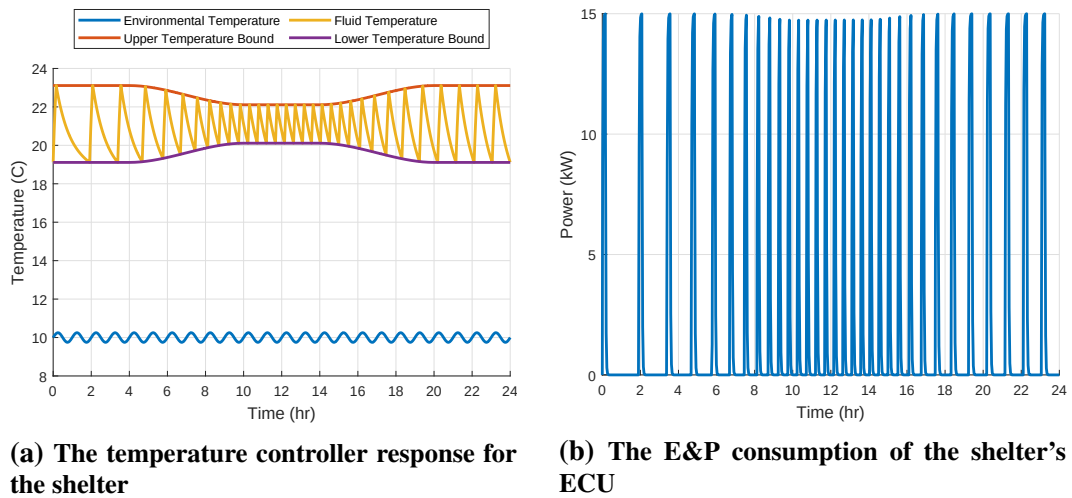


Fig. 14 The temperature controller response subject to the E&P consumption of the shelter's ECU

6. Shelter Configurations

There are 15 different shelter configurations including 1) guard shack, 2) enlisted billeting, 3) officer billeting, 4) combat operations center (COC) master, 5) COC submaster, 6) communications (COM) master, 7) COM submaster, 8) mess, 9) kitchen A, 10) kitchen b, (11) laundry A, 12) laundry B, 13) shower, 14) office, and 15) vehicle depot. Each shelter was configured as shown in Figs. 15 through 29. With exception of the guard shack, which was modeled as a rectangular prism (Fig. 12), all other shelter configurations were modeled as a half cylinder (Fig. 13). All of the shelters can be thermally regulated using an ECU as defined in Section 5.4; however, the guard shack, kitchen, and laundry shelters do not possess an ECU. No ECU was defined for the guard shack due to the overall size of the shelter. Conversely, the kitchen and laundry shelters did not include an ECU due to the high thermal loading. The officer billeting shelters are half the size of the enlisted billeting, COC, or COM shelters, and the vehicle depot shelter is twice as large as the COC or COM-based shelters. Multiple shelter configurations have one or more variations; all other shelters have a single variation and the name sufficiently describes the intended utilization of the shelter:

- There were two variants of the COC shelter: 1) the first variant, termed COC master shelter, was configured to house the critical operational technology required to manage the energy network's operation and 2) the second variant, termed COC submaster shelter, was configured to house the critical operational technology required to assist the master COC shelter to manage the energy network's operation. The COC shelter was driven by various other events.
- There were two variants of the COM shelter: 1) the first variant, termed COM master shelter, was configured to house the critical operational technology required to manage the energy network's communications and 2) the second variant, termed COM submaster shelter, was configured to house the critical operational technology required to assist the master COM shelter to manage the energy network's communications. The COM shelter was driven by various other events.
- There were two variants of the laundry shelter: 1) the first variant, termed laundry A, housed the clothes washers and was driven by laundry-related

events primarily the washing cycle of clothes and 2) the second variant, termed laundry B, housed the clothes dryers and was driven by laundry-related events primarily the drying cycle of clothes.

- There were two variants of the kitchen shelter: 1) the first variant, termed kitchen A, was used to prepare and cook the meals, and 2) the second variant, termed kitchen B, was used for food preparation and food storage. Both kitchen shelters utilization was driven by meal-related events.

A Microsoft Excel spreadsheet, which supports 64-bit numeric quantities, was used to define the parameters used in the simulation. Data contained in the Microsoft Excel document will dictate the precision of the values as observed within the subsequent tables.

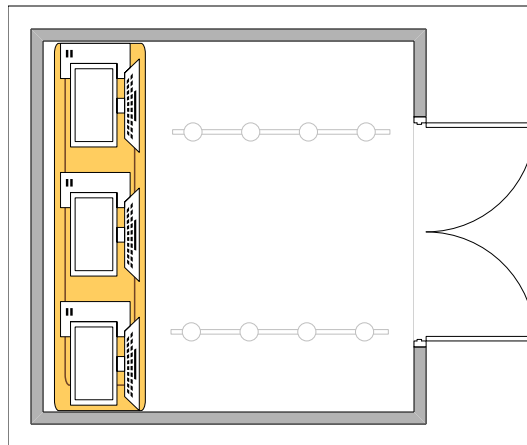


Fig. 15 Guard Shack's assumed shelter configuration

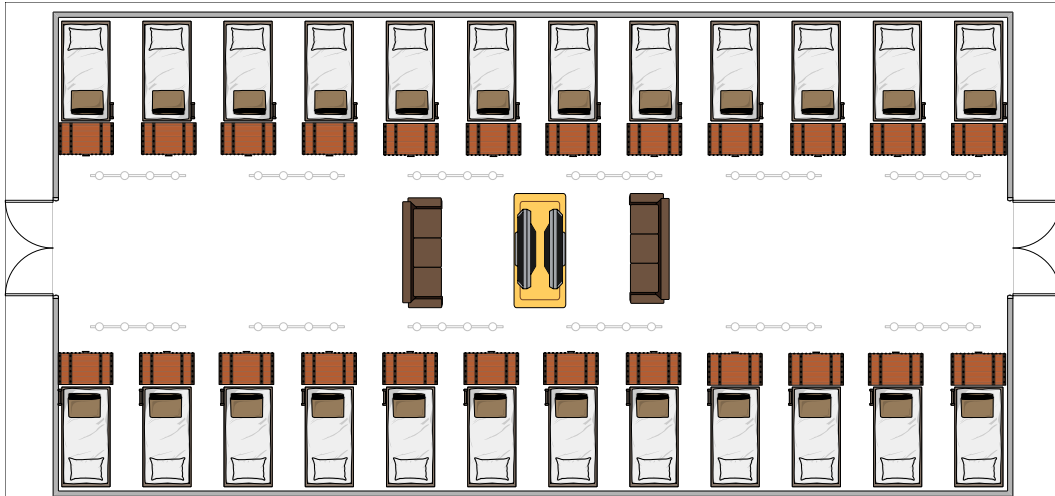


Fig. 16 Enlisted Billeting's assumed shelter configuration

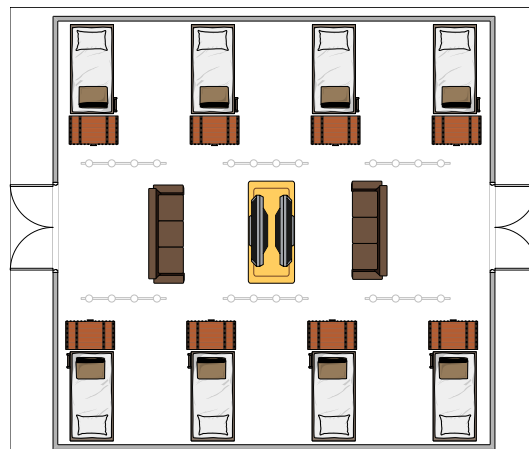


Fig. 17 Officer Billeting's assumed shelter configuration

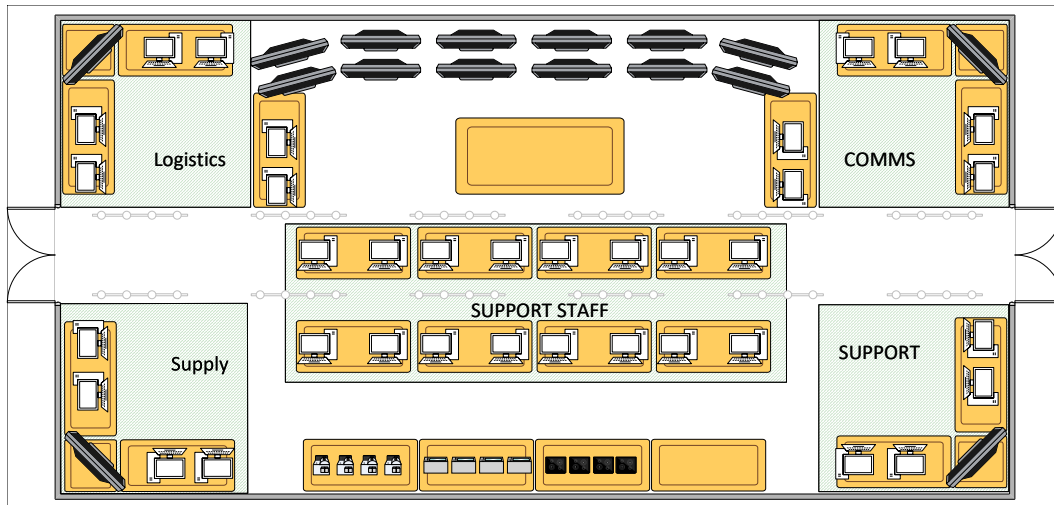


Fig. 18 COC Master's assumed shelter configuration

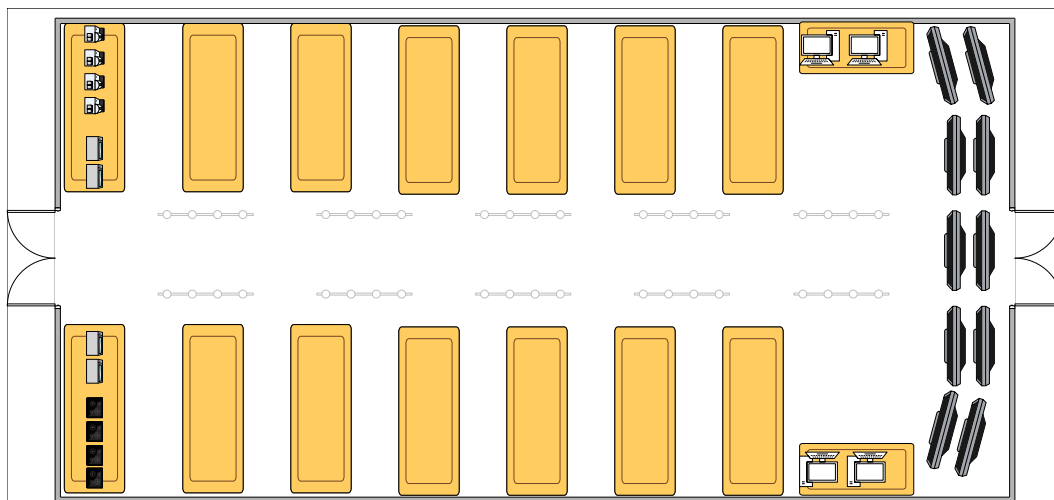


Fig. 19 COC Submaster's assumed shelter configuration

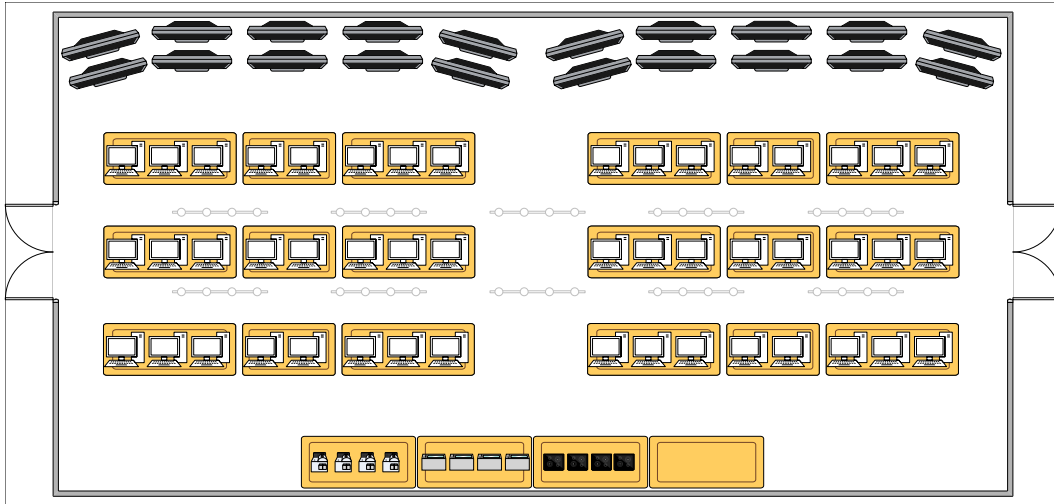


Fig. 20 COM Master's assumed shelter configuration

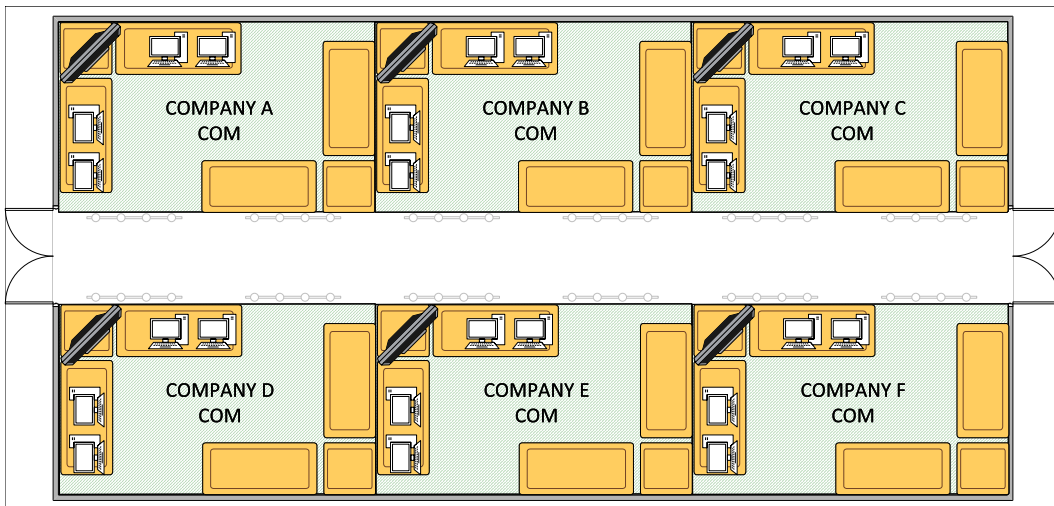


Fig. 21 COM Submaster's assumed shelter configuration

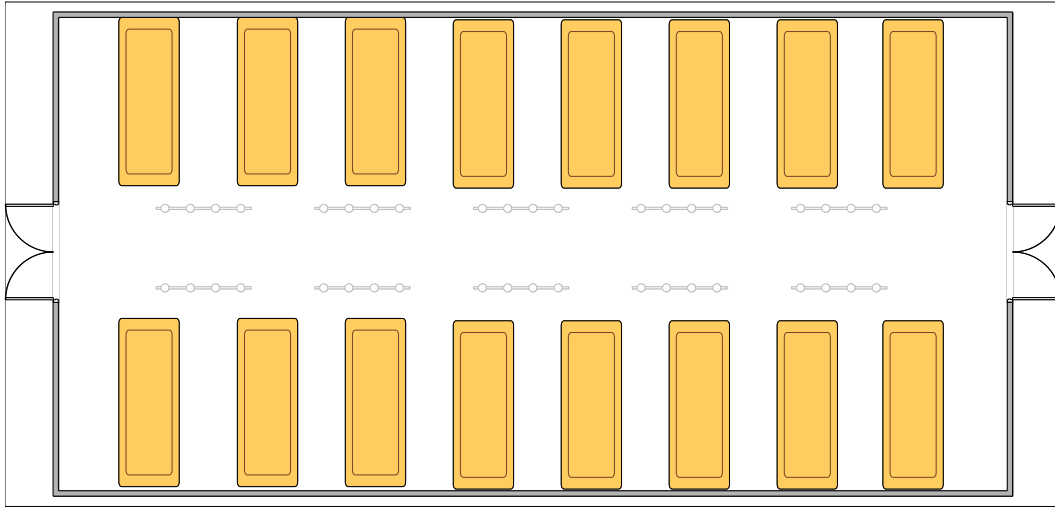


Fig. 22 Mess's assumed shelter configuration

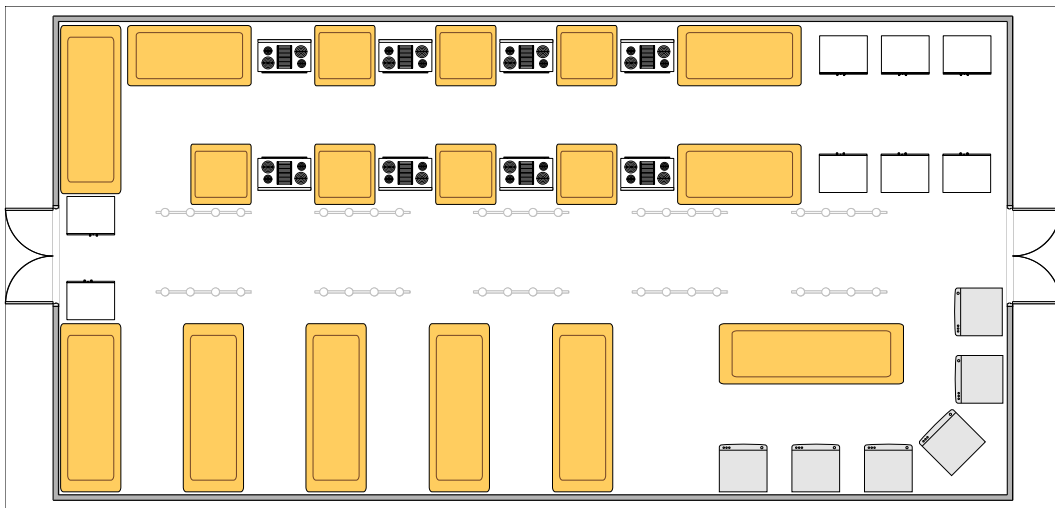


Fig. 23 Kitchen A's assumed shelter configuration

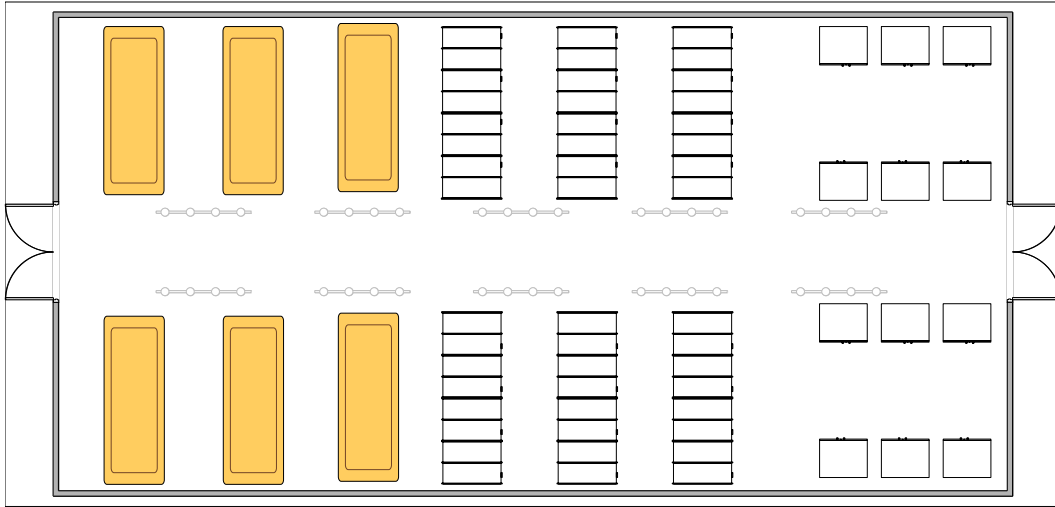


Fig. 24 Kitchen B's assumed shelter configuration

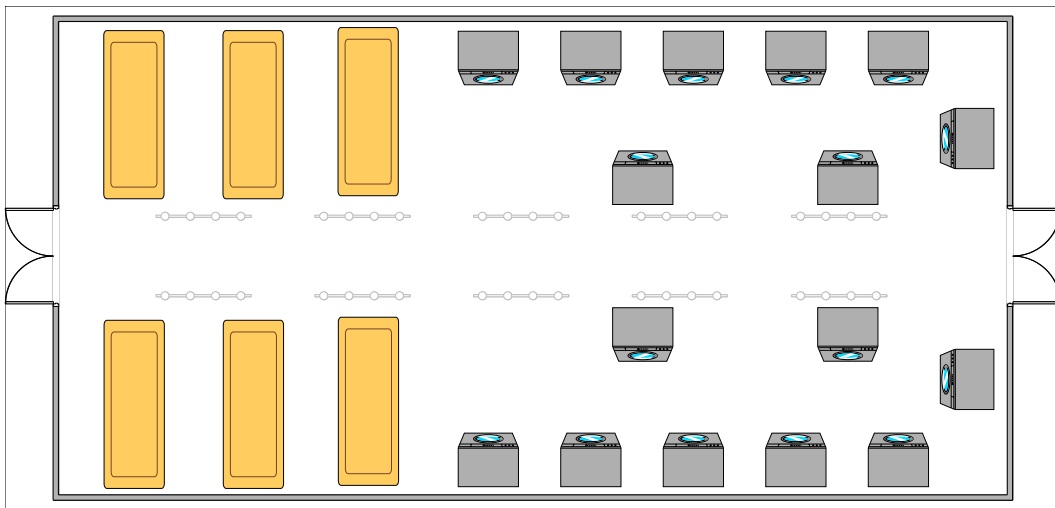


Fig. 25 Laundry A's assumed shelter configuration

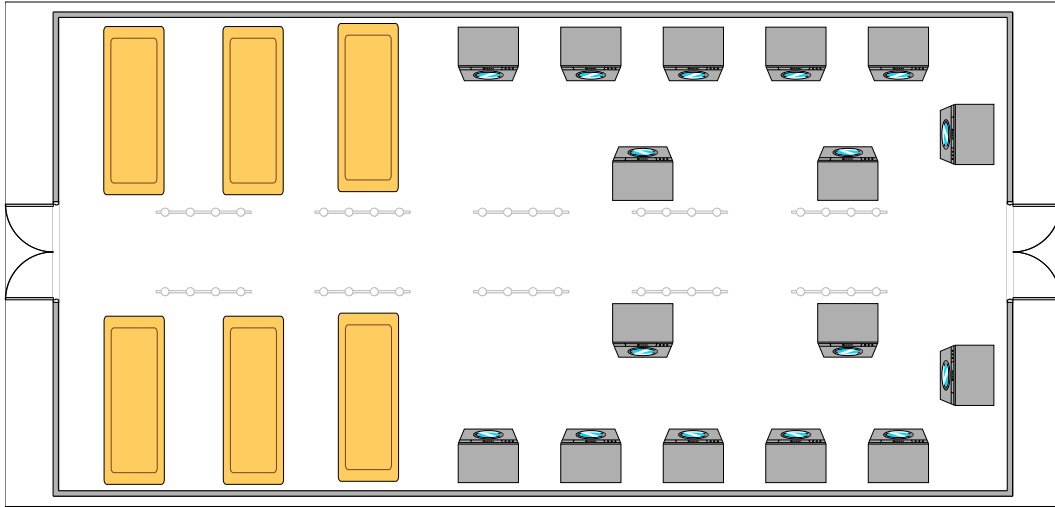


Fig. 26 Laundry B's assumed shelter configuration

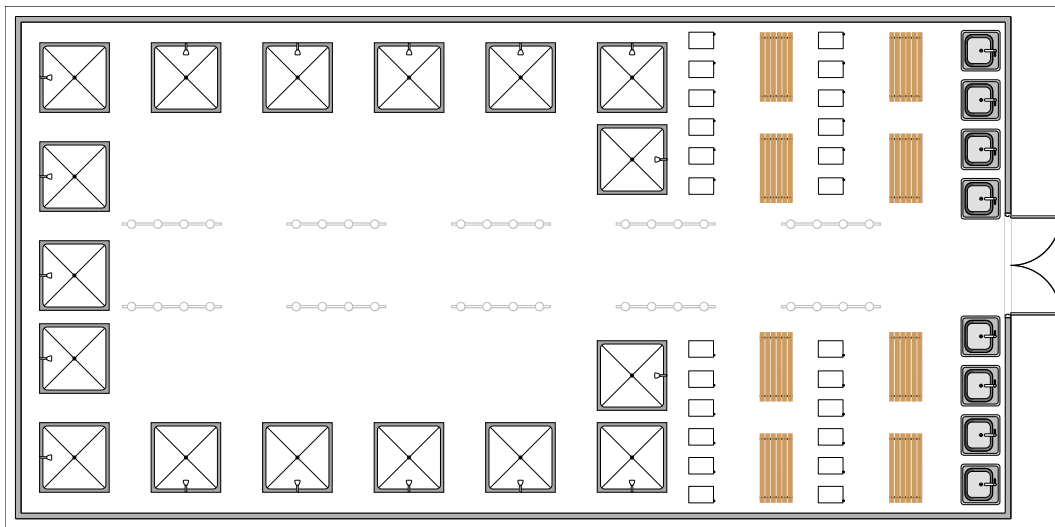


Fig. 27 Shower's assumed shelter configuration

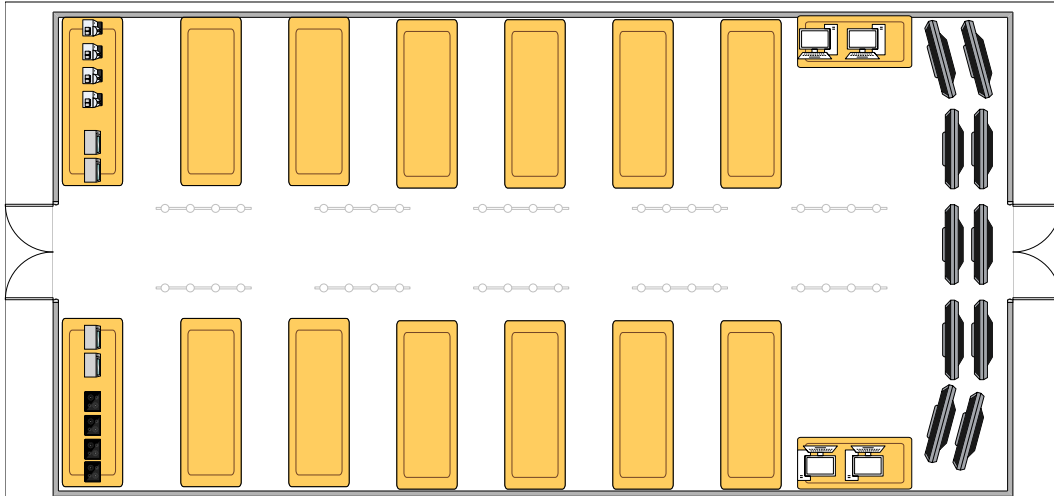


Fig. 28 Office's assumed shelter configuration

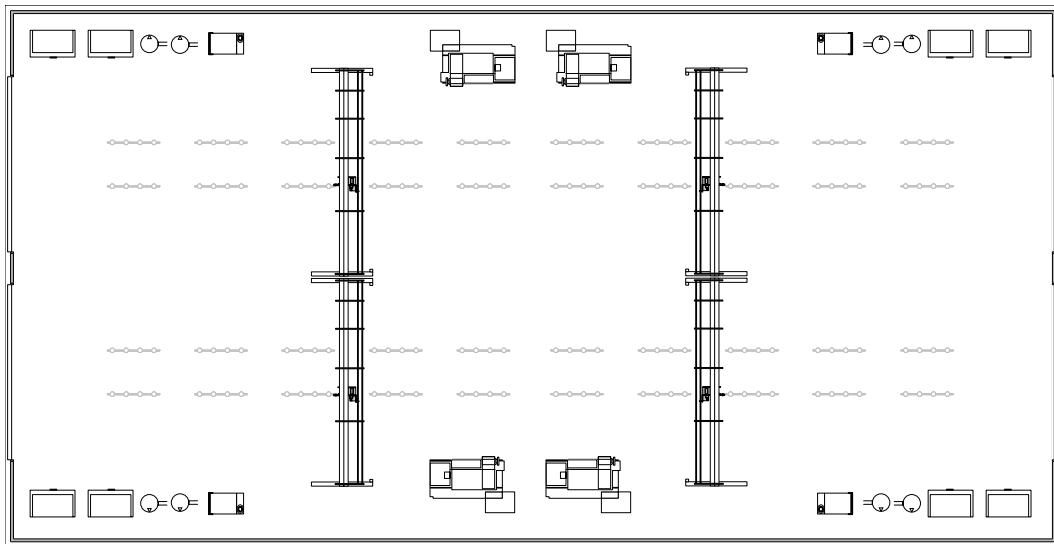


Fig. 29 Depot's assumed shelter configuration

7. Scenario

Two separate operation scenarios were evaluated through this effort. The first scenario includes a fully established brigade-sized COP, expected to last 96 h. The second scenario includes a brigade-sized COP, which goes through three phases. Phase 1 begins as inoperable and over a 96-h period, the COP was constructed, at which point the COP runs for a 2-week period (Phase 2). At the conclusion of the 2-week period, the COP was deconstructed (Phase 3). During the operational Phase 2

period, the COP was assumed to be operating with limited resupply. Both scenarios are defined within the subsequent subsections of this report.

7.1 Fully Established Combat Outpost

This scenario was created to emulate that of a fully operational COP, with the assumption that the COP was fully established and operational at the time the simulation began as shown in Fig. 30. Each shelter as shown in Fig. 30 will contain multiple pieces of electrical equipment and are configured as shown in Section 6.

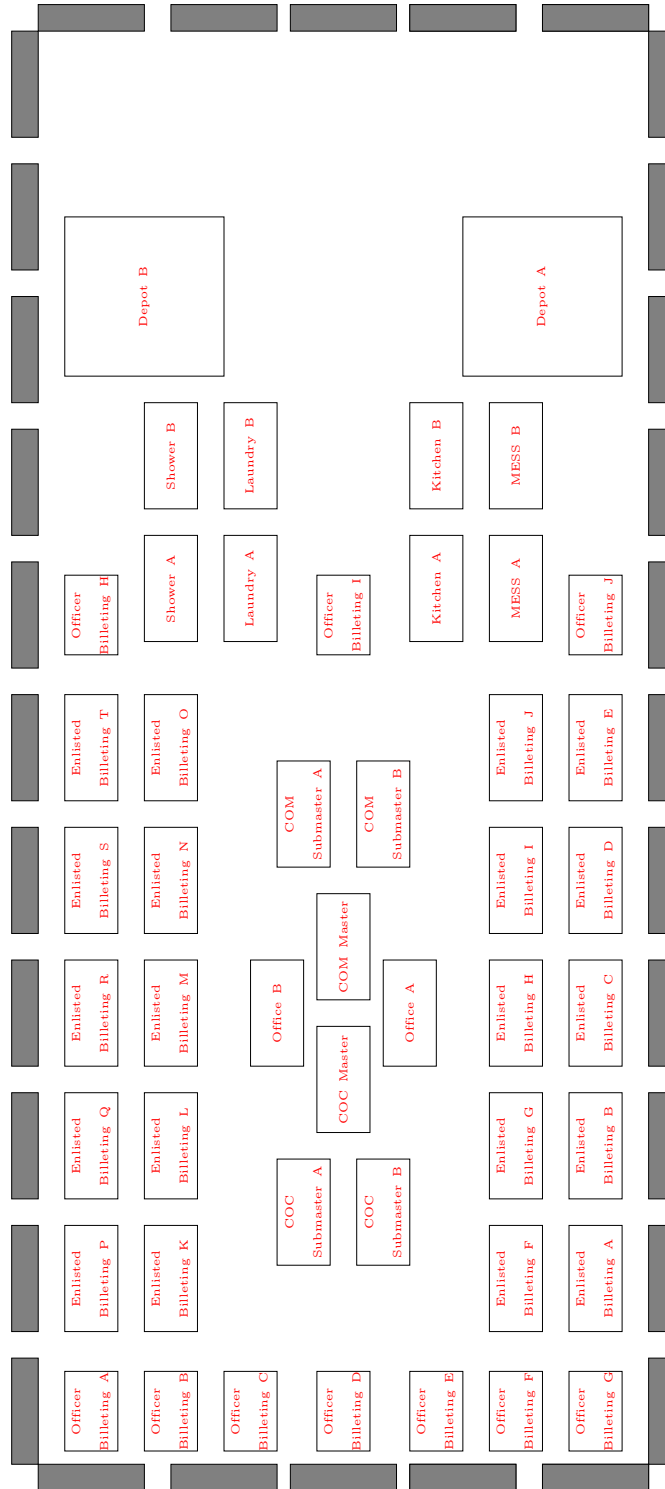


Fig. 30 Physical layout of the fully established COP

7.2 Limited Tactical Resupply Combat Outpost

This scenario was created to emulate the complete progression of a COP: 1) the construction phase (Fig. 31), 2) the operational phase (Fig. 32), and 3) the deconstruction phase (Fig. 33).



Fig. 31 The beginning stages of the COP construction in which allied forces arrive in force to deploy friendly forces including the equipment required to construct the COP



Fig. 32 The operational stage of the COP in which the primary allied forces have withdrawn from the area leaving a tactically capable military force



Fig. 33 The final stages of the COP deconstruction in which allied forces arrive in force to extract friendly forces including the equipment which previously was used to establish the COP

This scenario is meant to emulate a command-and-conquer-based operational environment in which COPs are continuously created and destroyed to capture disputed locations. Within the subsequent figures, colors and geometric shape are used to indicate the status of a shelter: 1) geometric shapes with a gray background fill represent shipping containers, which are placed along the outside of the COP loosely approximating the relative location of the COP protective barriers; 2) the lack of any discernible geometric shape indicates a fully deconstructed or nonexistent shelter (i.e., not yet constructed or unpacked); 3) a geometric shape with a yellow background fill and black hatch pattern indicates a shelter being constructed or deconstructed assuming the COP is within the construction or deconstruction phase; and 4) a geometric shape with a white background fill indicates a fully operational shelter. The Limited Tactical Resupply COP E&P scenario begins with the assumption that all material required to construct the COP has been transported to the geographic location in which the COP will be established. Conversely, the scenario ends with the assumption that all material required to construct the COP has been deconstructed and placed back within the shipping containers awaiting transportation to exit the battlefield.

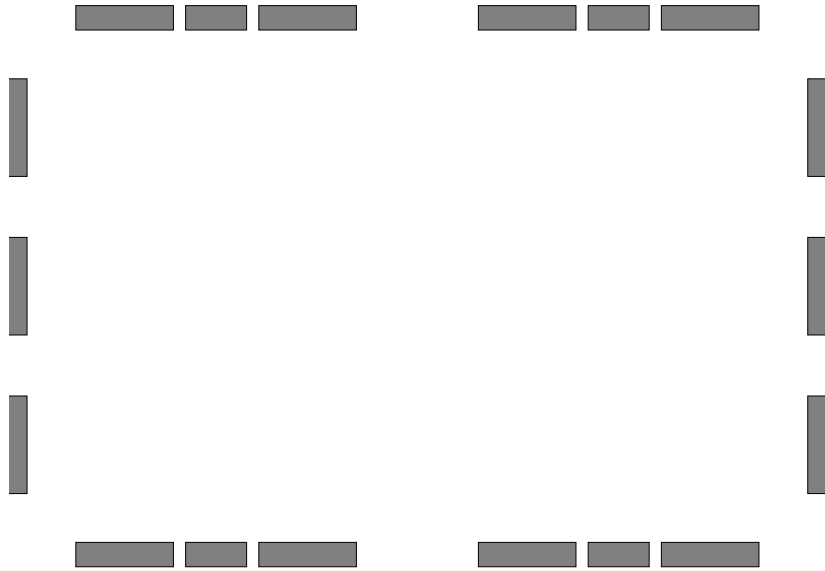


Fig. 34 Limited tactical resupply COP network topology: 0 h

After a perimeter has been established, combat engineers begin unpacking and establishing the shelters. The combat engineers begin by constructing two of the six guard stations, as shown in Fig. 35. The combat engineers take 3 h to construct/deconstruct each individual guard station.

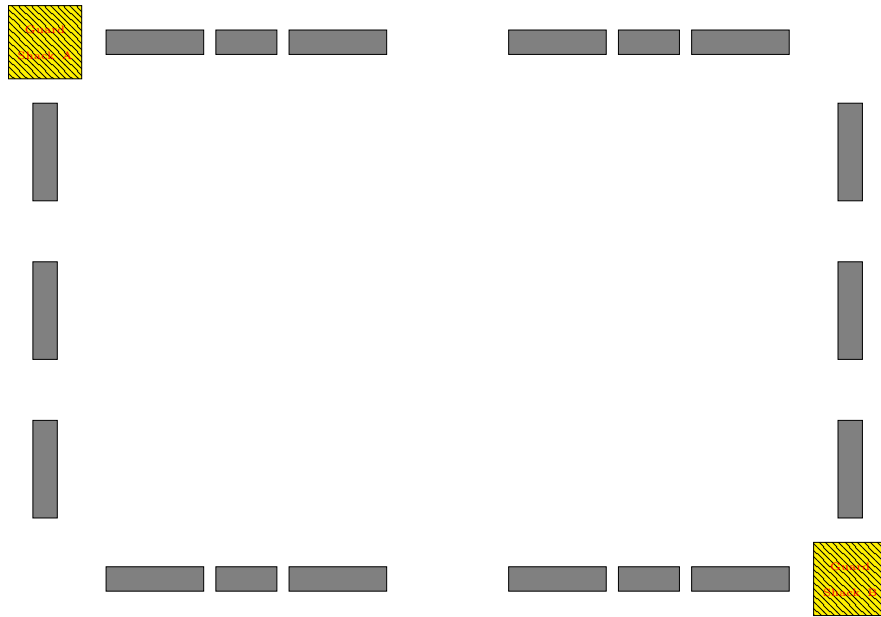


Fig. 35 Limited tactical resupply COP network topology: [0–3] h

Three hours after the combat engineers began construction of the first set of guard stations, two guard stations will become fully operational. At this point, the combat engineers begin construction of two additional guard stations, as shown in Fig. 36.

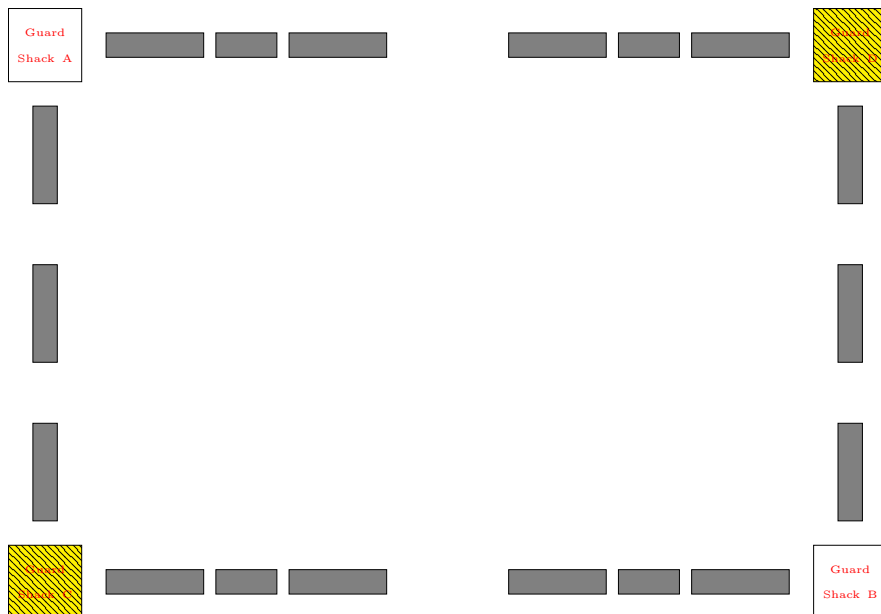


Fig. 36 Limited tactical resupply COP network topology: [3–6] h

Three hours after the combat engineers began construction of the second set of guard stations, two additional guard stations will become fully operational. At this point, the combat engineers begin construction of the final set of guard stations, as shown in Fig. 37.

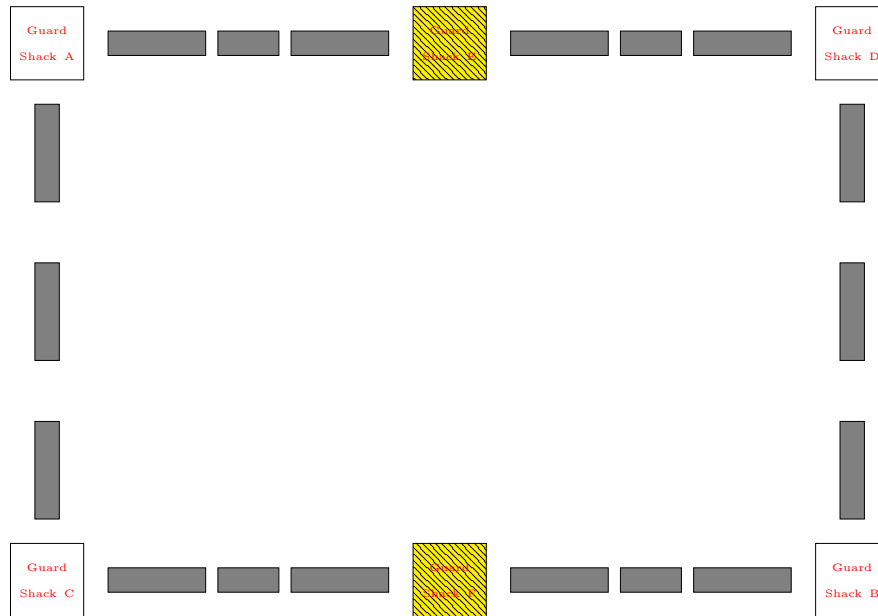


Fig. 37 Limited tactical resupply COP network topology: [6–9] h

Three hours after the combat engineers began construction of the third and final set of guard stations, all guard stations become fully operational, thus concluding the buildup phase of the guard stations. The combat engineers now begin construction of the COC and COM shelters. This scenario has three separate COC- and COM-based shelters: 1) the Master COC Shelter, 2) the master COM Shelter, 3–4) two submaster COC-based shelters, and 5–6) two submaster COM-based shelters, it takes 6 h to construct/deconstruct each individual COC- or COM-based shelter. The combat engineers begin by constructing the Master COC and COM shelters, the COP now resembles that of Fig. 38.

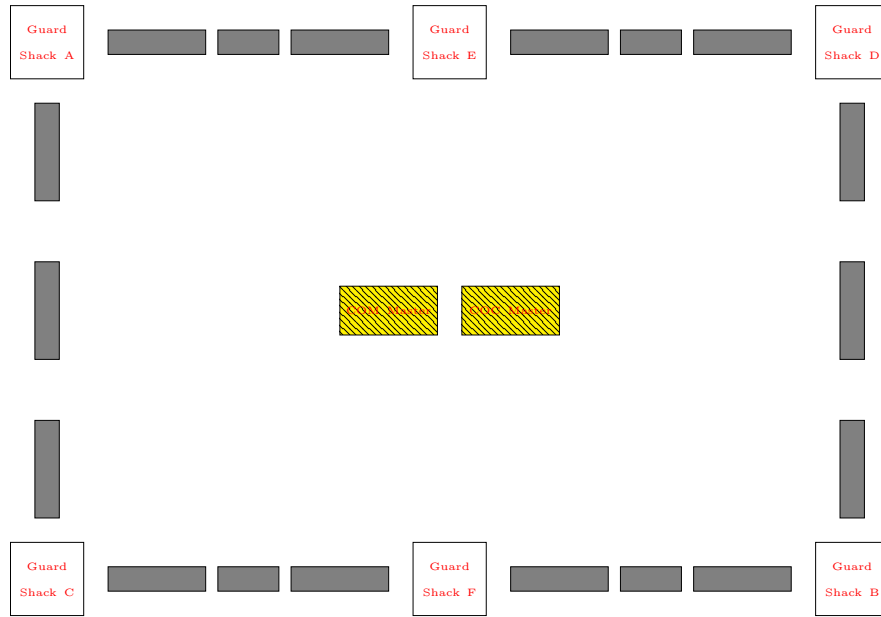


Fig. 38 Limited tactical resupply COP network topology: [9–15] h

Six hours after the combat engineers began construction of the master COC and COM shelters, both become fully operational. The combat engineers now begin construction of the first set of submaster COC and COM shelters. The COP now resembles that of Fig. 39.

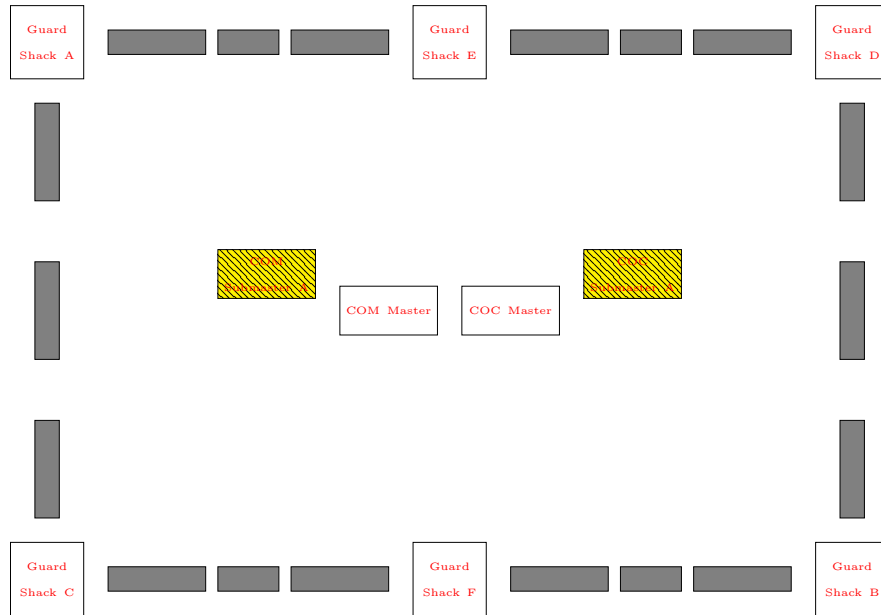


Fig. 39 Limited tactical resupply COP network topology: [15–21] h

Six hours after the combat engineers began construction of the first set of submaster COC and COM shelters, both shelters become fully operational. The combat engineers now begin construction of the final set of submaster COC and COM shelters. The COP now resembles that of Fig. 40.

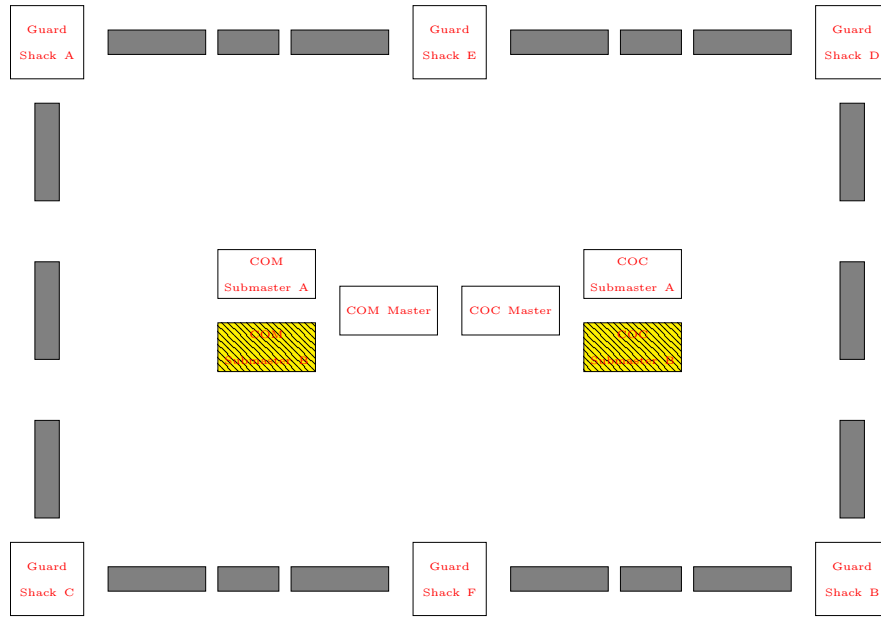


Fig. 40 Limited tactical resupply COP network topology: [21–27] h

Six hours after the combat engineers began construction of the final set of submaster COC and COM shelters, all COC- and COM-based shelters become fully operational, thus concluding the construction phase of the COC- and COM-based shelters. Construction now begins on the officer billeting shelters; each shelter will take 3 h to construct/deconstruct each shelter. The combat engineers begin by constructing two of the officer billeting shelters, as shown in Fig. 41.

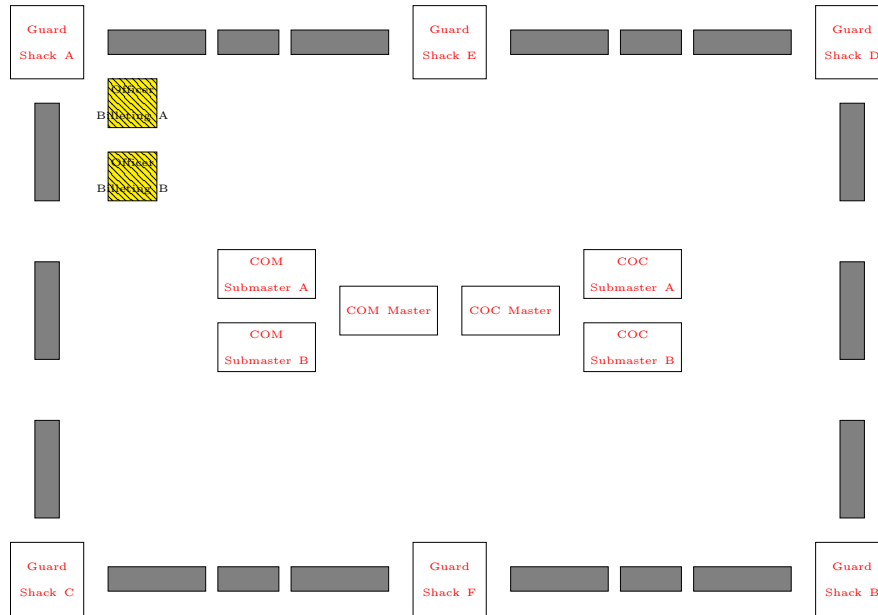


Fig. 41 Limited tactical resupply COP network topology: [27–30] h

Three hours after the combat engineers began construction of the first set of officer billeting shelters, both become fully operational. At this point, the combat engineers begin construction of two additional officer billeting shelters, as shown in Fig. 42.

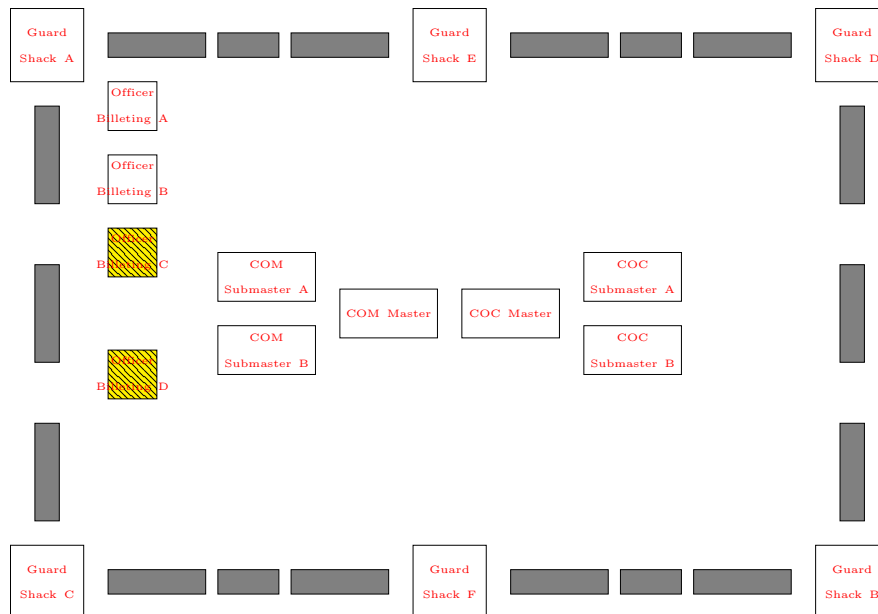


Fig. 42 Limited tactical resupply COP network topology: [30–33] h

Three hours after the combat engineers began construction of the second set of officer billeting shelters, both become fully operational. At this point, the combat engineers begin construction of the final two officer billeting shelters, as shown in Fig. 43.

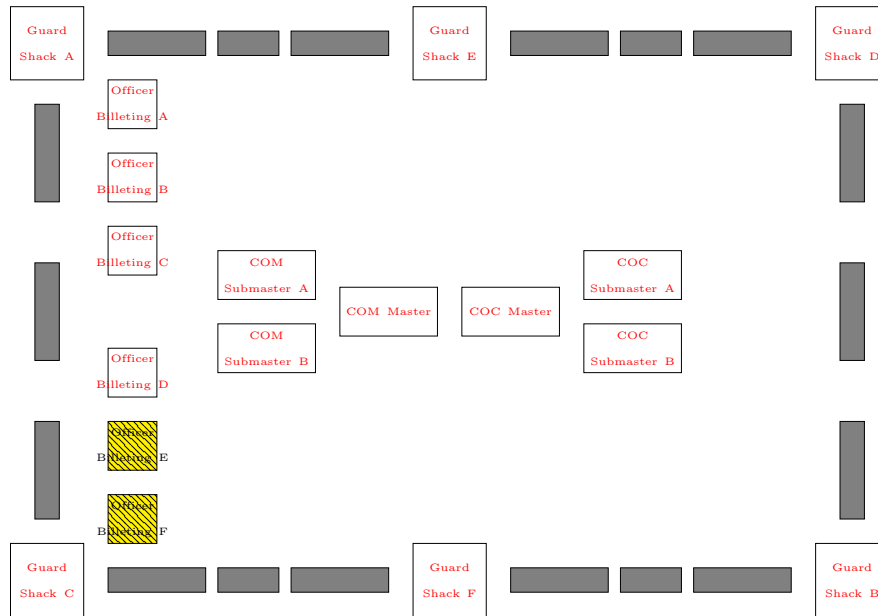


Fig. 43 Limited tactical resupply COP network topology: [33–36] h

Three hours after the combat engineers began construction of the final set of officer billeting shelters become fully operational, thus concluding the construction phase of the officer billeting shelters. Construction now begins on the enlisted billeting shelters; each shelter will take 6 h to construct/deconstruct each shelter. The combat engineers begin by constructing two of the enlisted billeting shelters, as shown in Fig. 44.

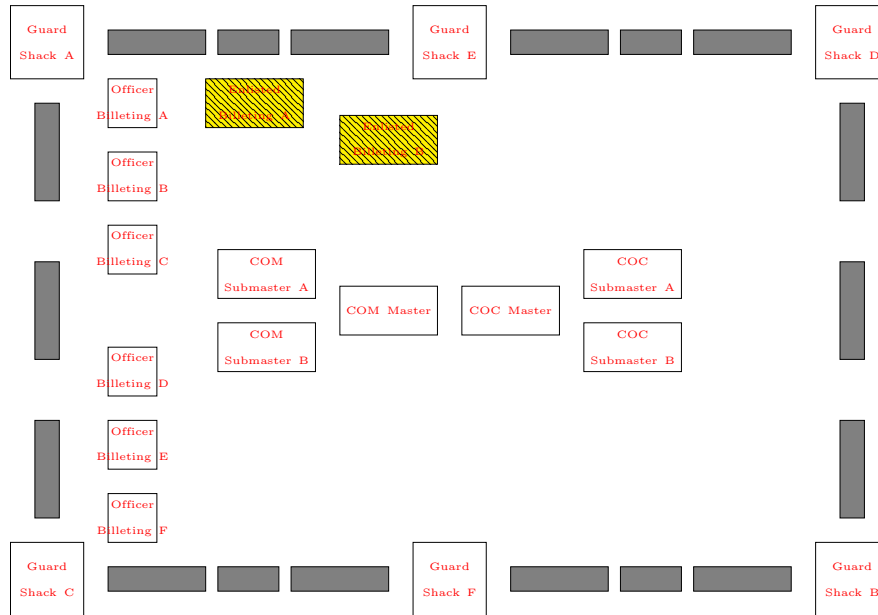


Fig. 44 Limited tactical resupply COP network topology: [36–42] h

Six hours after the combat engineers began construction of the first set of enlisted billeting shelters, both become fully operational. At this point, the combat engineers begin construction of two additional enlisted billeting shelters, as shown in Fig. 45.

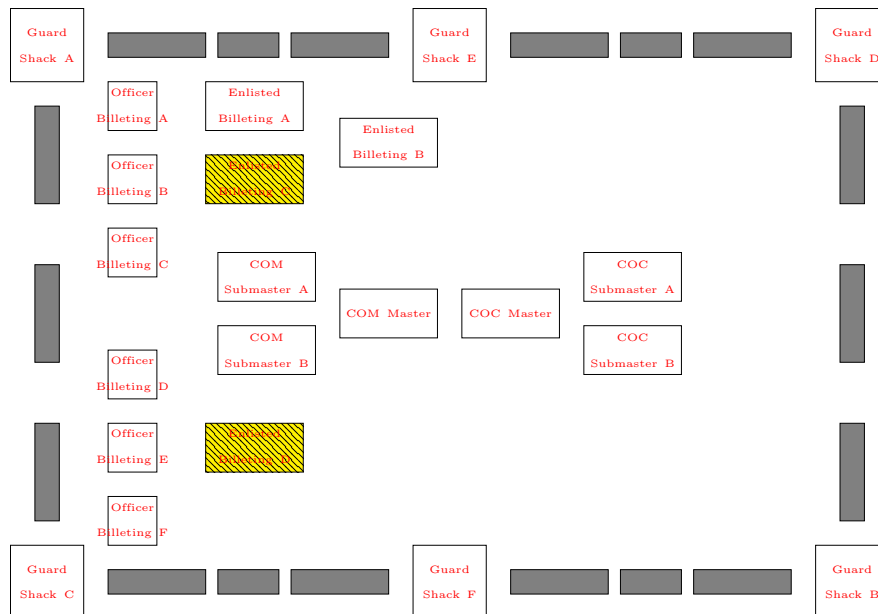


Fig. 45 Limited tactical resupply COP network topology: [42–48] h

Six hours after the combat engineers began construction of the second set of enlisted billeting shelters, both become fully operational. At this point, the combat engineers begin construction of the final two enlisted billeting shelters, as shown in Fig. 46.

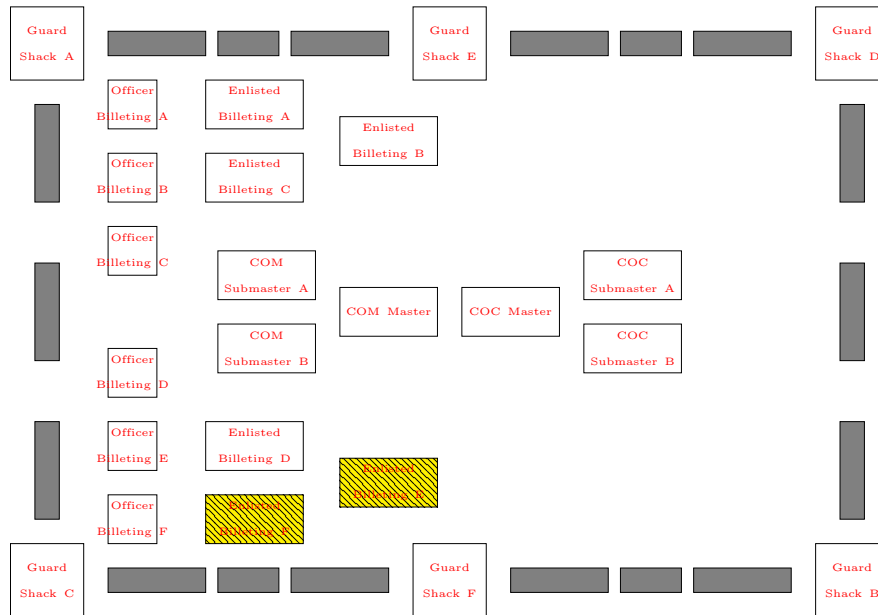


Fig. 46 Limited tactical resupply COP network topology: [48–54] h

Six hours after the combat engineers began construction of the final set of enlisted billeting shelters become fully operational, thus concluding the construction phase of the enlisted billeting shelters. Construction now begins on the first set of office shelters; each shelter will take 6 h to construct/deconstruct each shelter. The combat engineers begin by constructing two of the office shelters, as shown in Fig. 47.

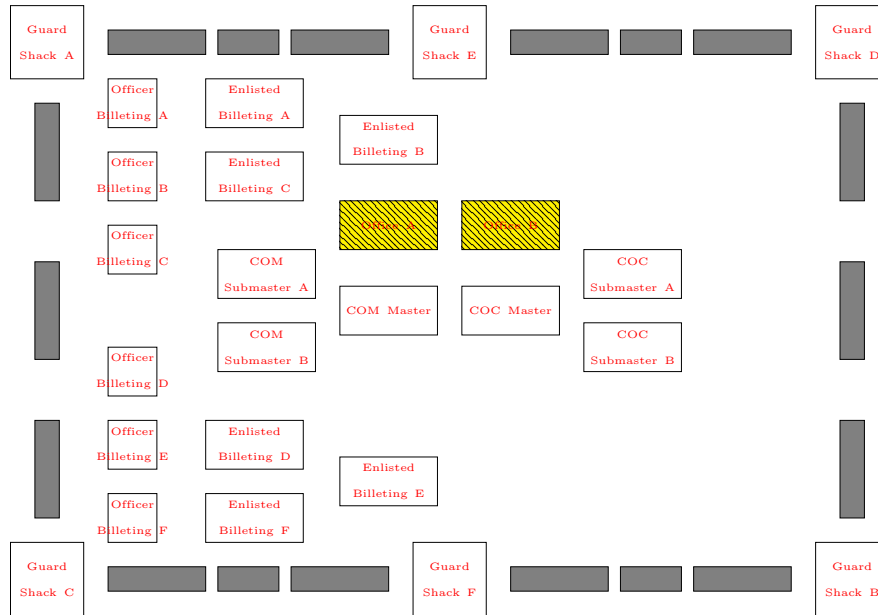


Fig. 47 Limited tactical resupply COP network topology: [54–60] h

Six hours after the combat engineers began construction of the second set of the first set of office shelters, both become fully operational. At this point, the combat engineers begin construction of the final set of office shelters, as shown in Fig. 48.

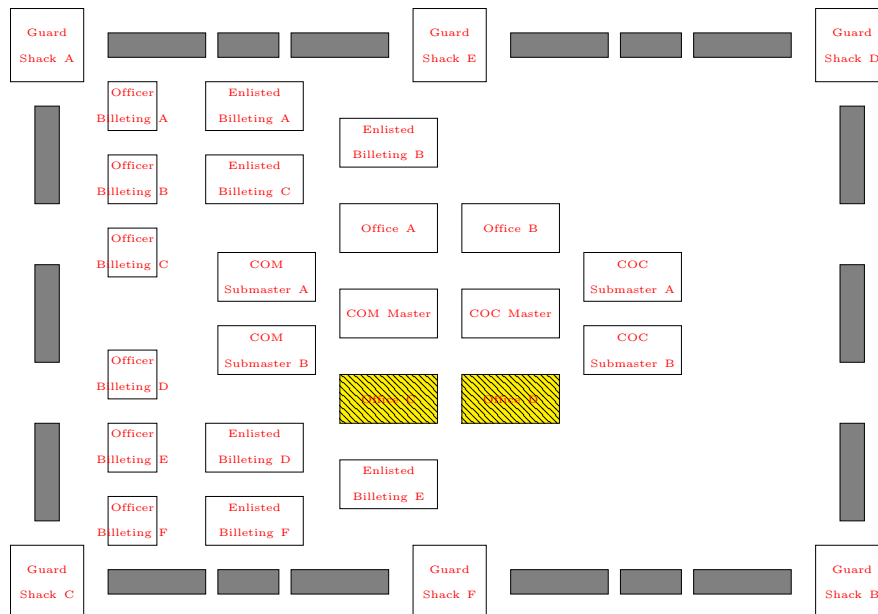


Fig. 48 Limited tactical resupply COP network topology: [60–66] h

Six hours after the combat engineers began construction of the final set of office shelters become fully operational, thus concluding the construction phase of the office shelters. Construction now begins on the Mess shelters; each shelter will take 6 h to construct/deconstruct each shelter. The combat engineers begin by constructing the Mess shelters, as shown in Fig. 49.

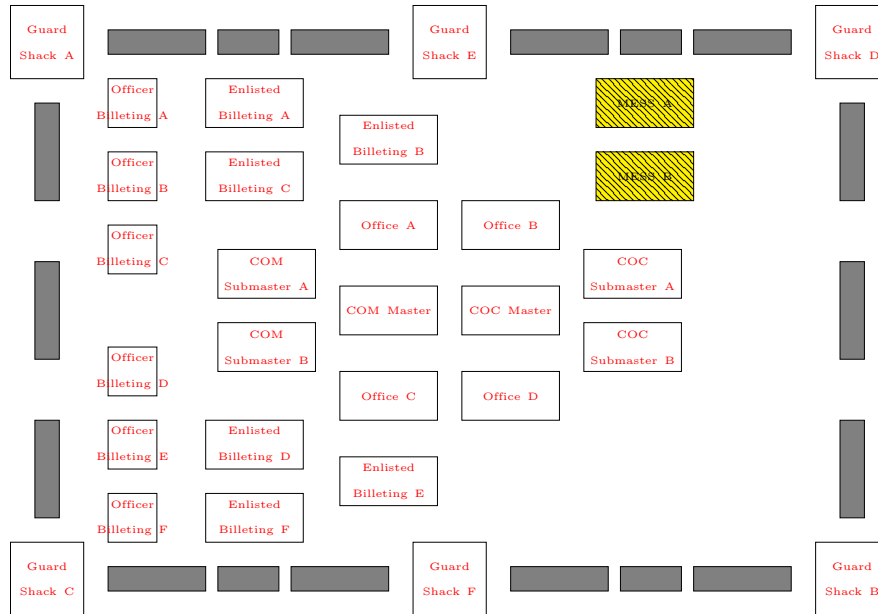


Fig. 49 Limited tactical resupply COP network topology: [66–72] h

Six hours after the combat engineers began construction of the Mess shelters become fully operational, thus concluding the construction phase of the Mess shelters. Construction now begins on the shower shelters; each shelter will take 6 h to construct/deconstruct each shelter. The combat engineers begin by constructing the shower shelters, as shown in Fig. 50.

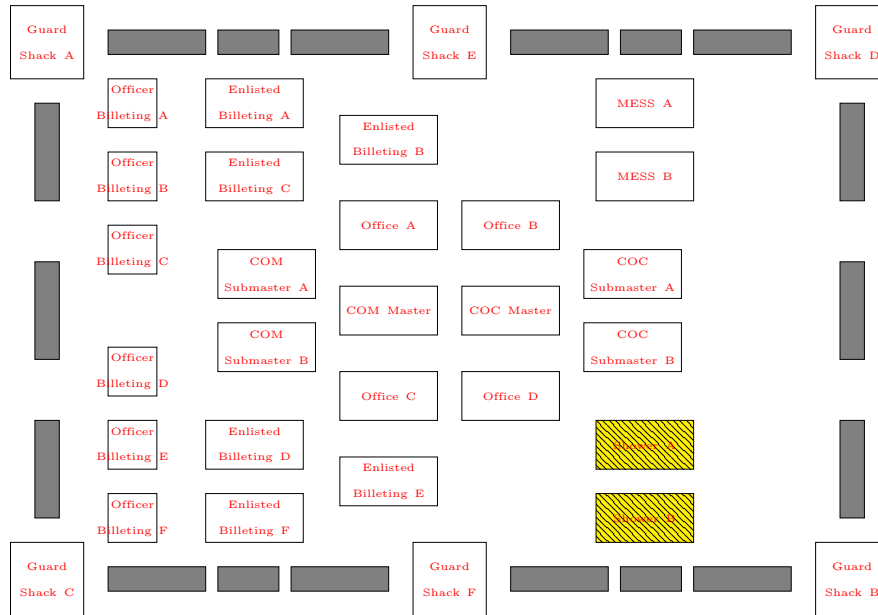


Fig. 50 Limited tactical resupply COP network topology: [72–78] h

Six hours after the combat engineers began construction of the shower shelters become fully operational, thus concluding the construction phase of the shower shelters. Construction now begins on the vehicle depot. The shelter will take 6 h to construct/deconstruct a vehicle depot shelter. The combat engineers begin by constructing the vehicle depot shelter, as shown in Fig. 51.

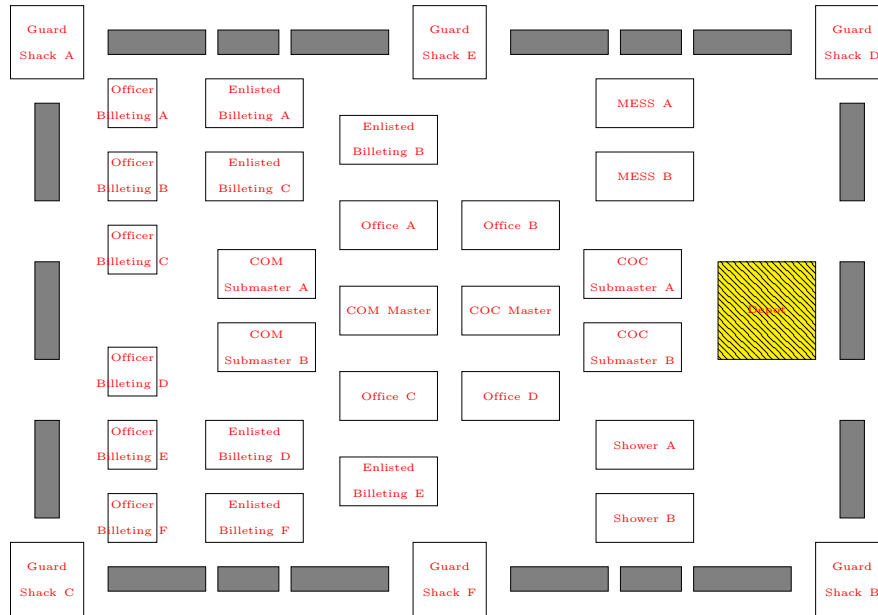


Fig. 51 Limited tactical resupply COP network topology: [78–84] h

Six hours after the combat engineers began construction of the vehicle depot shelter become fully operational, thus concluding the construction phase of the vehicle depot shelter. At this stage in the in limited tactical resupply, the COP is fully operational. The COP now resembles Fig. 52.

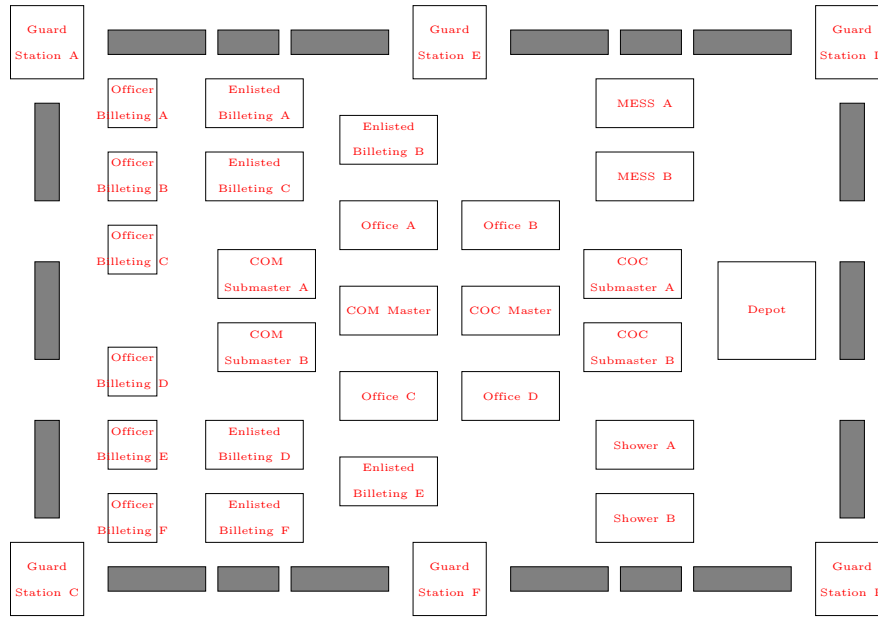


Fig. 52 Limited tactical resupply COP network topology: [96–432] h

The COP now operates for a next 2-week period with limited or no resupply capabilities. At the end of the 2-week period, the COP would be deconstructed over another 96-h period. The deconstruction process of the COP was reversed when compared to the previously discussed build/construction phase, starting with the deconstruction of the vehicle depot, followed by the shower shelters, Mess shelters, office shelters, enlisted billeting shelters, officer billeting shelters, the COM- and COC-based shelters, concluding with the deconstruction of the guard stations.

8. Fully Established Combat Outpost Results

The fully established COP E&P scenario contains 48 separate shelters including 20 enlisted billeting shelters, 10 officer billeting shelters, 2 mess shelters, 2 kitchen shelters (one used for food preparation and storage and another used primarily for cooking), 2 laundry shelters (one that houses the clothes washers and the other that houses clothes dryers), 2 shower shelters, 1 COC master shelter, 2 COC submaster shelters, 1 COM master shelter, 2 COM submaster shelters, 2 office shelters (primarily used for briefings), and 2 vehicle depots. Each of the shelters electrical and thermal responses are highlighted within the subsequent sections as dictated by Tables 10 through 12. The aggregate tiered electrical load representing the complete energy network is shown in Fig. 53. Figure 53 illustrates the tiered electrical

response of the load, where the red area indicates a tier 1 load, the orange area indicates a tier 2 load, and finally the green area indicates a tier 3 load.

Table 10 Summary of shelter results: enlisted billeting

Shelter designation	Section
Enlisted Billeting A	B.1
Enlisted Billeting B	B.2
Enlisted Billeting C	B.3
Enlisted Billeting D	B.4
Enlisted Billeting E	B.5
Enlisted Billeting F	B.6
Enlisted Billeting G	B.7
Enlisted Billeting H	B.8
Enlisted Billeting I	B.9
Enlisted Billeting J	B.10
Enlisted Billeting K	B.11
Enlisted Billeting L	B.12
Enlisted Billeting M	B.13
Enlisted Billeting N	B.14
Enlisted Billeting O	B.15
Enlisted Billeting P	B.16
Enlisted Billeting Q	B.17
Enlisted Billeting R	B.18
Enlisted Billeting S	B.19
Enlisted Billeting T	B.20

Table 11 Summary of shelter results: officer billeting

Shelter designation	Section
Officer Billeting A	B.21
Officer Billeting B	B.22
Officer Billeting C	B.23
Officer Billeting D	B.24
Officer Billeting E	B.25
Officer Billeting F	B.26
Officer Billeting G	B.27
Officer Billeting H	B.28
Officer Billeting I	B.29
Officer Billeting J	B.30

Table 12 Summary of shelter results: all other shelters

Shelter designation	Section
MESS A	B.31
MESS B	B.32
Kitchen A	B.33
Kitchen B	B.34
Laundry A	B.35
Laundry B	B.36
Shower A	B.37
Shower B	B.38
COC Master	B.39
COC Submaster A	B.40
COC Submaster B	B.41
COM Master	B.42
COM Submaster A	B.43
COM Submaster B	B.44
Office A	B.45
Office B	B.46
Depot A	B.47
Depot B	B.48

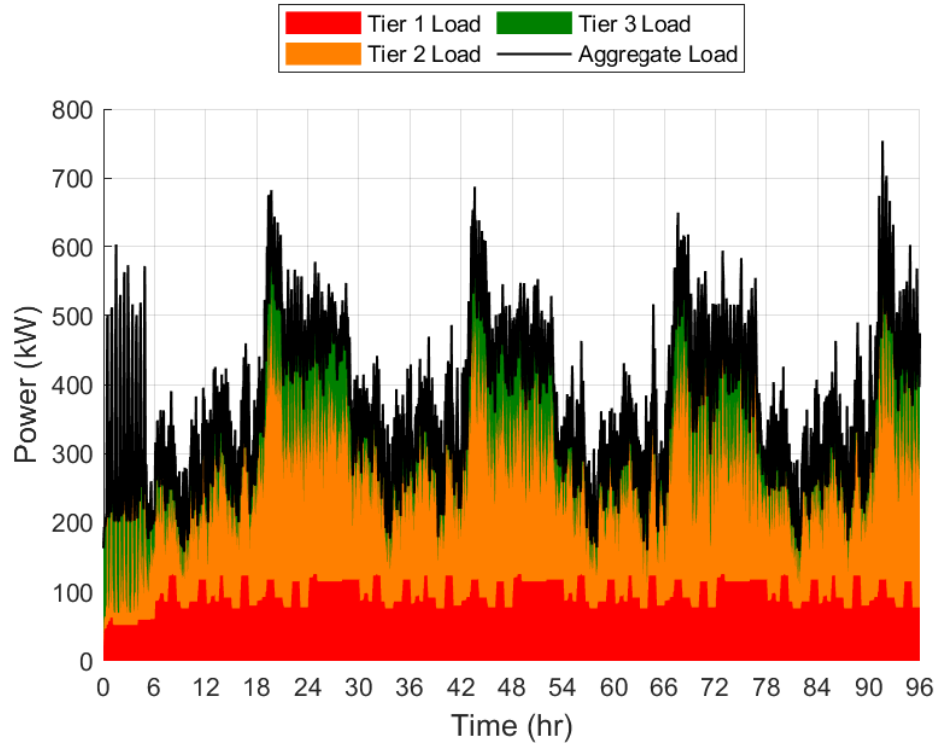


Fig. 53 The aggregate tiered electrical load for the energy network. The red-shaded region indicates tier 1 loads, the orange-shaded region indicates tier 2 loads, the green-shaded region indicates tier 3 loads, and the black line represents the aggregate electrical load for the COP.

The aggregate electrical load was separated into tiers as these tiered electrical loads represent which loads are required to be maintained. The aggregate electrical load can also be decomposed into the temperature-dependent and -independent electrical loads. (Fig. 54). Dependent and independent electrical loads are provided in Figs. 58 and 57, respectively. The shaded regions can subsequently be separated into their respective tiered electrical loads as shown in Figs. 57 and 58.

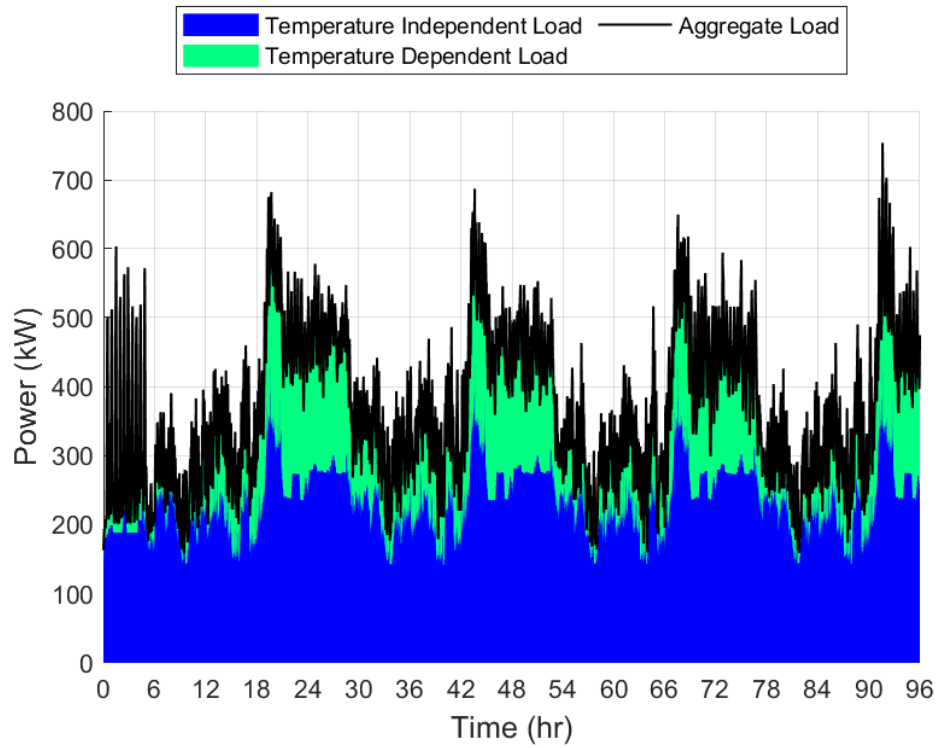


Fig. 54 The aggregate temperature-independent and -dependent load. The blue-shaded region represents the temperature-independent electrical load, while the green-shaded region represents the temperature-dependent electrical load, and the black line represents the aggregate electrical load for the COP.

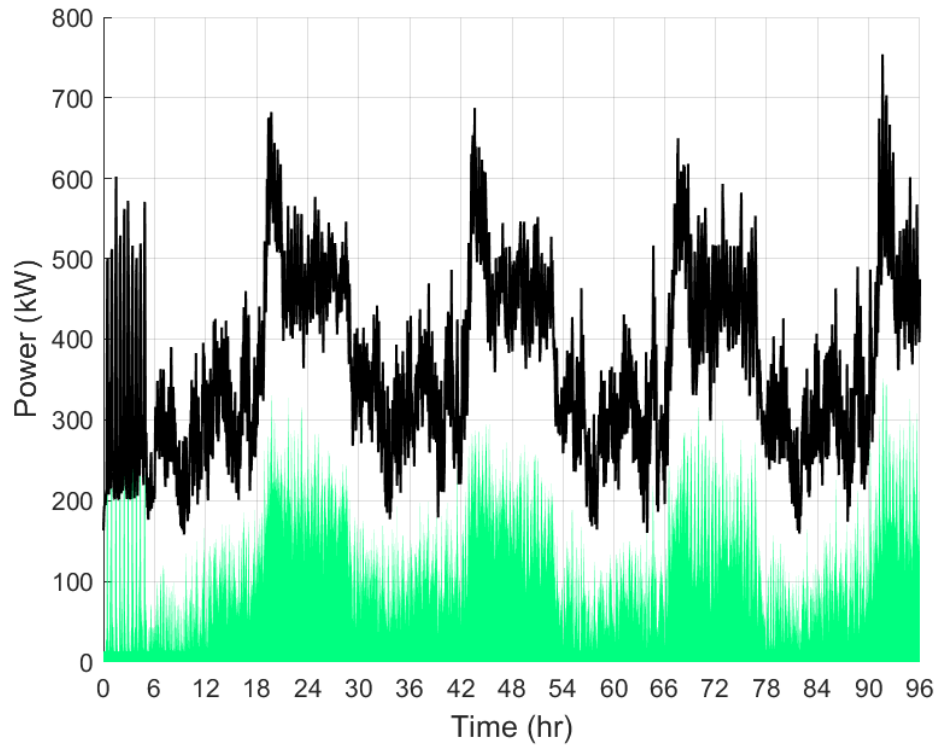


Fig. 55 The aggregate temperature-dependent electrical load. The shaded region represents the temperature-dependent electrical load, while the black line represents the aggregate electrical load for the COP.

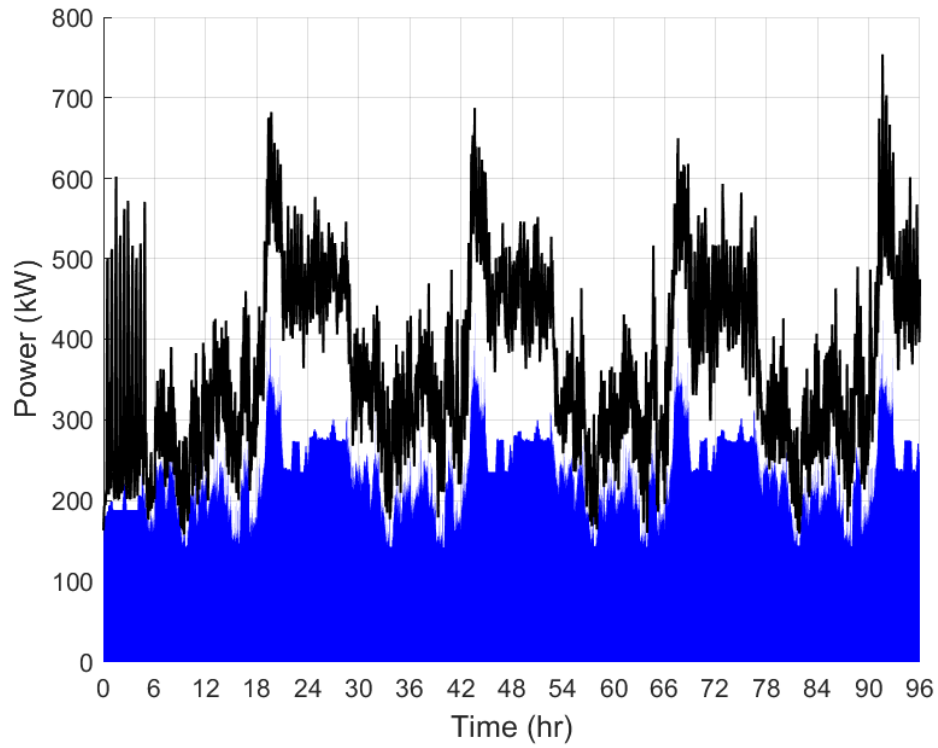


Fig. 56 The aggregate temperature-independent electrical load. The shaded region represents the temperature-independent electrical load, while the black line represents the aggregate electrical load for the COP.

Figures 57 and 58 illustrate the electrical tiered decomposition of the temperature-independent and -dependent electrical loads.

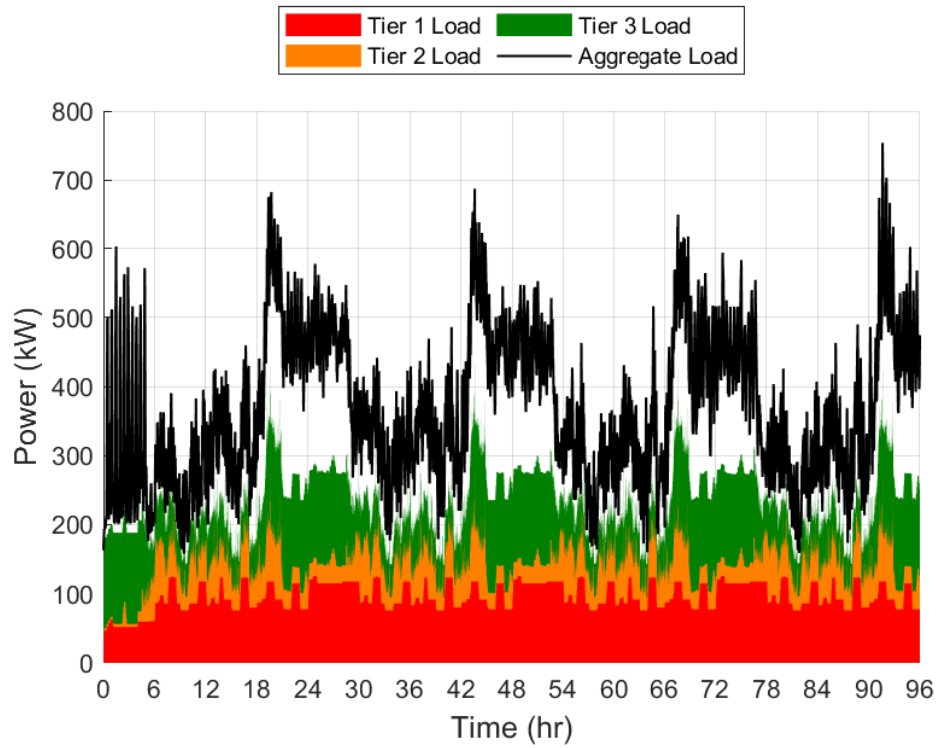


Fig. 57 The temperature-independent tiered electrical load for the energy network. The red-shaded region indicates tier 1 loads, the orange shaded region indicates tier 2 loads, the green shaded region indicates tier 3 loads, and the black line represents the aggregate electrical load for the COP.

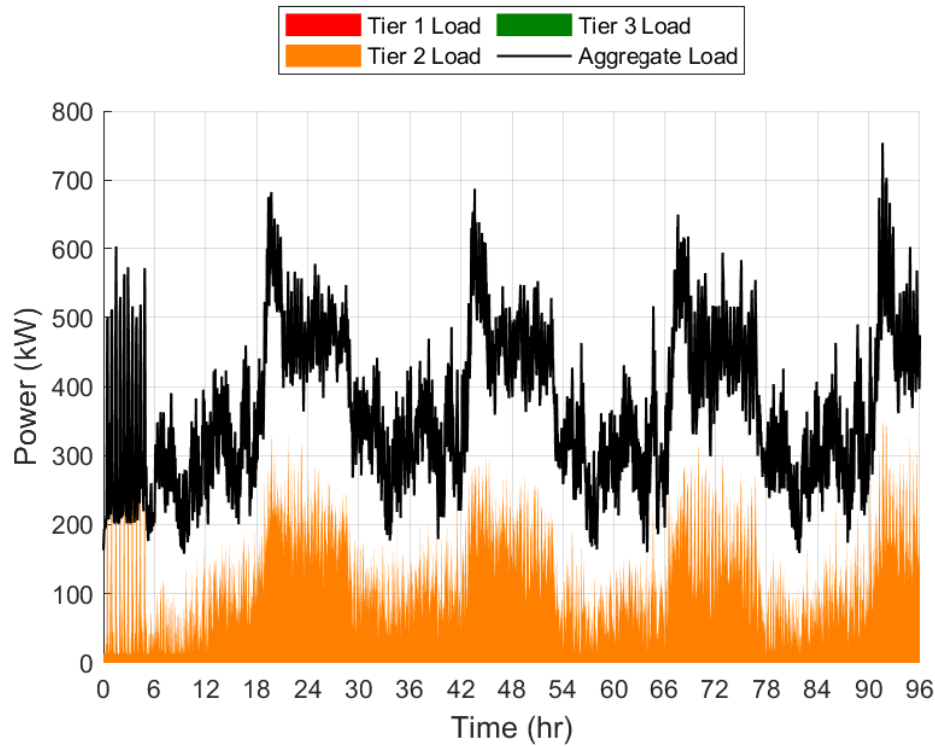


Fig. 58 The temperature-dependent tiered electrical load for the energy network. The red-shaded region indicates tier 1 loads, the orange-shaded region indicates tier 2 loads, the green-shaded region indicates tier 3 loads, and the black line represents the aggregate electrical load for the COP.

The simulation results as shown in Appendix B illustrate the individual E&P utilization for each shelter. The aggregation of each individual E&P response then provides holistic illustration of the E&P utilization for the aggregate energy network. With inclusion of the event schedule, increases or decreases within the electrical load can be linked to the US Army-relevant events, variable occupancy, and relevant atmospheric conditions. These capabilities allow us to understand the E&P utilization of the energy network. It also allows the electrical load profile to be used in combination with an optimization or control routine to manage the energy network. If the resupply logistics were interrupted or the combat outpost faced energy-contested or -constrained operations, various tiered electrical loads could be shed in an effort to prevent frequency or voltage collapse. Shedding the electrical loads could help regulate the energy use and thus extend military operations, should logistics be strained, or the mission parameters change, requiring adaptation

to a complex military environment. Such capabilities are achievable through development and deployment of energy awareness-based algorithms. Such algorithm can be combined to develop both atmospheric and operational based knowledge that can be used to inform optimization-based algorithms, used to reduce value stream impacts such as frequency or voltage deviation, minimize fuel consumption, or more effective or efficient regulation of traditional and non-traditional power generation and storage assets. Such capabilities are expected to become important as technological advancements lead to hybridized electrical networks, which require harmonization of E&P base capabilities.

9. Limited Tactical Resupply Combat Outpost Results

The limited tactical resupply COP E&P scenario contains 33 separate shelters including 6 guard stations, 1 a COC master shelter, 2 COC submaster shelters, 1 COM master shelter, 2 COM submaster shelters, 6 officer billeting shelters, 6 enlisted billeting shelters, 4 office shelters, 1 vehicle depots, 2 mess shelters, and 2 shower shelters. Each of the shelters electrical and thermal responses are highlighted within the subsequent sections as dictated by Tables 13 through 15. The resulting aggregate tiered electrical load representing the COP is shown in Fig. 59. Fig. 59 illustrates the tiered electrical response of the load, where the red area indicates a tier 1 load, the orange area indicates a tier 2 load, and finally the green area indicates a tier 3 load. Unlike the previous set of results, the Fig. 59 was broken down into three separate subfigures, this was done such that each of the three operational phases thermal/electrical response of the energy network could be observed.

Table 13 Summary of shelter results (part 1)

Shelter designation	Section
Guard Station A	C.1
Guard Station B	C.2
Guard Station C	C.3
Guard Station D	C.4
Guard Station E	C.5
Guard Station F	C.6
COC Master	C.7
COM Master	C.8
COC Submaster A	C.9
COM Submaster A	C.10
COC Submaster B	C.11
COM Submaster B	C.12

Table 14 Summary of shelter results (part 2)

Shelter designation	Section
Officer Billeting A	C.13
Officer Billeting B	C.14
Officer Billeting C	C.15
Officer Billeting D	C.16
Officer Billeting E	C.17
Officer Billeting F	C.18
Enlisted Billeting A	C.19
Enlisted Billeting B	C.20
Enlisted Billeting C	C.21
Enlisted Billeting D	C.22
Enlisted Billeting E	C.23
Enlisted Billeting F	C.24

Table 15 Summary of shelter results (part 3)

Shelter designation	Section
Office A	C.25
Office B	C.26
Office C	C.27
Office D	C.28
Depot	C.29
MESS A	C.30
MESS B	C.31
Shower A	C.32
Shower B	C.33

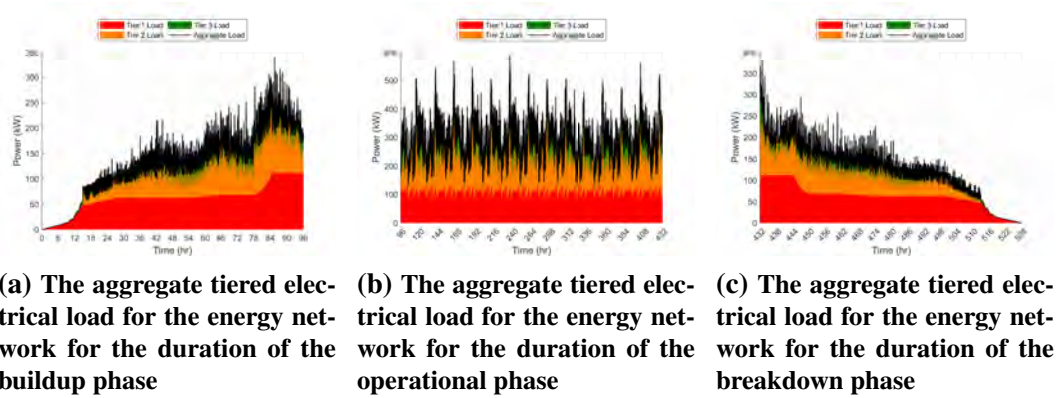
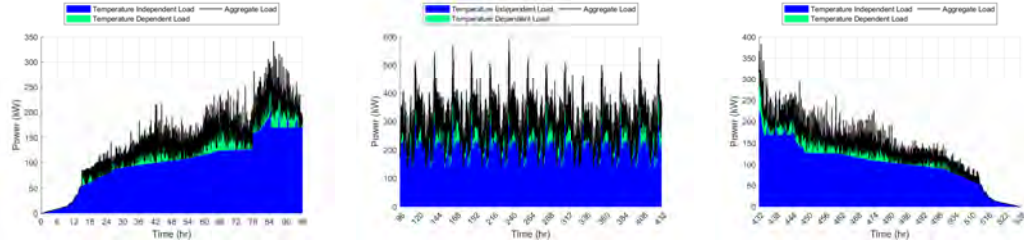


Fig. 59 The aggregate tiered electrical load for the energy network. The red-shaded region indicates tier 1 loads, the orange-shaded region indicates tier 2 loads, the green-shaded region indicates tier 3 loads, and the black line represents the aggregate electrical load for the COP.

The aggregate electrical load was separated into tiers as tiered electrical loads represent which loads are required to be maintained. The aggregate electrical load can also be decomposed into the temperature-dependent and -independent electrical loads, see Fig. 60. The dependent and independent electrical loads are provided in Figs. 61 and 62, respectively. Both of provided shaded regions can subsequently be separated into their respective tiered electrical loads, as shown in Figs. 63 and 64.

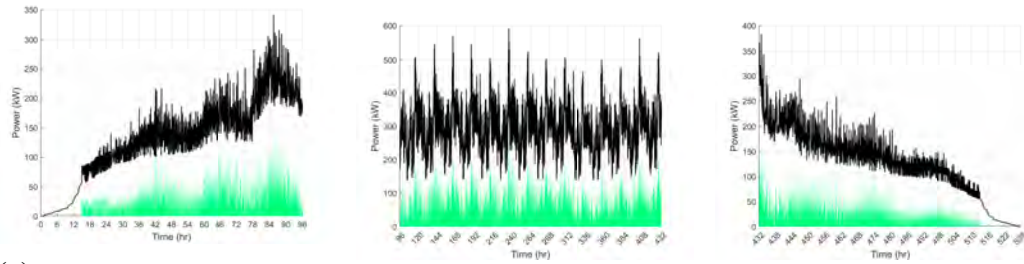


(a) The aggregate tiered electrical load for the energy network for the duration of the buildup phase

(b) The aggregate tiered electrical load for the energy network for the duration of the operational phase

(c) The aggregate tiered electrical load for the energy network for the duration of the breakdown phase

Fig. 60 The aggregate temperature-independent and -dependent load. The blue-shaded region represents the temperature-independent electrical load, while the green-shaded region represents the temperature-dependent electrical load, and the black line represents the aggregate electrical load for the COP.



(a) The aggregate temperature-dependent electrical load for the energy network for the duration of the buildup phase

(b) The aggregate temperature dependent electrical load for the duration of the operational phase

(c) The aggregate temperature dependent electrical load for the duration of the breakdown phase

Fig. 61 The aggregate temperature-dependent electrical load. The shaded region represents the temperature-dependent electrical load, while the black line represents the aggregate electrical load for the COP.

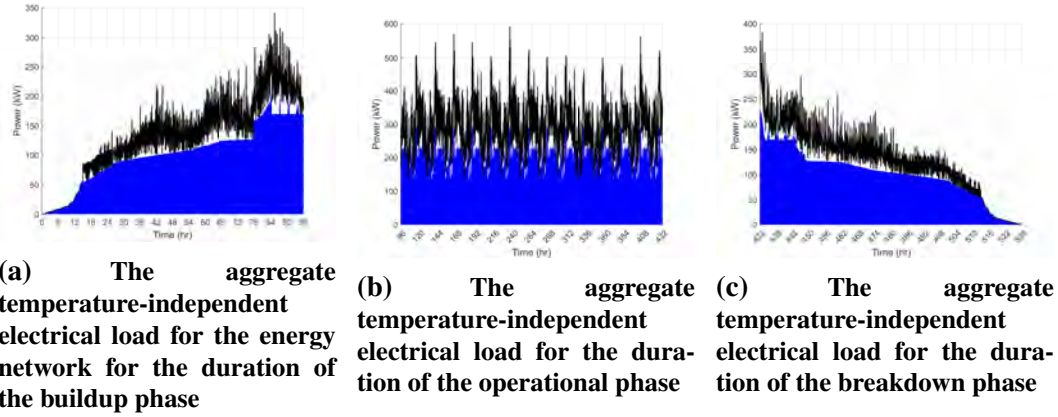


Fig. 62 The aggregate temperature-independent electrical load. The shaded region represents the temperature-independent electrical load, while the black line represents the aggregate electrical load for the COP.

Figures 61 and 62 illustrate the electrical tiered decomposition of the temperature-independent and -dependent electrical loads.

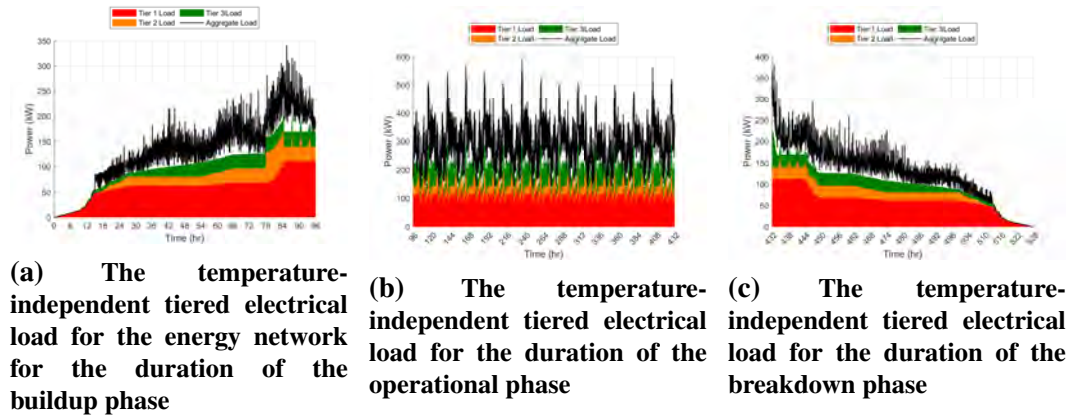


Fig. 63 The temperature-independent tiered electrical load for the energy network. The red-shaded region indicates tier 1 loads, the orange-shaded region indicates tier 2 loads, the green-shaded region indicates tier 3 loads, and the black line represents the aggregate electrical load for the COP.

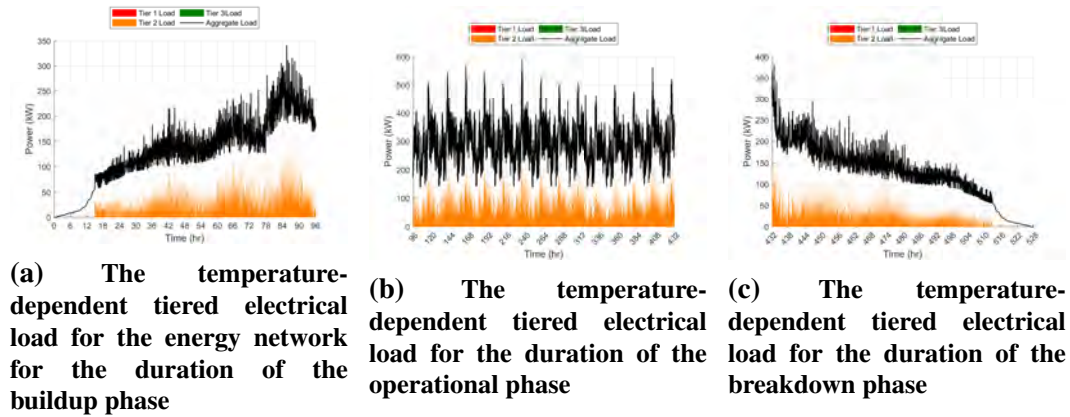


Fig. 64 The temperature-dependent tiered electrical load for the energy network. The red-shaded region indicates tier 1 loads, the orange-shaded region indicates tier 2 loads, the green-shaded region indicates tier 3 loads, and the black line represents the aggregate electrical load for the COP.

The simulation results as shown in Appendix C.1 through C.33 were aggregated to form the figures shown in this section. The future of US Army operations is expected to be less stagnant and more dynamic. Future combat capabilities must be effective and efficient and are unlikely to remain stationary for prolonged operations. Assuming a FOB exists and sufficient supply logistics are already in place, new alternative locations are established to bolster military prowess, effectively allowing contested objectives to be captured. Once the objective has been captured, it becomes the new FOB, all new alternative locations constructed to capture the objective are deconstructed, and the previous FOB is reduced in size but not in capability. The scenario defined in this section is meant to emulate the buildup, operation, and breakdown phases of the COP, which were established in pursuit of bolstering the military prowess required to take the contested objects. For the first 96 h of the simulation, the COP was unpacked and constructed; this constitutes the buildup phase of the military outpost. For the next 2-week period, the military outpost must operate with limited tactical resupply capabilities; this constitutes the operational phase of the COP. For the final 96-h period, the COP was deconstructed and packed away into the shipping containers, this constitutes the breakdown phase of the COP. The intended use of these three scenarios is to be paired with optimization routine and applied to the AIHPG testbed. The tiered electrical load profile represents the net E&P demands for the COP. Using an optimization routine, the

E&P generation capabilities of the energy network could be more effectively or efficiently operated in service of the prescribed mission.

10. Conclusions and Future Work

This report presents a set of MATLAB/*Simulink*-based components developed to model the E&P capabilities of a COP or FOB. To illustrate the components developed, two separate US Army–relevant event schedules were defined including 1) a brigade-sized COP constructed to support prolonged occupation and 2) a limited tactical resupply brigade-sized COP intended to operate for a finite period of time that covered the buildup, breakdown, and operational phases of the energy network.

The model components permitted the E&P requirements or capabilities for each military shelter to be impacted by the US Army–relevant events, which in turn determined the shelter occupancy. Atmospheric perturbations also impacted the energy network performance, presuming the shelter had been outfitted with an ECU. All electrical equipment as defined for a shelter was subsequently be aggregated to form a holistic understanding of multi-tiered electrical load power requirements or capabilities of the shelter. The aggregate electrical load was further decomposed into its temperature-dependent or -independent electrical load, allowing the atmospheric contribution of the shelter to be observed. COPs or FOBs often have multiple shelters. The aggregation of each individual shelter load ultimately formed the aggregate energy network electrical load. Similarly, the aggregate electrical load profile will provide insight into the tiered electrical load, which can also be decomposed into the temperature-dependent or -independent electrical load. Such a capability will permit the development of energy awareness, which helps bolster efficiency and effectiveness of military operations.

Because the electrical load is linked to the US Army–relevant events and atmospheric input, artificial intelligence (AI) and machine learning (ML) algorithms were subsequently applied to further develop energy awareness, as required to forecast the demand side E&P capabilities for the COP or FOB defined. The electrical load can subsequently be used in combination with advanced predictive capabilities and optimization routines to model hybridized tactical E&P networks. The inclusion of the optimization routine permitted E&P capabilities of the energy network to manage the effectiveness or efficiency, in service of the mission. Such capabilities have the potential to effect operational science and prompt energy independence,

extending mission duration, reducing energy usage, improving signature management through adaptive regulation of energy, and balancing energy across multiple platforms, which can cascade into reduced sustainment requirements.

The AIHPG testbed¹⁻⁵ contains multiple sets of standard and non-standard atmospheric measurements, a programmable load, renewable power generation (photovoltaic array), AI/ML based predicative control algorithms, and an optimization routine intended to manage the dissimilar E&P capabilities of the energy network. An illustration of the AIHPG testbed is provided in Fig. 65.

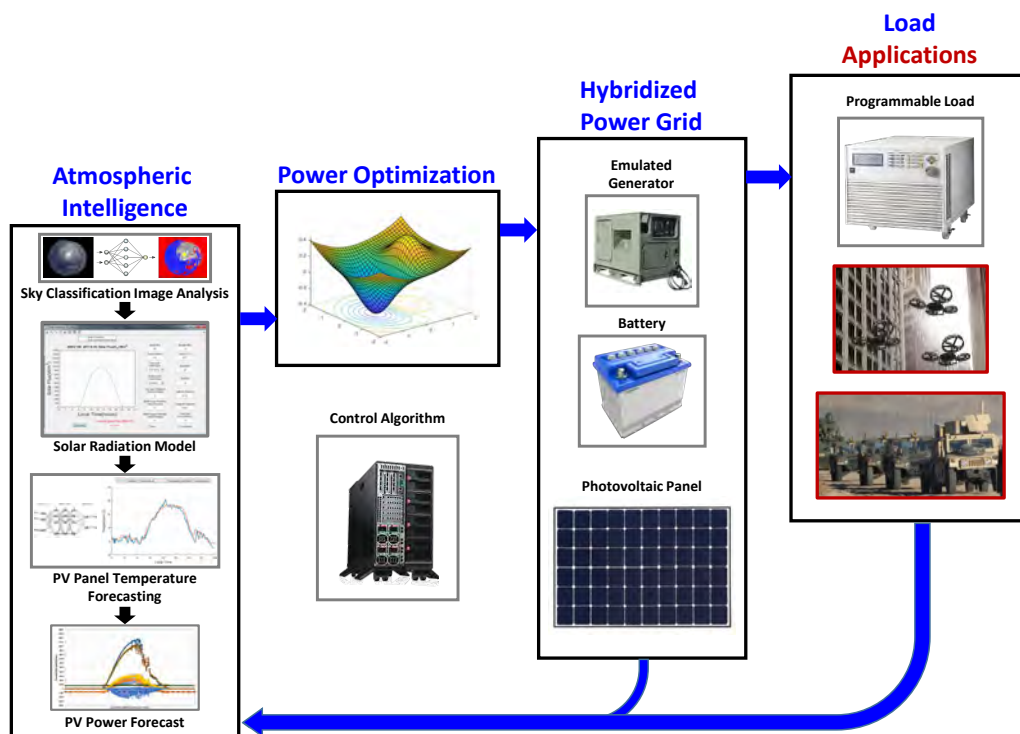


Fig. 65 The AIHPG testbed consists of an optimization routine coupled with predictive capabilities derived from AI/ML, a programmable load, energy storage, renewable power generation (photovoltaic array), and standard and non-standard of standard atmospheric sensors

Future work regarding μ -grid operational scenarios includes scaling the load such that it is consistent with the AIHPG testbed's power generation and storage capabilities and deploying the aggregate load profile into the programmable load. Using this design, the AIHPG testbed can be tailored for simulating optimizing energy

generation and storage needs with respect to the earlier military operation through the development and deployment of energy awareness-based algorithms.

11. References

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Appendix A. Combat Outpost Model Parameters

This Appendix contains additional information regarding the combat outpost (COP) energy and power (E&P) scenario. Specifically, it defines all parameters as defined within the Microsoft Excel document that was used to model the various electrical components as defined within the COP E&P scenario. Table A-1 specifies which subsections or appendices of this report have more information pertaining to each individual electrical model component.

A Microsoft Excel spreadsheet, which supports 64-bit numeric quantities, was used to define the parameters used in the simulation, data contained in the Excel document dictates the precision of the values as observed within the subsequent tables.

Table A-1 μ -grid-based scenario content list

Component	Assigned shelter	Section	Appendix
Specialized electrical equipment	Any	5.1	A.1
Desktop computer	Any		A.2
TVs	Any		A.3
Game console	Any		A.4
Shop lights	Any		A.5
Fans	Any		A.6
Laptop computer	Any		A.7
Cell phone	Any		A.8
Projector	Any		A.9
Microwave	Any		A.10
Heaters	Any		A.11
Hot plate	Any		A.12
Refrigerator	Any	5.2	A.13
Freezer	Any		A.14
Oven	Any		A.15
Warmer	Any		A.16
Water heater	Any		A.17
Dishwasher	Any	5.3	A.18
Clothes washer	Any		A.19
Clothes dryer	Any		A.20
ECU	Any	5.4	...
Shelter	...	5.5	...

A.1 Specialized Electrical Equipment Parameters

The parameters used to model the specialized electrical equipment are provided in Tables A-2 through A-3.

Table A-2 Parameters required to model the specialized electrical equipment (part 1)

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	62.5	500	[0 0 100]
2	generic	62.5	500	[0 100 0]
3	generic	62.5	500	[100 0 0]
4	generic	125	1000	[0 0 100]
5	generic	125	1000	[0 100 0]
6	generic	125	1000	[100 0 0]
7	generic	250	2000	[0 0 100]
8	generic	250	2000	[0 100 0]
9	generic	250	2000	[100 0 0]
10	generic	375	3000	[0 0 100]
11	generic	375	3000	[0 100 0]
12	generic	375	3000	[100 0 0]
13	generic	500	4000	[0 0 100]
14	generic	500	4000	[0 100 0]
15	generic	500	4000	[100 0 0]
16	generic	625	5000	[0 0 100]
17	generic	625	5000	[0 100 0]
18	generic	625	5000	[100 0 0]
19	generic	750	6000	[0 0 100]
20	generic	750	6000	[0 100 0]

Table A-3 Parameters required to model the specialized electrical equipment (part 2)

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
21	generic	750	6000	[100 0 0]
22	generic	875	7000	[0 0 100]
23	generic	875	7000	[0 100 0]
24	generic	875	7000	[100 0 0]
25	generic	1000	8000	[0 0 100]
26	generic	1000	8000	[0 100 0]
27	generic	1000	8000	[100 0 0]
28	generic	1125	9000	[0 0 100]
29	generic	1125	9000	[0 100 0]
30	generic	1125	9000	[100 0 0]
31	generic	1250	10000	[0 0 100]
32	generic	1250	10000	[0 100 0]
33	generic	1250	10000	[100 0 0]

A.2 Desktop Computer Parameters

The parameters used to model the desktop computer are provided in Table A-4.

Table A-4 Parameters required to model the desktop computer

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	200	30	[0 0 100]
2	generic	200	30	[0 100 0]
3	generic	200	30	[100 0 0]

A.3 Televisions Parameters

The parameters used to model the televisions are provided in Tables A-5 through A-6.

Table A-5 Parameters required to model the televisions (part 1)

Type	Manufacture	Screen size	Configuration	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(in)	(nd)	%		
1	generic	30	LCD	60	9	[0 0 100]
2	generic	30	LCD	60	9	[0 100 0]
3	generic	30	LCD	60	9	[100 0 0]
4	generic	30	Plasma	150	22.5	[0 0 100]
5	generic	30	Plasma	150	22.5	[0 100 0]
6	generic	30	Plasma	150	22.5	[100 0 0]
7	generic	30	LED	50	7.5	[0 0 100]
8	generic	30	LED	50	7.5	[0 100 0]
9	generic	30	LED	50	7.5	[100 0 0]
10	generic	42	LCD	120	18	[0 0 100]
11	generic	42	LCD	120	18	[0 100 0]
12	generic	42	LCD	120	18	[100 0 0]
13	generic	42	Plasma	220	33	[0 0 100]
14	generic	42	Plasma	220	33	[0 100 0]
15	generic	42	Plasma	220	33	[100 0 0]
16	generic	42	LED	80	12	[0 0 100]
17	generic	42	LED	80	12	[0 100 0]
18	generic	42	LED	80	12	[100 0 0]
19	generic	50	LCD	150	22.5	[0 0 100]
20	generic	50	LCD	150	22.5	[0 100 0]

Table A-6 Parameters required to model the televisions (part 2)

Type	Manufacture	Screen size	Configuration	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(in)	(nd)	%		
21	generic	50	LCD	150	22.5	[100 0 0]
22	generic	50	Plasma	300	45	[0 0 100]
23	generic	50	Plasma	300	45	[0 100 0]
24	generic	50	Plasma	300	45	[100 0 0]
25	generic	50	LED	100	15	[0 0 100]
26	generic	50	LED	100	15	[0 100 0]
27	generic	50	LED	100	15	[100 0 0]

A.4 Game Console Parameters

The parameters used to model the game console are provided in Table A-7.

Table A-7 Parameters required to model the game console

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	200	30	[0 0 100]
2	generic	200	30	[0 100 0]
3	generic	200	30	[100 0 0]

A.5 Shop Lights Parameters

The parameters used to model the shop lights are provided in Table A-8.

Table A-8 Parameters required to model the shop lights

Type	Manufacture	Length	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(in)	(W)	(W)	(%)
1	generic	48	20	1	[0 0 100]
2	generic	48	20	1	[0 100 0]
3	generic	48	20	1	[100 0 0]
4	generic	72	30	1.5	[0 0 100]
5	generic	72	30	1.5	[0 100 0]
6	generic	72	30	1.5	[100 0 0]

A.6 Fans Parameters

The parameters used to model the fan are provided in Table A-9.

Table A-9 Parameters required to model the fan

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	50	5	[0 0 100]
2	generic	50	5	[0 100 0]
3	generic	50	5	[100 0 0]

A.7 Laptop Computer Parameters

The parameters used to model the laptop computer are provided in Table A-10.

Table A-10 Parameters required to model the laptop computer

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	75	7.5	[0 0 100]
2	generic	75	7.5	[0 100 0]
3	generic	75	7.5	[100 0 0]

A.8 Cell Phone Parameters

The parameters used to model the cell phone are provided in Table A-11.

Table A-11 Parameters required to model the cell phone

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	5	0.25	[0 0 100]
2	generic	5	0.25	[0 100 0]
3	generic	5	0.25	[100 0 0]

A.9 Projector Parameters

The parameters used to model the projector are provided in Table A-12.

Table A-12 Parameters required to model the projector

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	675	65	[0 0 100]
2	generic	675	65	[0 100 0]
3	generic	675	65	[100 0 0]

A.10 Microwave Parameters

The parameters used to model the microwave are provided in Table A-13.

Table A-13 Parameters required to model the microwave

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	2100	105	[0 0 100]
2	generic	2100	105	[0 100 0]
3	generic	2100	105	[100 0 0]

A.11 Heater Parameters

The parameters used to model the heater are provided in Table A-14.

Table A-14 Parameters required to model the heater

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	1500	15	[0 0 100]
2	generic	1500	15	[0 100 0]
3	generic	1500	15	[100 0 0]

A.12 Hot Plate Parameters

The parameters used to model the hot plate are provided in Table A-15.

Table A-15 Parameters required to model the hot plate

Type	Manufacture	Discontinuous use power consumption	Continuous use power consumption	Tier allocation
(nd)	(nd)	(W)	(W)	(%)
1	generic	200	10	[0 0 100]
2	generic	200	10	[0 100 0]
3	generic	200	10	[100 0 0]

A.13 Refrigerator Parameters

The parameters used to model the refrigerator are provided in Tables A-16 through A-18.

Table A-16 Parameters required to model the refrigerator (part 1)

Type	Manufacture	Rated Power	COP	Temperature Setpoint	Delta Temperature
(nd)	(nd)	(W)	(nd)	(°C)	(°C)
1	generic	2300	1.25	1.6667	1
2	generic	2300	1.25	1.6667	1
3	generic	2300	1.25	1.6667	1

Table A-17 Parameters required to model the refrigerator (part 2)

Length	Width	Height	Internal material thickness	External material thickness	Material thermal conductivity
(m)	(m)	(m)	(m)	(m)	(kJ/K.m)
0.762	0.9144	1.7526	0.0127	0.0127	5.25E-09
0.762	0.9144	1.7526	0.0127	0.0127	5.25E-09
0.762	0.9144	1.7526	0.0127	0.0127	5.25E-09

Table A-18 Parameters required to model the refrigerator (part 3)

Material density	Material average specific heat	Tier allocation
(kg / m ³)	(kJ/kg/K)	(%)
2940	0.39	[0 0 100]
2940	0.39	[0 100 0]
2940	0.39	[100 0 0]

A.14 Freezer Parameters

The parameters used to model the freezer are provided in Tables A-19 through A-21.

Table A-19 Parameters required to model the freezer (part 1)

Type	Manufacture	Rated power	COP	Temperature setpoint	Delta temperature
(nd)	(nd)	(W)	(nd)	(°C)	(°C)
1	generic	750	1.25	-12.2	1
2	generic	750	1.25	-12.2	1
3	generic	750	1.25	-12.2	1

Table A-20 Parameters required to model the freezer (part 2)

Length	Width	Height	Internal material thickness	External material thickness	Material thermal conductivity
(m)	(m)	(m)	(m)	(m)	(kJ/K.m)
1.3716	0.83185	2.10185	0.0127	0.0127	5.25E-09
1.3716	0.83185	2.10185	0.0127	0.0127	5.25E-09
1.3716	0.83185	2.10185	0.0127	0.0127	5.25E-09

Table A-21 Parameters required to model the freezer (part 3)

Material density	Material average specific heat	Tier allocation
(kg / m ³)	(kJ/kg/K)	(%)
2940	0.39	[0 0 100]
2940	0.39	[0 100 0]
2940	0.39	[100 0 0]

A.15 Oven Parameters

The parameters used to model the oven are provided in Tables A-22 through A-24.

Table A-22 Parameters required to model the oven (part 1)

Type (nd)	Manufacture (nd)	Rated power (W)	COP (nd)	Temperature setpoint (°C)	Delta temperature (°C)	Time constant (s)
1	generic	2125	0.85	176.667	10	1500
2	generic	2125	0.85	176.667	10	1500
3	generic	2125	0.85	176.667	10	1500

Table A-23 Parameters required to model the oven (part 2)

Length (m)	Width (m)	Height (m)	Internal material thickness (m)	External material thickness (m)	Material thermal conductivity (kJ/K.m)
0.73025	0.762	1.17475	0.0127	0.0127	3.75E-07
0.73025	0.762	1.17475	0.0127	0.0127	3.75E-07
0.73025	0.762	1.17475	0.0127	0.0127	3.75E-07

Table A-24 Parameters required to model the oven (part 3)

Material density (kg / m ³)	Material average specific heat (kJ/kg/K)	Tier allocation (%)
2940	0.39	[0 0 100]
2940	0.39	[0 100 0]
2940	0.39	[100 0 0]

A.16 Warmer Parameters

The parameters used to model the warmer are provided in Tables A-25 through A-27.

Table A-25 Parameters required to model the warmer (part 1)

Type	Manufacture	Rated power	COP	Temperature setpoint	Delta temperature	Time constant
(nd)	(nd)	(W)	(nd)	(°C)	(°C)	(s)
1	generic	1440	0.85	176.67	10	2300
2	generic	1440	0.85	176.67	10	2300
3	generic	1440	0.85	176.67	10	2300

Table A-26 Parameters required to model the warmer (part 2)

Length	Width	Height	Internal material thickness	External material thickness	Material thermal conductivity
(m)	(m)	(m)	(m)	(m)	(kJ/K.m)
0.5334	0.78105	1.6891	0.0127	0.0127	3.50E-07
0.5334	0.78105	1.6891	0.0127	0.0127	3.50E-07
0.5334	0.78105	1.6891	0.0127	0.0127	3.50E-07

Table A-27 Parameters required to model the warmer (part 3)

Material density	Material average specific heat	Tier allocation
(kg / m ³)	(kJ/kg/K)	(%)
2940	0.39	[0 0 100]
2940	0.39	[0 100 0]
2940	0.39	[100 0 0]

A.17 Water Heater Parameters

The parameters used to model the water heater are provided in Tables A-28 through A-30.

Table A-28 Parameters required to model the water heater (part 1)

Type	Manufacture	Rated power	COP	Temperature setpoint	Delta temperature	Tank capacity
(nd)	(nd)	(W)	(nd)	(°C)	(°C)	(gal)
1	generic	4000	0.85	48.89	2	120
2	generic	4000	0.85	48.89	2	120
3	generic	4000	0.85	48.89	2	120

Table A-29 Parameters required to model the water heater (part 2)

Radius	Internal material thickness	External material thickness	Material thermal conductivity
(m)	(m)	(m)	(kJ/K.m)
0.3556	0.0127	0.0127	0.000125
0.3556	0.0127	0.0127	0.000125
0.3556	0.0127	0.0127	0.000125

Table A-30 Parameters required to model the water heater (part 3)

Material density	Material average Specific heat	Shower duration	Water consumption	Tier allocation
(kg / m ³)	(kJ/kg/K)	(s)	(gal/min)	(%)
2940	0.39	450	1.75	[0 0 100]
2940	0.39	450	1.75	[0 100 0]
2940	0.39	450	1.75	[100 0 0]

A.18 Dishwasher Parameters

The parameters used to model the dishwasher are provided in Table A-31.

Table A-31 Parameters required to model the dishwasher

Type (nd)	Manufacture (nd)	Average power (W)	Random delay (s)	Tier allocation (%)
1	generic	1250	300	[0 0 100]
2	generic	1250	300	[0 100 0]
3	generic	1250	300	[100 0 0]

A.19 Clothes Washer Parameters

The parameters used to model the clothes washer are provided in Table A-32.

Table A-32 Parameters required to model the clothes washer

Type (nd)	Manufacture (nd)	Average power (W)	Random delay (s)	Tier allocation (%)
1	generic	1275	300	[0 0 100]
2	generic	1275	300	[0 100 0]
3	generic	1275	300	[100 0 0]

A.20 Clothes Dryer Parameters

The parameters used to model the clothes dryer are provided in Table A-33.

Table A-33 Parameters required to model the clothes dryer

Type (nd)	Manufacture (nd)	Average power (W)	Random delay (s)	Tier allocation (%)
1	generic	6000	300	[0 0 100]
2	generic	6000	300	[0 100 0]
3	generic	6000	300	[100 0 0]

A.21 Shelter Configuration Parameters

This section of the Appendix contains all parameters that were used to define each of the fifteen military style shelters including the guard shack, enlisted billeting,

officer billeting, Combat Operations Center (COC) master, COC submaster, Communications (COM) master, COM submaster, mess, kitchen A, kitchen B, laundry A, laundry B, shower, office, and depot shelters.

Table A-34 Shelter parameters (part 1)

Configuration	Length	Width	Height	Radius	Internal material thickness	External material thickness
(var)	(m)	(m)	(m)	(m)	(m)	(m)
Guard Shack	3.048	3.048	3.048	...	0.003175	0.003175
Enlisted Billeting	18.288	...	...	4.572	0.003175	0.003175
Officer Billeting	9.144	...	...	4.572	0.003175	0.003175
COC Master	18.288	...	...	4.572	0.003175	0.003175
COC Submaster	18.288	...	...	4.572	0.003175	0.003175
COM Master	18.288	...	...	4.572	0.003175	0.003175
COM Submaster	18.288	...	...	4.572	0.003175	0.003175
Mess	18.288	...	...	4.572	0.003175	0.003175
Kitchen A	18.288	...	...	4.572	0.003175	0.003175
Kitchen B	18.288	...	...	4.572	0.003175	0.003175
Laundry A	18.288	...	...	4.572	0.003175	0.003175
Laundry B	18.288	...	...	4.572	0.003175	0.003175
Shower	18.288	...	...	4.572	0.003175	0.003175
Office	18.288	...	...	4.572	0.003175	0.003175
Depot	36.576	...	...	9.144	0.003175	0.003175

Table A-35 Shelter parameters (part 2)

Configuration	Material thermal conductivity	Material average specific heat	Material density	Material emissivity
(var)	(kJ/K.m)	(kJ/kg/K)	(kg / m³)	(nd)
Guard Shack	7.50E-06	3.75	1865	0.5
Enlisted Billeting	7.50E-06	3.75	1865	0.5
Officer Billeting	7.50E-06	3.75	1865	0.5
COC Master	7.50E-06	3.75	1865	0.5
COC Submaster	7.50E-06	3.75	1865	0.5
COM Master	7.50E-06	3.75	1865	0.5
COM Submaster	7.50E-06	3.75	1865	0.5
Mess	7.50E-06	3.75	1865	0.5
Kitchen A	7.50E-06	3.75	1865	0.5
Kitchen B	7.50E-06	3.75	1865	0.5
Laundry A	7.50E-06	3.75	1865	0.5
Laundry B	7.50E-06	3.75	1865	0.5
Shower	7.50E-06	3.75	1865	0.5
Office	7.50E-06	3.75	1865	0.5
Depot	7.50E-06	3.75	1865	0.5

Table A-36 Shelter parameters (part 3)

Configuration (var)	Maximum occupancy (no.)	Temperature setpoint (°C)	ECU requirement (no.)
Guard Shack	6	21.1	3
Enlisted Billeting	50	21.1	8
Officer Billeting	15	21.1	3
COC Master	25	21.1	8
COC Submaster	35	21.1	8
COM Master	35	21.1	8
COM Submaster	25	21.1	8
Mess	50	21.1	8
Kitchen A	20	21.1	8
Kitchen B	20	21.1	8
Laundry A	20	21.1	8
Laundry B	20	21.1	8
Shower	16	21.1	8
Office	50	21.1	8
Depot	25	21.1	20

Table A-37 Shelter parameters (part 4)

Configuration (var)	Average occupancy number for each event (no.)										
	A	B	C	D	E	F	G	H	I	J	K
Guard Shack	3	3	3	3	3	3	3	6	6	3	3
Enlisted Billeting						...					
Officer Billeting						...					
COC Master	15	15	5	15	15	15	15	25	20	15	20
COC Submaster	5	5	5	5	5	5	50	20	0	5	15
COM Master	20	20	10	20	20	20	30	20	20	20	3
COM Submaster	15	15	5	15	15	15	15	25	20	15	20
Mess	0	0	50	0	0	0	0	0	0	0	0
Kitchen A	5	20	20	5	5	5	5	5	5	5	5
Kitchen B	5	20	20	5	5	5	5	5	5	5	5
Laundry A	0	0	0	20	0	0	0	0	0	0	0
Laundry B	0	0	0	0	20	0	0	0	0	0	0
Shower	0	0	0	0	0	16	0	0	0	0	0
Office	5	5	5	5	5	5	50	20	0	5	15
Depot	15	15	15	15	15	15	15	5	5	15	15

Table A-38 Shelter parameters (part 5)

Configuration (var)	Average occupancy number for each event										
	(no.)										
	L	M	N	O	P	Q	R	S	T	U	V
Guard Shack	3	3	3	3	3	3	3	3	0	0	0
Enlisted Billeting						...					
Officer Billeting						...					
COC Master	20	20	20	10	10	20	20	15	0	0	0
COC Submaster	15	15	5	5	5	5	5	5	0	0	0
COM Master	35	35	20	20	30	35	35	20	0	0	0
COM Submaster	20	20	15	15	10	15	15	25	0	0	0
Mess	0	0	0	0	0	0	0	0	0	0	0
Kitchen A	5	5	5	5	5	5	5	5	0	0	0
Kitchen B	5	5	5	5	5	5	5	5	0	0	0
Laundry A	0	0	0	0	0	0	0	0	0	0	0
Laundry B	0	0	0	0	0	0	0	0	0	0	0
Shower	0	0	0	0	0	16	0	0	0	0	0
Office	15	15	5	5	5	5	5	5	0	0	0
Depot	15	15	15	15	15	15	15	5	0	0	0

Table A-39 Shelter parameters (part 6)

Configuration (var)	Average occupancy number for each event										
	(%)										
	A	B	C	D	E	F	G	H	I	J	K
Guard Shack	50.00	50.00	50.00	50.00	50.00	50.00	50.00	100.00	100.00	50.00	50.00
Enlisted Billeting						...					
Officer Billeting						...					
COC Master	57.14	57.14	28.57	57.14	57.14	57.14	85.71	57.14	57.14	71.43	57.14
COC Submaster	10.00	10.00	10.00	10.00	10.00	10.00	100.00	40.00	0.00	10.00	30.00
COM Master	57.14	57.14	28.57	57.14	57.14	57.14	85.71	57.14	57.14	57.14	85.71
COM Submaster	60.00	60.00	20.00	60.00	60.00	60.00	60.00	100.00	80.00	60.00	80.00
Mess	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kitchen A	25.00	100.00	100.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Kitchen B	25.00	100.00	100.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Laundry A	0.00	0.00	0.00	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Laundry B	0.00	0.00	0.00	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Shower	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Office	10.00	10.00	10.00	10.00	10.00	10.00	100.00	40.00	0.00	10.00	30.00
Depot	60.00	60.00	60.00	60.00	60.00	60.00	60.00	20.00	20.00	60.00	60.00

Table A-40 Shelter parameters (part 7)

Configuration (var)	Average occupancy number for each event										
	(%)										
	L	M	N	O	P	Q	R	S	T	U	V
Guard Shack	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	0.00	0.00	0.00
Enlisted Billeting						...					
Officer Billeting						...					
COC Master	57.14	57.14	57.14	28.57	28.57	57.14	57.14	42.86	0.00	0.00	0.00
COC Submaster	30.00	30.00	10.00	10.00	10.00	10.00	10.00	10.00	0.00	0.00	0.00
COM Master	100.00	100.00	57.14	57.14	85.71	100.00	100.00	57.14	0.00	0.00	0.00
COM Submaster	80.00	80.00	60.00	60.00	40.00	60.00	60.00	100.00	0.00	0.00	0.00
Mess	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kitchen A	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	0.00	0.00	0.00
Kitchen B	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	0.00	0.00	0.00
Laundry A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laundry B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shower	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Office	30.00	30.00	10.00	10.00	10.00	10.00	10.00	10.00	0.00	0.00	0.00
Depot	60.00	60.00	60.00	60.00	60.00	60.00	60.00	20.00	0.00	0.00	0.00

Table A-41 Shelter parameters (part 8)

Configuration (var)	Transition time for each event										
	(min)										
	A	B	C	D	E	F	G	H	I	J	K
Guard Shack	10	10	10	10	10	10	10	5	5	10	10
Enlisted Billeting						...					
Officer Billeting						...					
COC Master	15	15	30	5	5	5	60	25	15	5	5
COC Submaster	15	15	15	15	15	15	10	10	5	10	5
COM Master	15	15	10	15	15	15	5	10	5	15	10
COM Submaster	15	15	10	15	15	15	15	5	5	15	10
Mess	15	15	10	15	15	15	15	15	15	15	15
Kitchen A	15	5	10	15	15	15	15	15	15	15	15
Kitchen B	15	5	10	15	15	15	15	15	15	15	15
Laundry A	15	15	15	5	5	15	15	15	15	15	15
Laundry B	15	15	15	5	5	15	15	15	15	15	15
Shower	15	15	15	15	15	5	15	15	15	15	15
Office	15	15	15	15	15	15	10	10	5	10	5
Depot	15	15	15	15	15	15	15	10	10	15	15

Table A-42 Shelter parameters (part 9)

Configuration (var)	Transition time for each event (min)										
	L	M	N	O	P	Q	R	S	T	U	V
Guard Shack	10	10	10	10	10	10	10	10	10	10	10
Enlisted Billeting						...					
Officer Billeting						...					
COC Master	5	5	5	60	30	5	5	60	15	15	15
COC Submaster	5	5	5	5	5	5	5	5	15	15	15
COM Master	5	5	15	15	5	5	5	15	15	15	15
COM Submaster	15	15	15	15	10	15	15	5	15	15	15
Mess	15	15	15	15	15	15	15	15	15	15	15
Kitchen A	15	15	15	15	15	15	15	15	15	15	15
Kitchen B	15	15	15	15	15	15	15	15	15	15	15
Laundry A	15	15	15	15	15	15	15	15	15	15	15
Laundry B	15	15	15	15	15	15	15	15	15	15	1
Shower	15	15	15	15	15	15	15	15	15	15	15
Office	5	5	5	5	5	5	5	5	15	15	15
Depot	15	15	15	15	15	15	15	10	15	15	15

Table A-43 Shelter parameters (part 10)

Configuration (var)	Average maximum occupancy	Average minimum occupancy
	(%)	(%)
Guard Shack	...	...
Enlisted Billeting	100	20
Officer Billeting	100	20
COC Master	...	...
COC Submaster	...	...
COM Master	...	...
COM Submaster	...	...
Mess	...	...
Kitchen A	...	...
Kitchen B	...	...
Laundry A	...	...
Laundry B	...	...
Shower	...	...
Office	...	...
Depot	...	...

Table A-44 Shelter parameters (part 11)

Configuration (var)	Transition time for each event										
	(h)										
	A	B	C	D	E	F	G	H	I	J	K
Guard Shack	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Enlisted Billeting						...					
Officer Billeting						...					
COC Master	0.25	0.25	0.50	0.08	0.08	0.08	1.00	0.42	0.25	0.08	0.08
COC Submaster	0.25	0.25	0.25	0.25	0.25	0.25	0.17	0.17	0.08	0.17	0.08
COM Master	0.25	0.25	0.17	0.25	0.25	0.25	0.08	0.17	0.08	0.25	0.17
COM Submaster	0.25	0.25	0.17	0.25	0.25	0.25	0.25	0.08	0.08	0.25	0.17
Mess	0.25	0.25	0.17	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Kitchen A	0.25	0.08	0.17	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Kitchen B	0.25	0.08	0.17	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Laundry A	0.25	0.25	0.25	0.08	0.08	0.25	0.25	0.25	0.25	0.25	0.25
Laundry B	0.25	0.25	0.25	0.08	0.08	0.25	0.25	0.25	0.25	0.25	0.25
Shower	0.25	0.25	0.25	0.25	0.25	0.08	0.25	0.25	0.25	0.25	0.25
Office	0.25	0.25	0.25	0.25	0.25	0.25	0.17	0.17	0.08	0.17	0.08
Depot	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.17	0.17	0.25	0.25

Table A-45 Shelter parameters (part 12)

Configuration (var)	Transition time for each event										
	(h)										
	L	M	N	O	P	Q	R	S	T	U	V
Guard Shack	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.08	0.08	0.17	0.17
Enlisted Billeting						...					
Officer Billeting						...					
COC Master	0.08	0.08	0.08	1.00	0.50	0.08	0.08	1.00	0.25	0.25	0.25
COC Submaster	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.25	0.25	0.25
COM Master	0.08	0.08	0.25	0.25	0.08	0.08	0.08	0.25	0.25	0.25	0.25
COM Submaster	0.25	0.25	0.25	0.25	0.17	0.25	0.25	0.08	0.25	0.25	0.25
Mess	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Kitchen A	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Kitchen B	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Laundry A	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Laundry B	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Shower	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Office	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.25	0.25	0.25
Depot	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.17	0.25	0.25	0.25

Table A-46 Shelter parameters (part 13). The operational status is one for the COP scenario, and zero for limited tactical resupply COP scenario. A one indicates the shelter has been constructed and is consuming power, while zero indicates the shelter is not constructed and not consuming any power.

Configuration (var)	Offset (no.)	HVAC installed (nd)	Rated generator capacity (kW)	Operational status (nd)	Buildup breakdown duration (hr)
Guard Shack	...	0	5	0 or 1	3
Enlisted Billeting	4	1	60	0 or 1	6
Officer Billeting	4	1	30	0 or 1	6
COC Master	...	1	60	0 or 1	6
COC Submaster	...	1	60	0 or 1	6
COM Master	...	1	60	0 or 1	6
COM Submaster	...	1	60	0 or 1	6
Mess	...	1	60	0 or 1	6
Kitchen A	...	0	60	0 or 1	6
Kitchen B	...	0	60	0 or 1	6
Laundry A	...	0	60	0 or 1	6
Laundry B	...	0	60	0 or 1	6
Shower	...	1	60	0 or 1	6
Office	...	1	60	0 or 1	6
Depot	...	1	120	0 or 1	6

Table A-47 Shelter parameters (part 14)

Configuration	Number of specialized equipment	Type of specialized equipment	Number of desktop computers	Type of desktop computers
(var)	(no.)	(nd)	(no.)	(nd)
Guard Shack	1	9	...	...
Enlisted Billeting	...	...	...	...
Officer Billeting	...	...	...	...
COC Master	4	15	...	...
COC Submaster	2	11	...	...
COM Master	4	15	...	...
COM Submaster	2	11	...	...
Mess	2	2	...	...
Kitchen A	...	...	...	...
Kitchen B	...	...	...	...
Laundry A	...	...	...	...
Laundry B	...	...	...	...
Shower	...	...	...	...
Office	2	8	...	...
Depot	10	18	...	...

Table A-48 Shelter parameters (part 15)

Configuration	Number of	Type of	Number of	Type of
(var)	TVs	TVs	game consoles	game consoles
(no.)	(nd)	(no.)	(nd)	
Guard Shack	...	...	...	...
Enlisted Billeting	2	22	2	1
Officer Billeting	2	22	2	1
COC Master	16	24	...	...
COC Submaster	8	24	...	...
COM Master	16	24	...	...
COM Submaster	8	24	...	...
Mess	1	4	...	...
Kitchen A	...	...	...	...
Kitchen B	...	...	...	...
Laundry A	...	...	...	...
Laundry B	...	...	...	...
Shower	...	...	...	...
Office	8	24	...	...
Depot	...	...	...	...

Table A-49 Shelter parameters (part 16)

Configuration	Number of	Type of	Number of	Type of
(var)	shop lights	shop lights	fans	fans
(no.)	(nd)	(no.)	(nd)	
Guard Shack	2	6	...	...
Enlisted Billeting	12	4	6	1
Officer Billeting	6	4	4	1
COC Master	12	4	6	3
COC Submaster	12	6	6	3
COM Master	12	6	6	3
COM Submaster	12	6	6	3
Mess	12	4	6	3
Kitchen A	12	4	6	1
Kitchen B	12	4	6	1
Laundry A	12	4	6	1
Laundry B	12	4	6	1
Shower	12	4	6	1
Office	12	6	6	3
Depot	48	6	24	3

Table A-50 Shelter parameters (part 17)

Configuration	Number of	Type of	Number of	Type of
(var)	laptop computer	laptop computer	cell phones	cell phones
	(no.)	(nd)	(no.)	(nd)
Guard Shack	3	3	3	3
Enlisted Billeting	50	1	50	1
Officer Billeting	15	1	15	1
COC Master	40	3	10	3
COC Submaster	10	3	4	3
COM Master	36	3	15	3
COM Submaster	24	3	10	3
Mess	...	...	...	...
Kitchen A	...	...	...	...
Kitchen B	...	...	...	...
Laundry A	...	...	...	...
Laundry B	...	...	...	...
Shower	...	...	...	...
Office	10	3	4	3
Depot	10	3	4	3

Table A-51 Shelter parameters (part 18)

Configuration	Number of projectors	Type of projectors	Number of refrigerators	Type of refrigerators
(var)	(no.)	(nd)	(no.)	(nd)
Guard Shack	...	...	...	...
Enlisted Billeting	...	...	...	...
Officer Billeting	...	...	...	...
COC Master	...	...	...	...
COC Submaster	...	...	...	...
COM Master	...	...	...	...
COM Submaster	...	...	...	...
Mess	...	...	...	...
Kitchen A	...	...	...	...
Kitchen B	...	...	6	2
Laundry A	...	...	...	...
Laundry B	...	...	...	...
Shower	...	...	...	...
Office	...	...	...	...
Depot	...	...	...	...

Table A-52 Shelter parameters (part 19)

Configuration	Number of freezers	Type of freezers	Number of ovens	Type of ovens
(var)	(no.)	(nd)	(no.)	(nd)
Guard Shack	...	...	...	...
Enlisted Billeting	...	...	...	...
Officer Billeting	...	...	...	...
COC Master	...	...	...	...
COC Submaster	...	...	...	...
COM Master	...	...	...	...
COM Submaster	...	...	...	...
Mess	...	...	...	...
Kitchen A	...	...	8	2
Kitchen B	12	2	...	...
Laundry A	...	...	...	...
Laundry B	...	...	...	...
Shower	...	...	...	...
Office	...	...	...	...
Depot	...	...	...	...

Table A-53 Shelter parameters (part 20)

Configuration	Number of warmers	Type of warmers	Number of microwaves	Type of microwaves
(var)	(no.)	(nd)	(no.)	(nd)
Guard Shack	...	...	...	...
Enlisted Billeting	...	...	...	...
Officer Billeting	...	...	...	...
COC Master	...	...	2	1
COC Submaster	...	...	...	...
COM Master	...	...	2	1
COM Submaster	...	...	...	...
Mess	...	...	3	1
Kitchen A	8	2	2	1
Kitchen B	...	...	...	...
Laundry A	...	...	...	...
Laundry B	...	...	...	...
Shower	...	...	...	...
Office	...	...	...	...
Depot	...	...	...	...

Table A-54 Shelter parameters (part 21)

Configuration	Number of heaters	Type of heaters	Number of water heaters	Type of water heaters
(var)	(no.)	(nd)	(no.)	(nd)
Guard Shack	...	...	...	...
Enlisted Billeting	...	...	...	...
Officer Billeting	...	...	...	...
COC Master	...	...	...	...
COC Submaster	...	...	...	...
COM Master	...	...	...	...
COM Submaster	...	...	...	...
Mess	...	...	...	...
Kitchen A	...	...	...	...
Kitchen B	...	...	...	...
Laundry A	...	...	...	...
Laundry B	...	...	...	...
Shower	...	...	4	2
Office	...	...	...	...
Depot	...	...	...	...

Table A-55 Shelter parameters (part 22)

Configuration	Number of hot plates	Type of hot plates	Number of dishwashers	Type of water dishwashers
(var)	(no.)	(nd)	(no.)	(nd)
Guard Shack	...	...	...	...
Enlisted Billeting	...	...	...	...
Officer Billeting	...	...	...	...
COC Master	2	1	...	...
COC Submaster	...	...	...	...
COM Master	2	1	...	...
COM Submaster	...	...	...	...
Mess	3	1	...	...
Kitchen A	...	...	6	2
Kitchen B	...	...	...	...
Laundry A	...	...	...	...
Laundry B	...	...	...	...
Shower	...	...	...	...
Office	...	...	...	...
Depot	...	...	...	...

Table A-56 Shelter parameters (part 23)

Configuration (var)	Number of clothes washers (no.)	Type of clothes washers (nd)	Number of clothes dryer (no.)	Type of clothes dryer (nd)
Guard Shack	...	...	...	...
Enlisted Billeting	...	...	...	...
Officer Billeting	...	...	...	...
COC Master	...	...	...	...
COC Submaster	...	...	...	...
COM Master	...	...	...	...
COM Submaster	...	...	...	...
Mess	...	...	...	...
Kitchen A	...	...	...	...
Kitchen B	...	...	...	...
Laundry A	14	2	...	...
Laundry B	...	...	14	2
Shower	...	...	...	...
Office	...	...	...	...
Depot	...	...	...	...

A.22 Fully Established Combat Outpost Parameters

All parameters for the fully established combat outpost E&P scenario are provided in the sheets of the Microsoft Excel document `ugrd_combat_outpost_configuration.xlsx`.

A.23 Limited Resupply Combat Outpost Parameters

All parameters for the limited resupply combat outpost E&P scenario are provided in the sheets of the Microsoft Excel document `ugrd_limited_resupply_combat_outpost_configuration.xlsx`.

Appendix B. Fully Established Combat Outpost

Using MATLAB/Simulink, we created a set of blocks that can emulate our various electrical components as shown in Section 5, all of which are contained in various military type shelters as shown in Section 6. The individual shelter results for the fully established combat outpost (COP) scenario have been separated into multiple subsections of this Appendix. Some of the shelter configurations were essentially duplicated; however, when the parameters were loaded into MATLAB, some of the thermal-based parameters were amended to incorporate randomness. For this scenario, there were 20 enlisted billeting shelters, 10 officer billeting shelters, 2 mess shelters, 2 kitchen shelters (kitchen A and B), 2 laundry shelters (laundry a and b), 2 shower shelters, a Combat Operations Center (COC) master shelter, 2 COC submaster shelters, a Communications (COM) master shelter, 2 COM submaster shelters, 2 office shelters, and 2 vehicle depot shelters, resulting in 48 shelters. Each of the shelters electrical and thermal responses are highlighted within the subsequent sections as dictated by Tables B-1 through B-3. The aggregation of the E&P response of each shelter is then provided in Section 8.

Table B-1 Summary of shelter results: enlisted billeting

Shelter designation	Section
Enlisted Billeting A	B.1
Enlisted Billeting B	B.2
Enlisted Billeting C	B.3
Enlisted Billeting D	B.4
Enlisted Billeting E	B.5
Enlisted Billeting F	B.6
Enlisted Billeting G	B.7
Enlisted Billeting H	B.8
Enlisted Billeting I	B.9
Enlisted Billeting J	B.10
Enlisted Billeting K	B.11
Enlisted Billeting L	B.12
Enlisted Billeting M	B.13
Enlisted Billeting N	B.14
Enlisted Billeting O	B.15
Enlisted Billeting P	B.16
Enlisted Billeting Q	B.17
Enlisted Billeting R	B.18
Enlisted Billeting S	B.19
Enlisted Billeting T	B.20

Table B-2 Summary of shelter results: officer billeting

Shelter designation	Section
Officer Billeting A	B.21
Officer Billeting B	B.22
Officer Billeting C	B.23
Officer Billeting D	B.24
Officer Billeting E	B.25
Officer Billeting F	B.26
Officer Billeting G	B.27
Officer Billeting H	B.28
Officer Billeting I	B.29
Officer Billeting J	B.30

Table B-3 Summary of shelter results: all other shelters

Shelter designation	Section
MESS A	B.31
MESS B	B.32
Kitchen A	B.33
Kitchen B	B.34
Laundry A	B.35
Laundry B	B.36
Shower A	B.37
Shower B	B.38
COC Master	B.39
COC Submaster A	B.40
COC Submaster B	B.41
COM Master	B.42
COM Submaster A	B.43
COM Submaster B	B.44
Office A	B.45
Office B	B.46
Depot A	B.47
Depot B	B.48

B.1 Enlisted Billeting A

The shelter labeled as enlisted billeting A houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was primarily driven by the time of day. During the morning or late evening

hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-1a), the time-varying occupancy (Fig. B-1b), the resulting thermal response (Fig. B-1c), aggregate electrical load (Fig. B-1d), and the ECU electrical load (Fig. B-1e) are provided in Fig. B-1.

The shelter labeled as enlisted billeting A contains six separate electrical components including 1) televisions (Fig. B-2a), 2) game consoles (Fig. B-2b), 3) fans (Fig. B-2c), 4) shop lights (Fig. B-2d), 5) laptop computers (Fig. B-2e), and 6) cell phones (Fig. B-2f), all of which is shown in Fig. B-2.

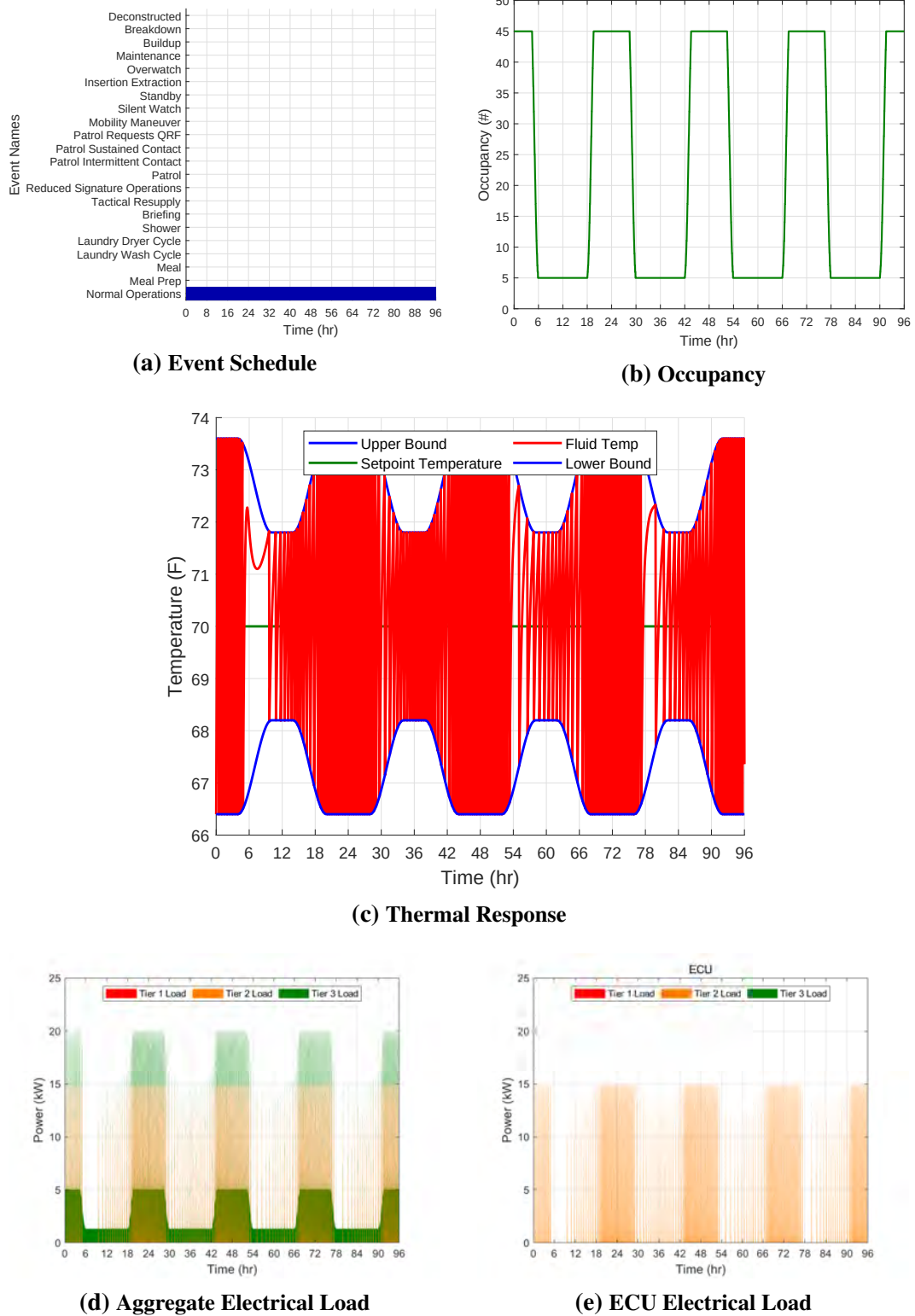
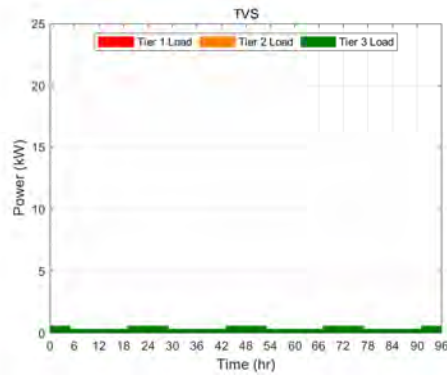
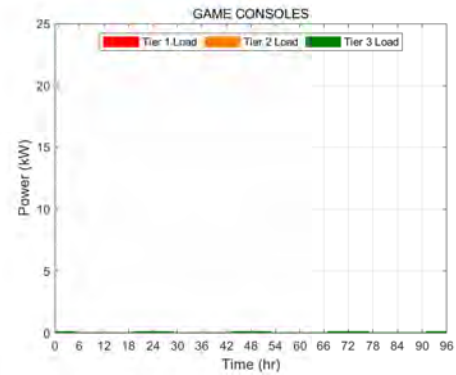


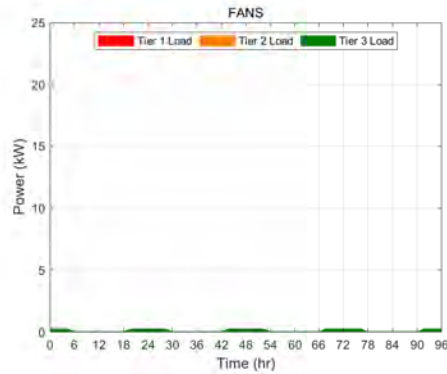
Fig. B-1 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



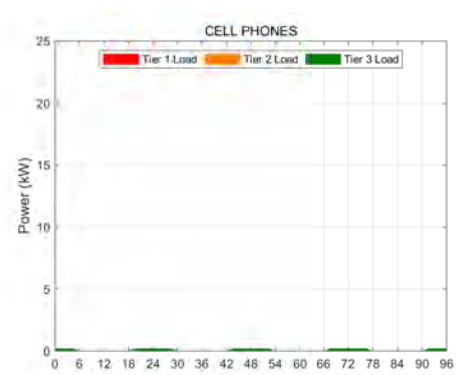
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-2 The electrical components housed within the military shelter

B.2 Enlisted Billeting B

The shelter labeled as enlisted billeting B houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-3a), the time-varying occupancy (Fig. B-3b), the resulting thermal response (Fig. B-3c), aggregate electrical load (Fig. B-3d), and the ECU electrical load (Fig. B-3e) are provided in Fig. B-3.

The shelter labeled as enlisted billeting B contains six separate electrical components including 1) televisions (Fig. B-4a), 2) game consoles (Fig. B-4b), 3) fans (Fig. B-4c), 4) shop lights (Fig. B-4d), 5) laptop computers (Fig. B-4e), and 6) cell phones (Fig. B-4f), all of which is shown in Fig. B-4.

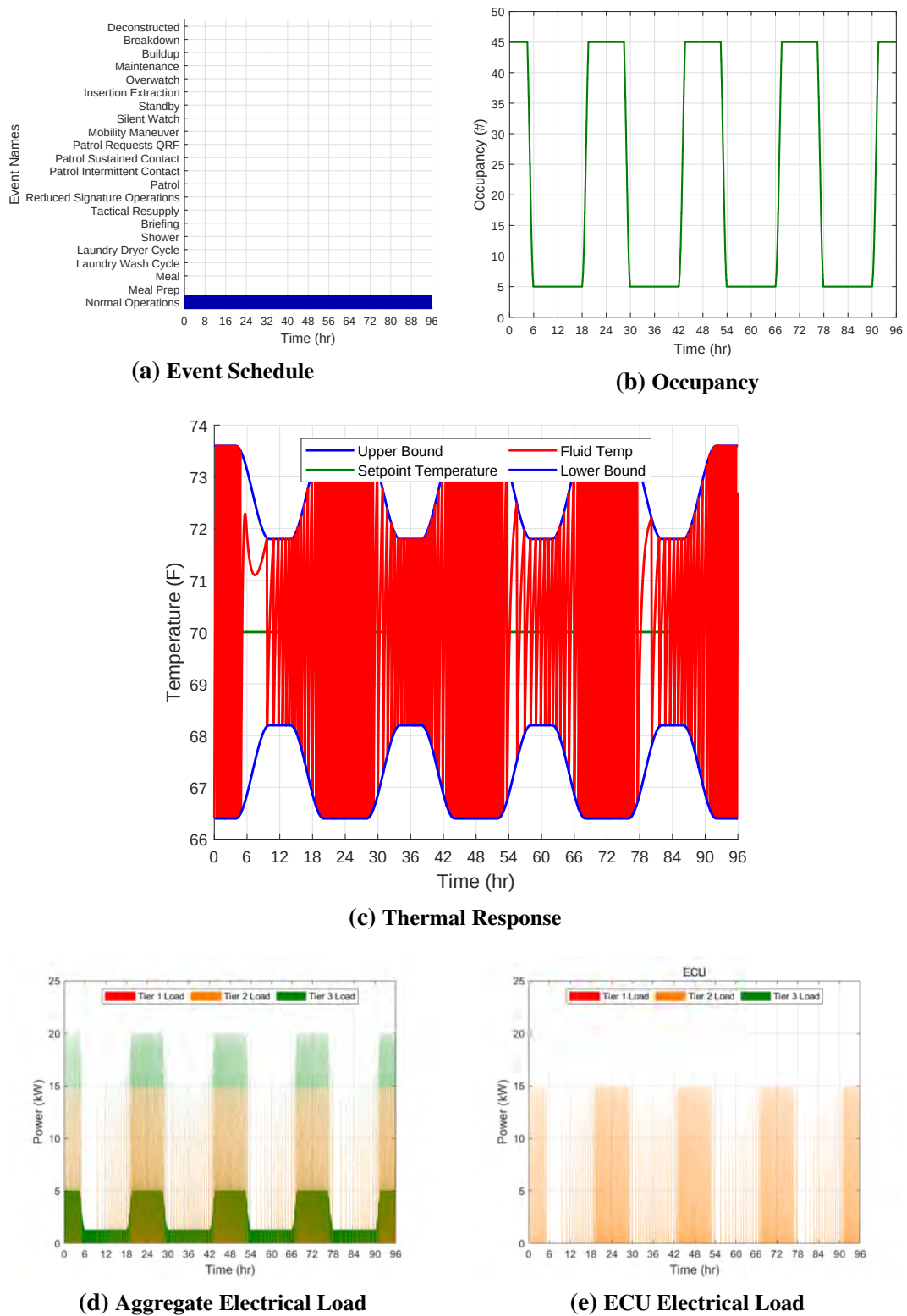
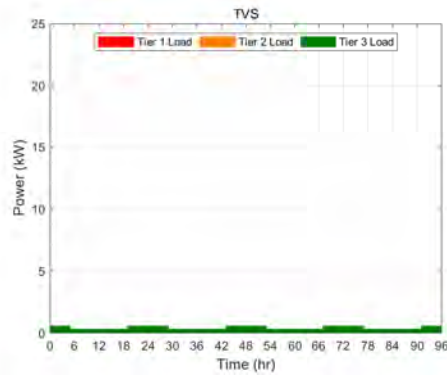
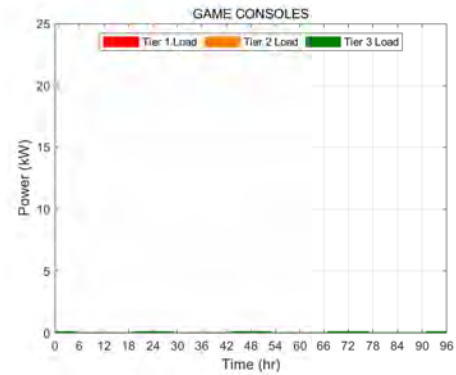


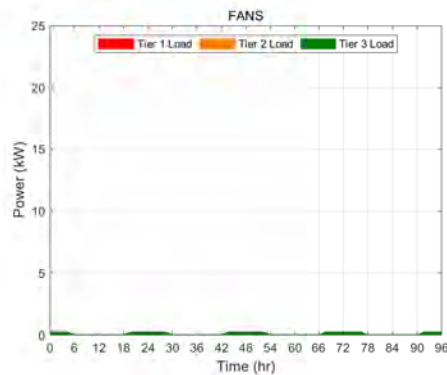
Fig. B-3 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



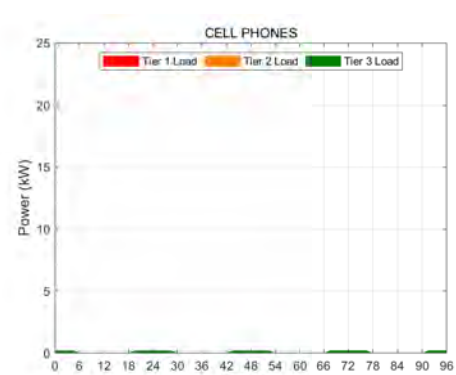
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-4 The electrical components housed within the military shelter

B.3 Enlisted Billeting C

The shelter labeled as enlisted billeting C houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-5a), the time-varying occupancy (Fig. B-5b), the resulting thermal response (Fig. B-5c), aggregate electrical load (Fig. B-5d), and the ECU electrical load (Fig. B-5e) are provided in Fig. B-5.

The shelter labeled as enlisted billeting C contains six separate electrical components including 1) televisions (Fig. B-6a), 2) game consoles (Fig. B-6b), 3) fans (Fig. B-6c), 4) shop lights (Fig. B-6d), 5) laptop computers (Fig. B-6e), and 6) cell phones (Fig. B-6f), all of which is shown in Fig. B-6.

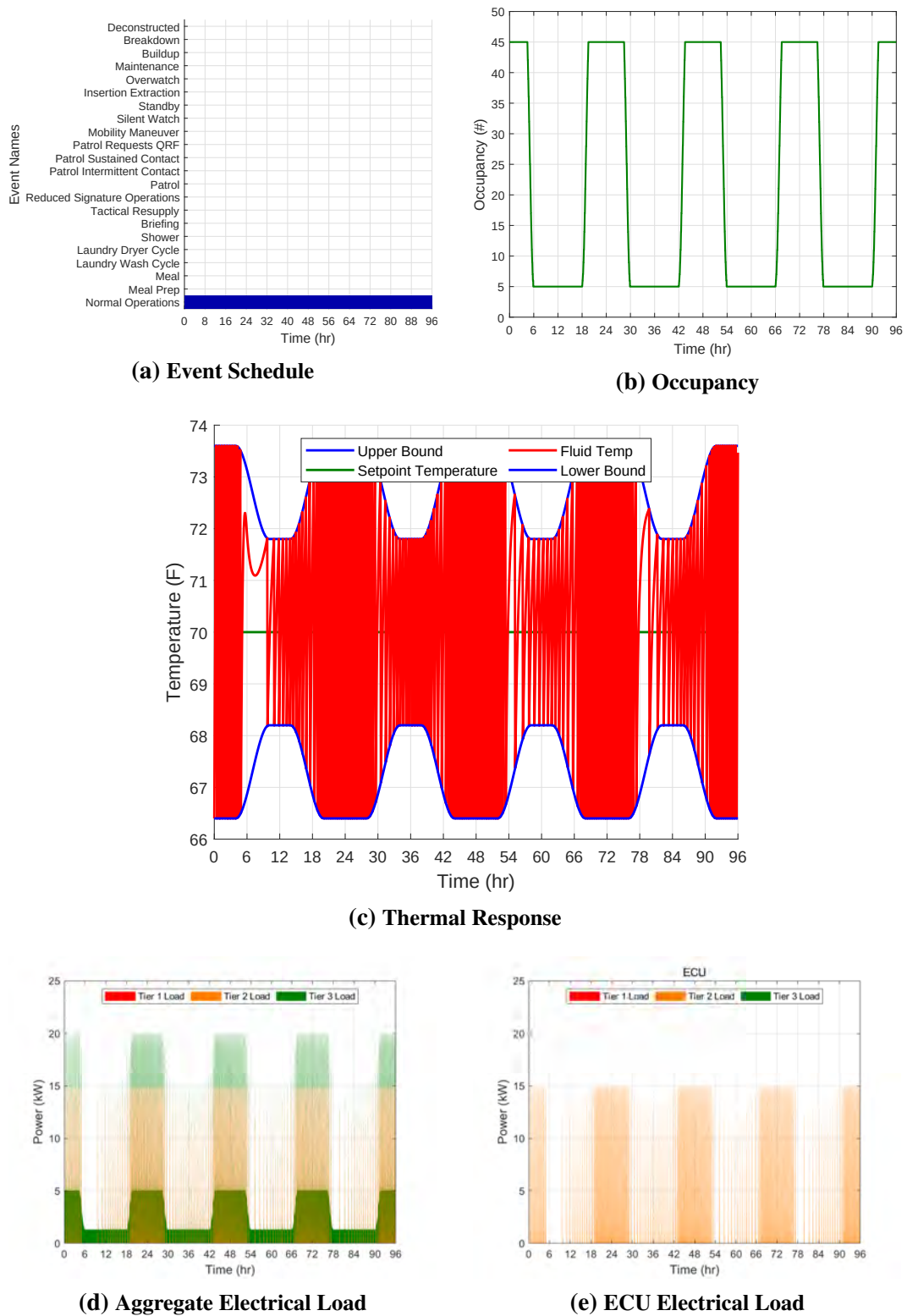
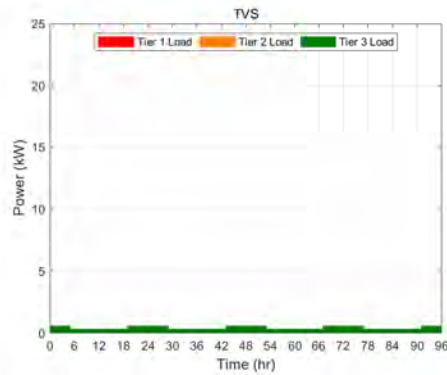
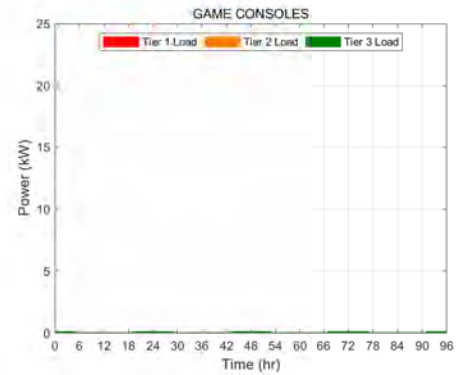


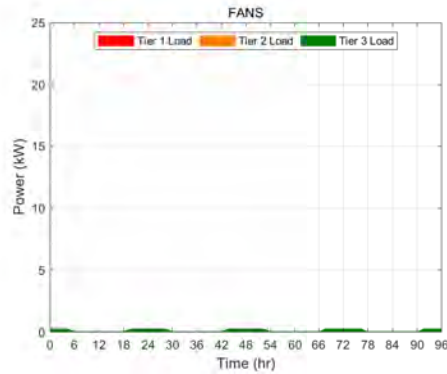
Fig. B-5 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



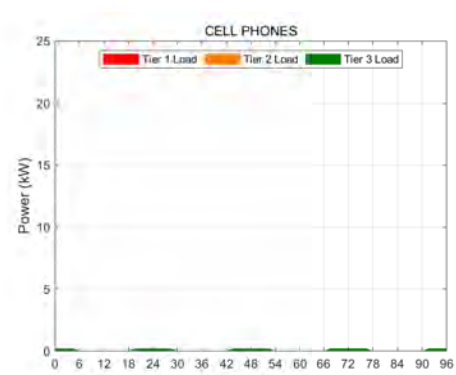
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-6 The electrical components housed within the military shelter

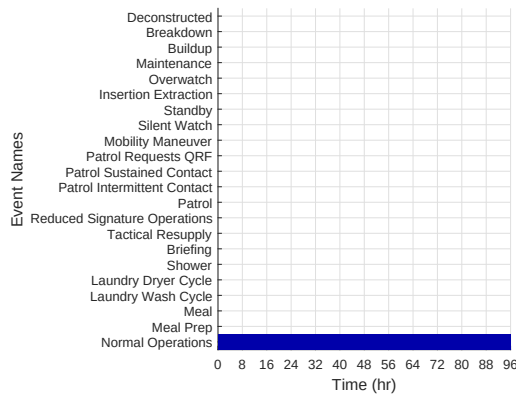
B.4 Enlisted Billeting D

The shelter labeled as enlisted billeting D houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

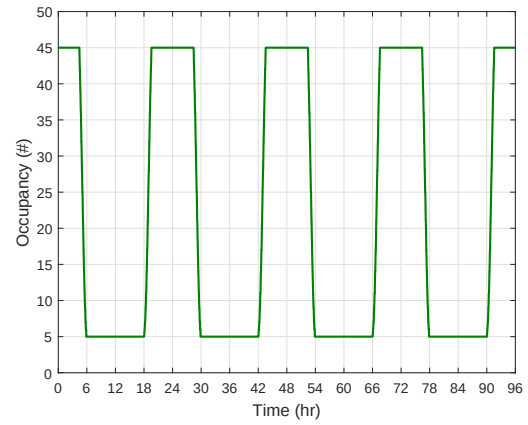
pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-7a), the time-varying occupancy (Fig. B-7b), the resulting thermal response (Fig. B-7c), aggregate electrical load (Fig. B-7d), and the ECU electrical load (Fig. B-7e) are provided in Fig. B-7.

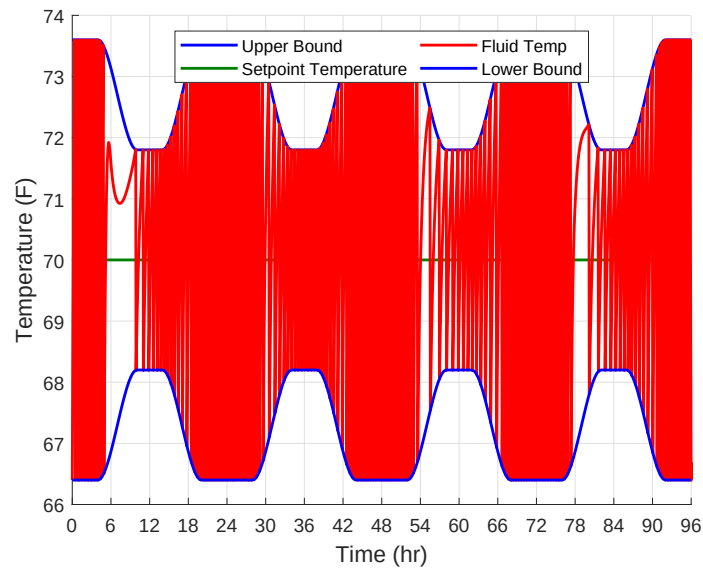
The shelter labeled as enlisted billeting D contains six separate electrical components including 1) televisions (Fig. B-8a), 2) game consoles (Fig. B-8b), 3) fans (Fig. B-8c), 4) shop lights (Fig. B-8d), 5) laptop computers (Fig. B-8e), and 6) cell phones (Fig. B-8f), all of which is shown in Fig. B-8.



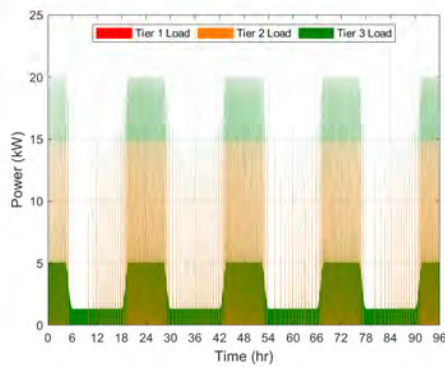
(a) Event Schedule



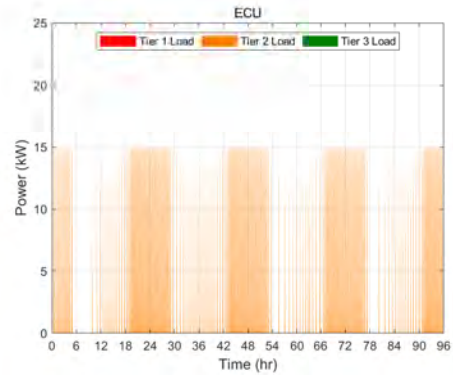
(b) Occupancy



(c) Thermal Response

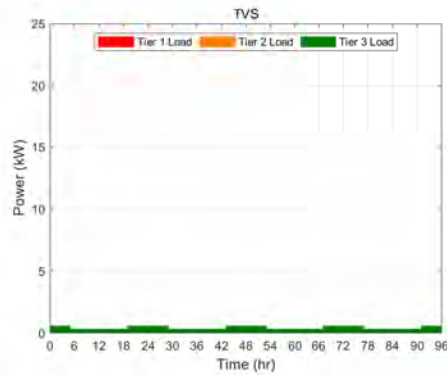


(d) Aggregate Electrical Load

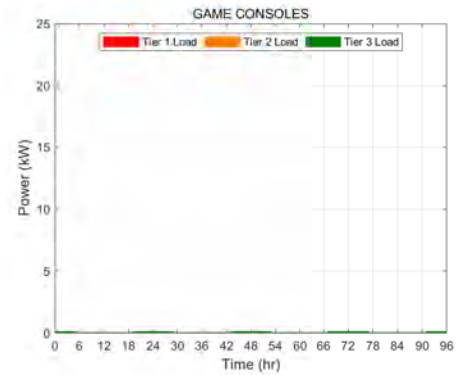


(e) ECU Electrical Load

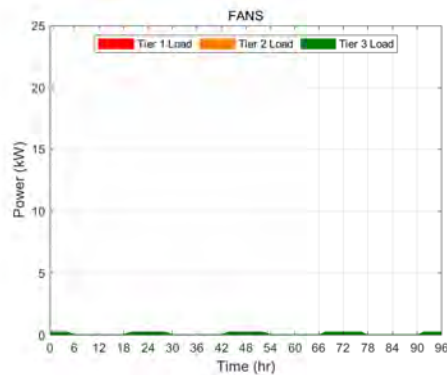
Fig. B-7 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



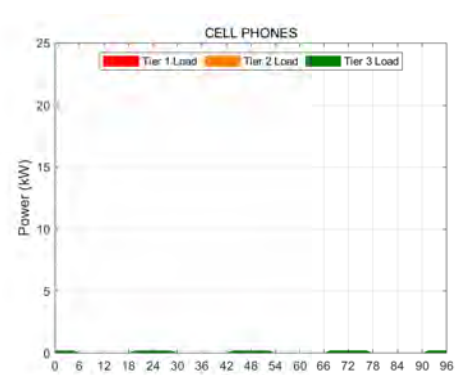
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-8 The electrical components housed within the military shelter

B.5 Enlisted Billeting E

The shelter labeled as enlisted billeting E houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-9a), the time-varying occupancy (Fig. B-9b), the resulting thermal response (Fig. B-9c), aggregate electrical load (Fig. B-9d), and the ECU electrical load (Fig. B-9e) are provided in Fig. B-9.

The shelter labeled as enlisted billeting E contains six separate electrical components including 1) televisions (Fig. B-10a), 2) game consoles (Fig. B-10b), 3) fans (Fig. B-10c), 4) shop lights (Fig. B-10d), 5) laptop computers (Fig. B-10e), and 6) cell phones (Fig. B-10f), all of which is shown in Fig. B-10.

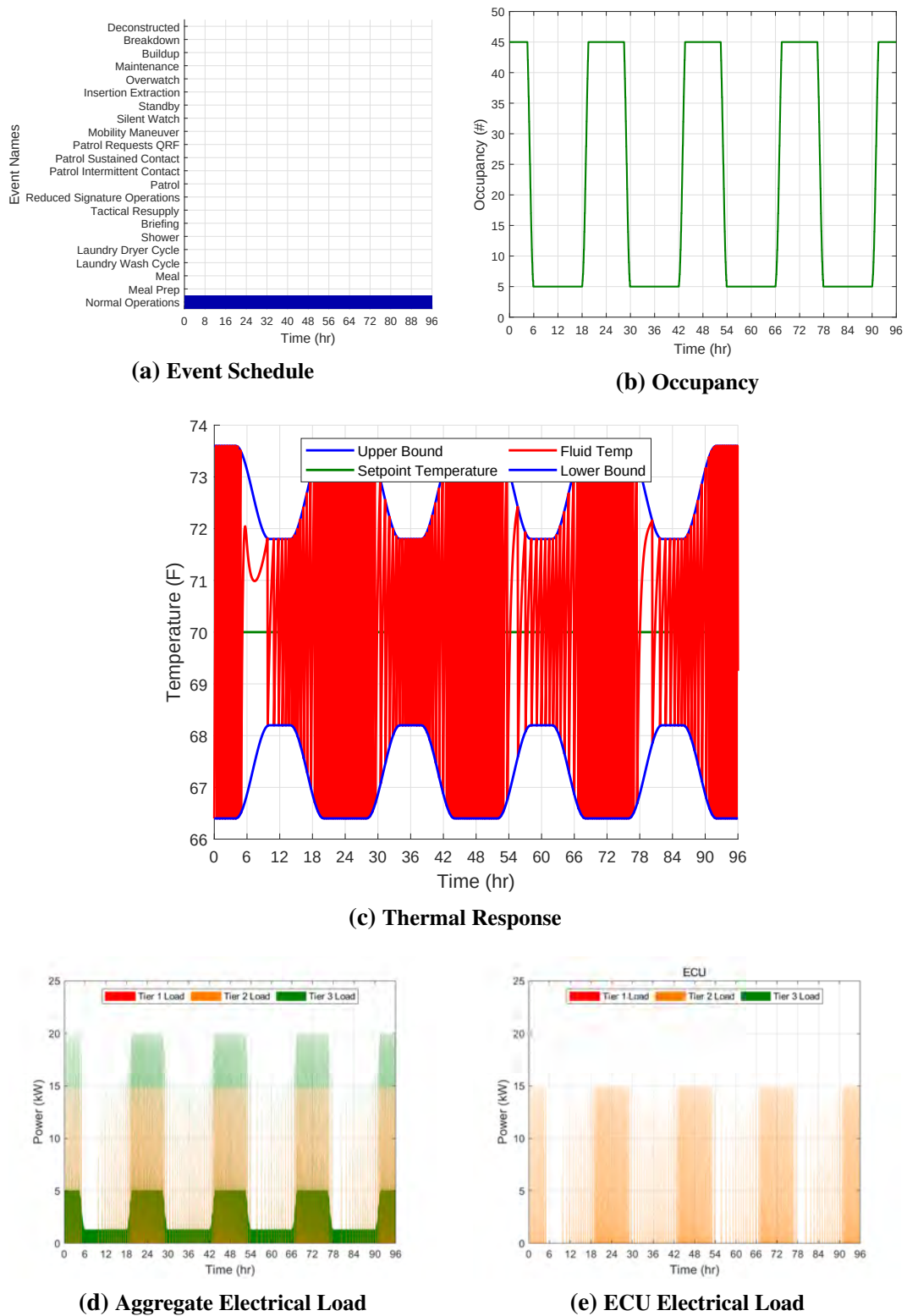
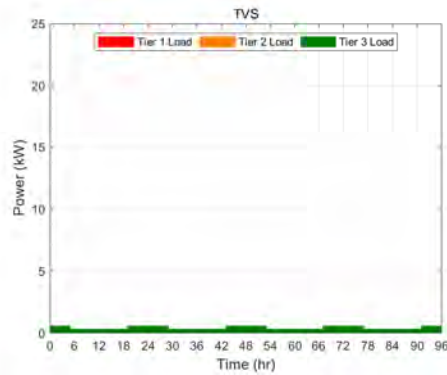
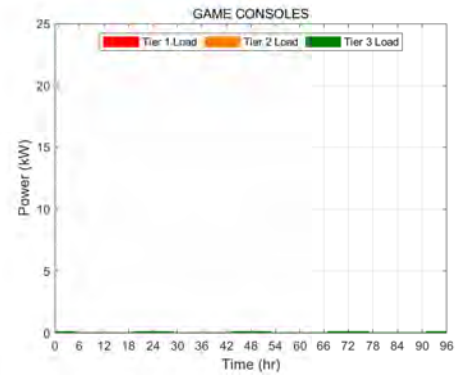


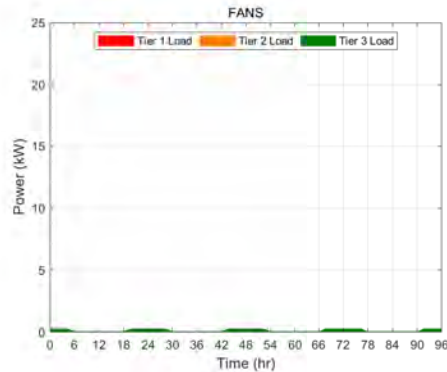
Fig. B-9 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



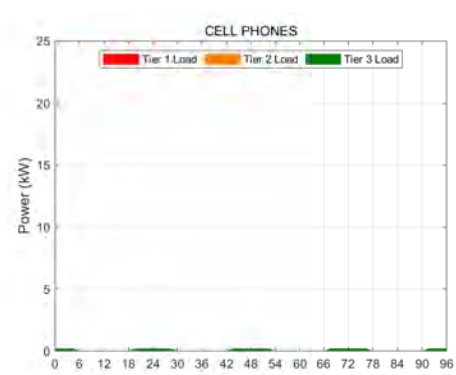
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-10 The electrical components housed within the military shelter

B.6 Enlisted Billeting F

The shelter labeled as enlisted billeting F houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-11a), the time-varying occupancy (Fig. B-11b), the resulting thermal response (Fig. B-11c), aggregate electrical load (Fig. B-11d), and the ECU electrical load (Fig. B-11e) are provided in Fig. B-11.

The shelter labeled as enlisted billeting F contains six separate electrical components including 1) televisions (Fig. B-12a), 2) game consoles (Fig. B-12b), 3) fans (Fig. B-12c), 4) shop lights (Fig. B-12d), 5) laptop computers (Fig. B-12e), and 6) cell phones (Fig. B-12f), all of which is shown in Fig. B-12.

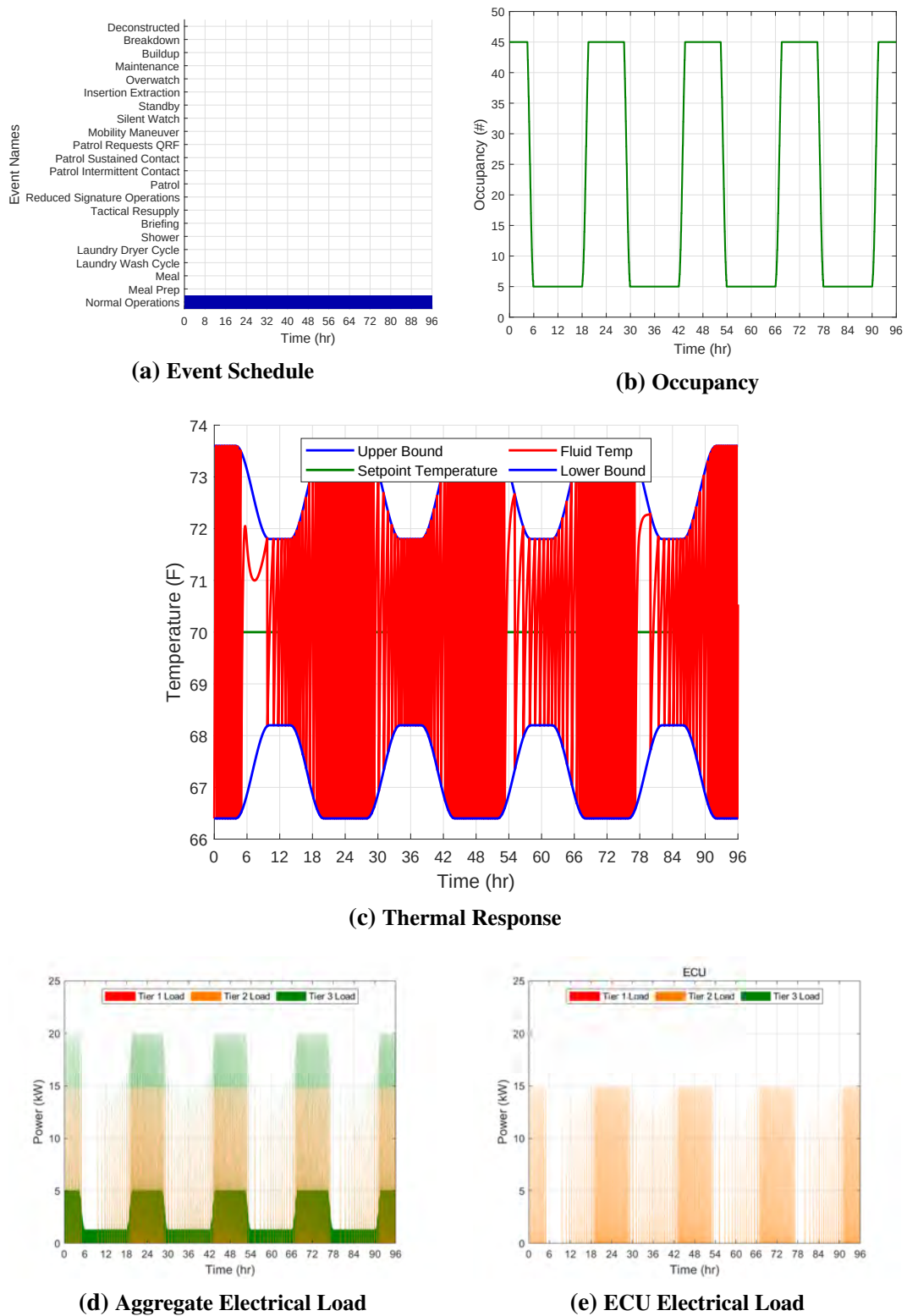
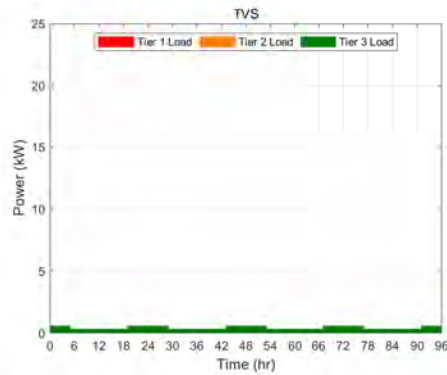
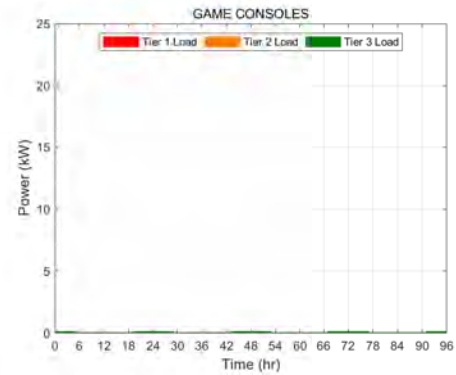


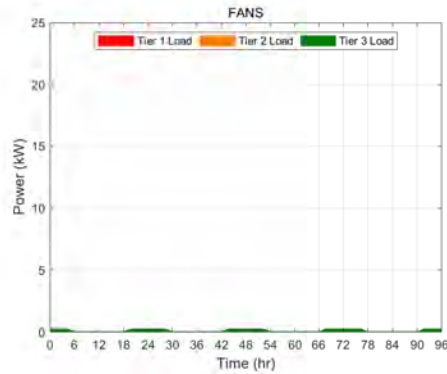
Fig. B-11 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



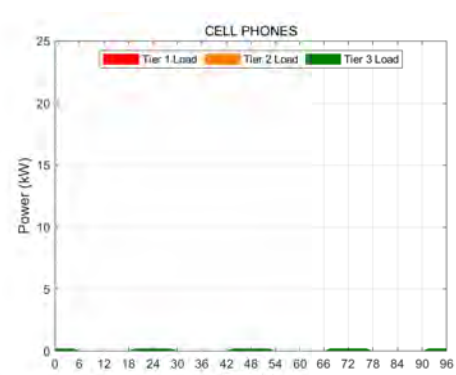
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-12 The electrical components housed within the military shelter

B.7 Enlisted Billeting G

The shelter labeled as enlisted billeting G houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-13a), the time-varying occupancy (Fig. B-13b), the resulting thermal response (Fig. B-13c), aggregate electrical load (Fig. B-13d), and the ECU electrical load (Fig. B-13e) are provided in Fig. B-13.

The shelter labeled as enlisted billeting G contains six separate electrical components including 1) televisions (Fig. B-14a), 2) game consoles (Fig. B-14b), 3) fans (Fig. B-14c), 4) shop lights (Fig. B-14d), 5) laptop computers (Fig. B-14e), and 6) cell phones (Fig. B-14f), all of which is shown in Fig. B-14.

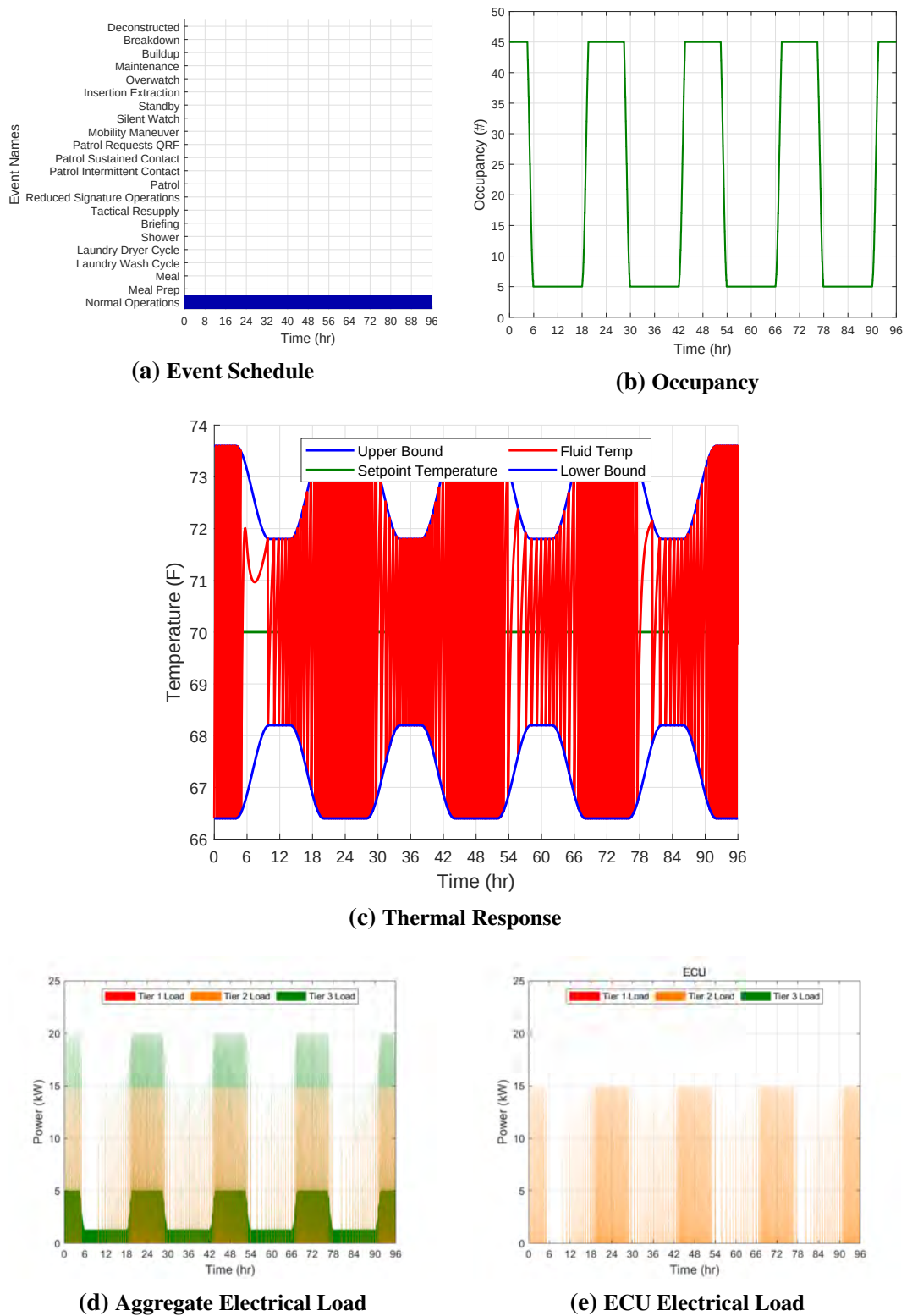
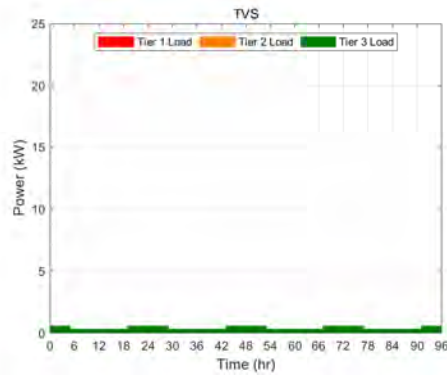
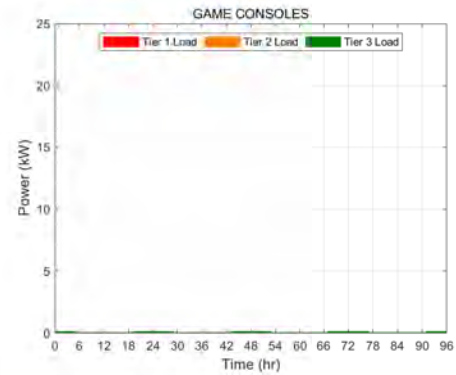


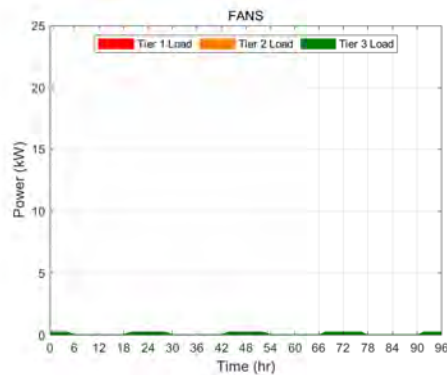
Fig. B-13 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



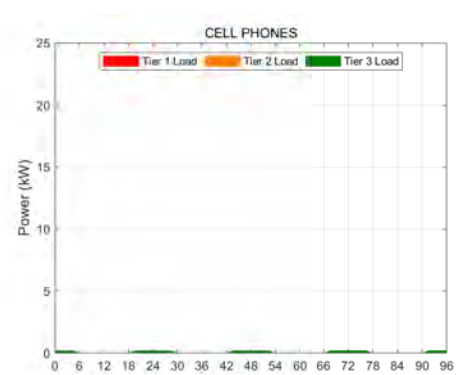
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-14 The electrical components housed within the military shelter

B.8 Enlisted Billeting H

The shelter labeled as enlisted billeting H houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-15a), the time-varying occupancy (Fig. B-15b), the resulting thermal response (Fig. B-15c), aggregate electrical load (Fig. B-15d), and the ECU electrical load (Fig. B-15e) are provided in Fig. B-15.

The shelter labeled as enlisted billeting H contains six separate electrical components including 1) televisions (Fig. B-16a), 2) game consoles (Fig. B-16b), 3) fans (Fig. B-16c), 4) shop lights (Fig. B-16d), 5) laptop computers (Fig. B-16e), and 6) cell phones (Fig. B-16f), all of which is shown in Fig. B-16.

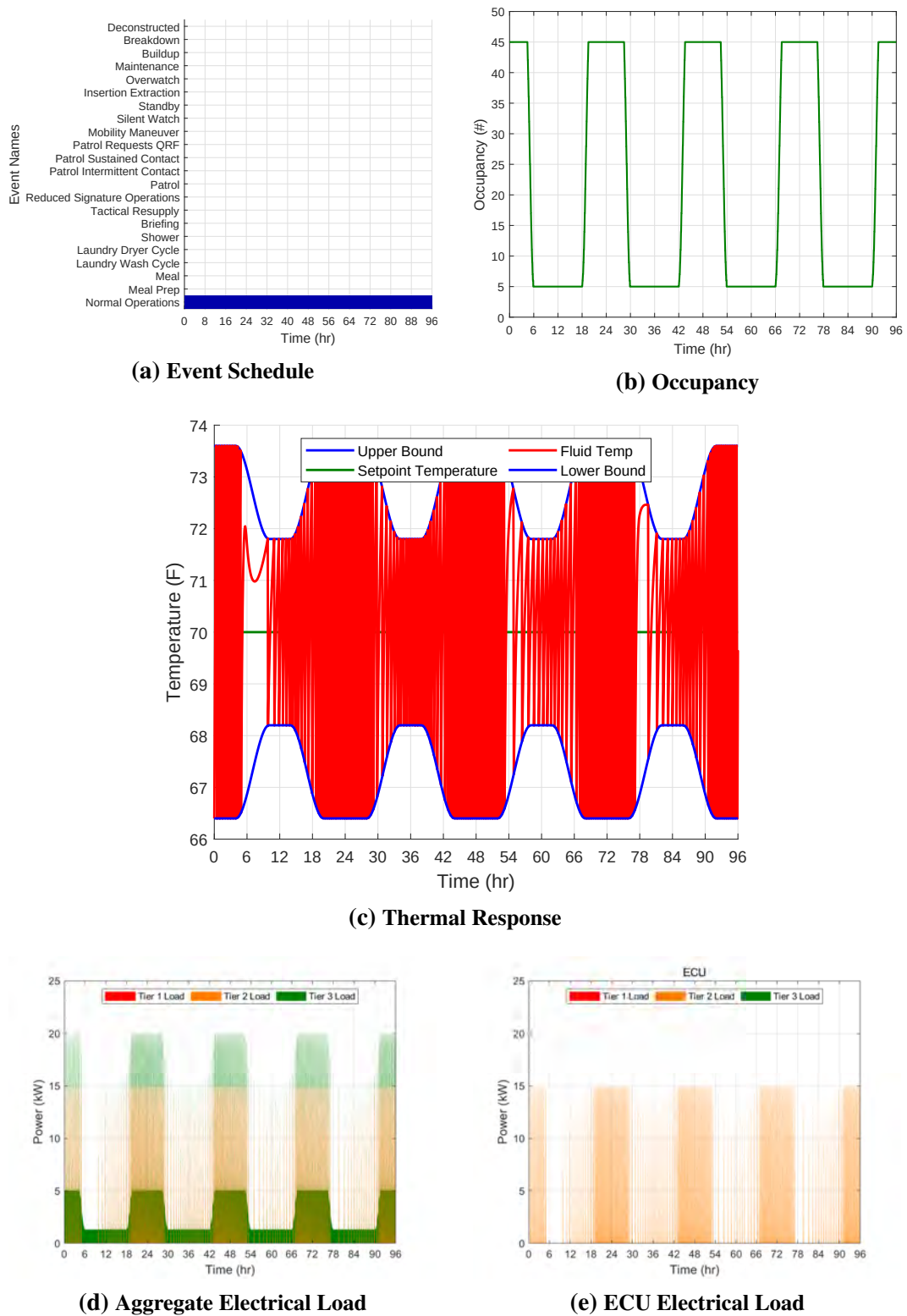
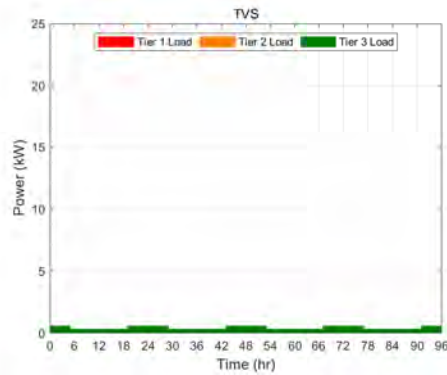
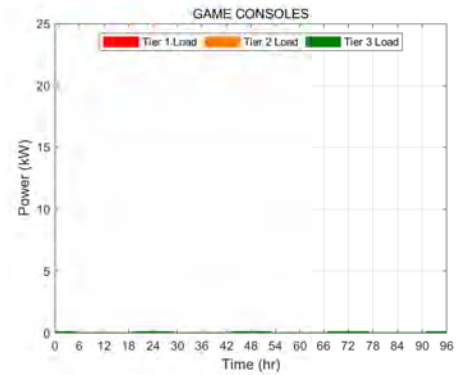


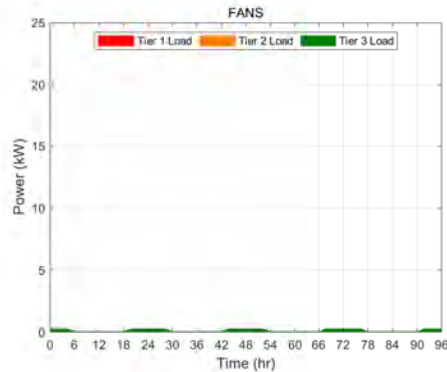
Fig. B-15 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



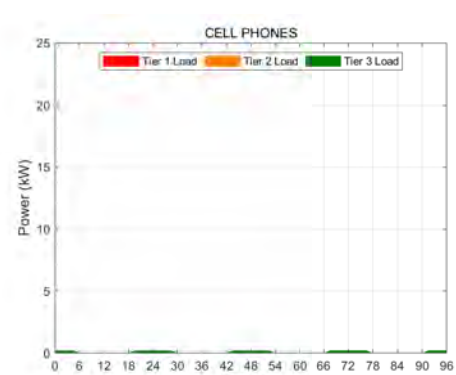
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-16 The electrical components housed within the military shelter

B.9 Enlisted Billeting I

The shelter labeled as enlisted billeting I houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-17a), the time-varying occupancy (Fig. B-17b), the resulting thermal response (Fig. B-17c), aggregate electrical load (Fig. B-17d), and the ECU electrical load (Fig. B-17e) are provided in Fig. B-17.

The shelter labeled as enlisted billeting I contains six separate electrical components including 1) televisions (Fig. B-18a), 2) game consoles (Fig. B-18b), 3) fans (Fig. B-18c), 4) shop lights (Fig. B-18d), 5) laptop computers (Fig. B-18e), and 6) cell phones (Fig. B-18f), all of which is shown in Fig. B-18.

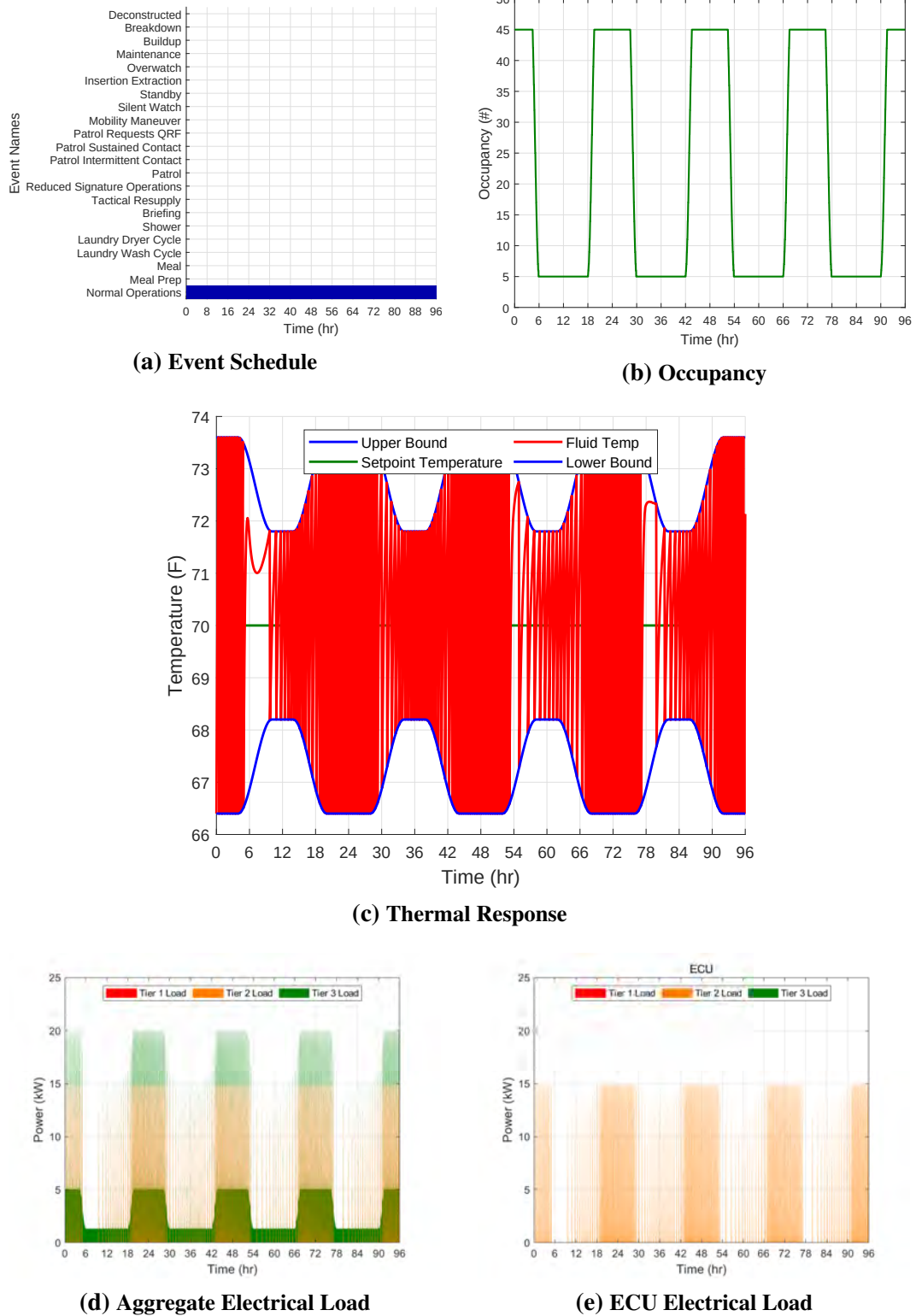
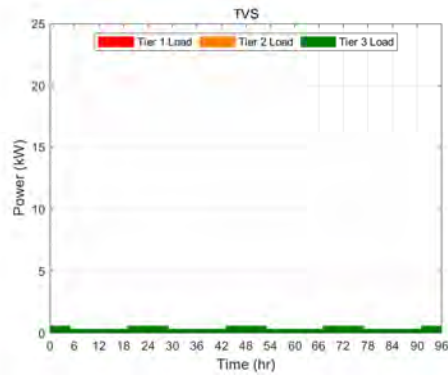
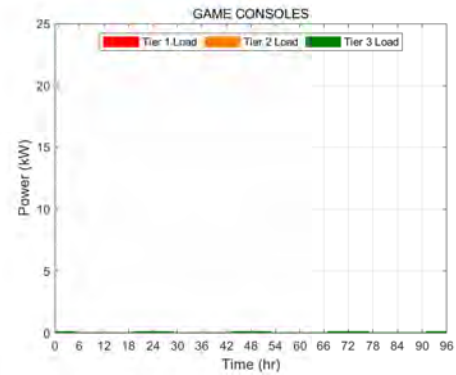


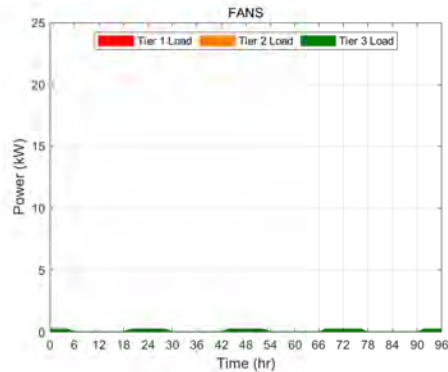
Fig. B-17 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



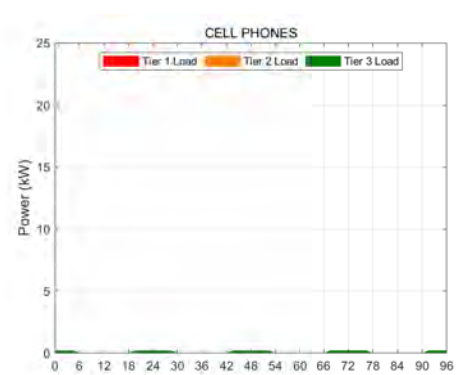
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-18 The electrical components housed within the military shelter

B.10 Enlisted Billeting J

The shelter labeled as enlisted billeting J houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-19a), the time-varying occupancy (Fig. B-19b), the resulting thermal response (Fig. B-19c), aggregate electrical load (Fig. B-19d), and the ECU electrical load (Fig. B-19e) are provided in Fig. B-19.

The shelter labeled as enlisted billeting J contains six separate electrical components including 1) televisions (Fig. B-20a), 2) game consoles (Fig. B-20b), 3) fans (Fig. B-20c), 4) shop lights (Fig. B-20d), 5) laptop computers (Fig. B-20e), and 6) cell phones (Fig. B-20f), all of which is shown in Fig. B-20.

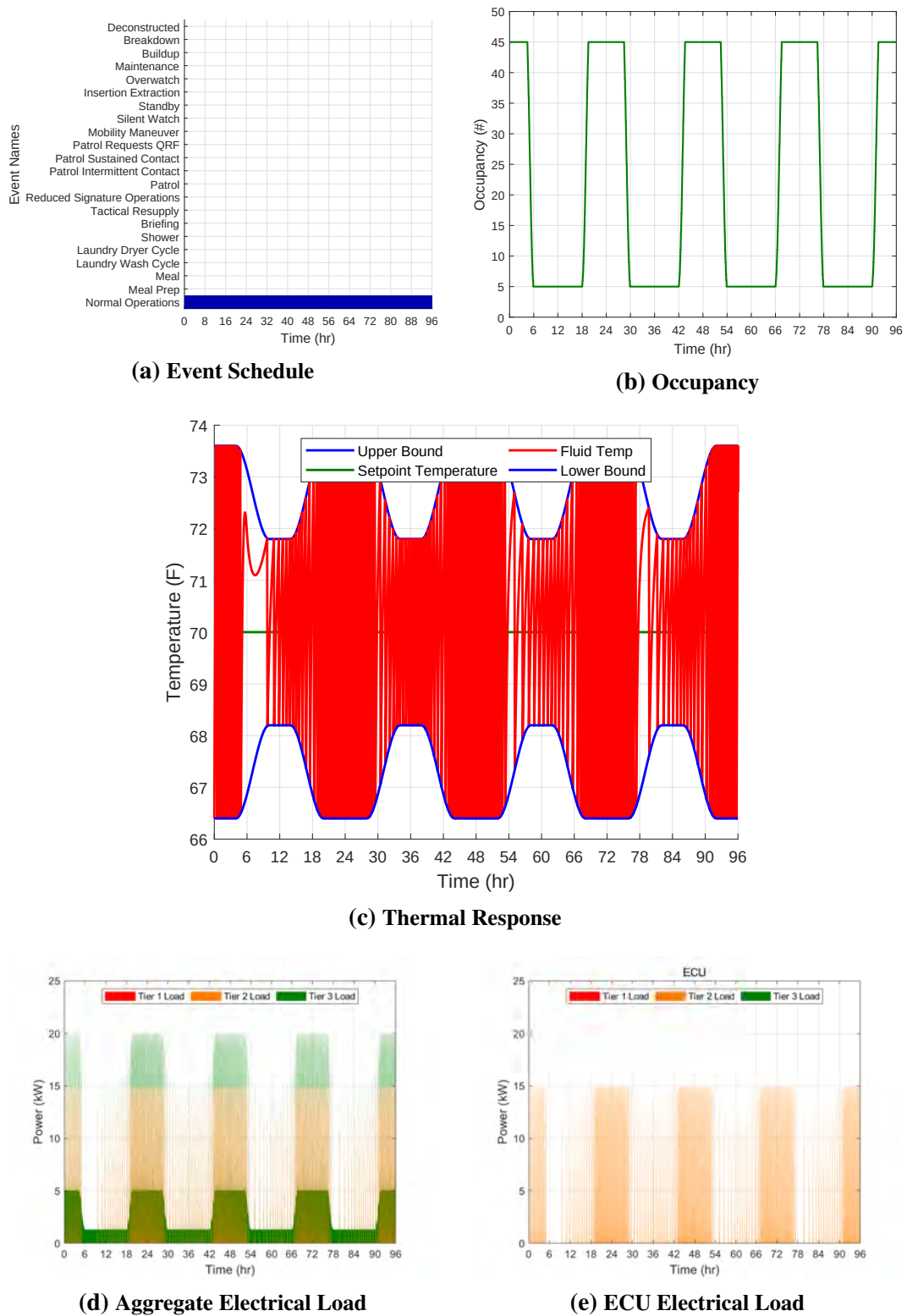
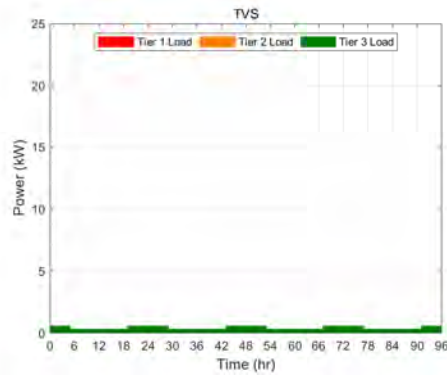
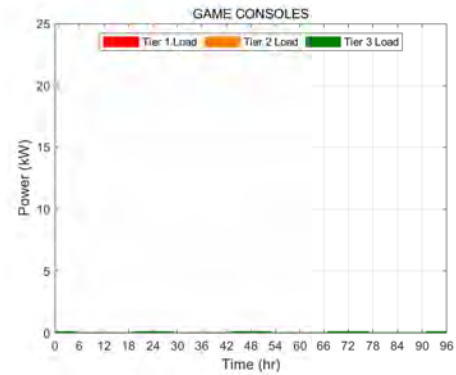


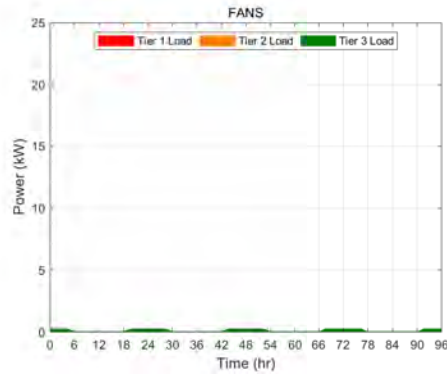
Fig. B-19 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



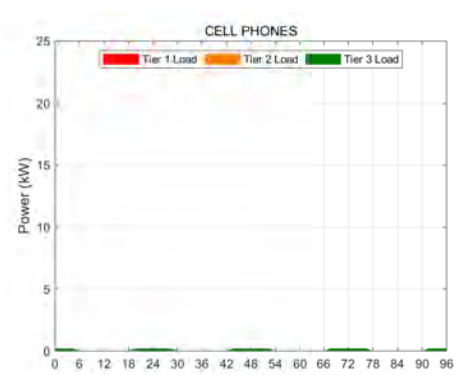
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-20 The electrical components housed within the military shelter

B.11 Enlisted Billeting K

The shelter labeled as enlisted billeting K houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-21a), the time-varying occupancy (Fig. B-21b), the resulting thermal response (Fig. B-21c), aggregate electrical load (Fig. B-21d), and the ECU electrical load (Fig. B-21e) are provided in Fig. B-21.

The shelter labeled as enlisted billeting K contains six separate electrical components including 1) televisions (Fig. B-22a), 2) game consoles (Fig. B-22b), 3) fans (Fig. B-22c), 4) shop lights (Fig. B-22d), 5) laptop computers (Fig. B-22e), and 6) cell phones (Fig. B-22f), all of which is shown in Fig. B-22.

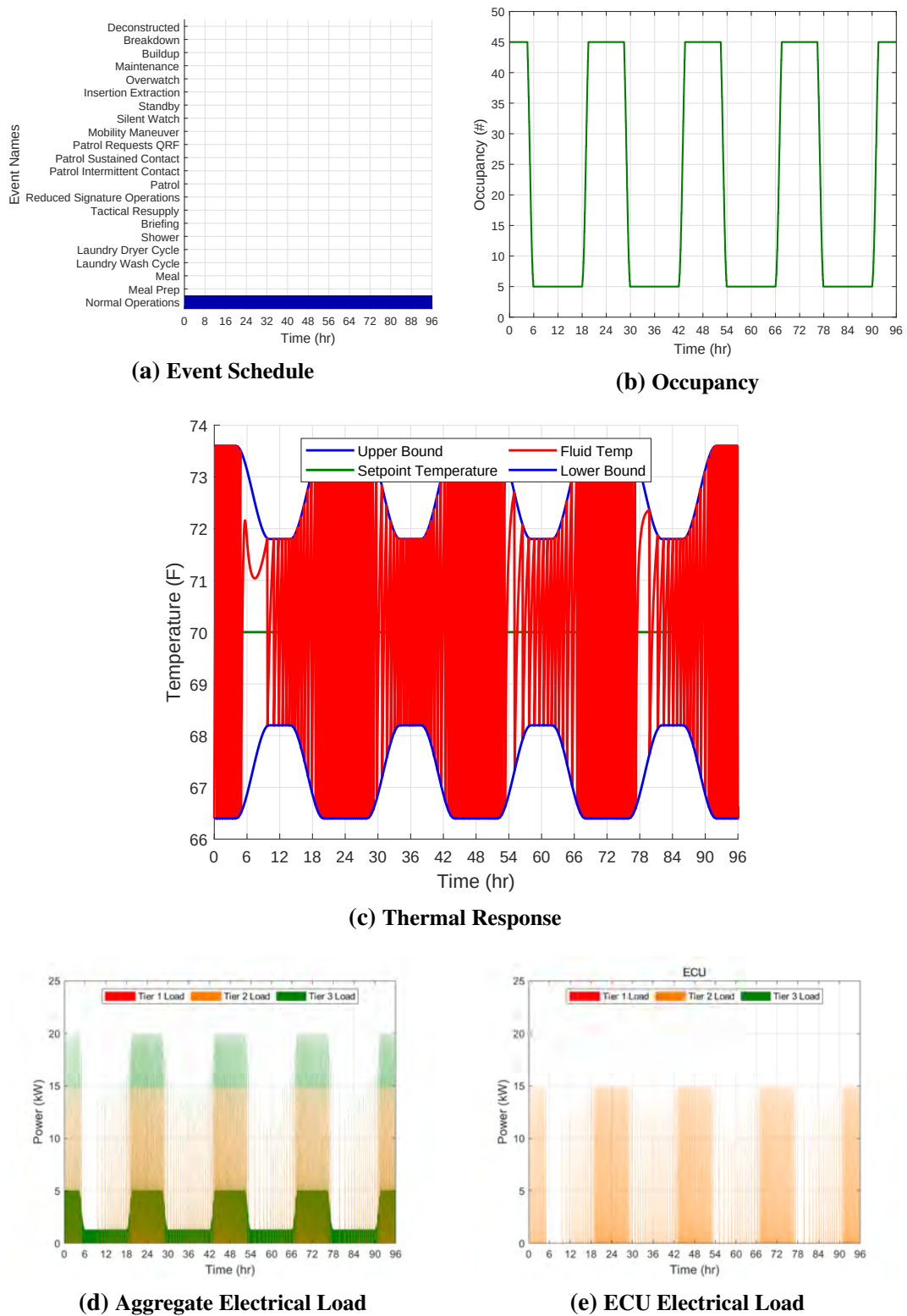
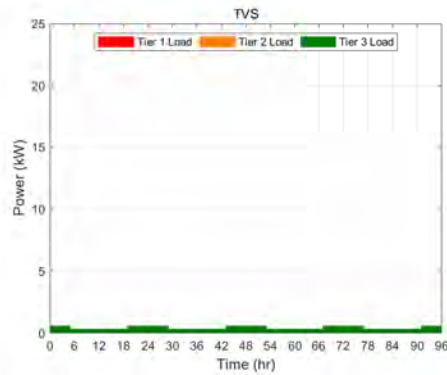
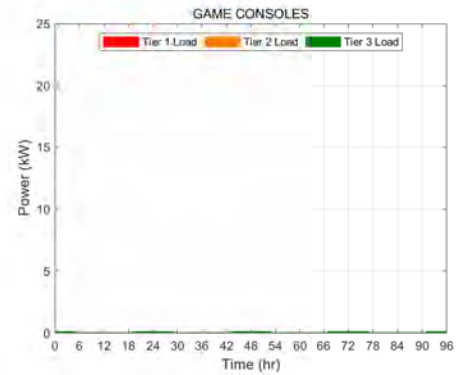


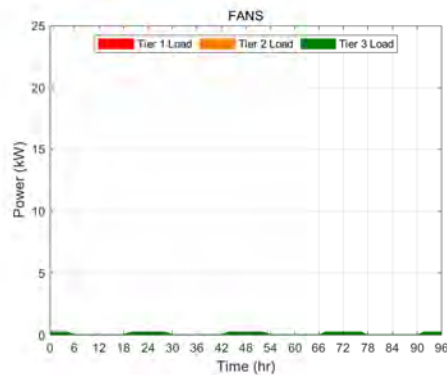
Fig. B-21 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



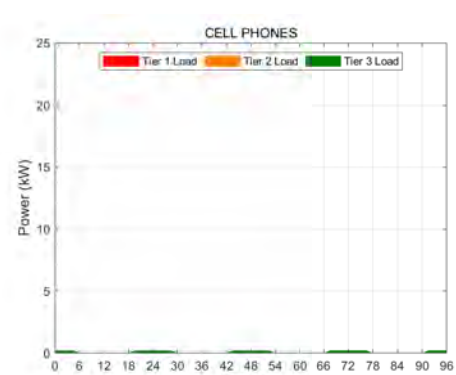
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-22 The electrical components housed within the military shelter

B.12 Enlisted Billeting L

The shelter labeled as enlisted billeting L houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-23a), the time-varying occupancy (Fig. B-23b), the resulting thermal response (Fig. B-23c), aggregate electrical load (Fig. B-23d), and the ECU electrical load (Fig. B-23e) are provided in Fig. B-23.

The shelter labeled as enlisted billeting L contains six separate electrical components including 1) televisions (Fig. B-24a), 2) game consoles (Fig. B-24b), 3) fans (Fig. B-24c), 4) shop lights (Fig. B-24d), 5) laptop computers (Fig. B-24e), and 6) cell phones (Fig. B-24f), all of which is shown in Fig. B-24.

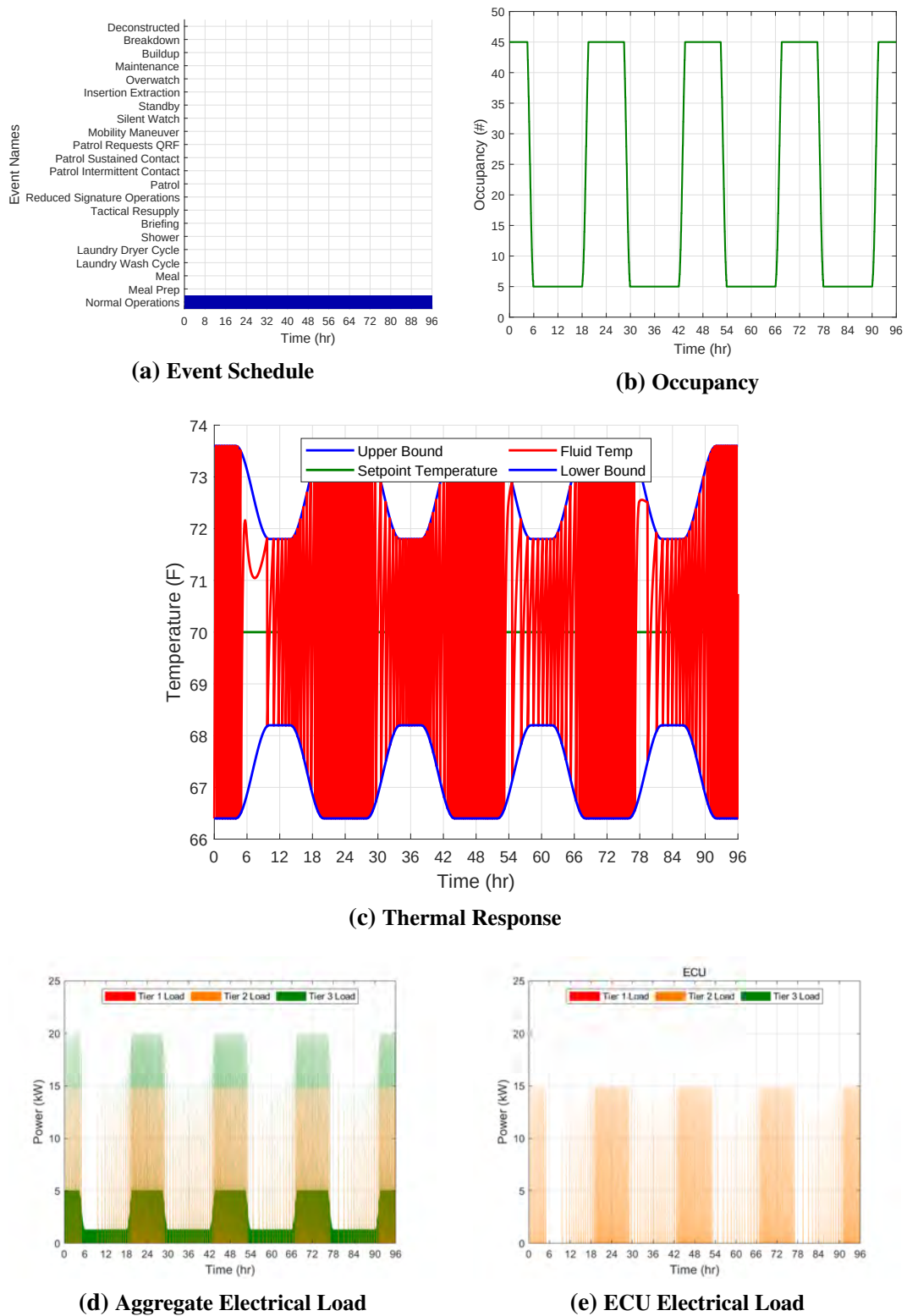
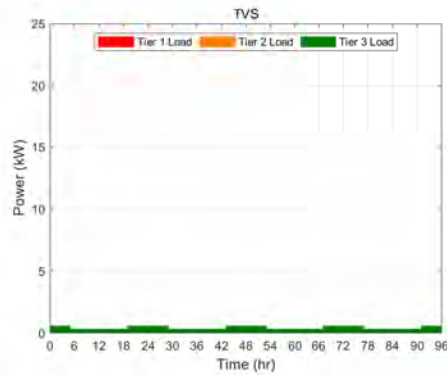
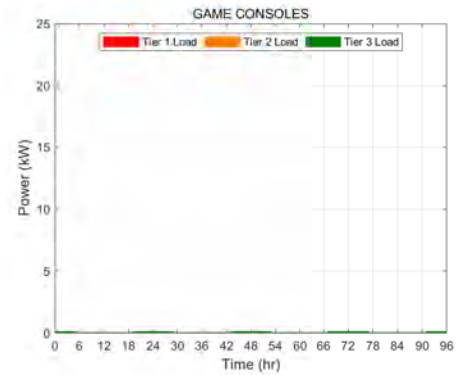


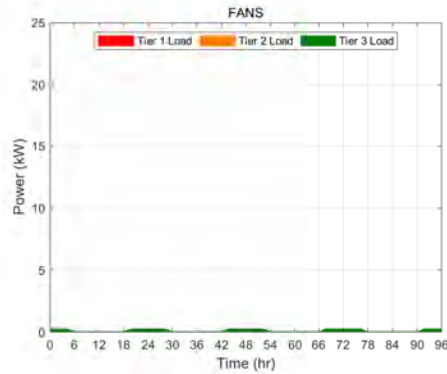
Fig. B-23 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



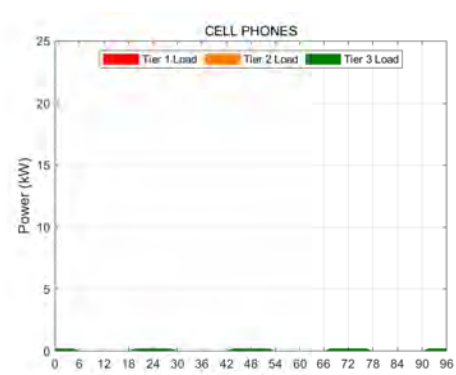
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-24 The electrical components housed within the military shelter

B.13 Enlisted Billeting M

The shelter labeled as enlisted billeting M houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-25a), the time-varying occupancy (Fig. B-25b), the resulting thermal response (Fig. B-25c), aggregate electrical load (Fig. B-25d), and the ECU electrical load (Fig. B-25e) are provided in Fig. B-25.

The shelter labeled as enlisted billeting M contains six separate electrical components including 1) televisions (Fig. B-26a), 2) game consoles (Fig. B-26b), 3) fans (Fig. B-26c), 4) shop lights (Fig. B-26d), 5) laptop computers (Fig. B-26e), and 6) cell phones (Fig. B-26f), all of which is shown in Fig. B-26.

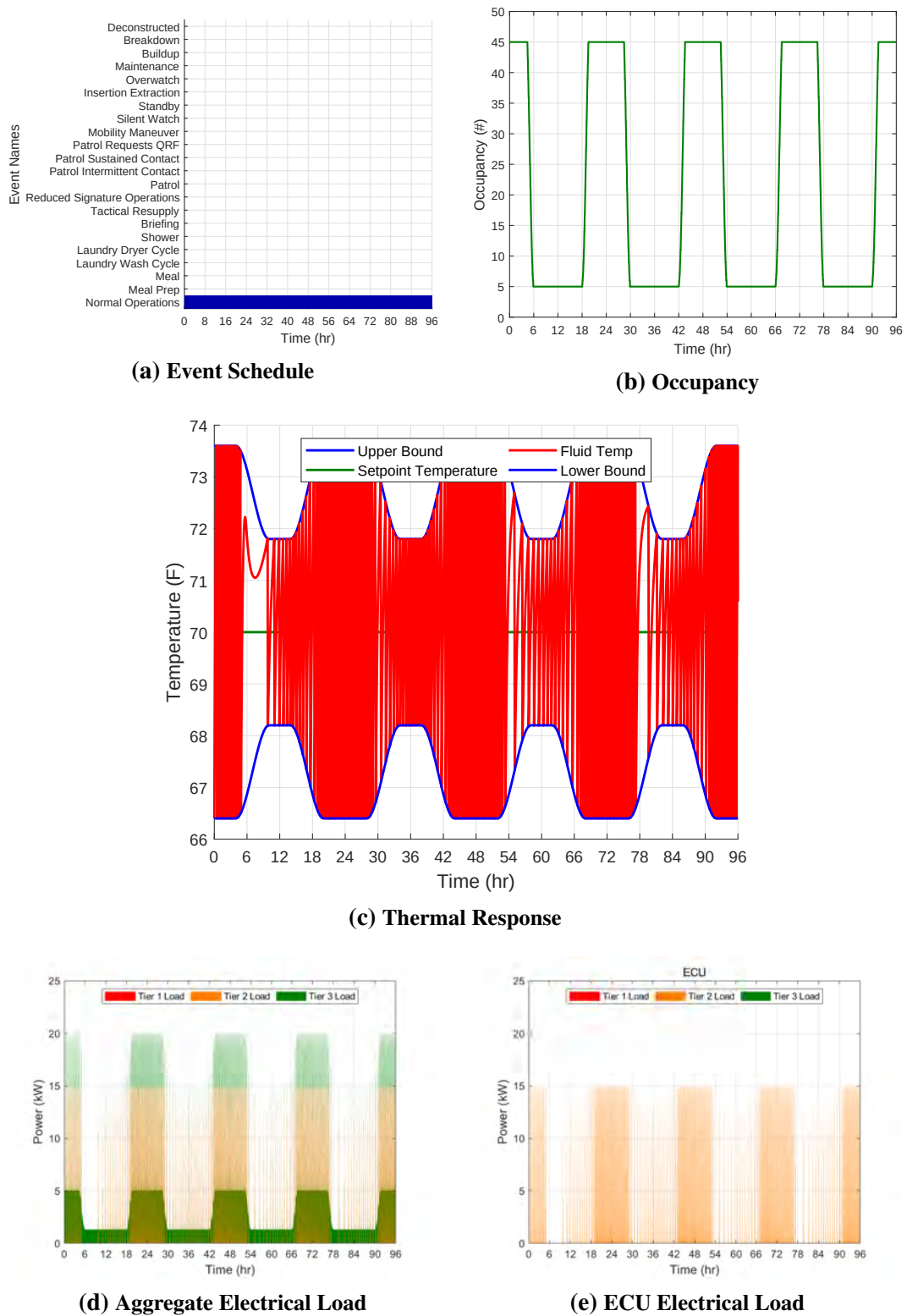
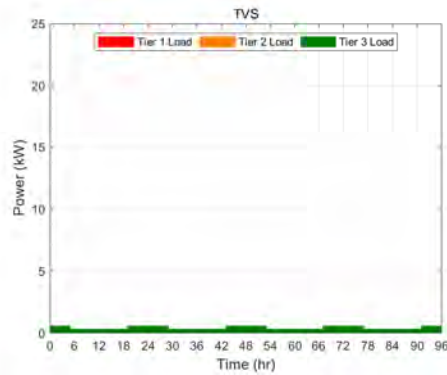
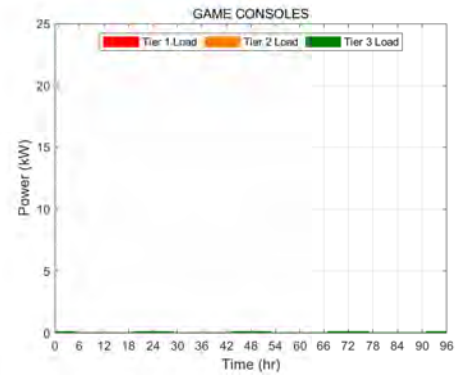


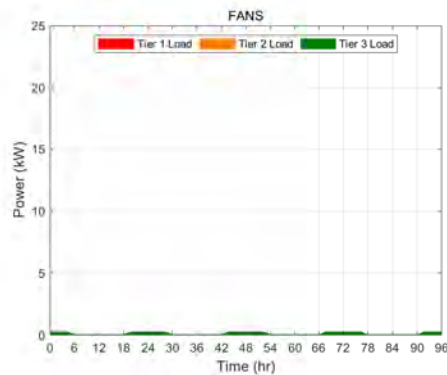
Fig. B-25 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



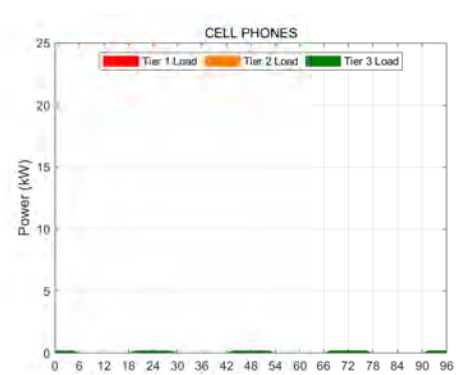
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-26 The electrical components housed within the military shelter

B.14 Enlisted Billeting N

The shelter labeled as enlisted billeting N houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-27a), the time-varying occupancy (Fig. B-27b), the resulting thermal response (Fig. B-27c), aggregate electrical load (Fig. B-27d), and the ECU electrical load (Fig. B-27e) are provided in Fig. B-27.

The shelter labeled as enlisted billeting N contains six separate electrical components including 1) televisions (Fig. B-28a), 2) game consoles (Fig. B-28b), 3) fans (Fig. B-28c), 4) shop lights (Fig. B-28d), 5) laptop computers (Fig. B-28e), and 6) cell phones (Fig. B-28f), all of which is shown in Fig. B-28.

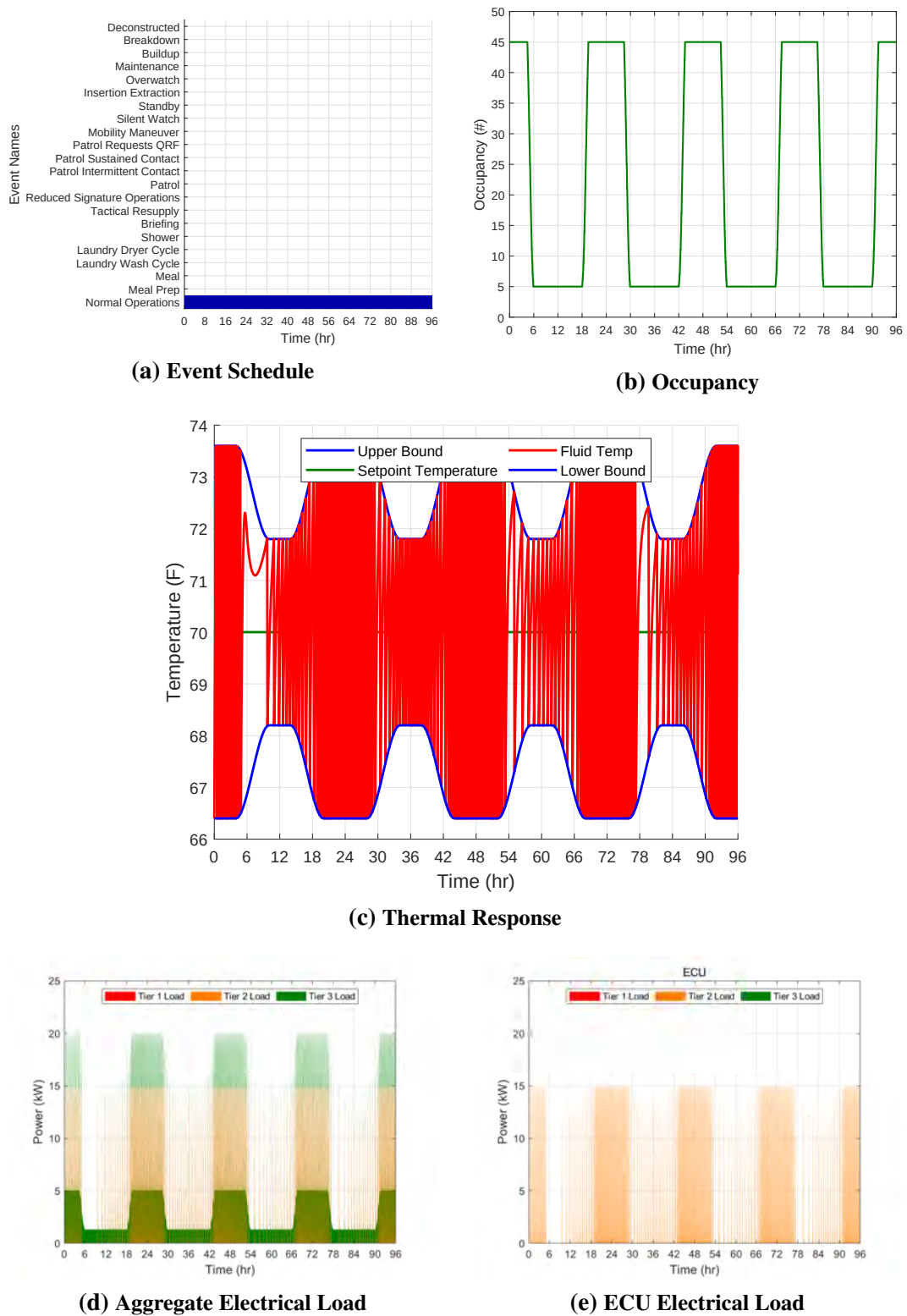
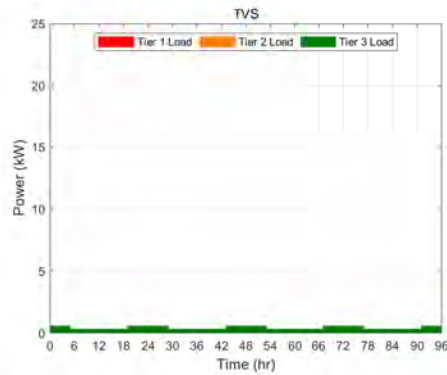
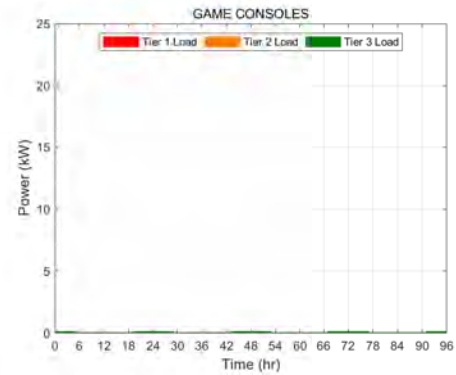


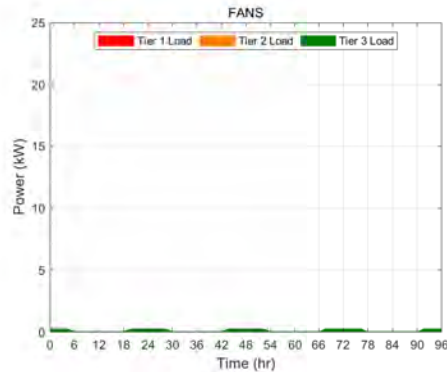
Fig. B-27 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



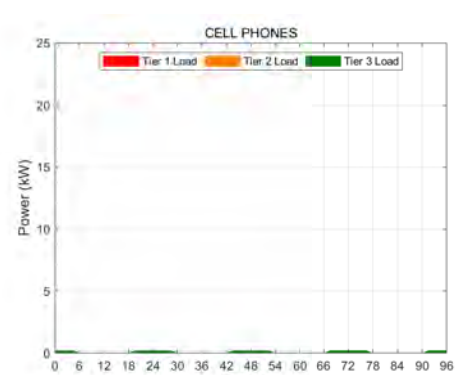
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-28 The electrical components housed within the military shelter

B.15 Enlisted Billeting O

The shelter labeled as enlisted billeting O houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-29a), the time-varying occupancy (Fig. B-29b), the resulting thermal response (Fig. B-29c), aggregate electrical load (Fig. B-29d), and the ECU electrical load (Fig. B-29e) are provided in Fig. B-29.

The shelter labeled as enlisted billeting O contains six separate electrical components including 1) televisions (Fig. B-30a), 2) game consoles (Fig. B-30b), 3) fans (Fig. B-30c), 4) shop lights (Fig. B-30d), 5) laptop computers (Fig. B-30e), and 6) cell phones (Fig. B-30f), all of which is shown in Fig. B-30.

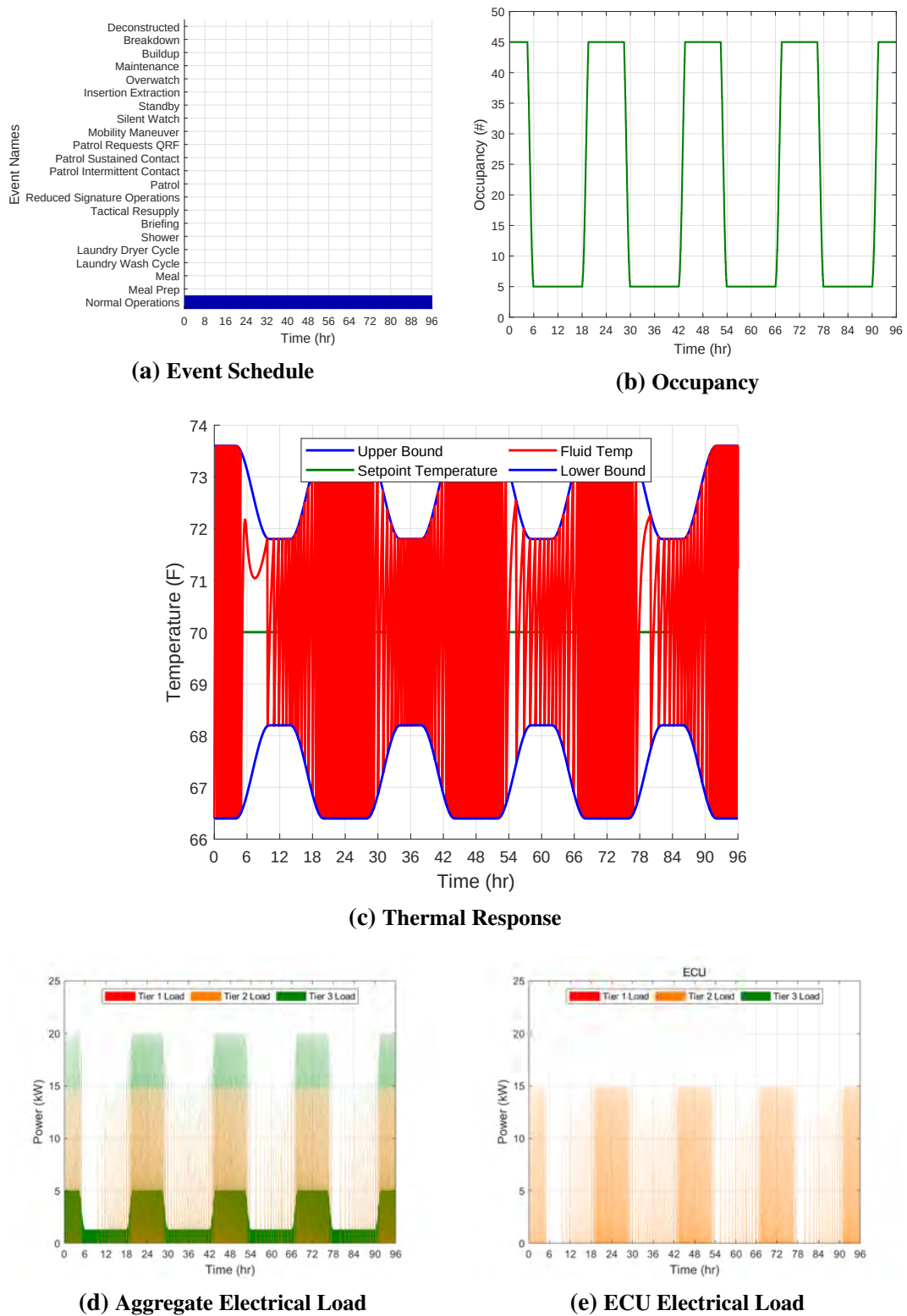
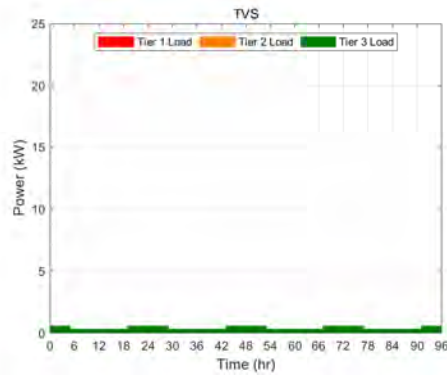
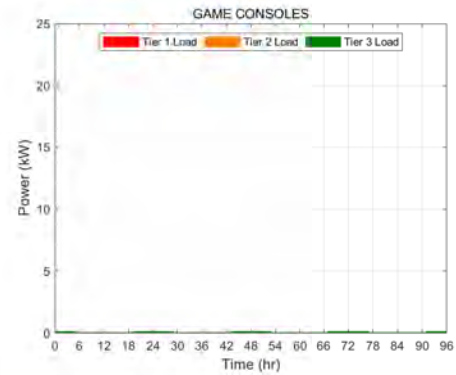


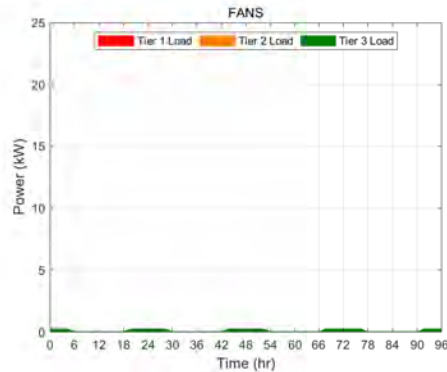
Fig. B-29 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



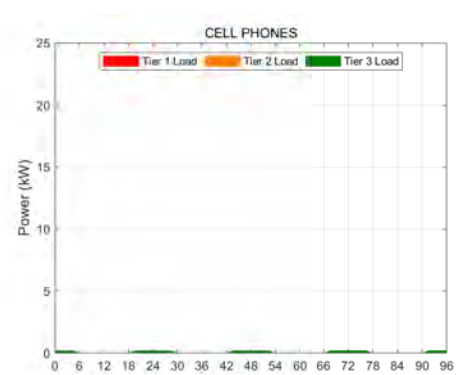
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-30 The electrical components housed within the military shelter

B.16 Enlisted Billeting P

The shelter labeled as enlisted billeting P houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-31a), the time-varying occupancy (Fig. B-31b), the resulting thermal response (Fig. B-31c), aggregate electrical load (Fig. B-31d), and the ECU electrical load (Fig. B-31e) are provided in Fig. B-31.

The shelter labeled as enlisted billeting P contains six separate electrical components including 1) televisions (Fig. B-32a), 2) game consoles (Fig. B-32b), 3) fans (Fig. B-32c), 4) shop lights (Fig. B-32d), 5) laptop computers (Fig. B-32e), and 6) cell phones (Fig. B-32f), all of which is shown in Fig. B-32.

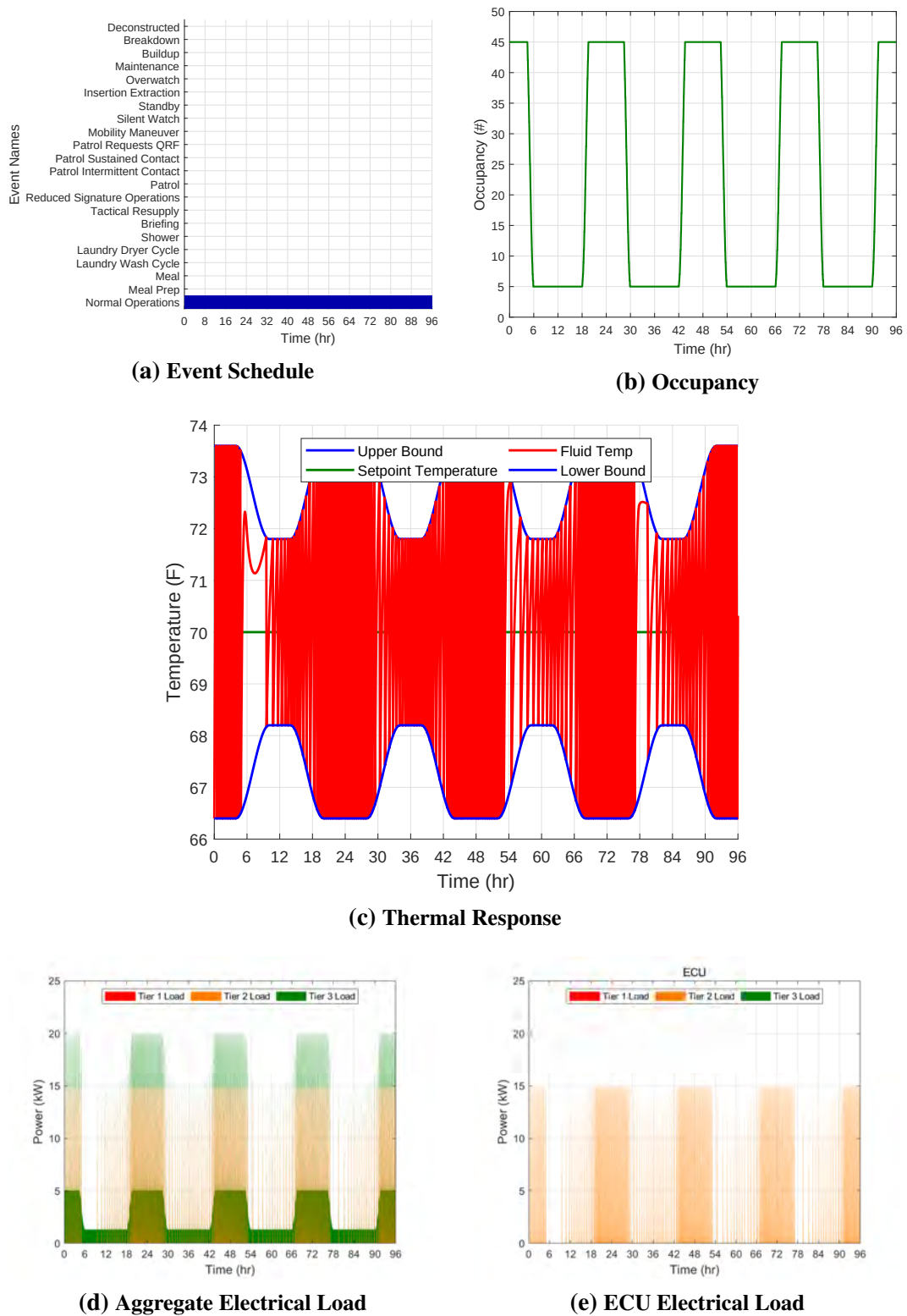
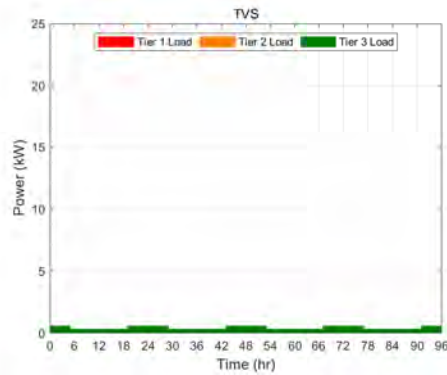
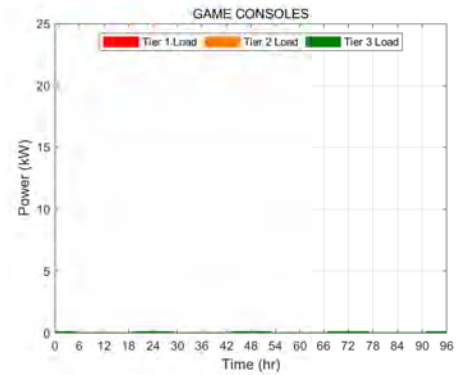


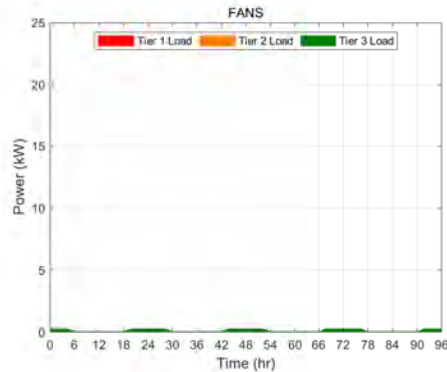
Fig. B-31 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



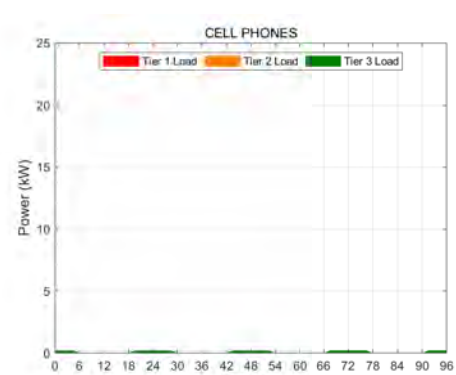
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-32 The electrical components housed within the military shelter

B.17 Enlisted Billeting Q

The shelter labeled as enlisted billeting Q houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-33a), the time-varying occupancy (Fig. B-33b), the resulting thermal response (Fig. B-33c), aggregate electrical load (Fig. B-33d), and the ECU electrical load (Fig. B-33e) are provided in Fig. B-33.

The shelter labeled as enlisted billeting Q contains six separate electrical components including 1) televisions (Fig. B-34a), 2) game consoles (Fig. B-34b), 3) fans (Fig. B-34c), 4) shop lights (Fig. B-34d), 5) laptop computers (Fig. B-34e), and 6) cell phones (Fig. B-34f), all of which is shown in Fig. B-34.

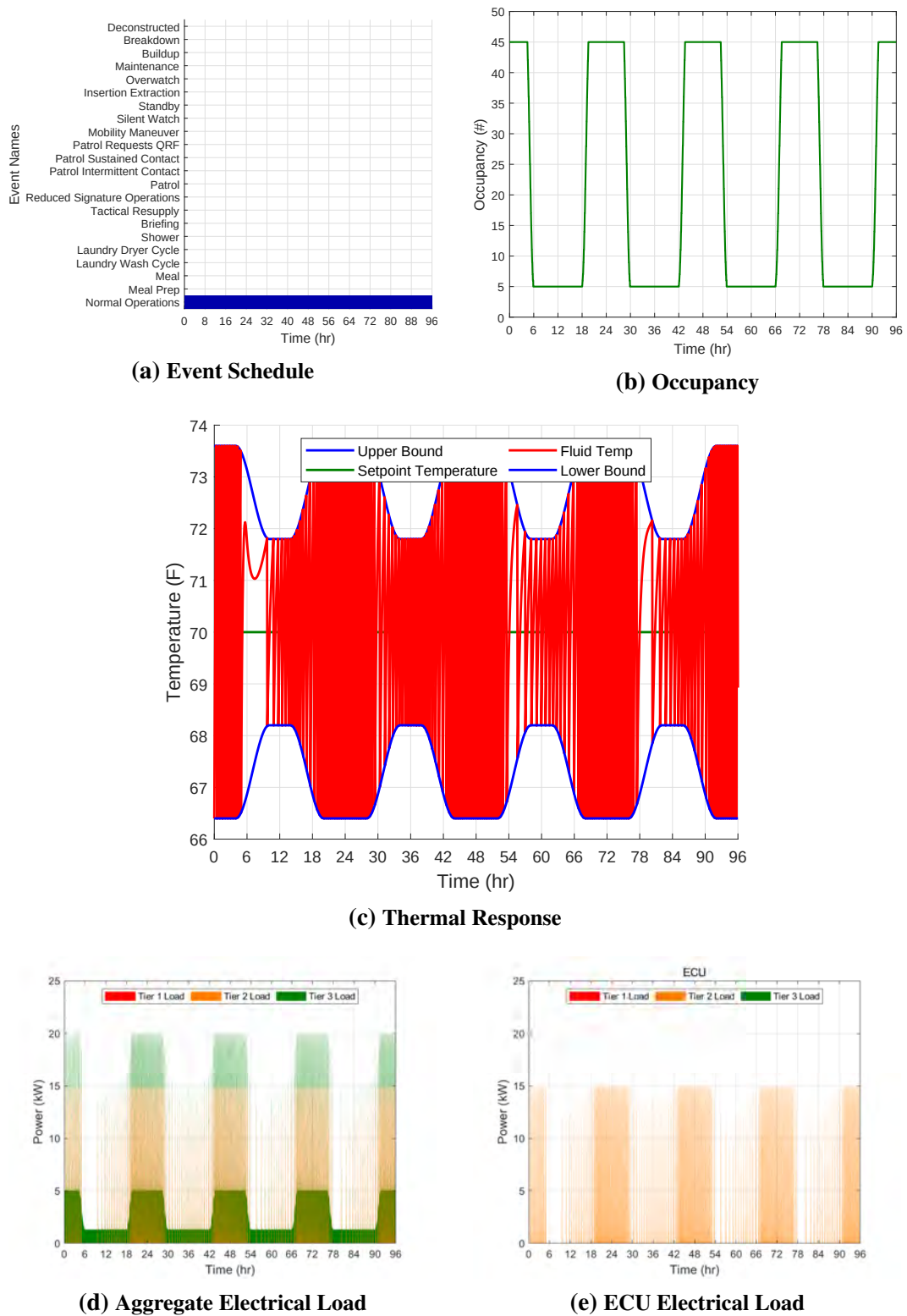
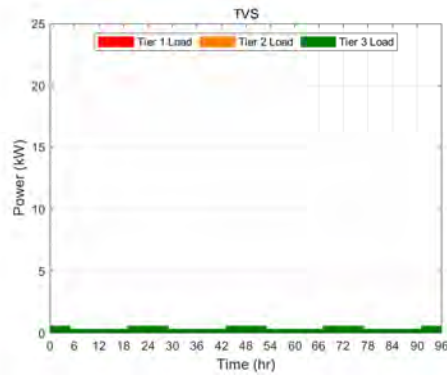
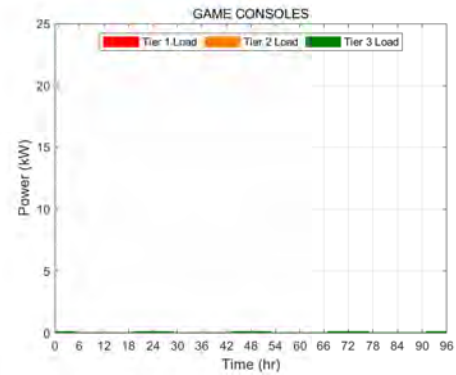


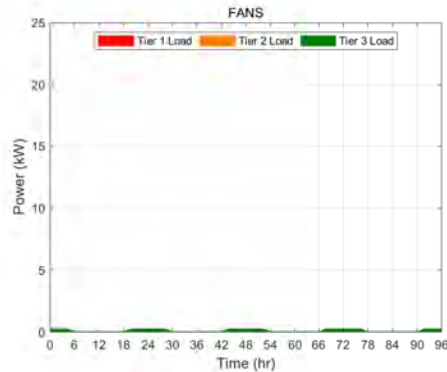
Fig. B-33 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



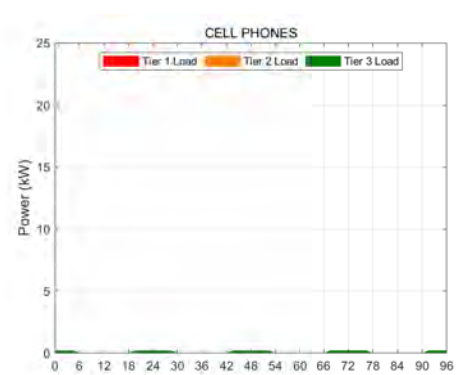
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-34 The electrical components housed within the military shelter

B.18 Enlisted Billeting R

The shelter labeled as enlisted billeting R houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-35a), the time-varying occupancy (Fig. B-35b), the resulting thermal response (Fig. B-35c), aggregate electrical load (Fig. B-35d), and the ECU electrical load (Fig. B-35e) are provided in Fig. B-35.

The shelter labeled as enlisted billeting R contains six separate electrical components including 1) televisions (Fig. B-36a), 2) game consoles (Fig. B-36b), 3) fans (Fig. B-36c), 4) shop lights (Fig. B-36d), 5) laptop computers (Fig. B-36e), and 6) cell phones (Fig. B-36f), all of which is shown in Fig. B-36.

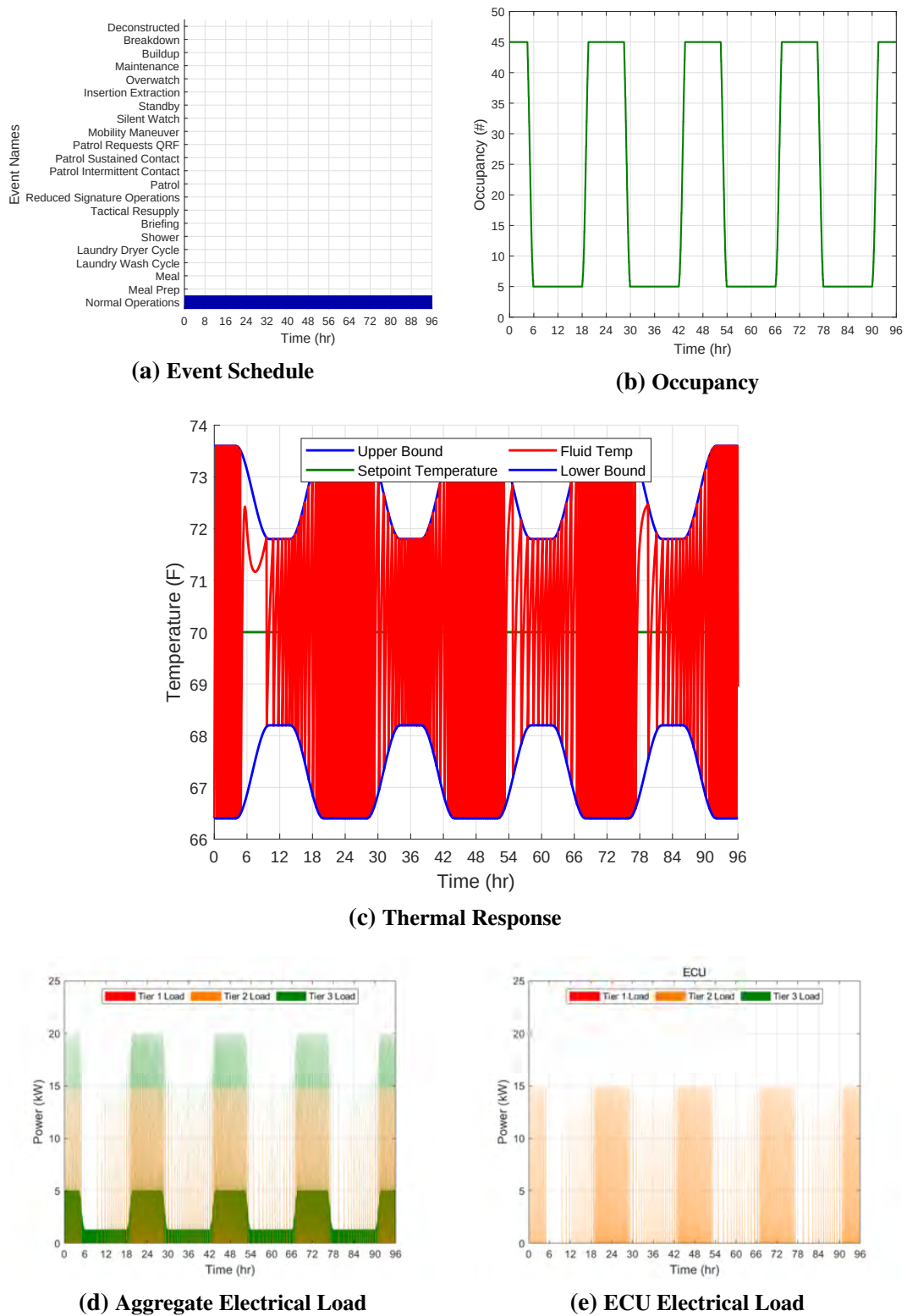
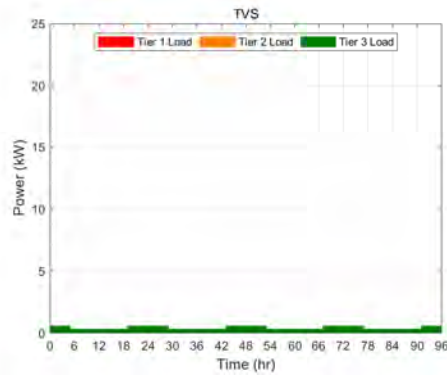
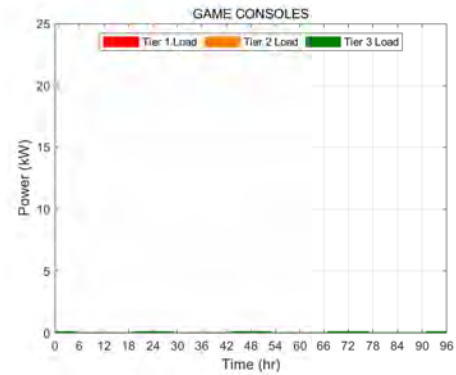


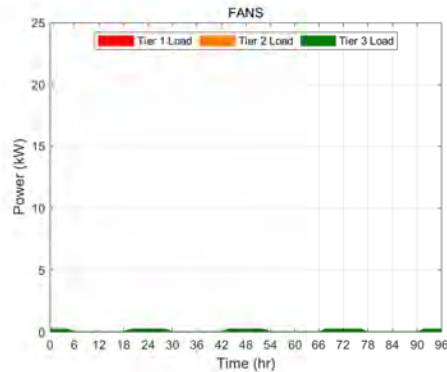
Fig. B-35 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



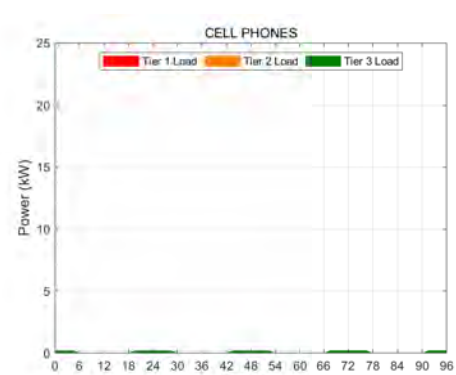
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-36 The electrical components housed within the military shelter

B.19 Enlisted Billeting S

The shelter labeled as enlisted billeting S houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-37a), the time-varying occupancy (Fig. B-37b), the resulting thermal response (Fig. B-37c), aggregate electrical load (Fig. B-37d), and the ECU electrical load (Fig. B-37e) are provided in Fig. B-37.

The shelter labeled as enlisted billeting S contains six separate electrical components including 1) televisions (Fig. B-38a), 2) game consoles (Fig. B-38b), 3) fans (Fig. B-38c), 4) shop lights (Fig. B-38d), 5) laptop computers (Fig. B-38e), and 6) cell phones (Fig. B-38f), all of which is shown in Fig. B-38.

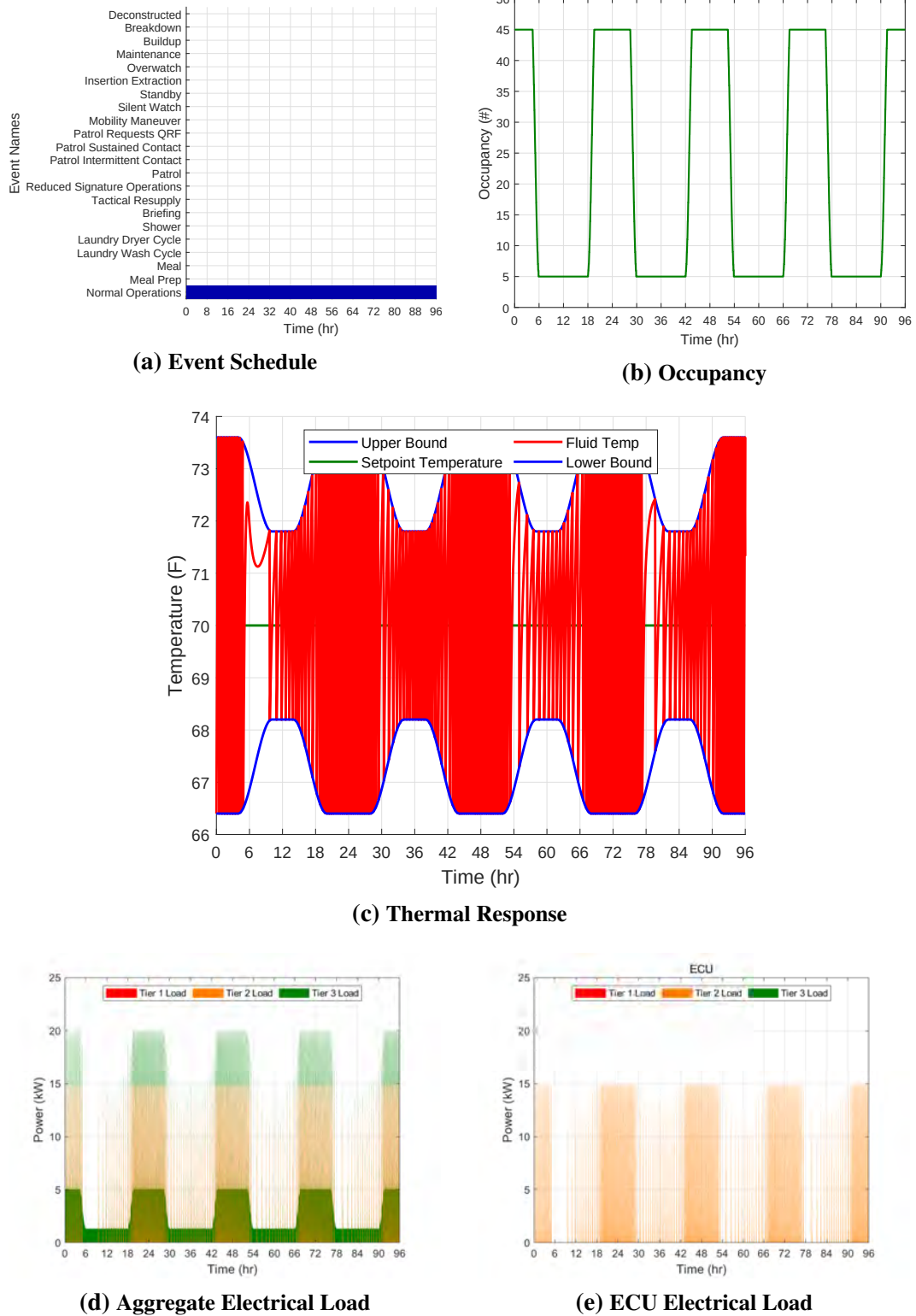
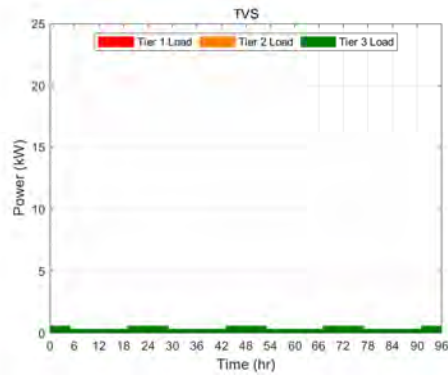
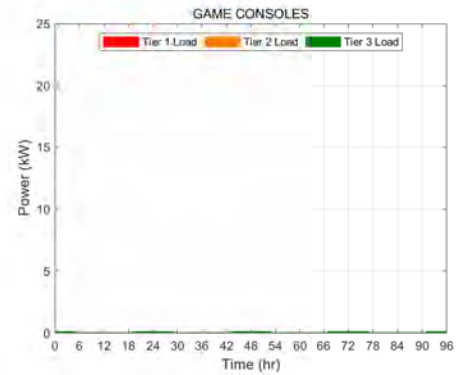


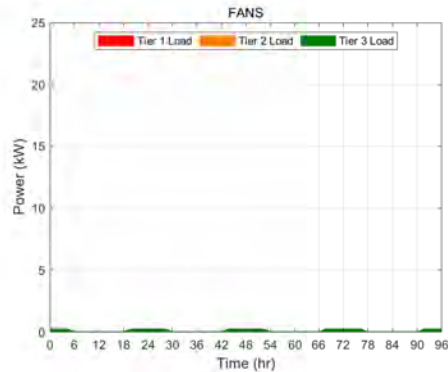
Fig. B-37 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



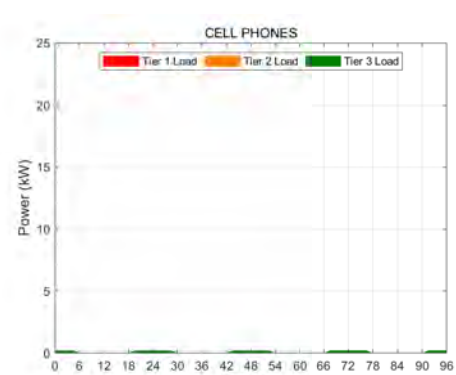
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-38 The electrical components housed within the military shelter

B.20 Enlisted Billeting T

The shelter labeled as enlisted billeting T houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occu-

pancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-39a), the time-varying occupancy (Fig. B-39b), the resulting thermal response (Fig. B-39c), aggregate electrical load (Fig. B-39d), and the ECU electrical load (Fig. B-39e) are provided in Fig. B-39.

The shelter labeled as enlisted billeting T contains six separate electrical components including 1) televisions (Fig. B-40a), 2) game consoles (Fig. B-40b), 3) fans (Fig. B-40c), 4) shop lights (Fig. B-40d), 5) laptop computers (Fig. B-40e), and 6) cell phones (Fig. B-40f), all of which is shown in Fig. B-40.

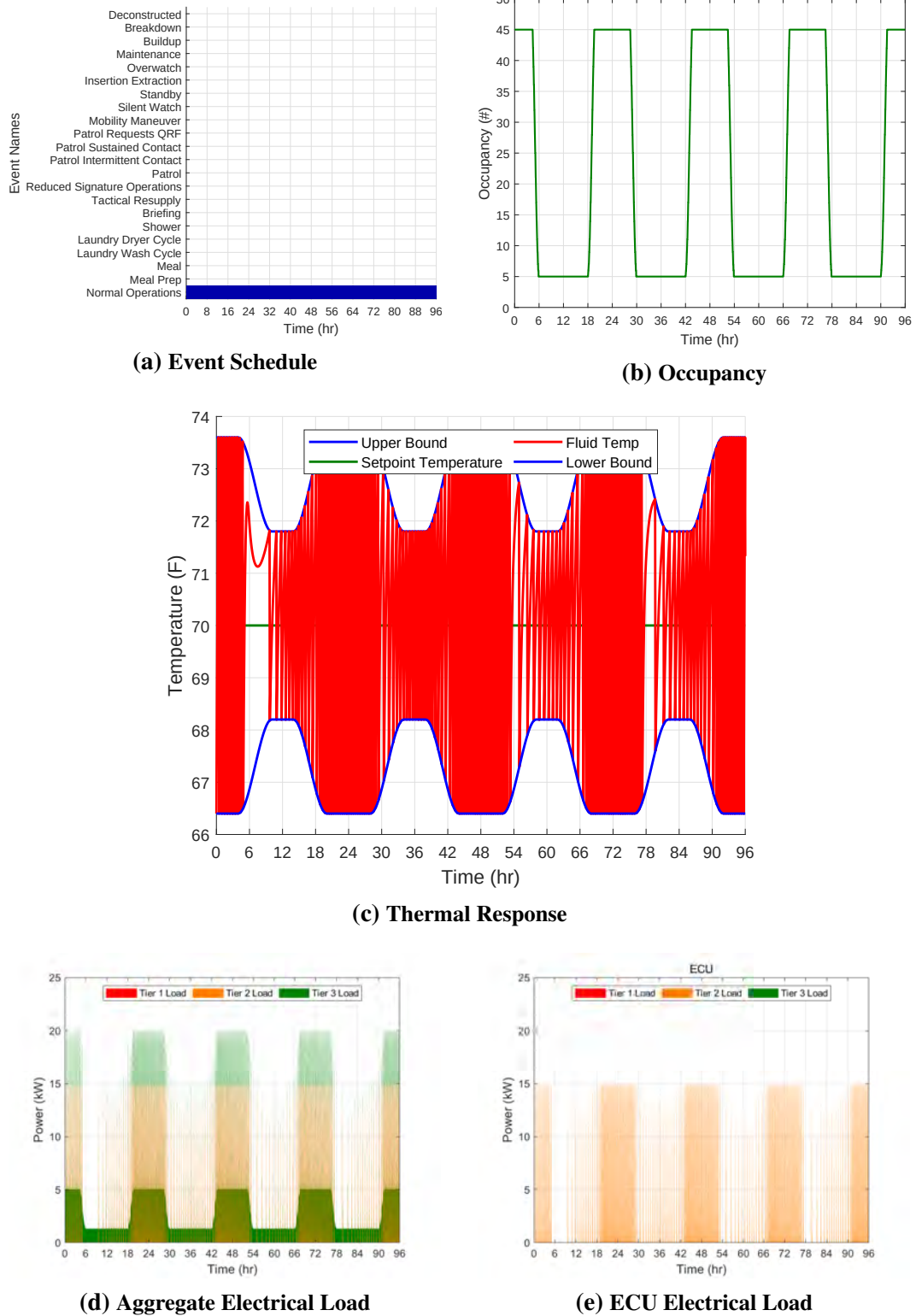
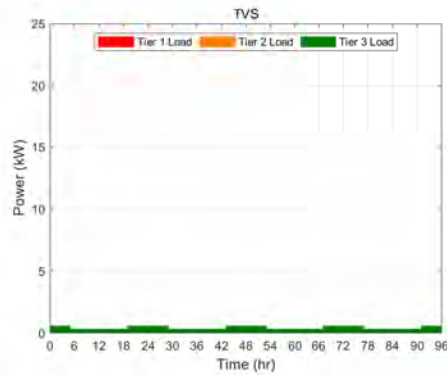
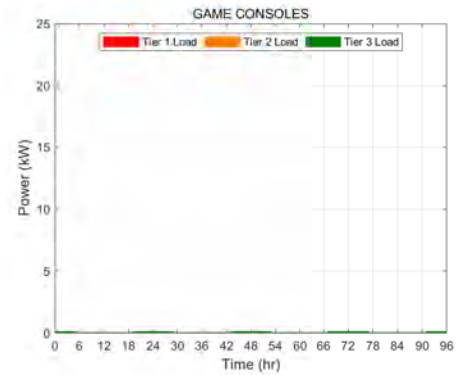


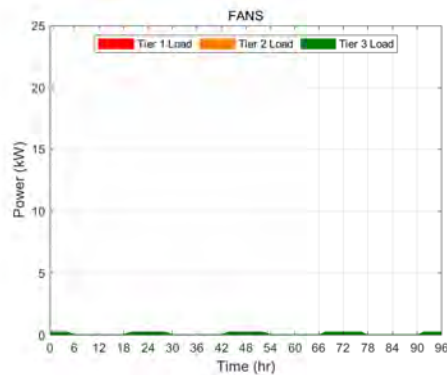
Fig. B-39 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



(b) Game Consoles Tiered Electrical Load



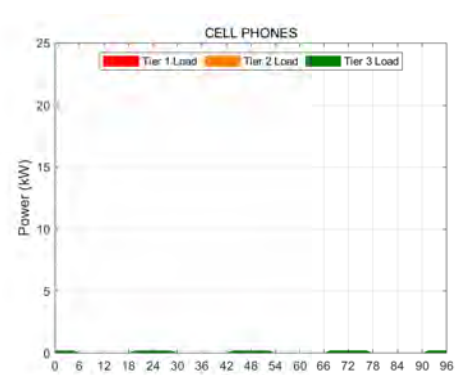
(c) Fans Tiered Electrical Load



(d) Shop Lights Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-40 The electrical components housed within the military shelter

B.21 Officer Billeting A

The shelter labeled as officer billeting A houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-41a), the time-varying occupancy (Fig. B-41b), the resulting thermal response (Fig. B-41c), aggregate electrical load (Fig. B-41d), and the ECU electrical load (Fig. B-41e) are provided in Fig. B-41.

The shelter labeled as officer billeting A contains five separate electrical components including 1) televisions (Fig. B-42a), 2) fans (Fig. B-42b), 3) shop lights (Fig. B-42c), 4) laptop computers (Fig. B-42d), and 5) cell phones (Fig. B-42e), all of which is shown in Fig. B-42.

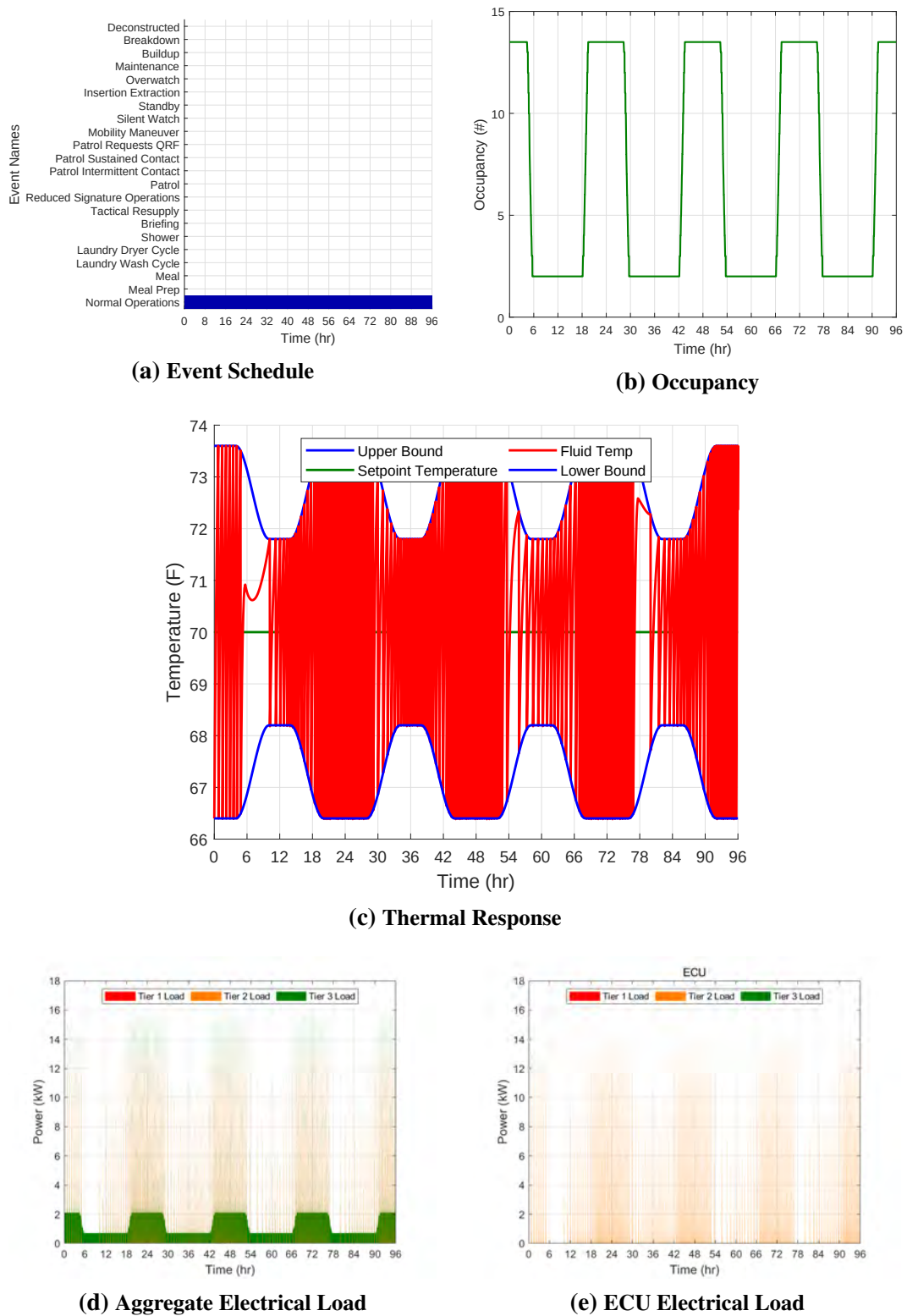
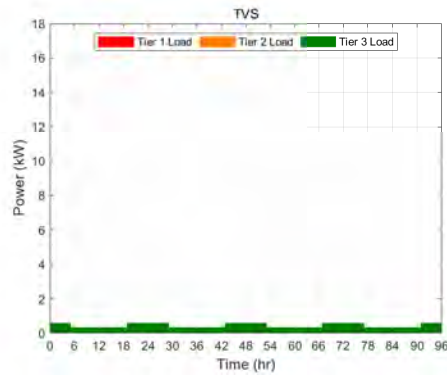
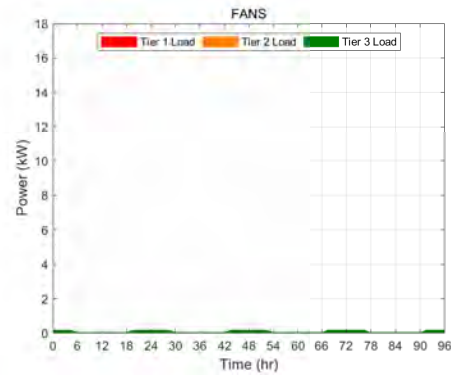


Fig. B-41 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



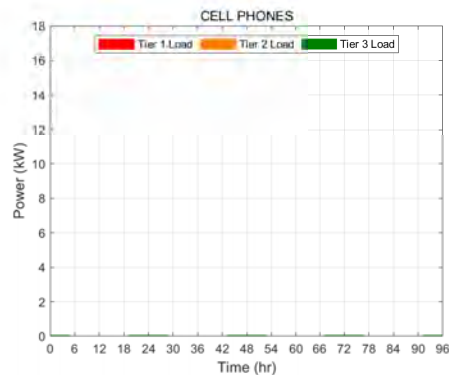
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-42 The electrical components housed within the military shelter

B.22 Officer Billeting B

The shelter labeled as officer billeting B houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-43a), the time-varying occupancy (Fig. B-43b), the resulting thermal response (Fig. B-43c), aggregate electrical load (Fig. B-43d), and the ECU electrical load (Fig. B-43e) are provided in Fig. B-43.

The shelter labeled as officer billeting B contains five separate electrical components including 1) televisions (Fig. B-44a), 2) fans (Fig. B-44b), 3) shop lights (Fig. B-44c), 4) laptop computers (Fig. B-44d), and 5) cell phones (Fig. B-44e), all of which is shown in Fig. B-44.

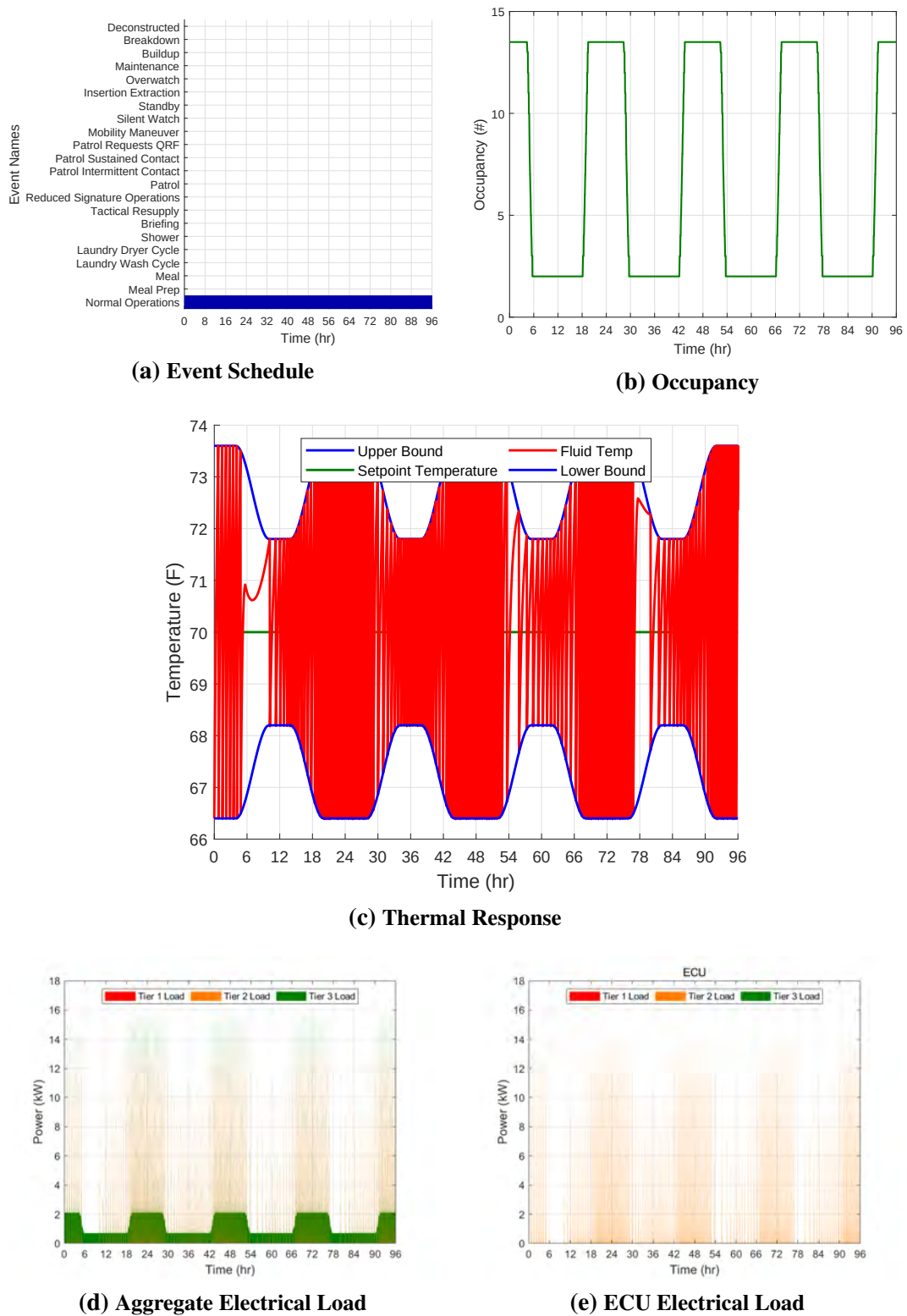
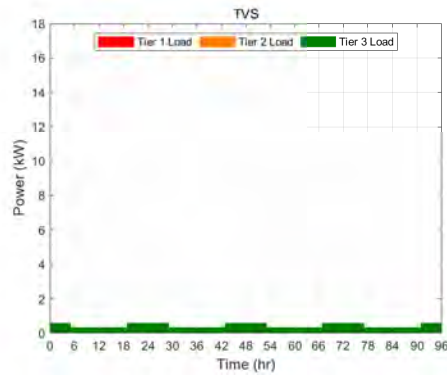
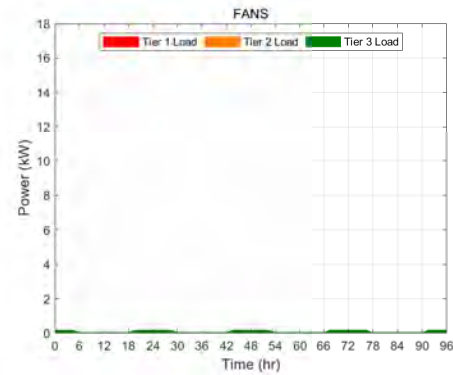


Fig. B-43 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



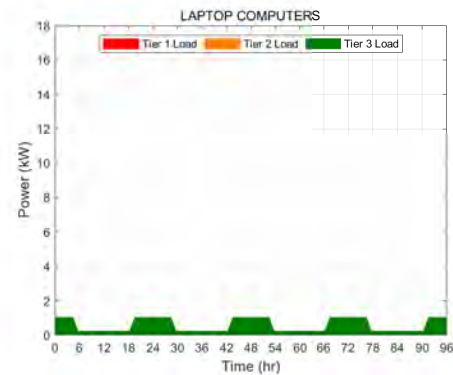
(a) Televisions Tiered Electrical Load



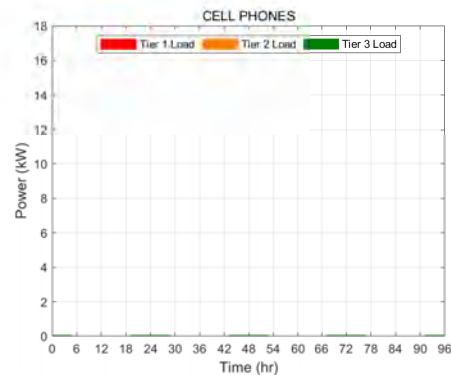
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-44 The electrical components housed within the military shelter

B.23 Officer Billeting C

The shelter labeled as officer billeting C houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-45a), the time-varying occupancy (Fig. B-45b), the resulting thermal response (Fig. B-45c), aggregate electrical load (Fig. B-45d), and the ECU electrical load (Fig. B-45e) are provided in Fig. B-45.

The shelter labeled as officer billeting C contains five separate electrical components including 1) televisions (Fig. B-46a), 2) fans (Fig. B-46b), 3) shop lights (Fig. B-46c), 4) laptop computers (Fig. B-46d), and 5) cell phones (Fig. B-46e), all of which is shown in Fig. B-46.

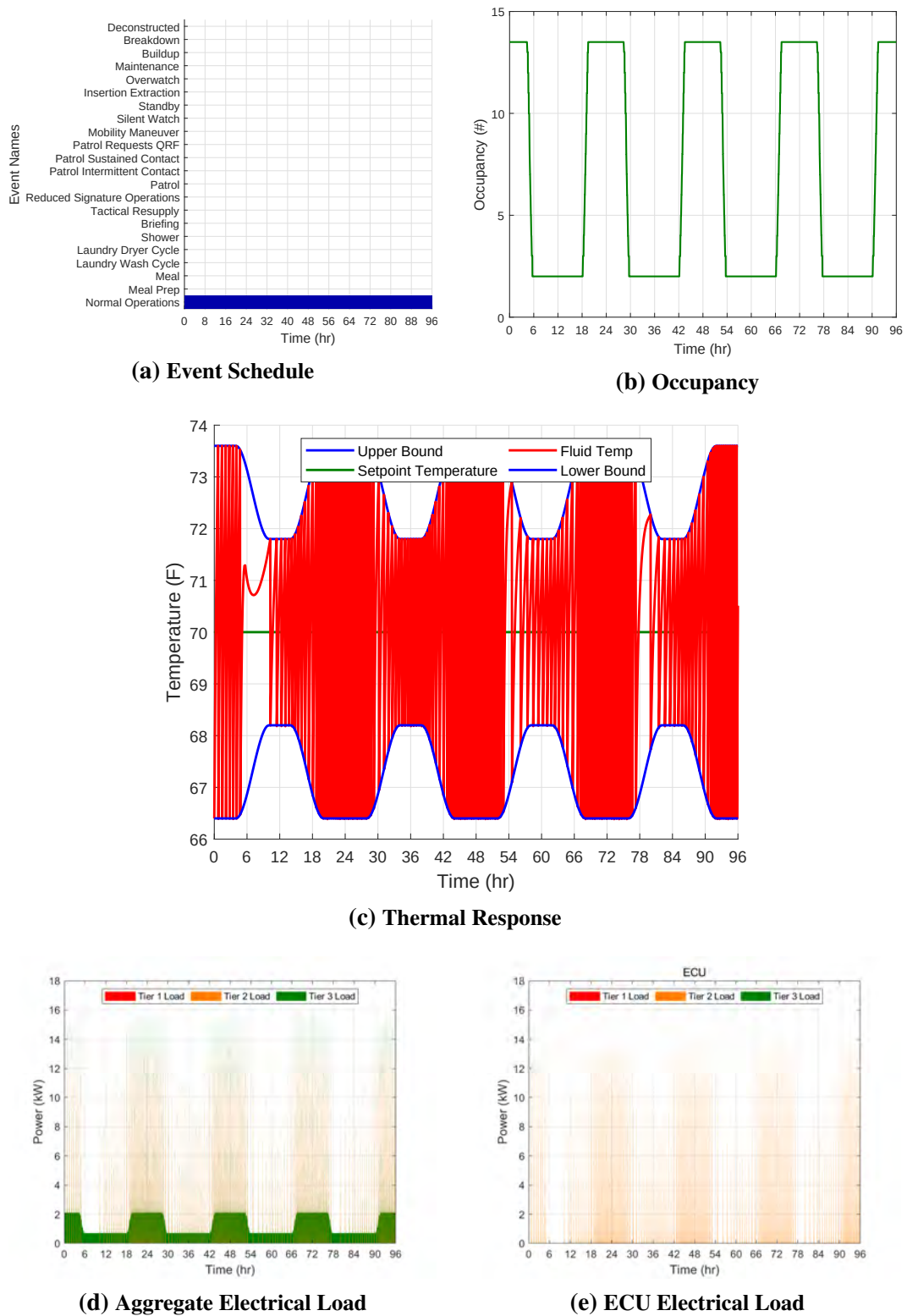
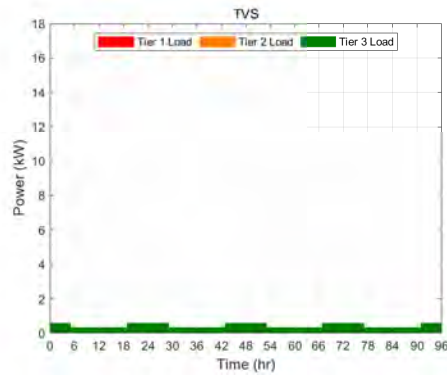
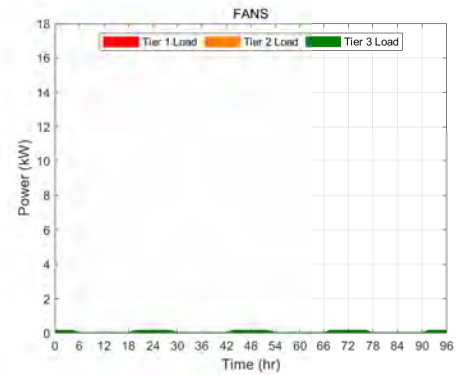


Fig. B-45 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



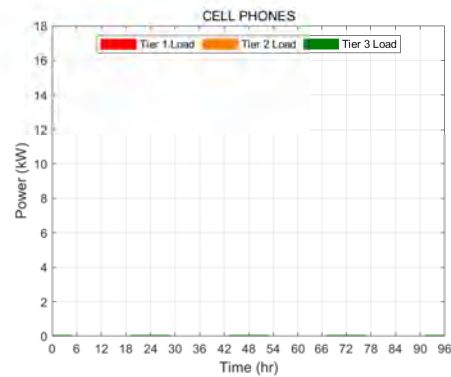
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-46 The electrical components housed within the military shelter

B.24 Officer Billeting D

The shelter labeled as officer billeting D houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-47a), the time-varying occupancy (Fig. B-47b), the resulting thermal response (Fig. B-47c), aggregate electrical load (Fig. B-47d), and the ECU electrical load (Fig. B-47e) are provided in Fig. B-47.

The shelter labeled as officer billeting D contains five separate electrical components including 1) televisions (Fig. B-48a), 2) fans (Fig. B-48b), 3) shop lights (Fig. B-48c), 4) laptop computers (Fig. B-48d), and 5) cell phones (Fig. B-48e), all of which is shown in Fig. B-48.

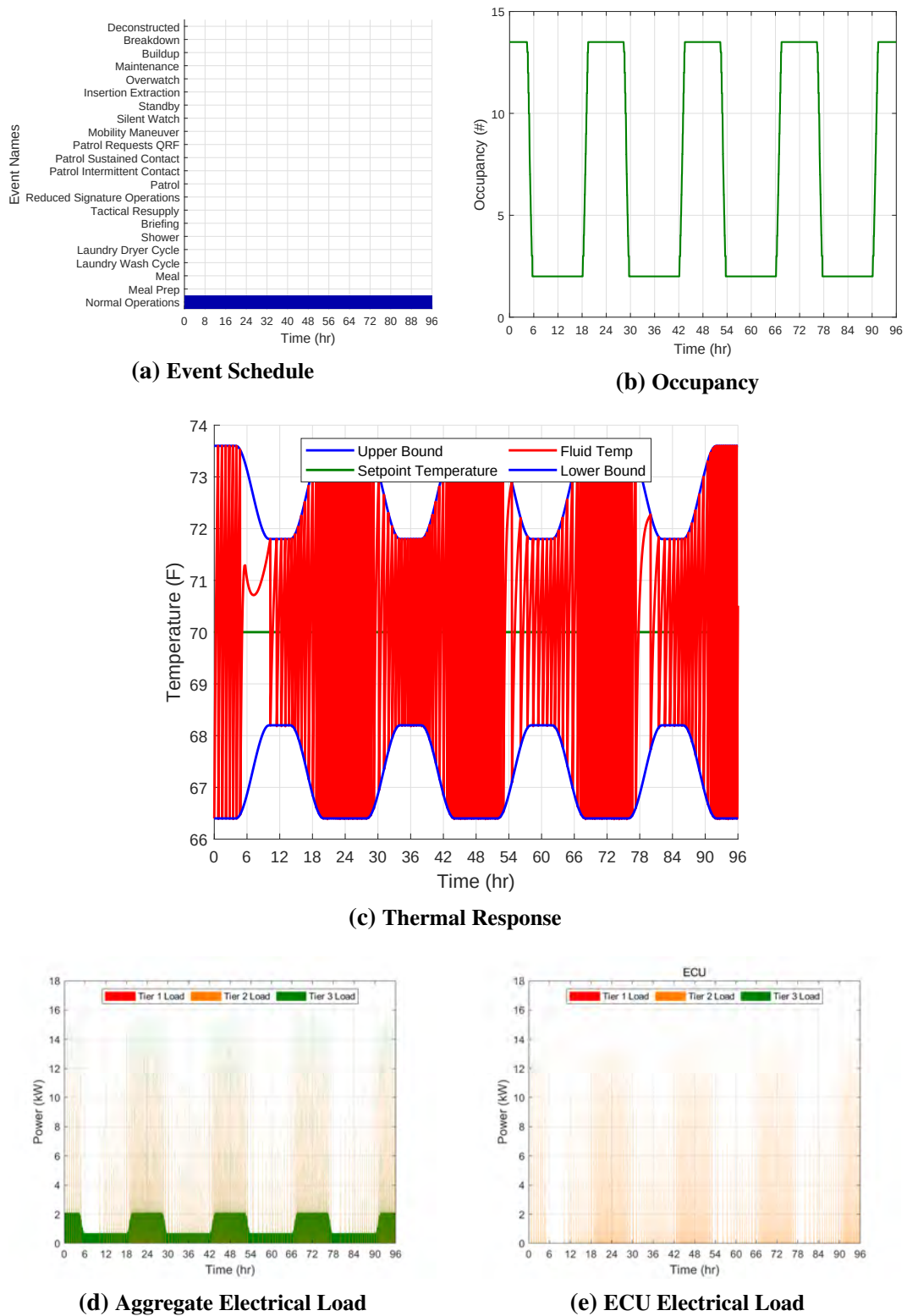
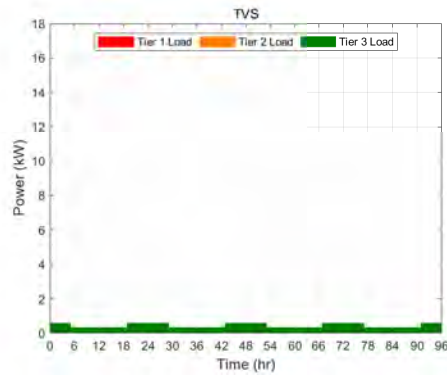
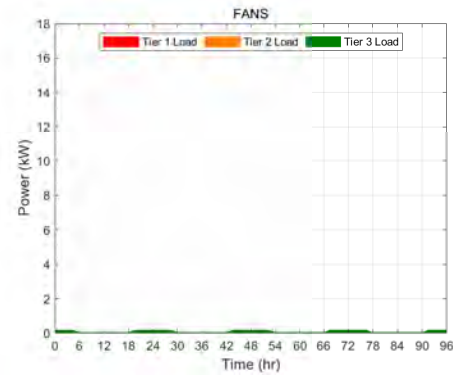


Fig. B-47 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



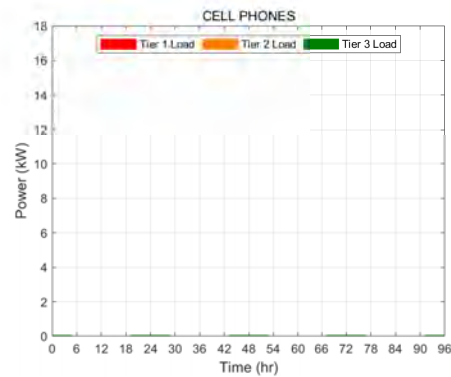
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-48 The electrical components housed within the military shelter

B.25 Officer Billeting E

The shelter labeled as officer billeting E houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-49a), the time-varying occupancy (Fig. B-49b), the resulting thermal response (Fig. B-49c), aggregate electrical load (Fig. B-49d), and the ECU electrical load (Fig. B-49e) are provided in Fig. B-49.

The shelter labeled as officer billeting E contains five separate electrical components including 1) televisions (Fig. B-50a), 2) fans (Fig. B-50b), 3) shop lights (Fig. B-50c), 4) laptop computers (Fig. B-50d), and 5) cell phones (Fig. B-50e), all of which is shown in Fig. B-50.

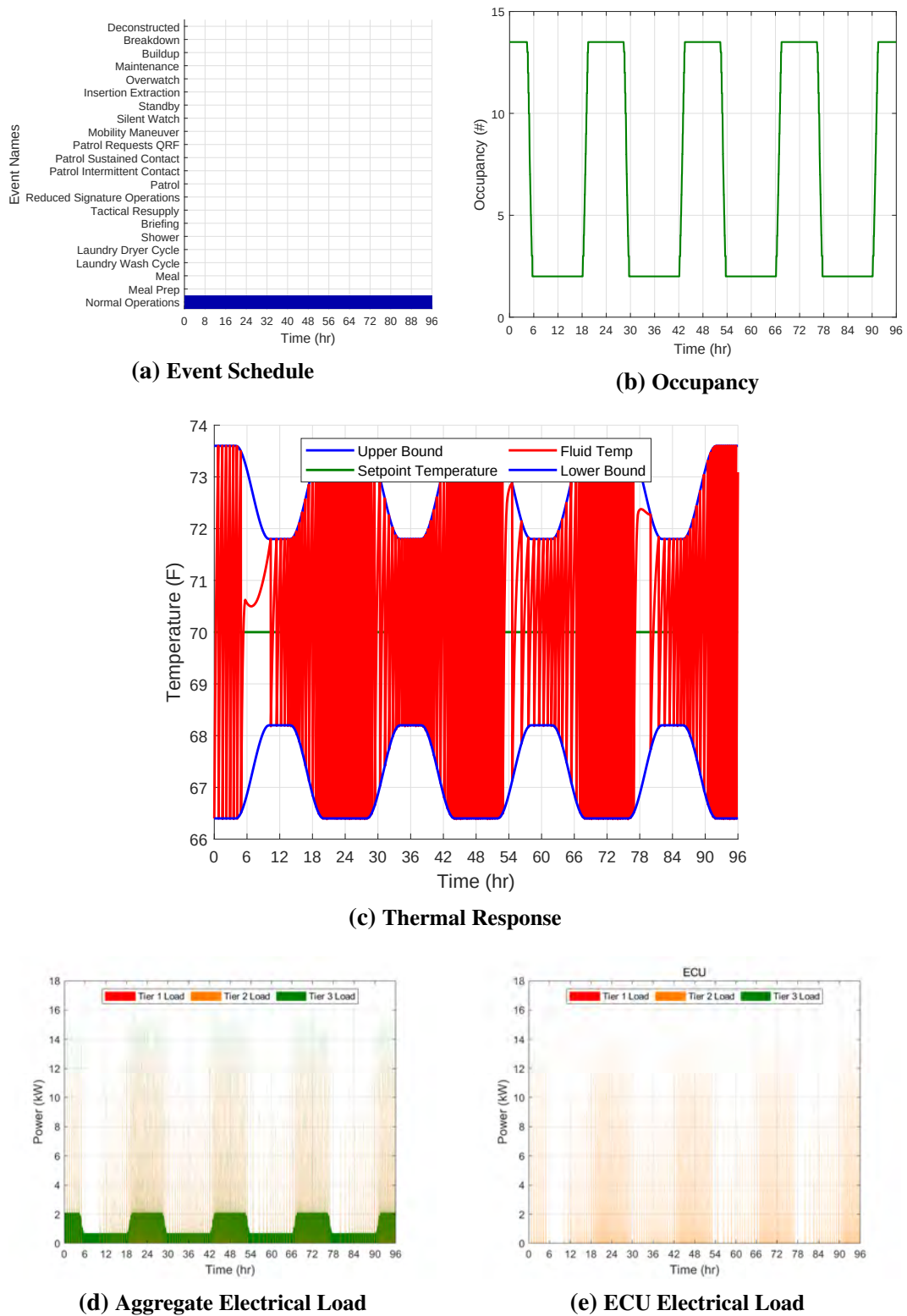
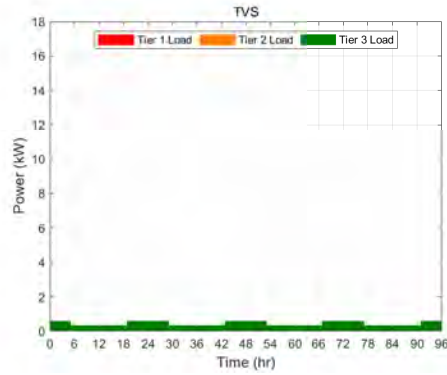
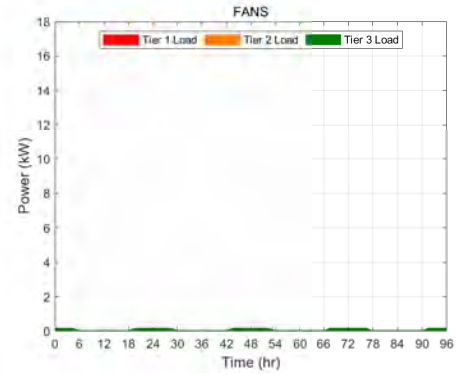


Fig. B-49 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



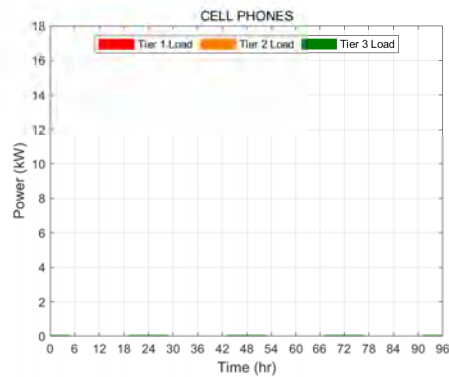
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-50 The electrical components housed within the military shelter

B.26 Officer Billeting F

The shelter labeled as officer billeting F houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-51a), the time-varying occupancy (Fig. B-51b), the resulting thermal response (Fig. B-51c), aggregate electrical load (Fig. B-51d), and the ECU electrical load (Fig. B-51e) are provided in Fig. B-51.

The shelter labeled as officer billeting F contains five separate electrical components including 1) televisions (Fig. B-52a), 2) fans (Fig. B-52b), 3) shop lights (Fig. B-52c), 4) laptop computers (Fig. B-52d), and 5) cell phones (Fig. B-52e), all of which is shown in Fig. B-52.

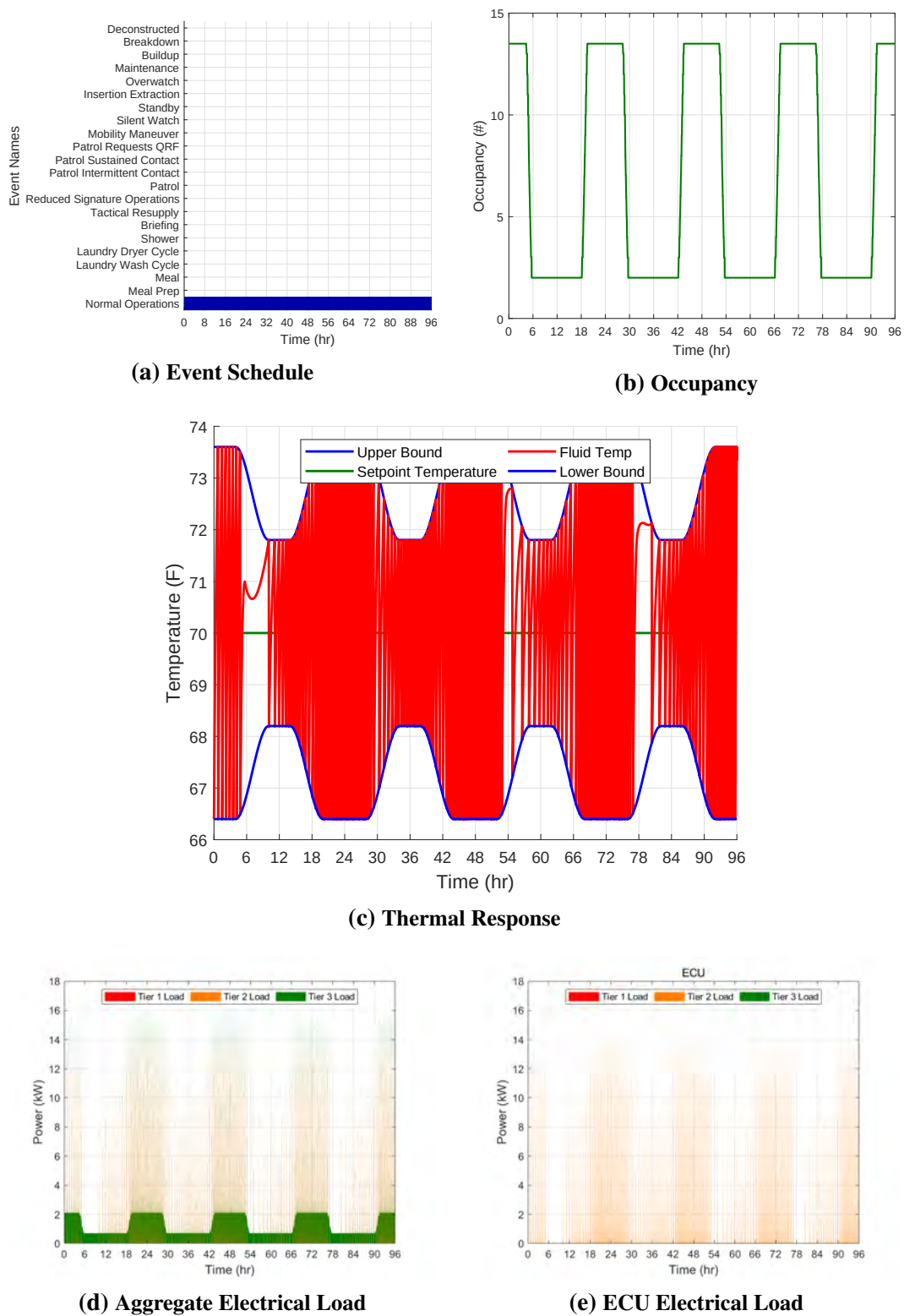
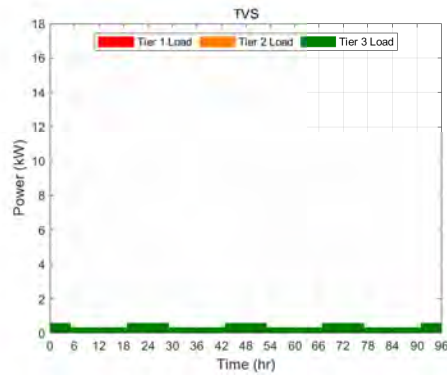
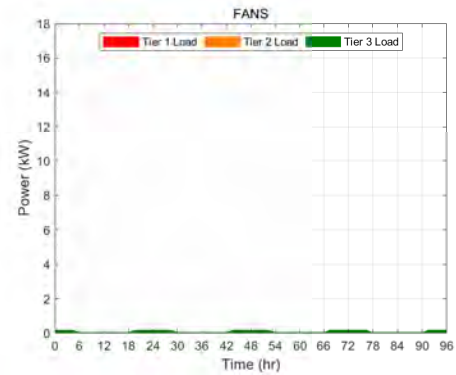


Fig. B-51 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



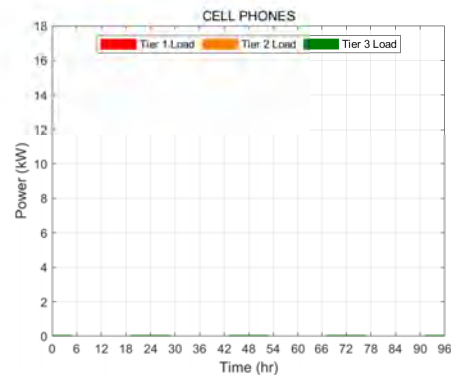
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-52 The electrical components housed within the military shelter

B.27 Officer Billeting G

The shelter labeled as officer billeting G houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-53a), the time-varying occupancy (Fig. B-53b), the resulting thermal response (Fig. B-53c), aggregate electrical load (Fig. B-53d), and the ECU electrical load (Fig. B-53e) are provided in Fig. B-53.

The shelter labeled as officer billeting G contains five separate electrical components including 1) televisions (Fig. B-54a), 2) fans (Fig. B-54b), 3) shop lights (Fig. B-54c), 4) laptop computers (Fig. B-54d), and 5) cell phones (Fig. B-54e), all of which is shown in Fig. B-54.

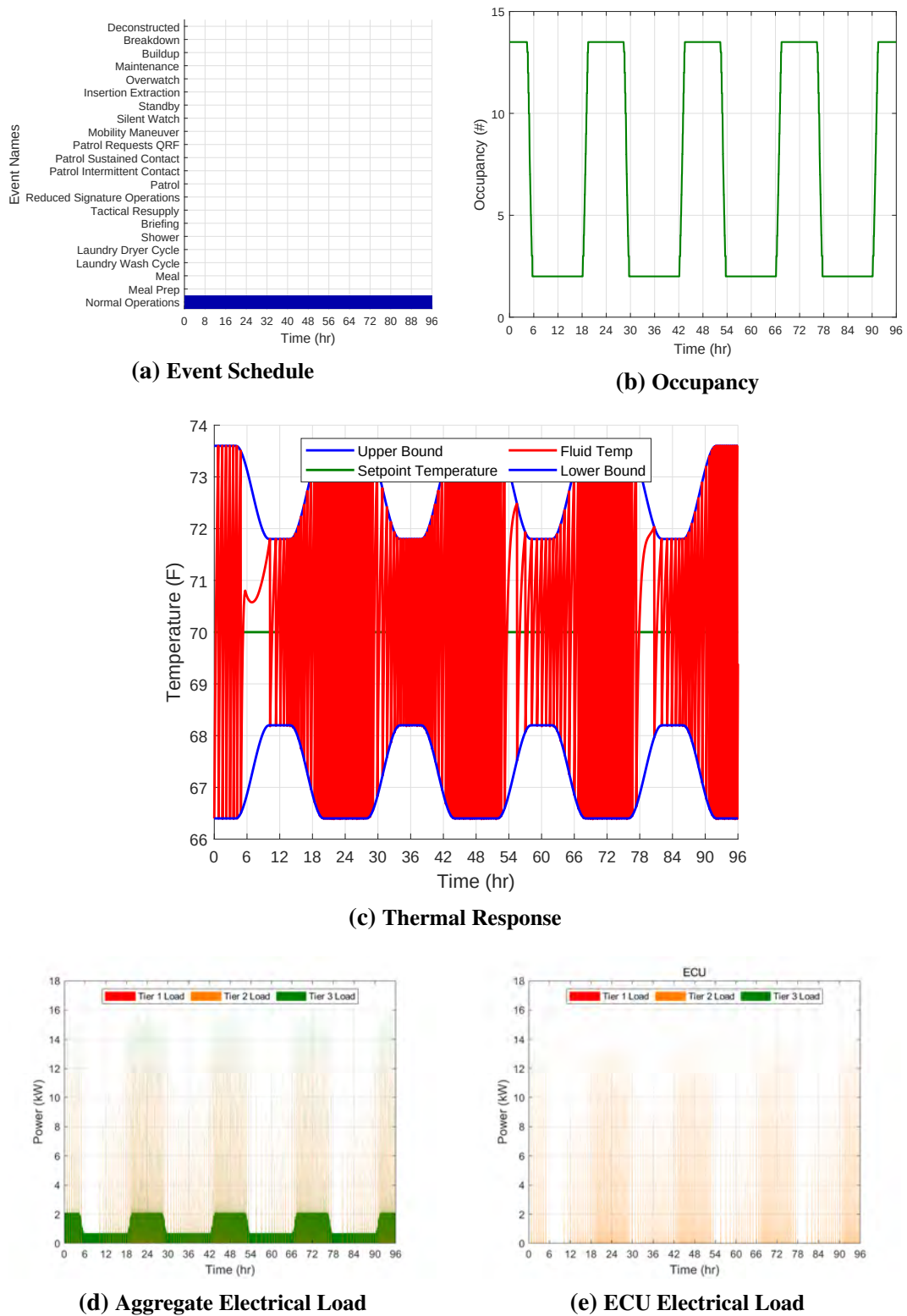
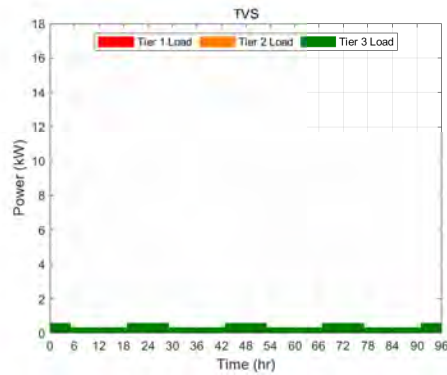
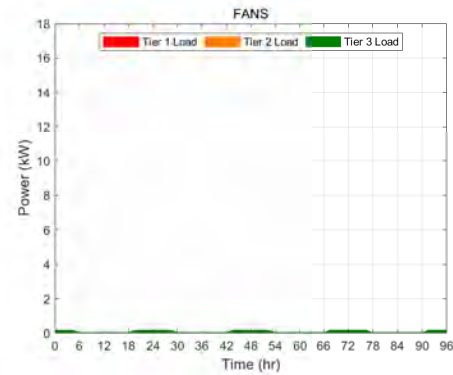


Fig. B-53 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



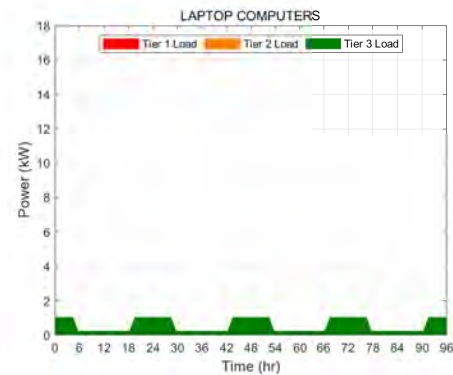
(a) Televisions Tiered Electrical Load



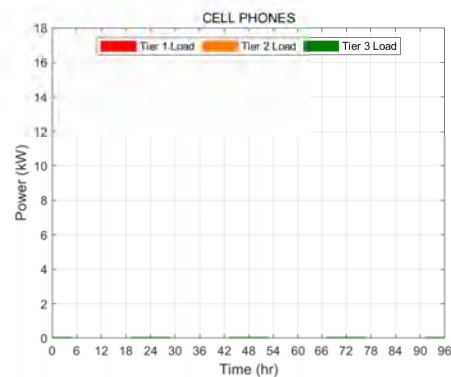
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-54 The electrical components housed within the military shelter

B.28 Officer Billeting H

The shelter labeled as officer billeting H houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-55a), the time-varying occupancy (Fig. B-55b), the resulting thermal response (Fig. B-55c), aggregate electrical load (Fig. B-55d), and the ECU electrical load (Fig. B-55e) are provided in Fig. B-55.

The shelter labeled as officer billeting H contains five separate electrical components including 1) televisions (Fig. B-56a), 2) fans (Fig. B-56b), 3) shop lights (Fig. B-56c), 4) laptop computers (Fig. B-56d), and 5) cell phones (Fig. B-56e), all of which is shown in Fig. B-56.

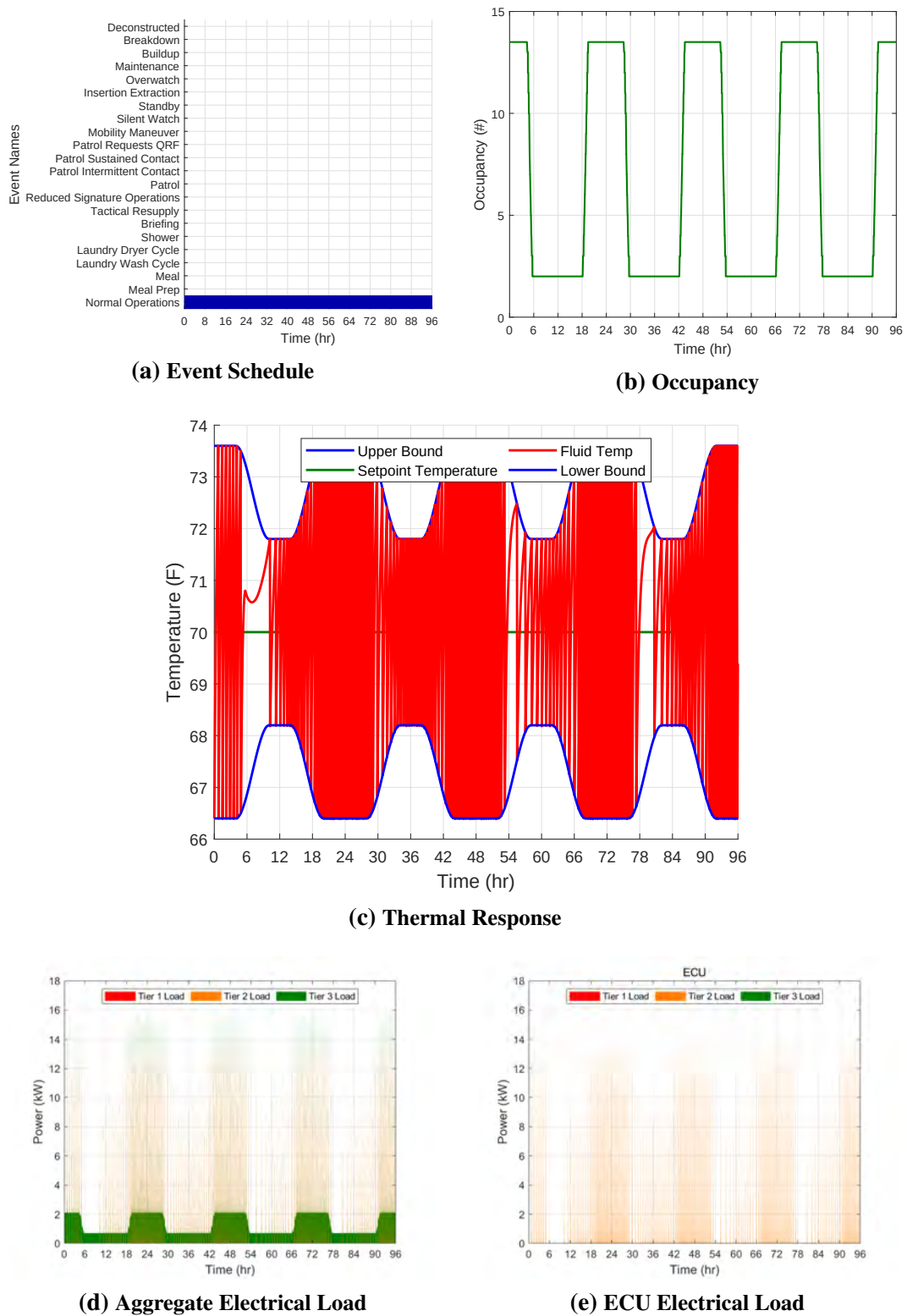
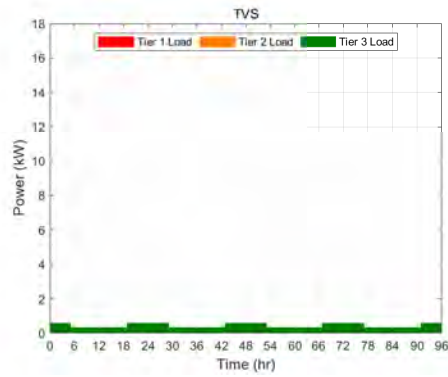
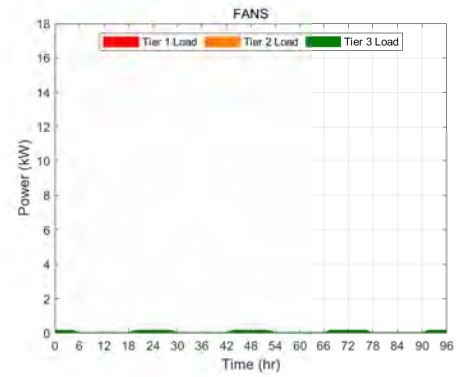


Fig. B-55 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



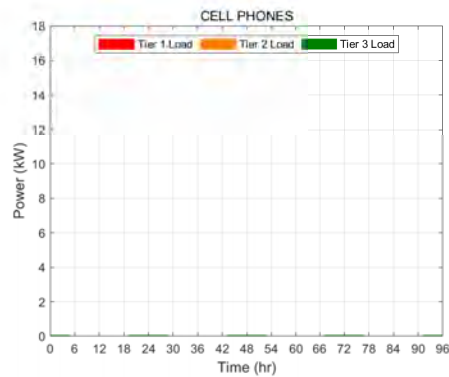
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-56 The electrical components housed within the military shelter

B.29 Officer Billeting I

The shelter labeled as officer billeting I houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-57a), the time-varying occupancy (Fig. B-57b), the resulting thermal response (Fig. B-57c), aggregate electrical load (Fig. B-57d), and the ECU electrical load (Fig. B-57e) are provided in Fig. B-57.

The shelter labeled as officer billeting I contains five separate electrical components including 1) televisions (Fig. B-58a), 2) fans (Fig. B-58b), 3) shop lights (Fig. B-58c), 4) laptop computers (Fig. B-58d), and 5) cell phones (Fig. B-58e), all of which is shown in Fig. B-58.

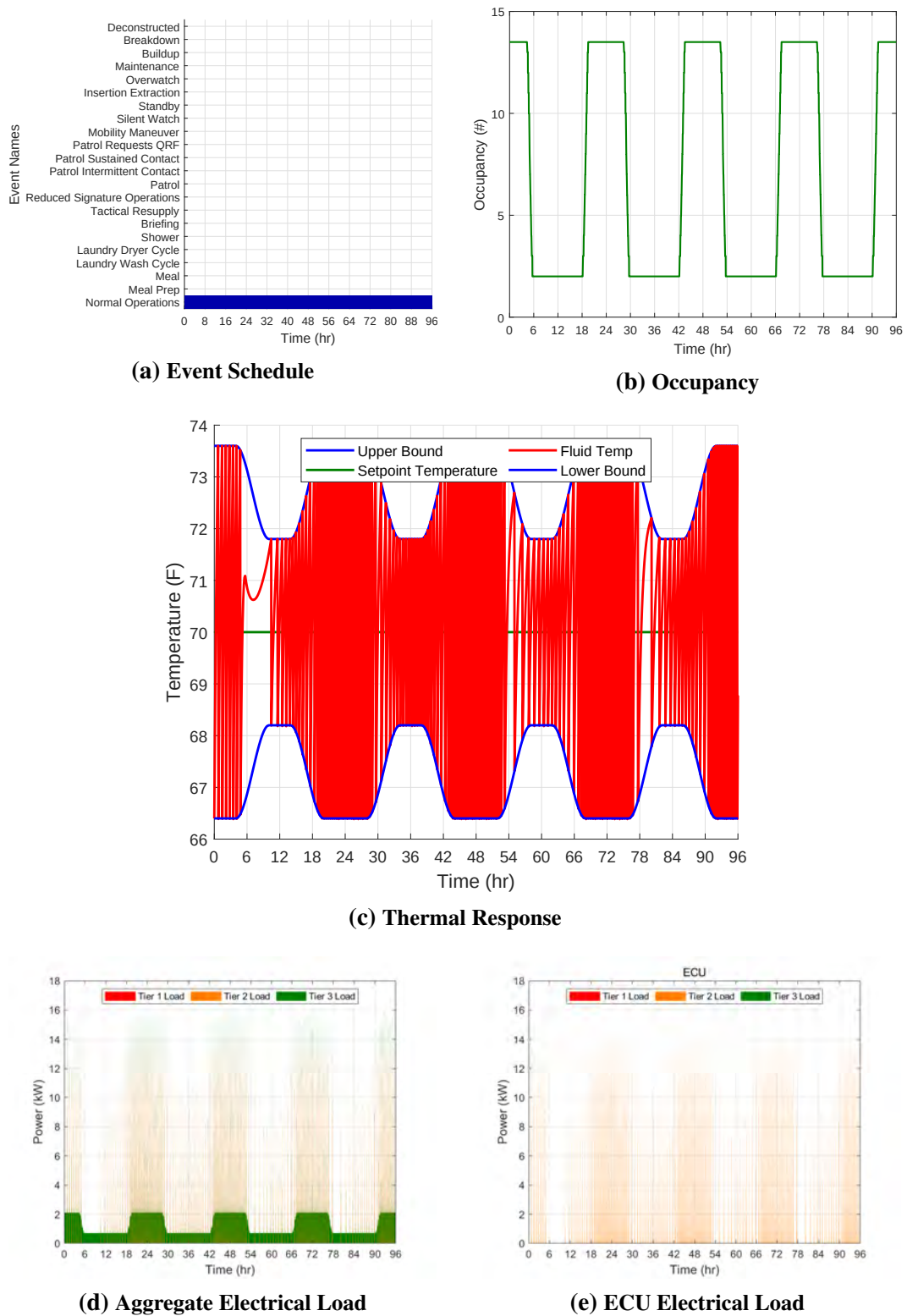
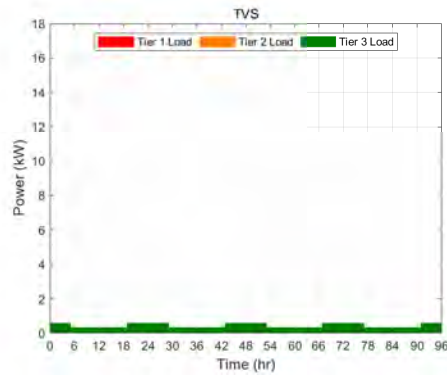
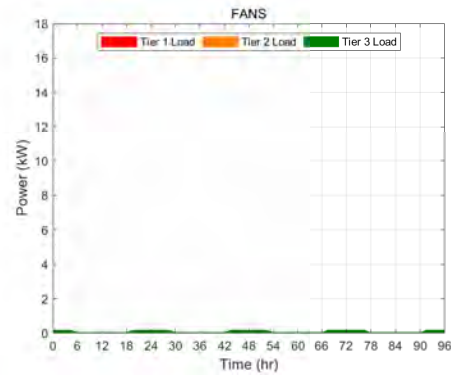


Fig. B-57 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



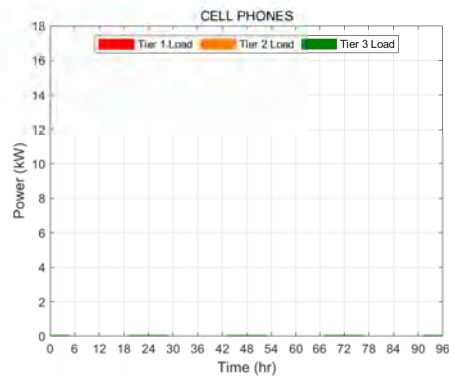
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-58 The electrical components housed within the military shelter

B.30 Officer Billeting J

The shelter labeled as officer billeting J houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy

was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. B-59a), the time-varying occupancy (Fig. B-59b), the resulting thermal response (Fig. B-59c), aggregate electrical load (Fig. B-59d), and the ECU electrical load (Fig. B-59e) are provided in Fig. B-59.

The shelter labeled as officer billeting J contains five separate electrical components including 1) televisions (Fig. B-60a), 2) fans (Fig. B-60b), 3) shop lights (Fig. B-60c), 4) laptop computers (Fig. B-60d), and 5) cell phones (Fig. B-60e), all of which is shown in Fig. B-60.

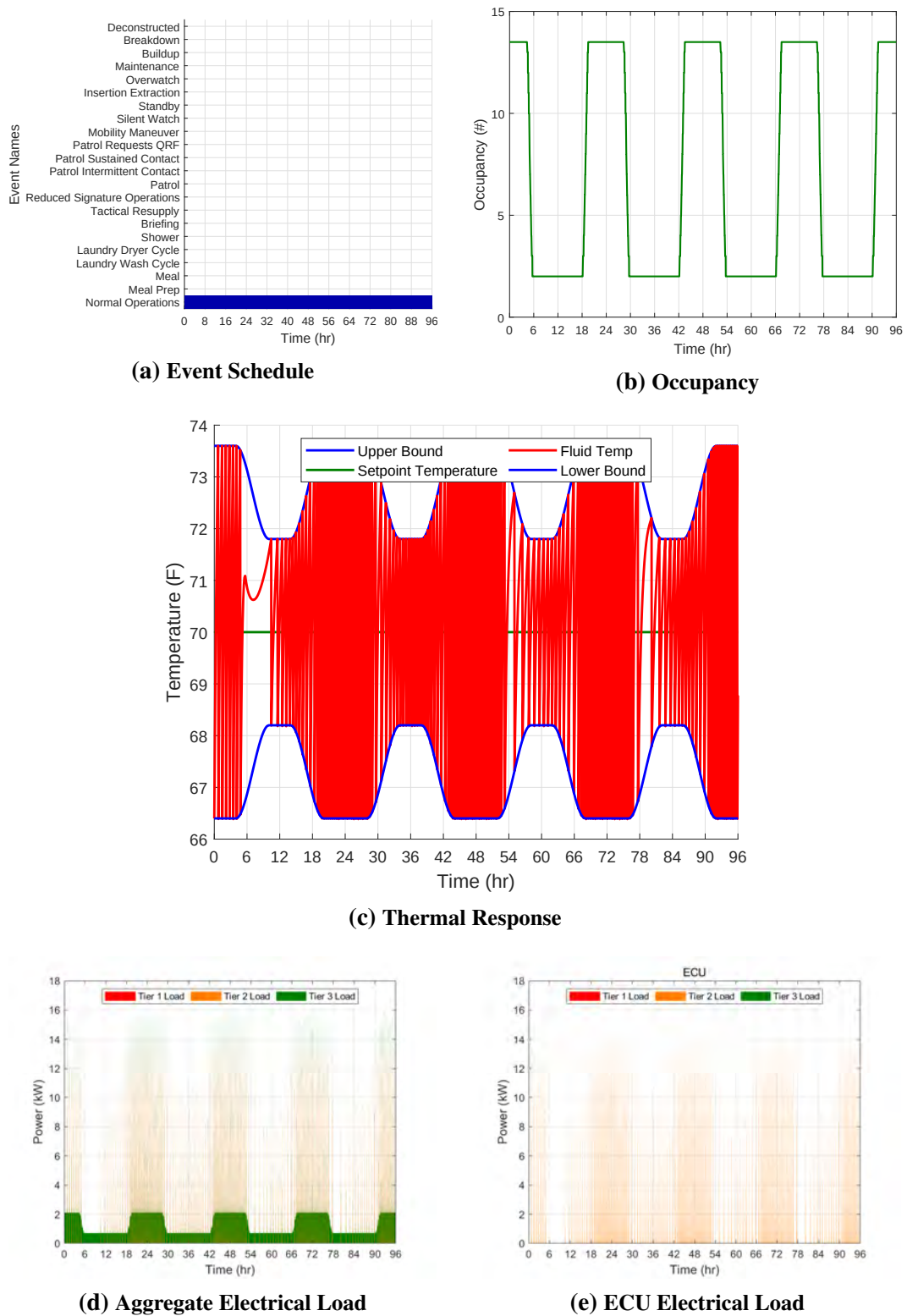
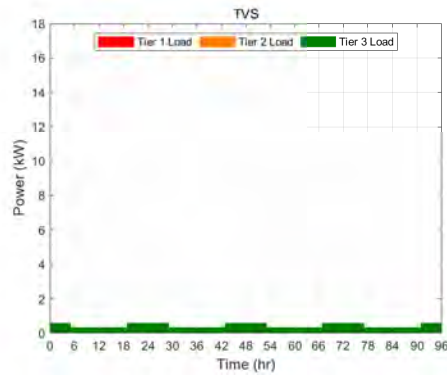
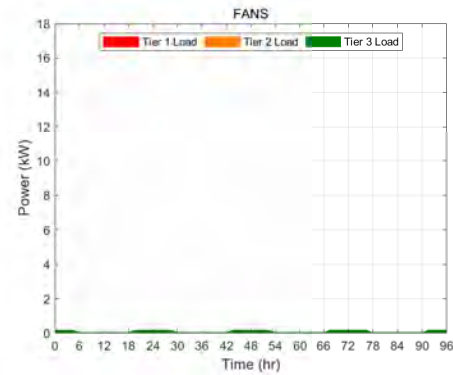


Fig. B-59 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Televisions Tiered Electrical Load



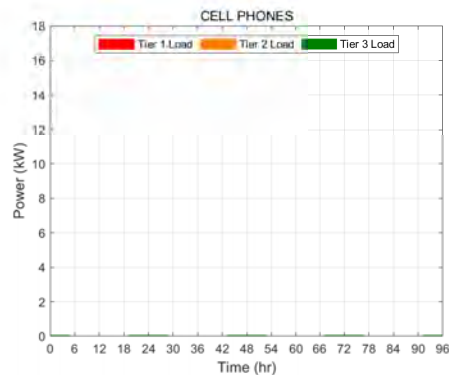
(b) Fans Tiered Electrical Load



(c) Shop Lights Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-60 The electrical components housed within the military shelter

B.31 Mess A

The shelter labeled as mess A was used to feed Soldier. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by

meal-related events. In the event of a meal event, the occupancy increases; when the meal event has concluded, the occupancy decreases to the nominal level of occupancy.

The event schedule (Fig. B-61a), the time-varying occupancy (Fig. B-61b), the resulting thermal response (Fig. B-61c), aggregate electrical load (Fig. B-61d), and the ECU electrical load (Fig. B-61e) are provided in Fig. B-61.

The shelter labeled as mess A contains six separate electrical components including 1) specialized electrical equipment (Fig. B-62a), 2) televisions (Fig. B-62b), 3) shop lights (Fig. B-62c), 4) fans (Fig. B-62d), 5) microwaves (Fig. B-62e), and 6) hot plates (Fig. B-62f), all of which is shown in Fig. B-62.

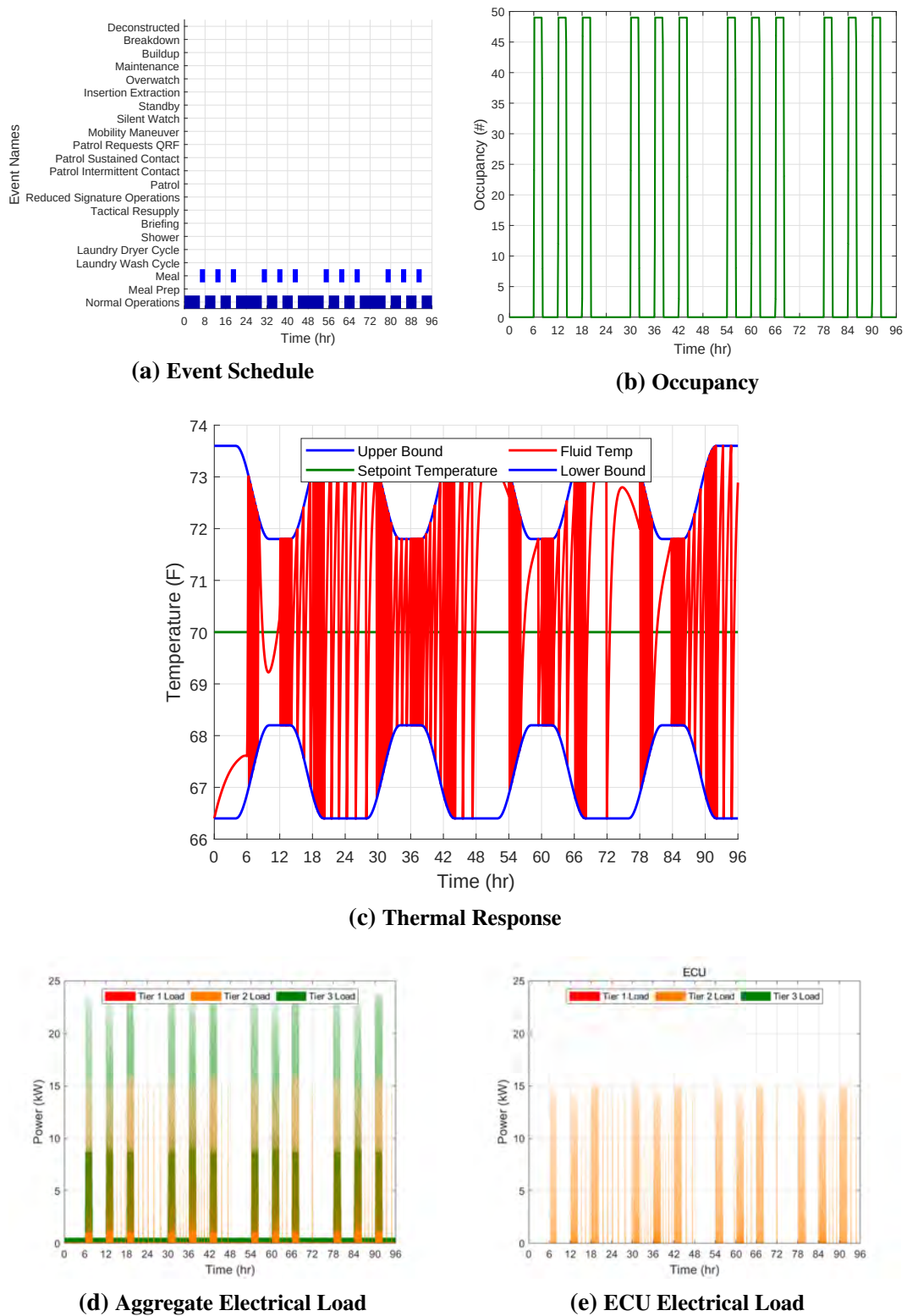
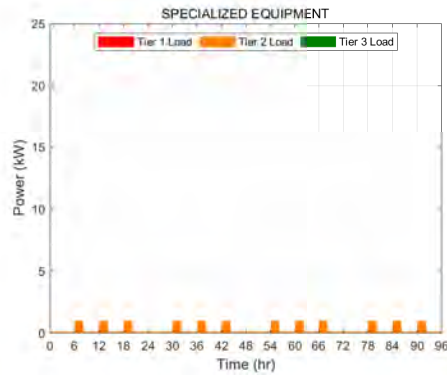
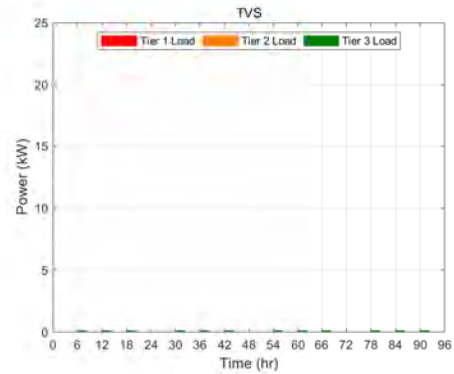


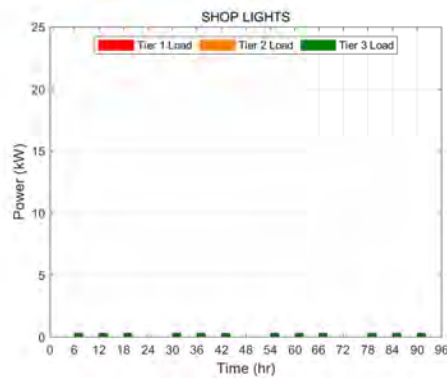
Fig. B-61 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



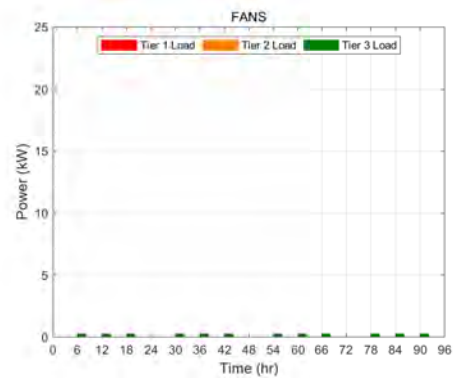
(a) Specialized Equipment Tiered Electrical Load



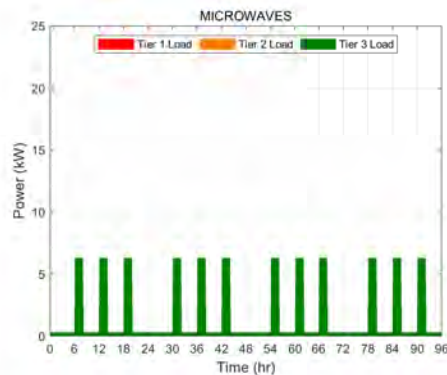
(b) Televisions Tiered Electrical Load



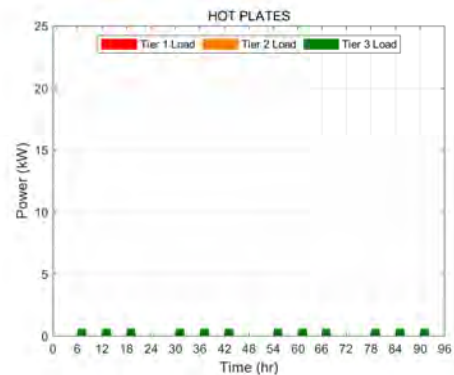
(c) Shop Lights Tiered Electrical Load



(d) Fans Tiered Electrical Load



(e) Microwaves Tiered Electrical Load



(f) Hot Plates Tiered Electrical Load

Fig. B-62 The electrical components housed within the military shelter

B.32 Mess B

The shelter labeled as mess B was used to feed Soldier. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by

meal-related events. In the event of a meal event, the occupancy increases; when the meal event has concluded, the occupancy decreases to the nominal level of occupancy.

The event schedule (Fig. B-63a), the time-varying occupancy (Fig. B-63b), the resulting thermal response (Fig. B-63c), aggregate electrical load (Fig. B-63d), and the ECU electrical load (Fig. B-63e) are provided in Fig. B-63.

The shelter labeled as mess B contains six separate electrical components including 1) specialized electrical equipment (Fig. B-64a), 2) televisions (Fig. B-64b), 3) shop lights (Fig. B-64c), 4) fans (Fig. B-64d), 5) microwaves (Fig. B-64e), and 6) hot plates (Fig. B-64f), all of which is shown in Fig. B-64.

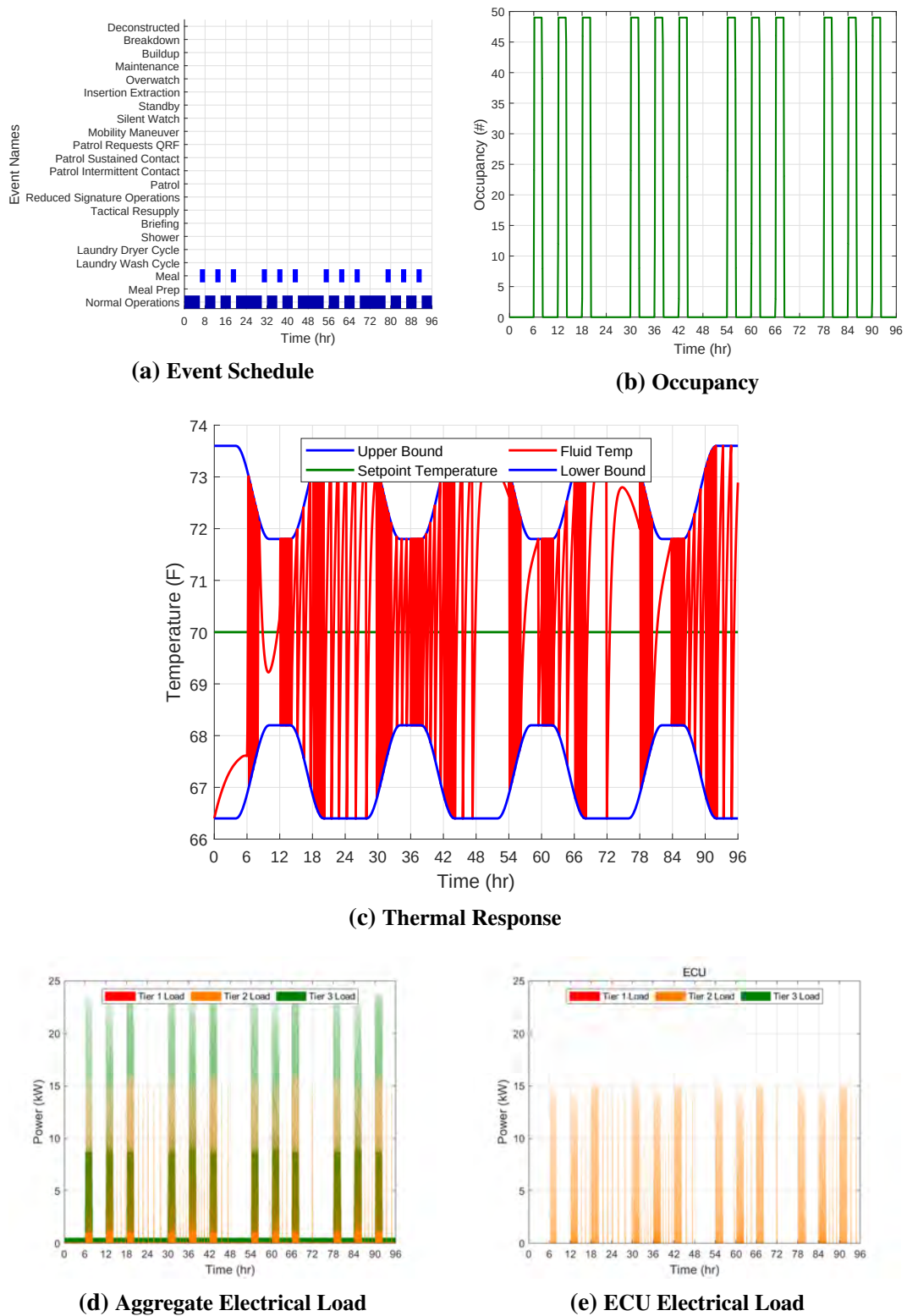
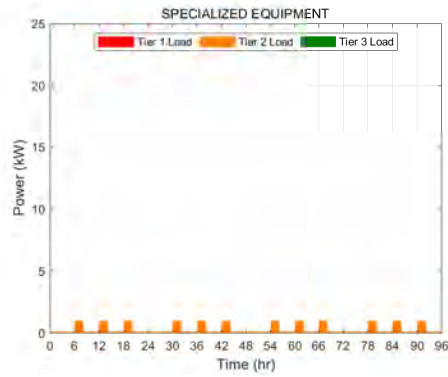
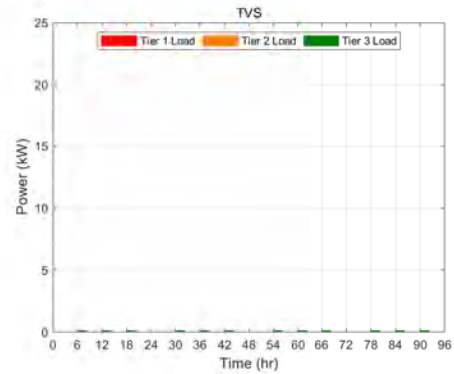


Fig. B-63 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



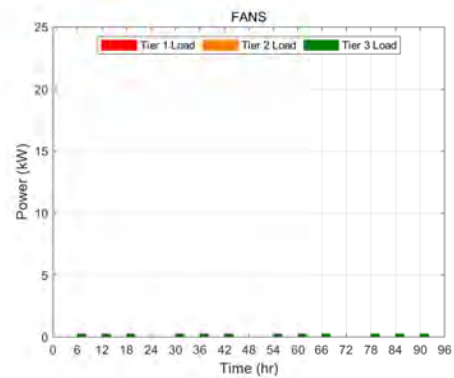
(a) Specialized Equipment Tiered Electrical Load



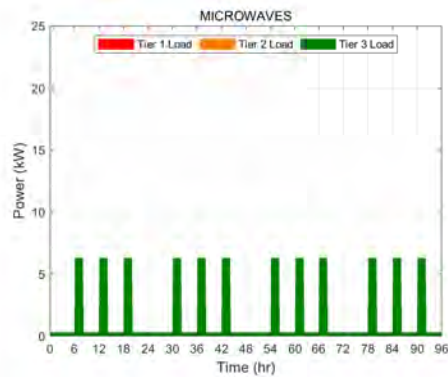
(b) Televisions Tiered Electrical Load



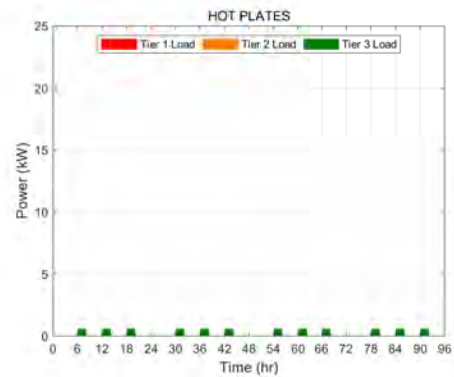
(c) Shop Lights Tiered Electrical Load



(d) Fans Tiered Electrical Load



(e) Microwaves Tiered Electrical Load



(f) Hot Plates Tiered Electrical Load

Fig. B-64 The electrical components housed within the military shelter

B.33 Kitchen A

The shelter labeled as kitchen A was used as the kitchen, more specifically this shelter variant was configured to prepare and cook the meals. The maximum capacity

of the shelter was estimated to be 20 Soldiers. The shelter's occupancy is driven by meal-related events. In the event of a meal event, the occupancy increases; when the meal event has concluded, the occupancy decreases to the nominal level of occupancy. This Kitchen shelter was configured to contain electrical equipment, which is primarily used for heating and cooking food for consumption by the Soldiers. The event schedule (Fig. B-65a), the time-varying occupancy (Fig. B-65b), the resulting thermal response (Fig. B-65c), aggregate electrical load (Fig. B-65d), and the ECU electrical load (Fig. B-65e) are provided in Fig. B-65.

The shelter labeled as kitchen A contains six separate electrical components including 1) shop lights (Fig. B-66a), 2) fans (Fig. B-66b), 3) ovens (Fig. B-66c), 4) warmers (Fig. B-66d), 5) microwaves (Fig. B-66e), and 6) dishwashers (Fig. B-66f), all of which is shown in Fig. B-66.

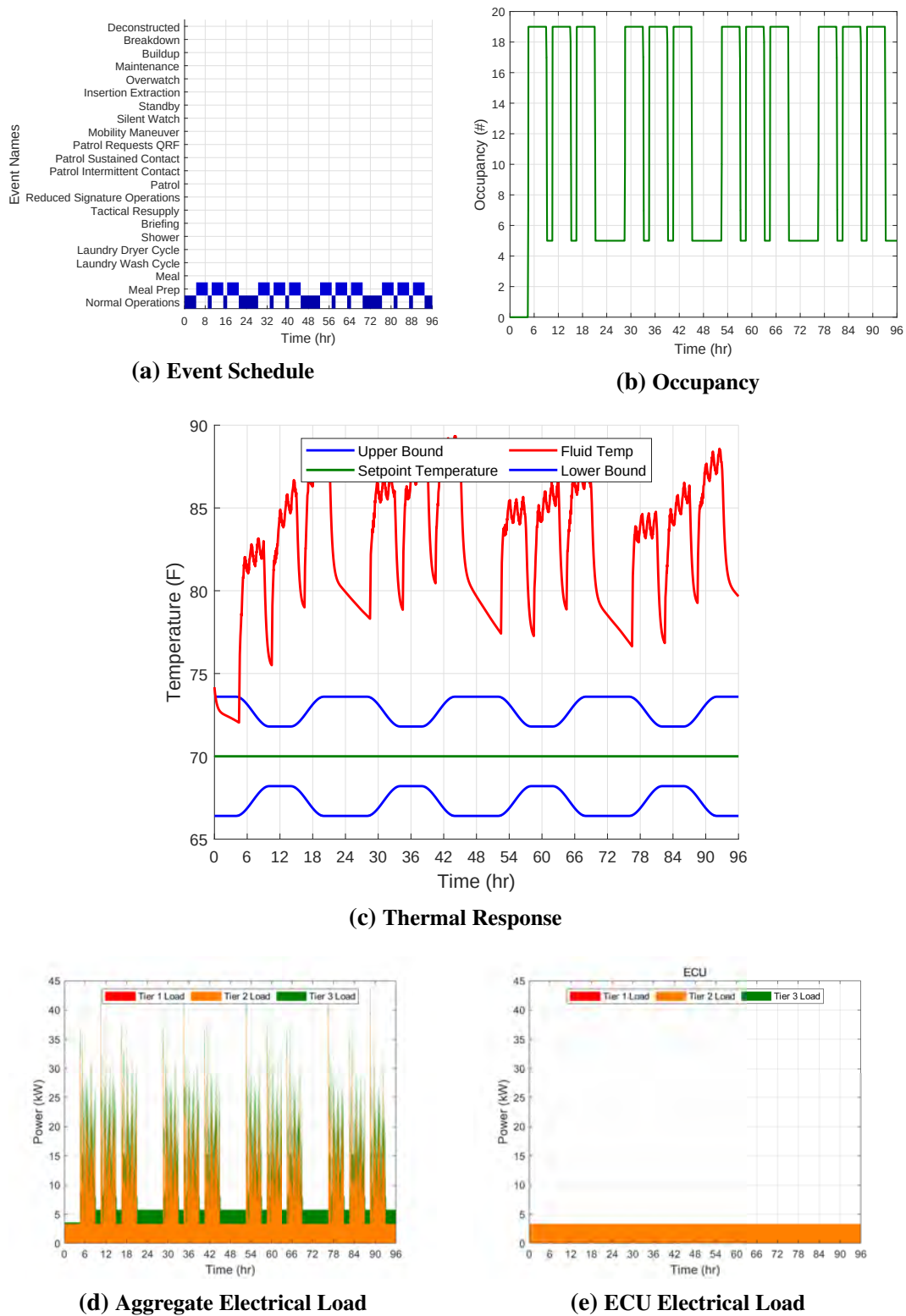
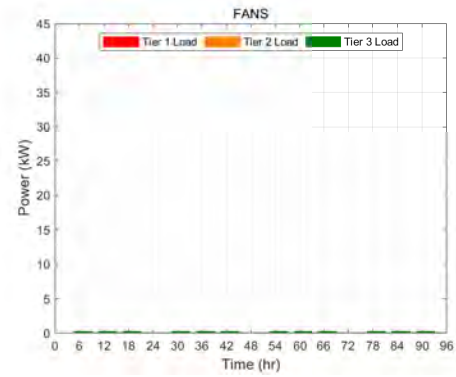


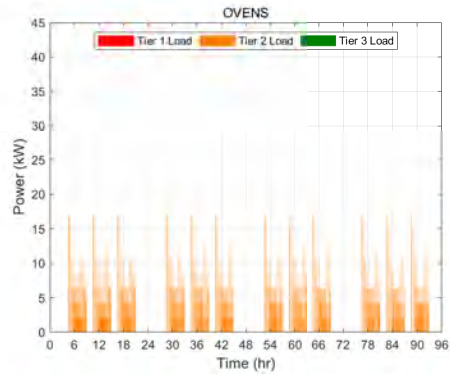
Fig. B-65 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



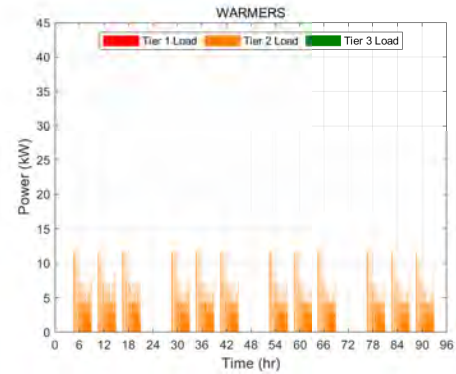
(a) Shop Lights Tiered Electrical Load



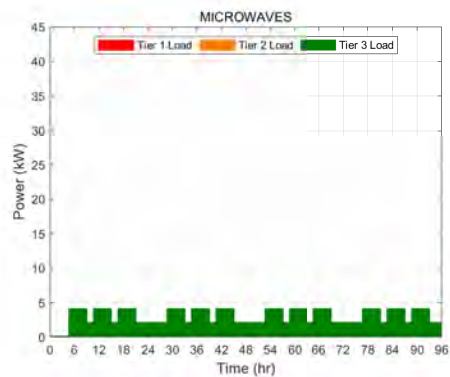
(b) Fans Tiered Electrical Load



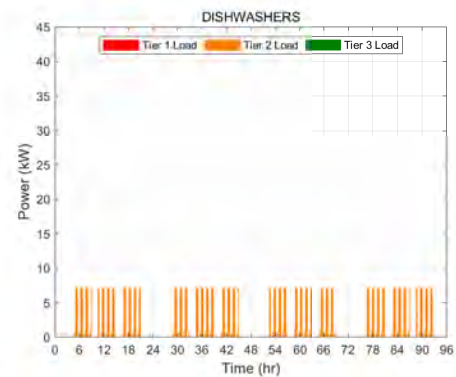
(c) Ovens Tiered Electrical Load



(d) Warmer Tiered Electrical Load



(e) Microwaves Tiered Electrical Load



(f) Dishwashers Tiered Electrical Load

Fig. B-66 The electrical components housed within the military shelter

B.34 Kitchen B

The shelter labeled as kitchen B was used as the kitchen, more specifically this shelter variant was configured to as food preparation and food storage. The maximum capacity of the shelter was estimated to be 20 Soldiers. The shelter's occupancy is driven by meal-related events. In the event of a meal event, the occupancy increases; when the meal event has concluded, the occupancy decreases to the nominal level of occupancy. This Kitchen shelter was configured to contain electrical equipment, which is primarily used for heating and cooking food for consumption by the Soldiers.

The event schedule (Fig. B-67a), the time-varying occupancy (Fig. B-67b), the resulting thermal response (Fig. B-67c), aggregate electrical load (Fig. B-67d), and the ECU electrical load (Fig. B-67e) are provided in Fig. B-67.

The shelter labeled as kitchen B contains four separate electrical components including 1) shop lights (Fig. B-68a), 2) fans (Fig. B-68b), 3) refrigerators (Fig. B-68c), and 4) freezers (Fig. B-68d), all of which is shown in Fig. B-68.

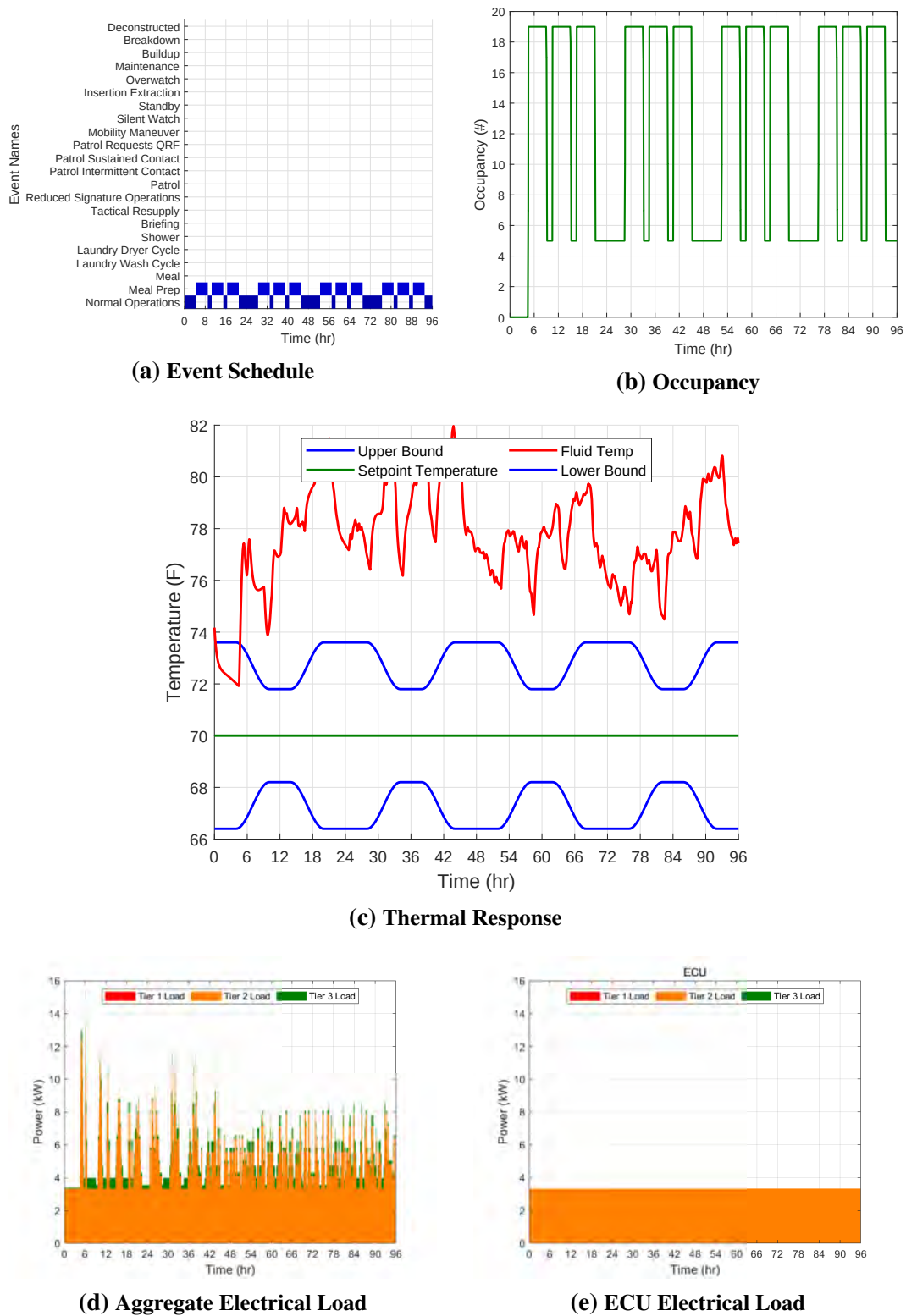
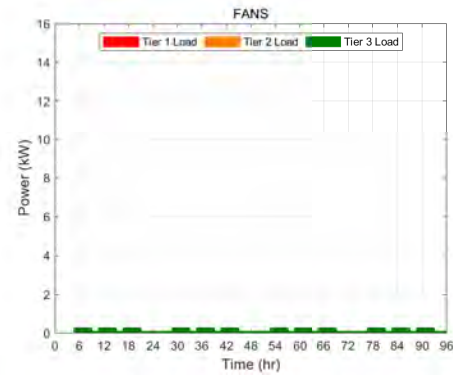


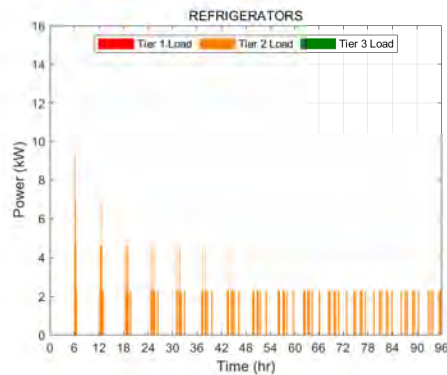
Fig. B-67 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



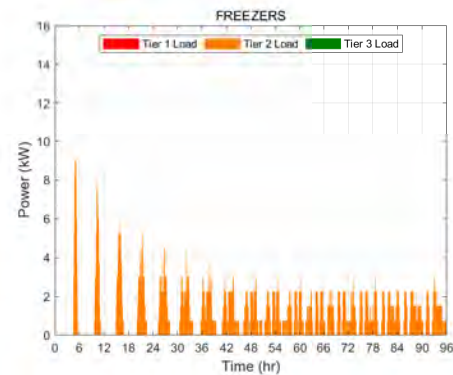
(a) Shop Lights Tiered Electrical Load



(b) Fans Tiered Electrical Load



(c) Refrigerators Tiered Electrical Load



(d) Freezers Tiered Electrical Load

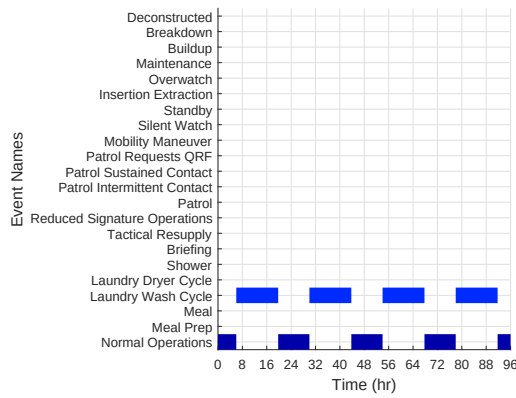
Fig. B-68 The electrical components housed within the military shelter

B.35 Laundry A

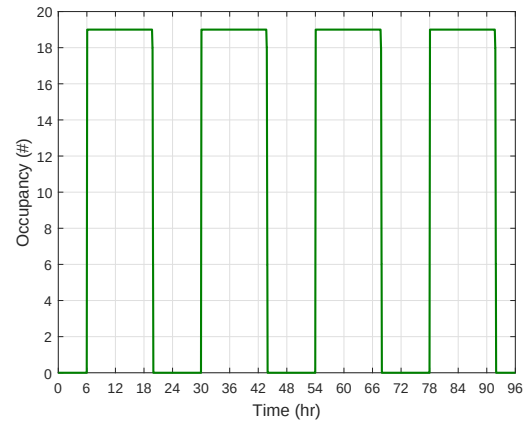
The shelter labeled as laundry A was used as the laundry, more specifically this shelter variant was configured to house the clothes washers. The maximum capacity of the shelter was estimated to be 20 Soldiers. The shelter's occupancy is driven by laundry-related events primarily the washing cycle of clothes.

The event schedule (Fig. B-69a), the time-varying occupancy (Fig. B-69b), the resulting thermal response (Fig. B-69c), aggregate electrical load (Fig. B-69d), and the ECU electrical load (Fig. B-69e) are provided in Fig. B-69.

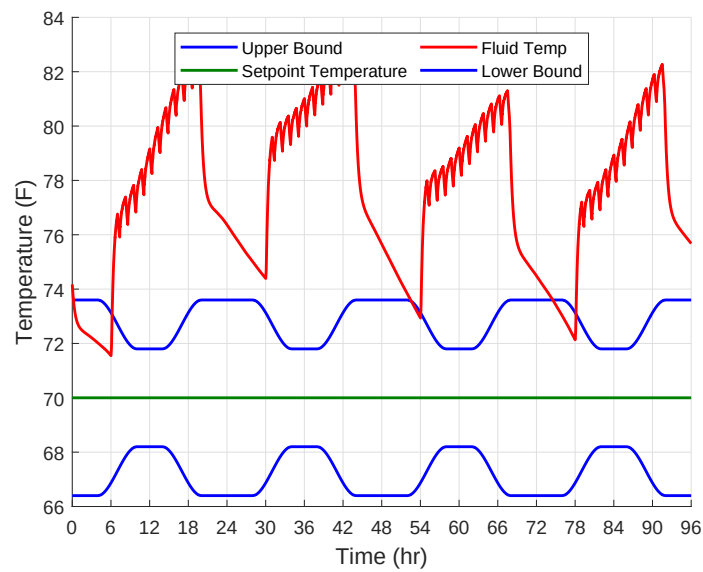
The shelter labeled as laundry A contains three separate electrical components including 1) shop lights (Fig. B-70a), 2) fans (Fig. B-70b), and 3) clothes washers (Fig. B-70c), all of which is shown in Fig. B-70.



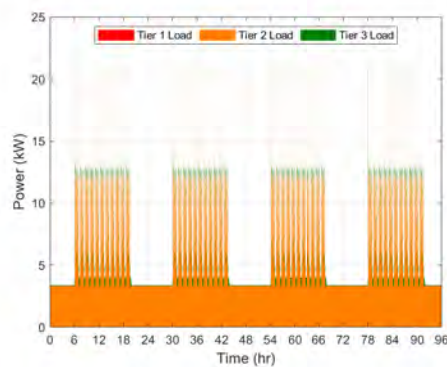
(a) Event Schedule



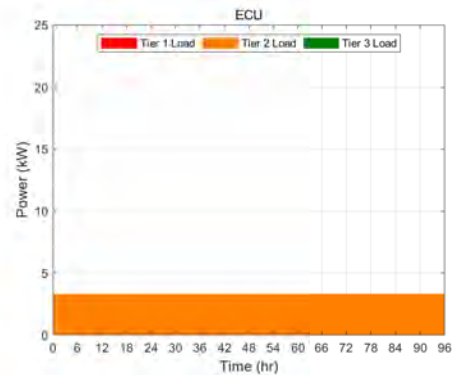
(b) Occupancy



(c) Thermal Response



(d) Aggregate Electrical Load

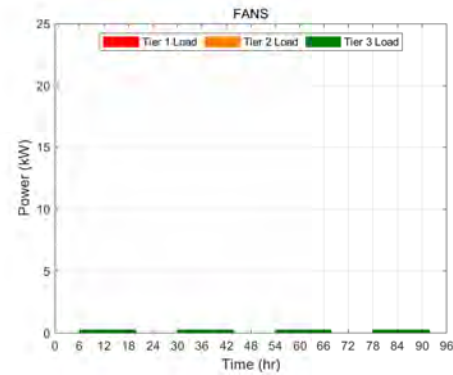


(e) ECU Electrical Load

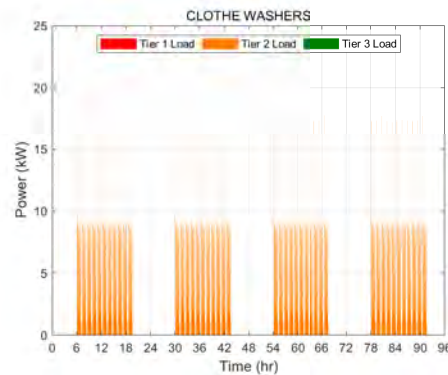
Fig. B-69 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Shop Lights Tiered Electrical Load



(b) Fans Tiered Electrical Load



(c) Clothes Washer Tiered Electrical Load

Fig. B-70 The electrical components housed within the military shelter

B.36 Laundry B

The shelter labeled as laundry B was used as the laundry, more specifically this shelter variant was configured to house the clothes dryers. The maximum capacity of the shelter was estimated to be 20 Soldiers. The shelter's occupancy is driven by laundry-related events primarily the drying cycle of clothes.

The event schedule (Fig. B-71a), the time-varying occupancy (Fig. B-71b), the resulting thermal response (Fig. B-71c), aggregate electrical load (Fig. B-71d), and the ECU electrical load (Fig. B-71e) are provided in Fig. B-71.

The shelter labeled as laundry B contains three separate electrical components including 1) shop lights (Fig. B-72a), 2) fans (Fig. B-72b), and 3) clothes dryers (Fig. B-72c), all of which is shown in Fig. B-72.

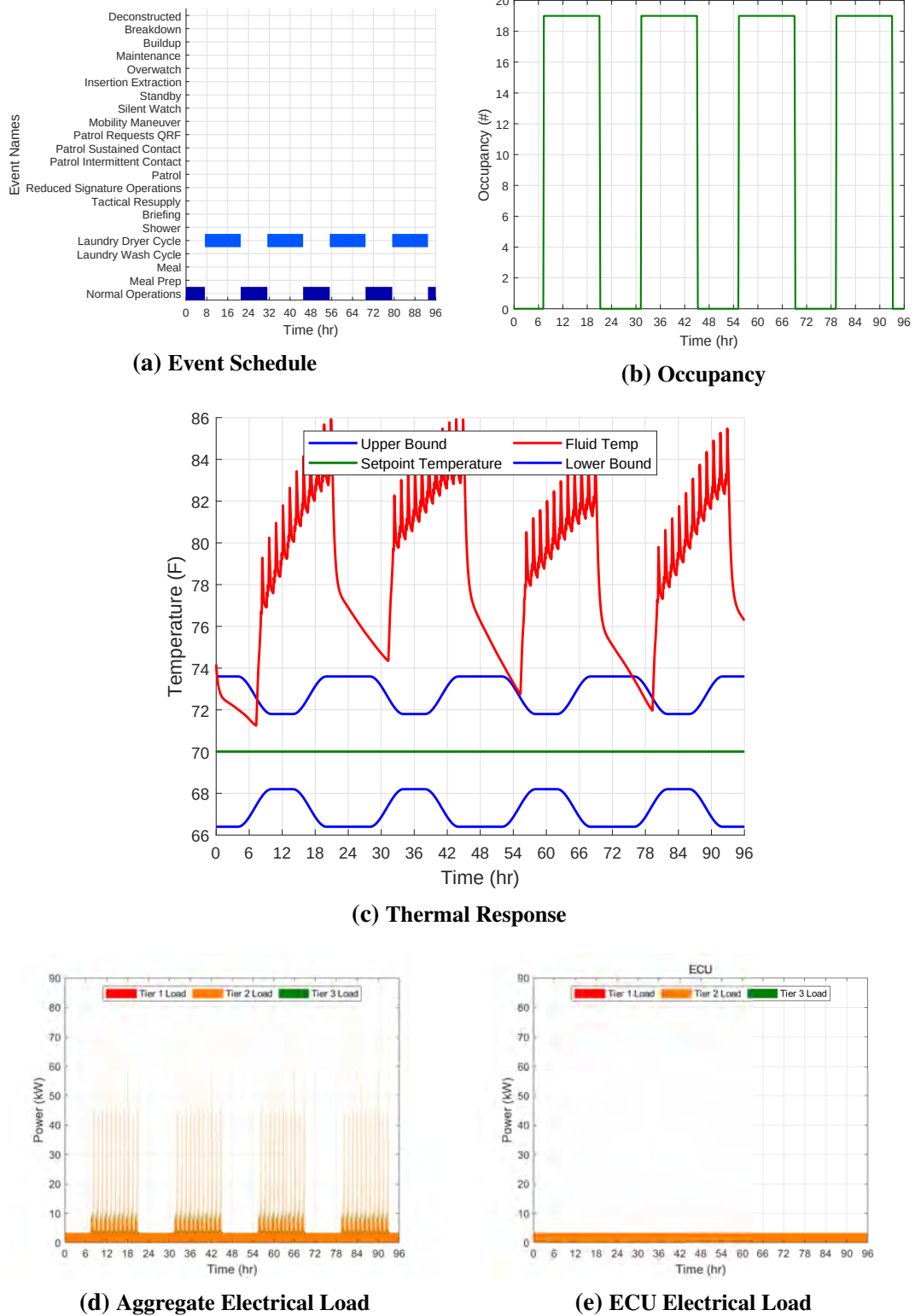
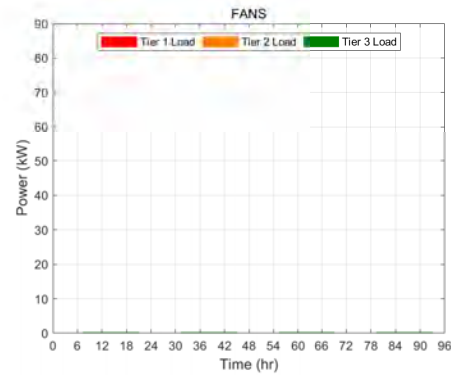


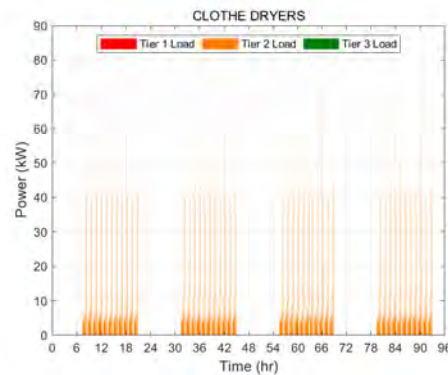
Fig. B-71 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Shop Lights Tiered Electrical Load



(b) Fans Tiered Electrical Load



(c) Clothes Dryers Tiered Electrical Load

Fig. B-72 The electrical components housed within the military shelter

B.37 Shower A

The shelter labeled as shower A was used as the shower. The maximum capacity of the shelter was estimated to be 16 Soldiers. The shelter's occupancy was driven by shower-related events. This shelter was configured to house the water heaters and all other related equipment or components required for Soldiers to take a shower.

The event schedule (Fig. B-73a), the time-varying occupancy (Fig. B-73b), the resulting thermal response (Fig. B-73c), aggregate electrical load (Fig. B-73d), and the ECU electrical load (Fig. B-73e) are provided in Fig. B-73.

The shelter labeled as shower A contains three separate electrical components including 1) shop lights (Fig. B-74a), 2) fans (Fig. B-74b), and 3) water heaters (Fig. B-74c), all of which is shown in Fig. B-74.

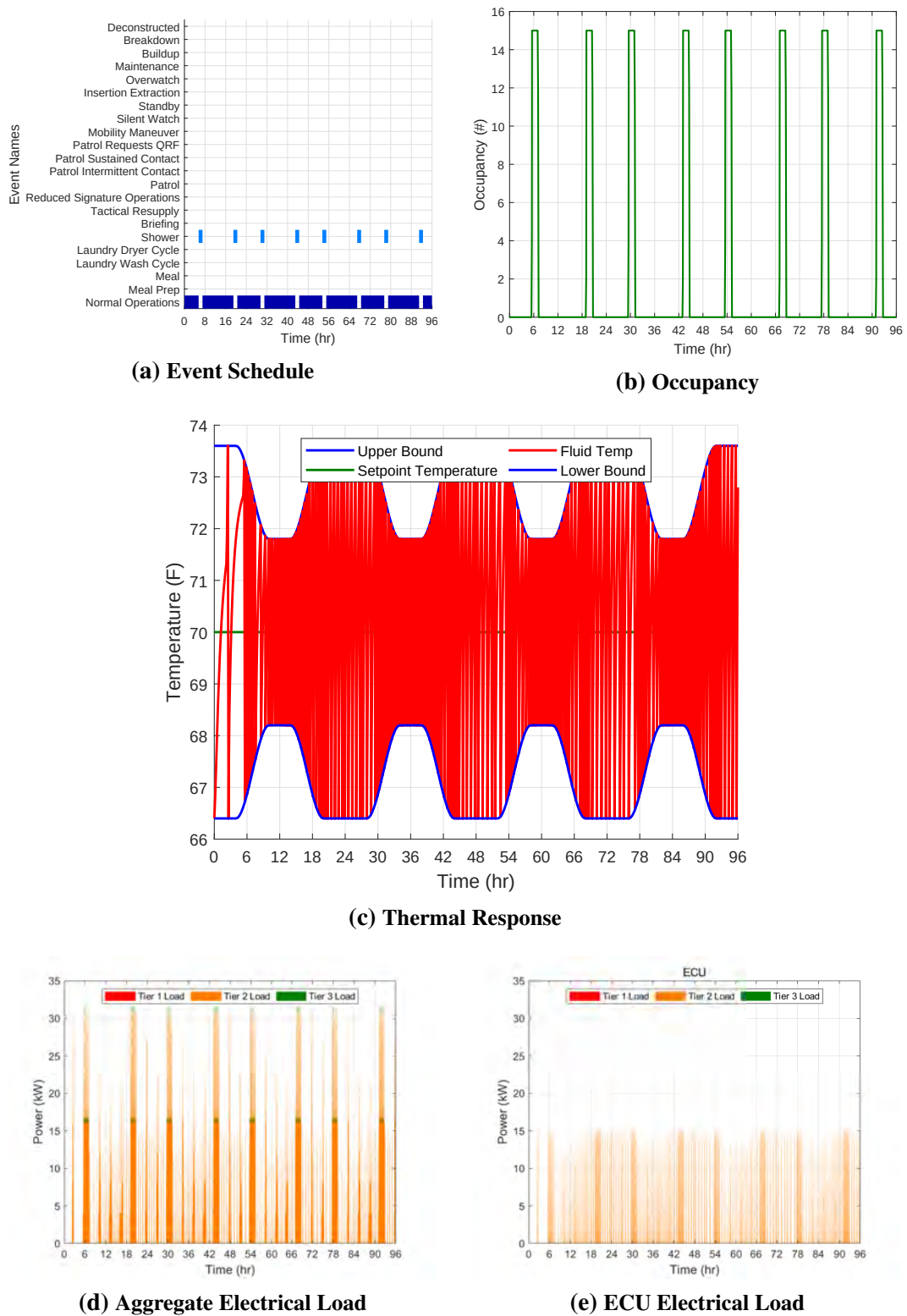
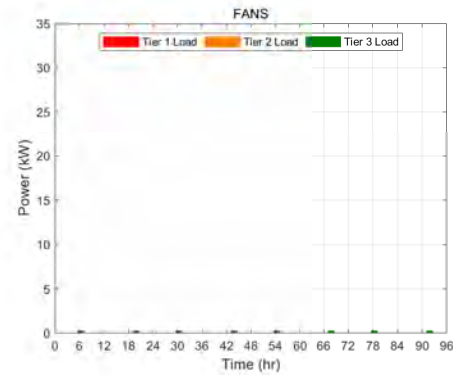


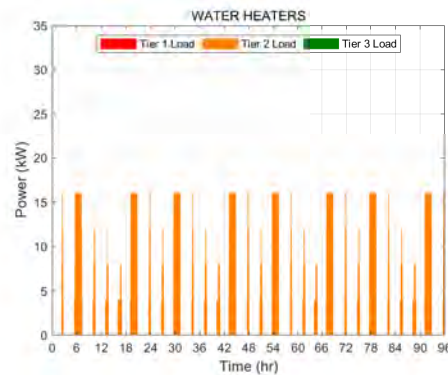
Fig. B-73 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Shop Lights Tiered Electrical Load



(b) Fans Tiered Electrical Load



(c) Water Heaters Tiered Electrical Load

Fig. B-74 The electrical components housed within the military shelter

B.38 Shower B

The shelter labeled as shower B was used as the shower. The maximum capacity of the shelter was estimated to be 16 Soldiers. The shelter's occupancy was driven by shower-related events. This shelter was configured to house the water heaters and all other related equipment or components required for Soldiers to take a shower.

The event schedule (Fig. B-75a), the time-varying occupancy (Fig. B-75b), the resulting thermal response (Fig. B-75c), aggregate electrical load (Fig. B-75d), and the ECU electrical load (Fig. B-75e) are provided in Fig. B-75.

The shelter labeled as shower B contains three separate electrical components including 1) shop lights (Fig. B-76a), 2) fans (Fig. B-76b), and 3) water heaters (Fig. B-76c), all of which is shown in Fig. B-76.

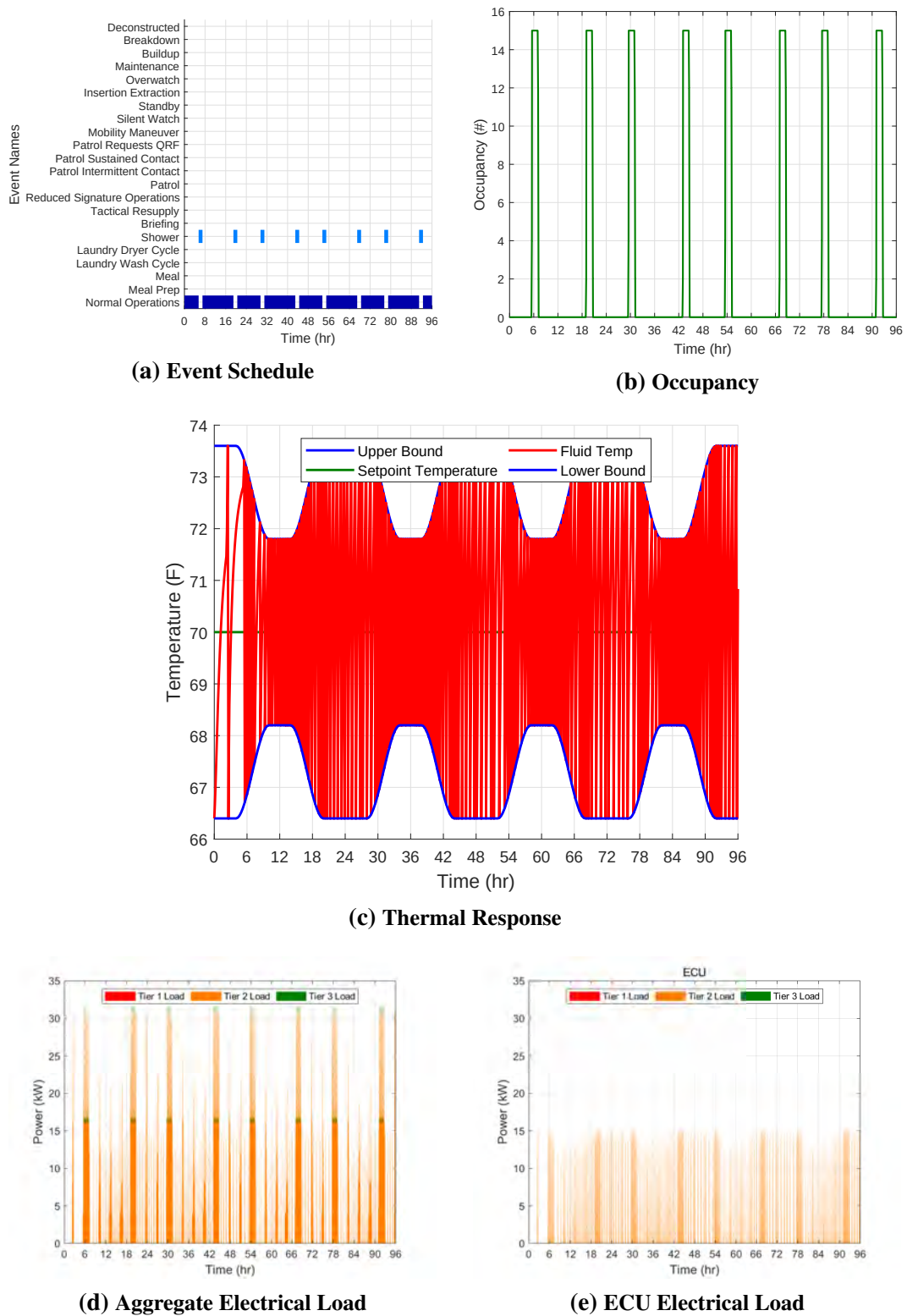
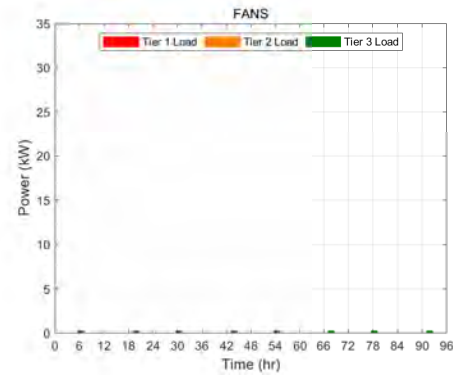


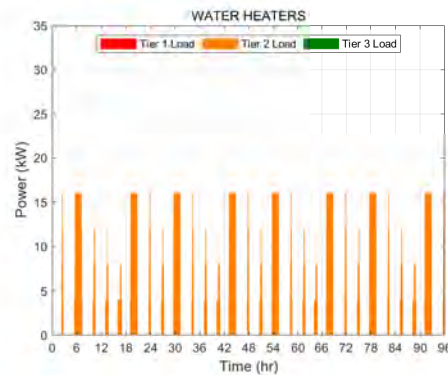
Fig. B-75 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Shop Lights Tiered Electrical Load



(b) Fans Tiered Electrical Load



(c) Water Heaters Tiered Electrical Load

Fig. B-76 The electrical components housed within the military shelter

B.39 COC Master

The shelter labeled as COC master was used as the primary COC shelter. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to manage the energy network's operation.

The event schedule (Fig. B-77a), the time-varying occupancy (Fig. B-77b), the resulting thermal response (Fig. B-77c), aggregate electrical load (Fig. B-77d), and the ECU electrical load (Fig. B-77e) are provided in Fig. B-77.

The shelter labeled as COC master contains eight separate electrical components including 1) specialized equipment (Fig. B-78a), 2) televisions (Fig. B-78b), 3) shop lights (Fig. B-78c), 4) fans (Fig. B-78d), 5) laptop computers (Fig. B-79a),

6) cell phones (Fig. B-79b), 7) microwaves (Fig. B-79c), and 8) hot plates (Fig. B-79d), all of which is shown in Fig. B-78 and Fig. B-79.

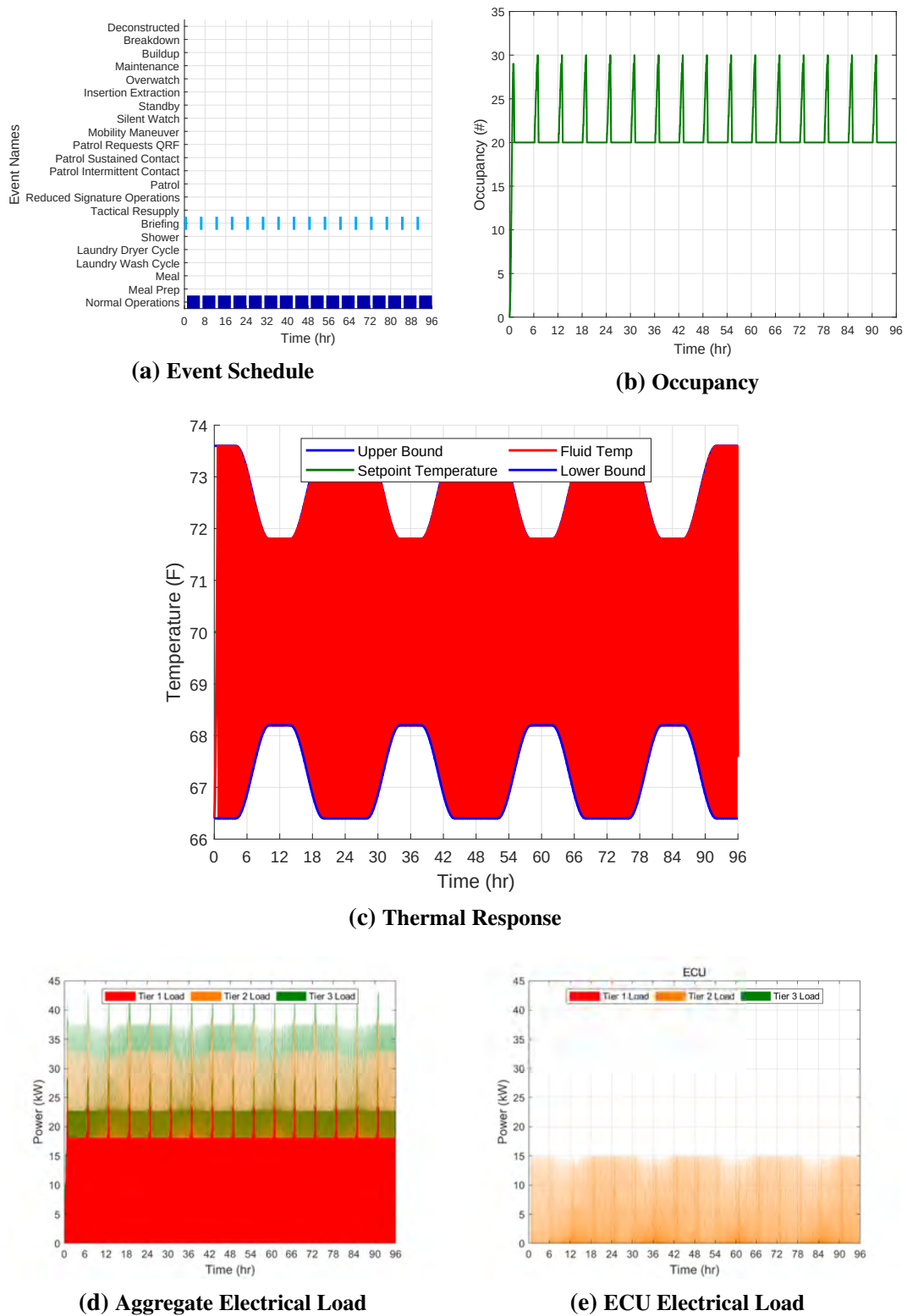
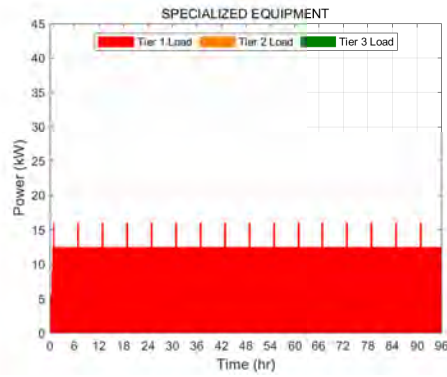
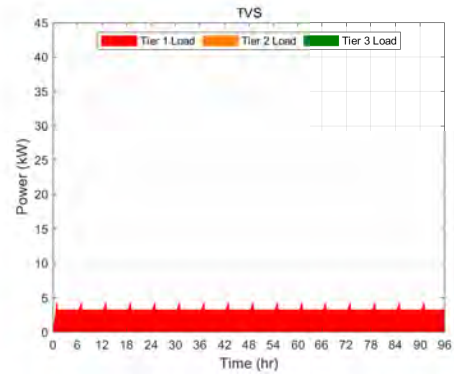


Fig. B-77 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



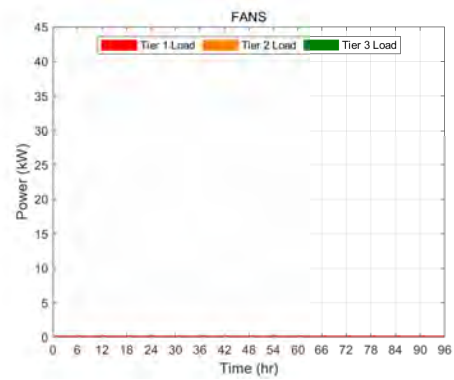
(a) Specialized Equipment Tiered Electrical Load



(b) Televisions Tiered Electrical Load

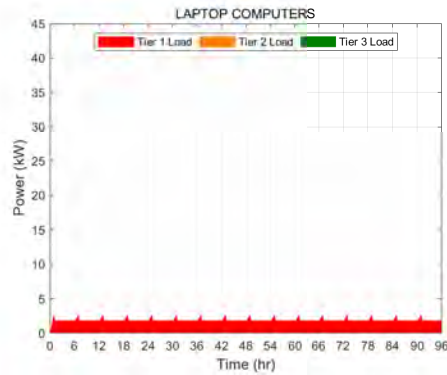


(c) Shop Lights Tiered Electrical Load

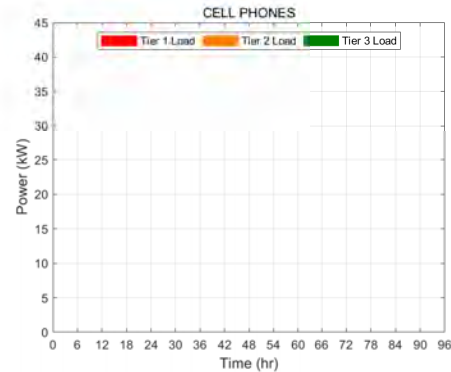


(d) Fans Tiered Electrical Load

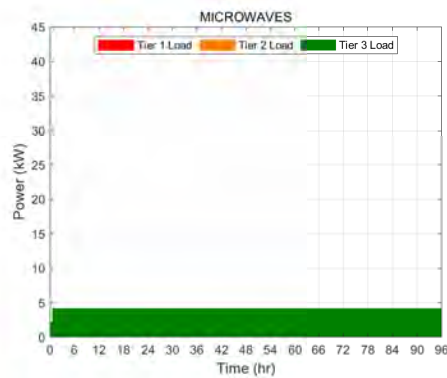
Fig. B-78 The electrical components housed within the military shelter



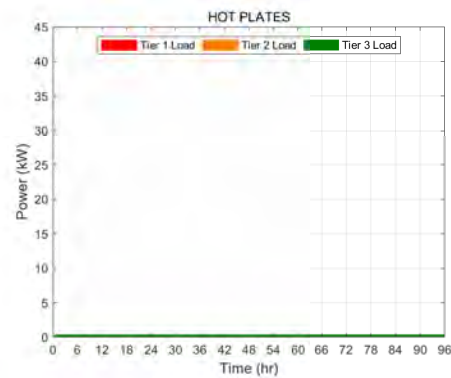
(a) Laptop Computers Tiered Electrical Load



(b) Cell Phones Tiered Electrical Load



(c) Microwaves Tiered Electrical Load



(d) Hot Plates Tiered Electrical Load

Fig. B-79 The electrical components housed within the military shelter

B.40 COC Submaster A

The shelter labeled as COC submaster A was used as a secondary COC shelter. The maximum capacity of the shelter was estimated to be 35 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to assist the master COC shelter to manage the energy network's operation.

The event schedule (Fig. B-80a), the time-varying occupancy (Fig. B-80b), the resulting thermal response (Fig. B-80c), aggregate electrical load (Fig. B-80d), and the ECU electrical load (Fig. B-80e) are provided in Fig. B-80.

The shelter labeled as COC submaster A contains six separate electrical components including 1) specialized equipment (Fig. B-81a), 2) televisions (Fig. B-81b),

3) shop lights (Fig. B-81c), 4) fans (Fig. B-81d), 5) laptop computers (Fig. B-81e), and 6) cell phones (Fig. B-81f), all of which is shown in Fig. B-81.

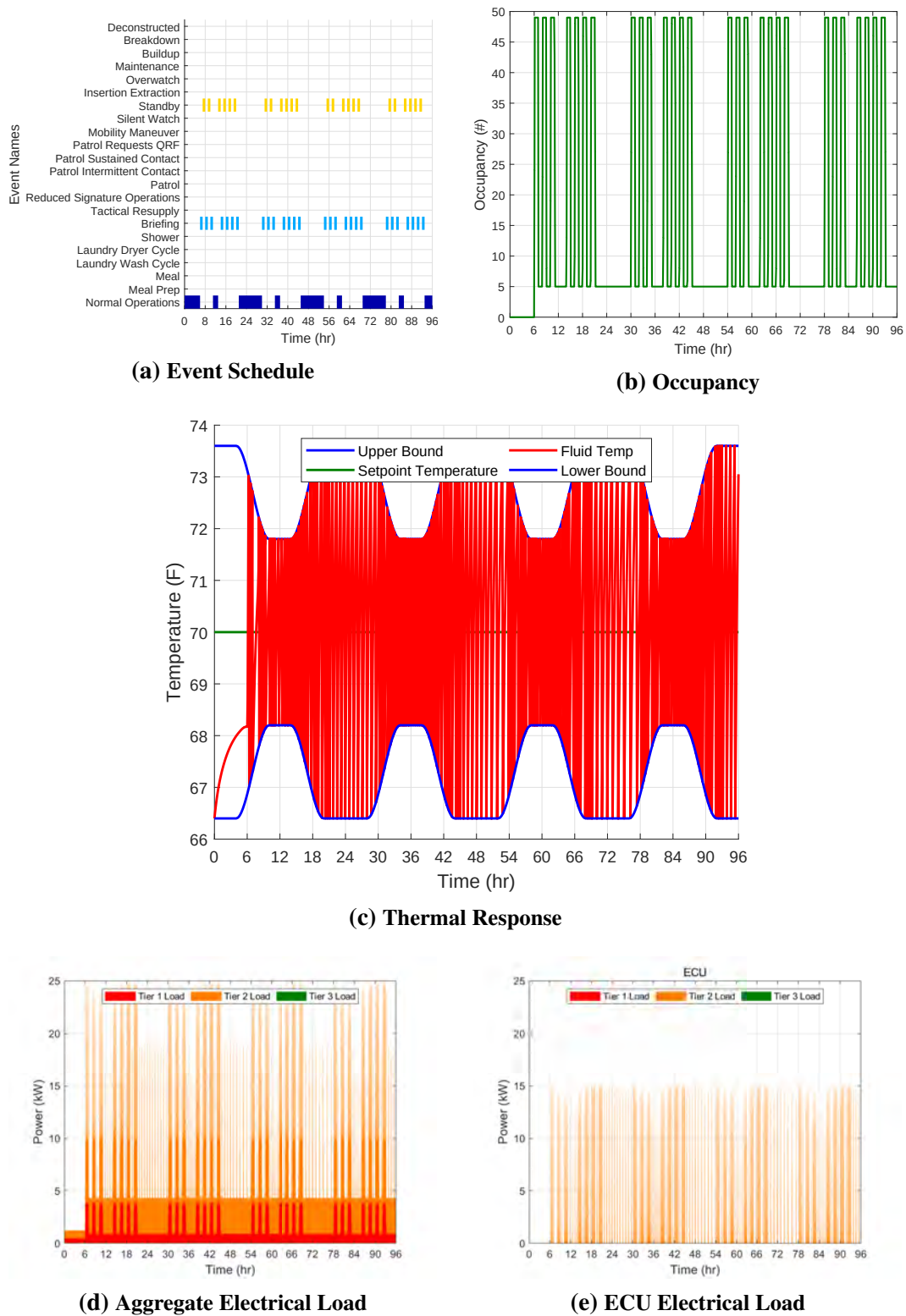
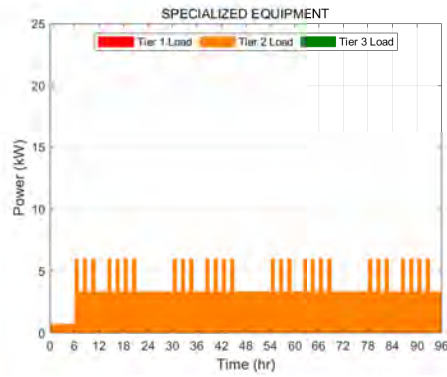
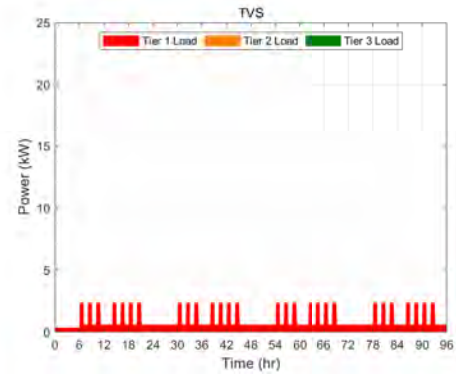


Fig. B-80 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



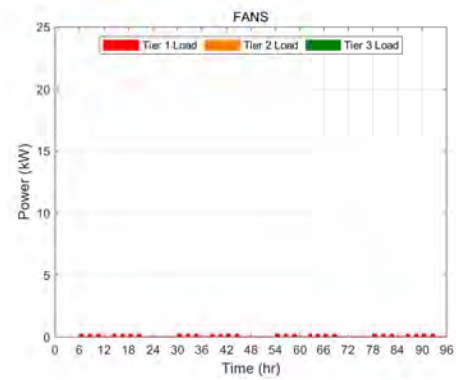
(a) Specialized Equipment Tiered Electrical Load



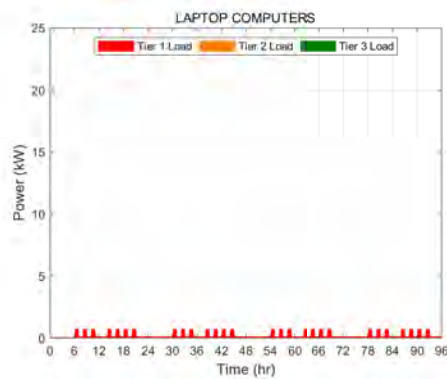
(b) Televisions Tiered Electrical Load



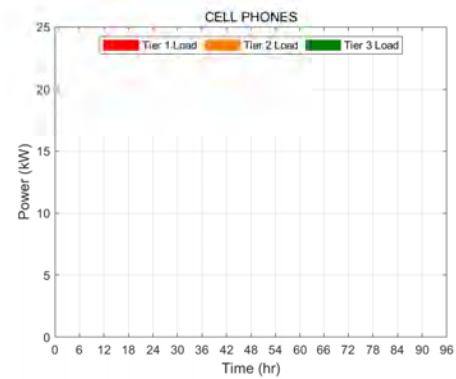
(c) Shop Lights Tiered Electrical Load



(d) Fans Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-81 The electrical components housed within the military shelter

B.41 COC Submaster B

The shelter labeled as COC submaster B was used as a secondary COC shelter. The maximum capacity of the shelter was estimated to be 35 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to assist the master COC shelter to manage the energy network's operation.

The event schedule (Fig. B-82a), the time-varying occupancy (Fig. B-82b), the resulting thermal response (Fig. B-82c), aggregate electrical load (Fig. B-82d), and the ECU electrical load (Fig. B-82e) are provided in Fig. B-82.

The shelter labeled as COC submaster B contains six separate electrical components including 1) specialized equipment (Fig. B-83a), 2) televisions (Fig. B-83b), 3) shop lights (Fig. B-83c), 4) fans (Fig. B-83d), 5) laptop computers (Fig. B-83e), and 6) cell phones (Fig. B-83f), all of which is shown in Fig. B-83.

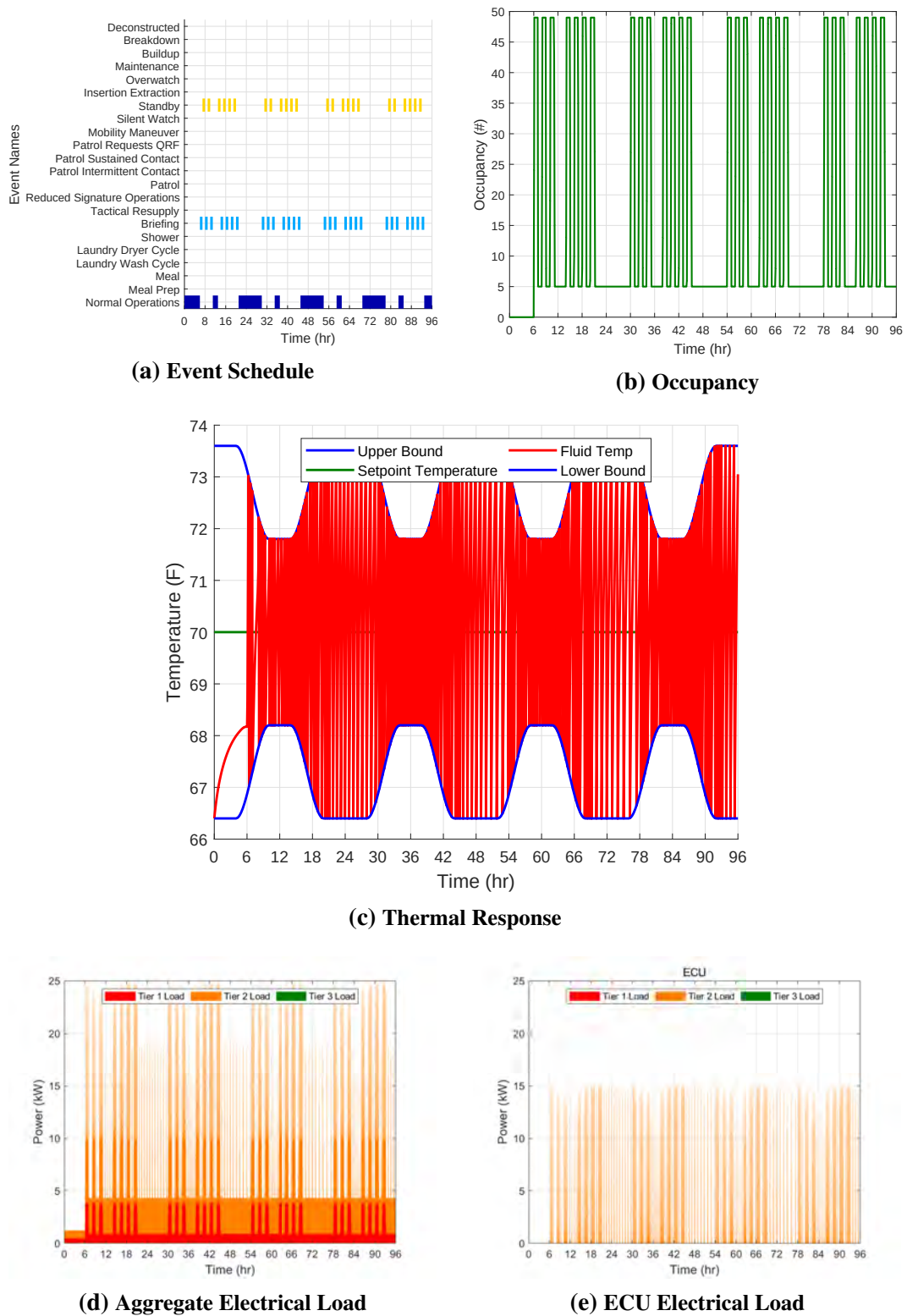
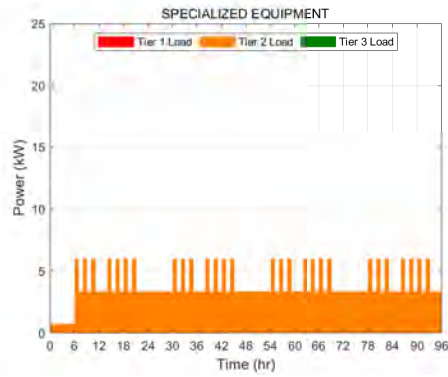
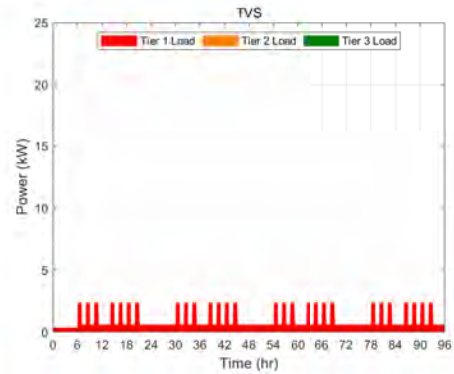


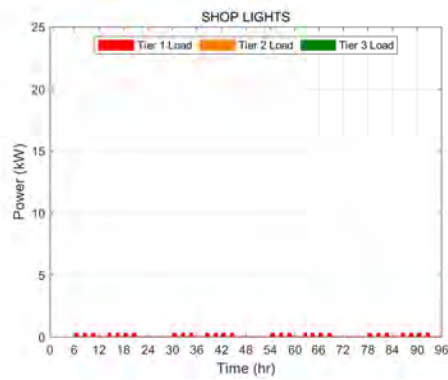
Fig. B-82 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



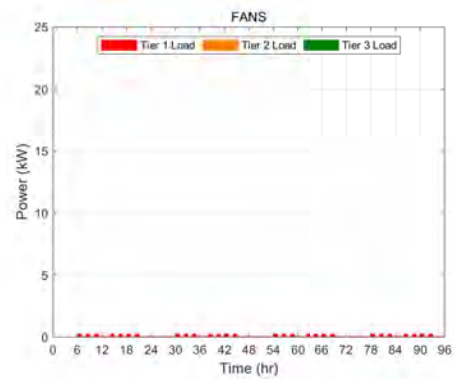
(a) Specialized Equipment Tiered Electrical Load



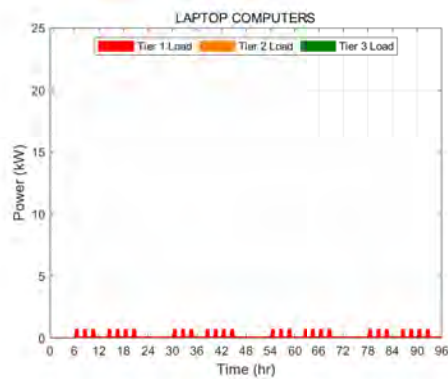
(b) Televisions Tiered Electrical Load



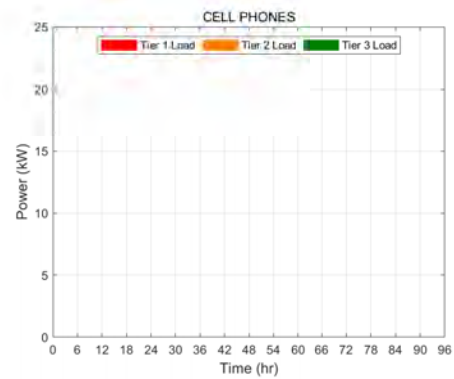
(c) Shop Lights Tiered Electrical Load



(d) Fans Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-83 The electrical components housed within the military shelter

B.42 COM Master A

The shelter labeled as COM master A was used as the primary COM shelter. The maximum capacity of the shelter was estimated to be 35 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to manage the energy network's communications.

The event schedule (Fig. B-84a), the time-varying occupancy (Fig. B-84b), the resulting thermal response (Fig. B-84c), aggregate electrical load (Fig. B-84d), and the ECU electrical load (Fig. B-84e) are provided in Fig. B-84.

The shelter labeled as COM master A contains eight separate electrical components including 1) specialized equipment (Fig. B-85a), 2) televisions (Fig. B-85b), 3) shop lights (Fig. B-85c), 4) fans (Fig. B-85d), 5) laptop computers (Fig. B-86a), 6) cell phones (Fig. B-86b), 7) microwaves (Fig. B-86c), and 8) hot plates (Fig. B-86d), all of which is shown in Fig. B-85 and Fig. B-86.

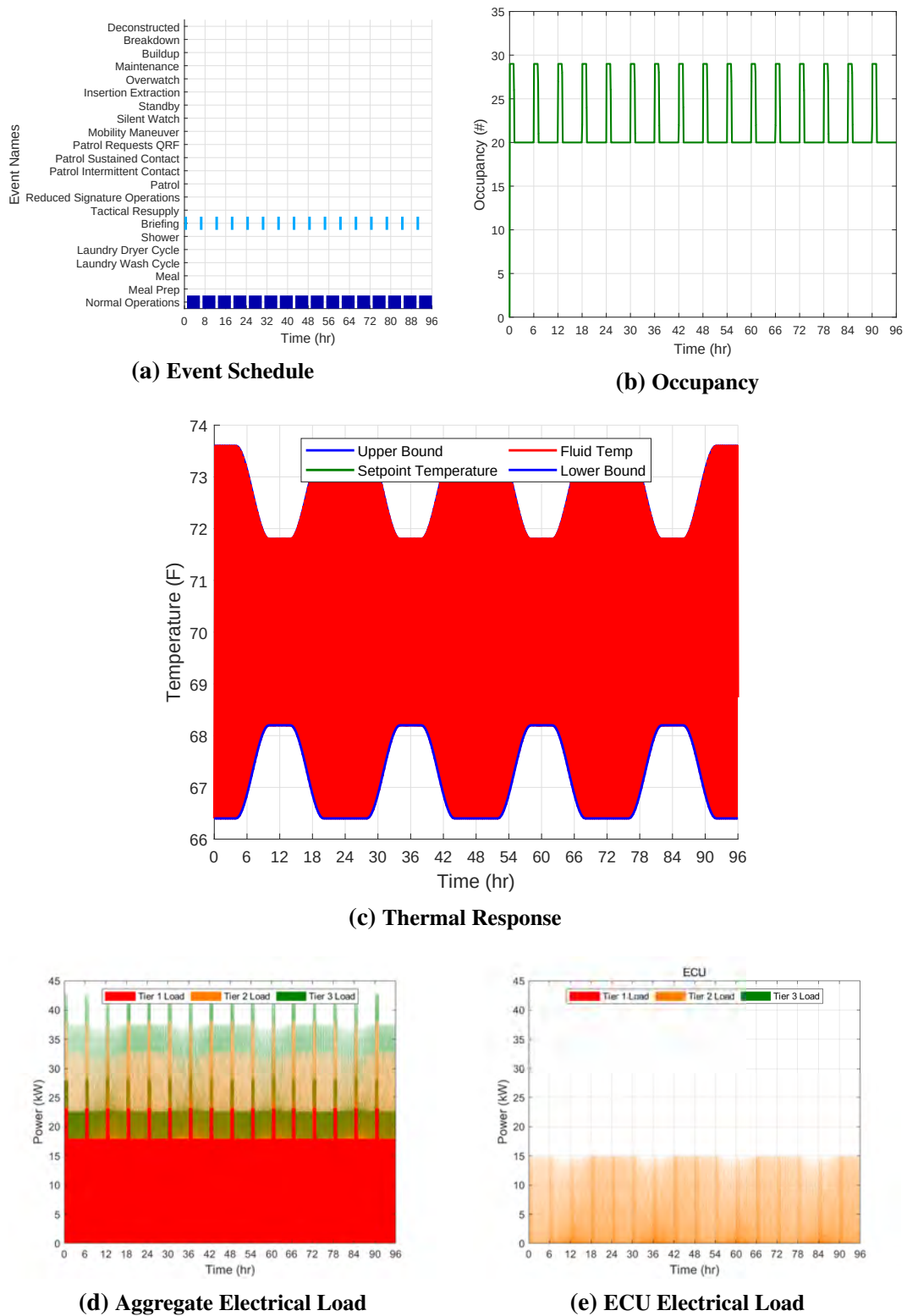
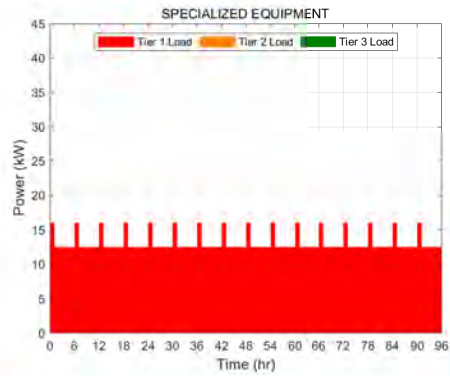
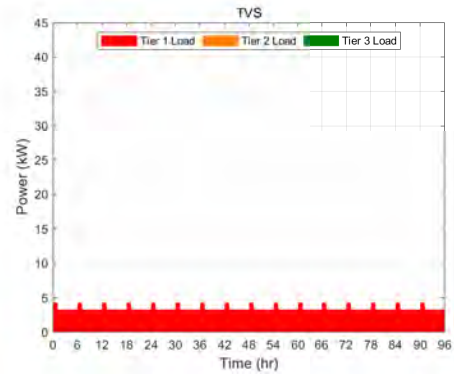


Fig. B-84 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



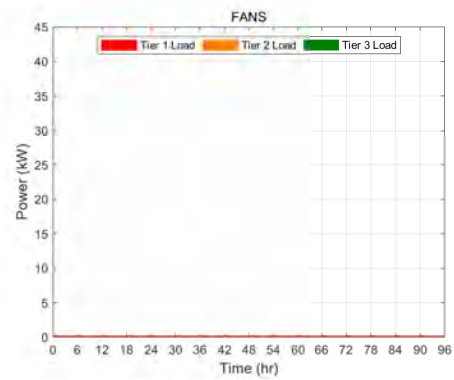
(a) Specialized Equipment Tiered Electrical Load



(b) Televisions Tiered Electrical Load

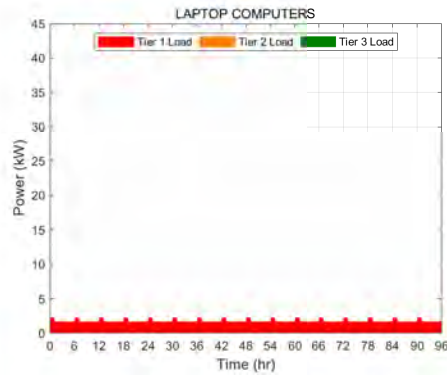


(c) Shop Lights Tiered Electrical Load

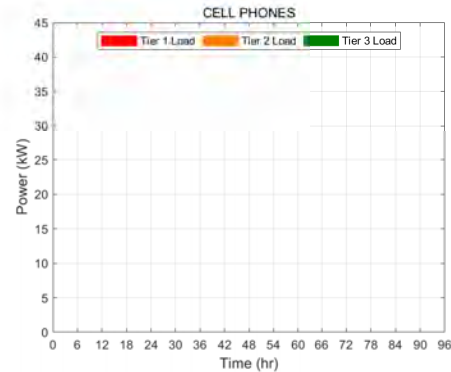


(d) Fans Tiered Electrical Load

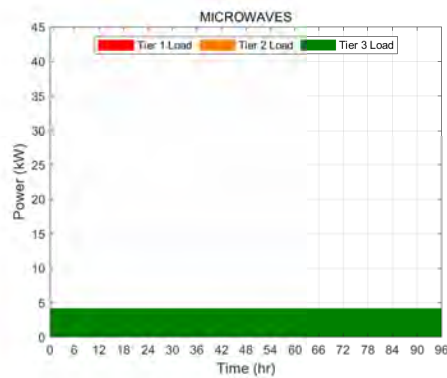
Fig. B-85 The electrical components housed within the military shelter



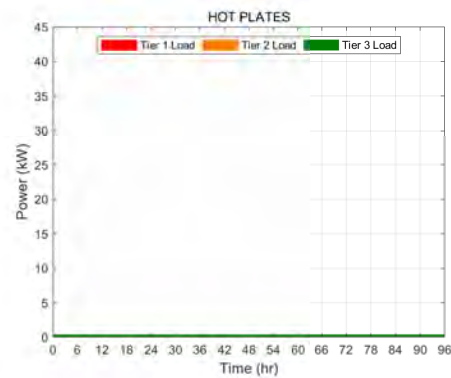
(a) Laptop Computers Tiered Electrical Load



(b) Cell Phones Tiered Electrical Load



(c) Microwaves Tiered Electrical Load



(d) Hot Plates Tiered Electrical Load

Fig. B-86 The electrical components housed within the military shelter

B.43 COM Submaster A

The shelter labeled as COM submaster A was used as a secondary COM shelter. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to assist the master COM shelter to manage the energy network's communications.

The event schedule (Fig. B-87a), the time-varying occupancy (Fig. B-87b), the resulting thermal response (Fig. B-87c), aggregate electrical load (Fig. B-87d), and the ECU electrical load (Fig. B-87e) are provided in Fig. B-87.

The shelter labeled as COM submaster A contains six separate electrical components including 1) specialized equipment (Fig. B-88a), 2) televisions (Fig. B-88b),

3) shop lights (Fig. B-88c), 4) fans (Fig. B-88d), 5) laptop computers (Fig. B-88e), and 6) cell phones (Fig. B-88f), all of which is shown in Fig. B-88.

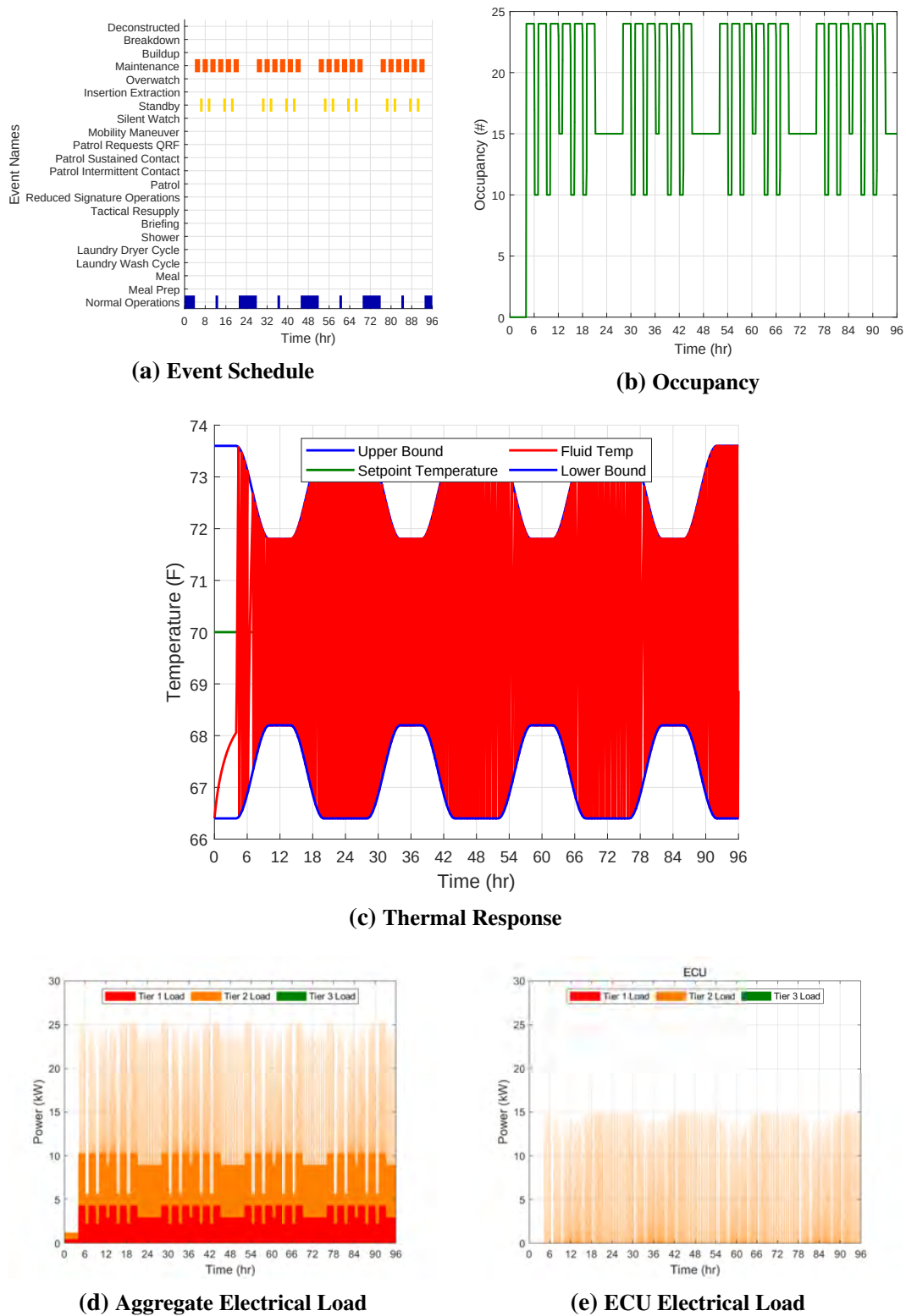
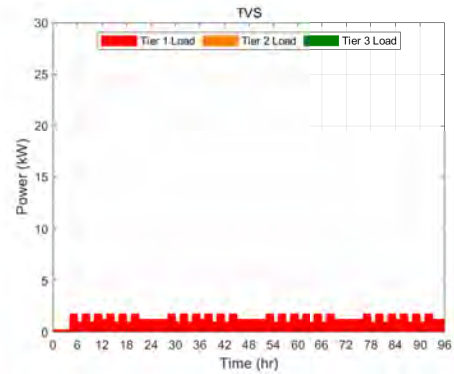


Fig. B-87 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



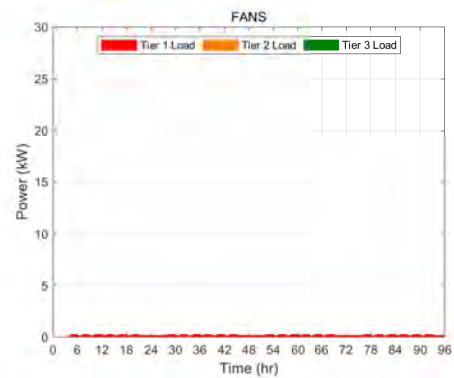
(a) Specialized Equipment Tiered Electrical Load



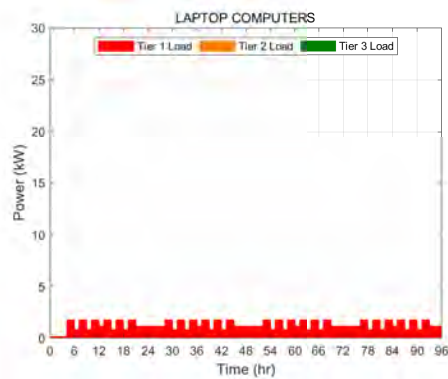
(b) Televisions Tiered Electrical Load



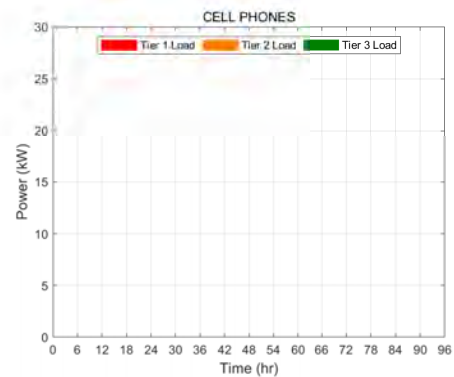
(c) Shop Lights Tiered Electrical Load



(d) Fans Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-88 The electrical components housed within the military shelter

B.44 COM Submaster B

The shelter labeled as COM submaster B was used as a secondary COM shelter. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to assist the master COM shelter to manage the energy network's communications.

The event schedule (Fig. B-89a), the time-varying occupancy (Fig. B-89b), the resulting thermal response (Fig. B-89c), aggregate electrical load (Fig. B-89d), and the ECU electrical load (Fig. B-89e) are provided in Fig. B-89.

The shelter labeled as COM submaster B contains six separate electrical components including 1) specialized equipment (Fig. B-90a), 2) televisions (Fig. B-90b), 3) shop lights (Fig. B-90c), 4) fans (Fig. B-90d), 5) laptop computers (Fig. B-90e), and 6) cell phones (Fig. B-90f), all of which is shown in Fig. B-90.

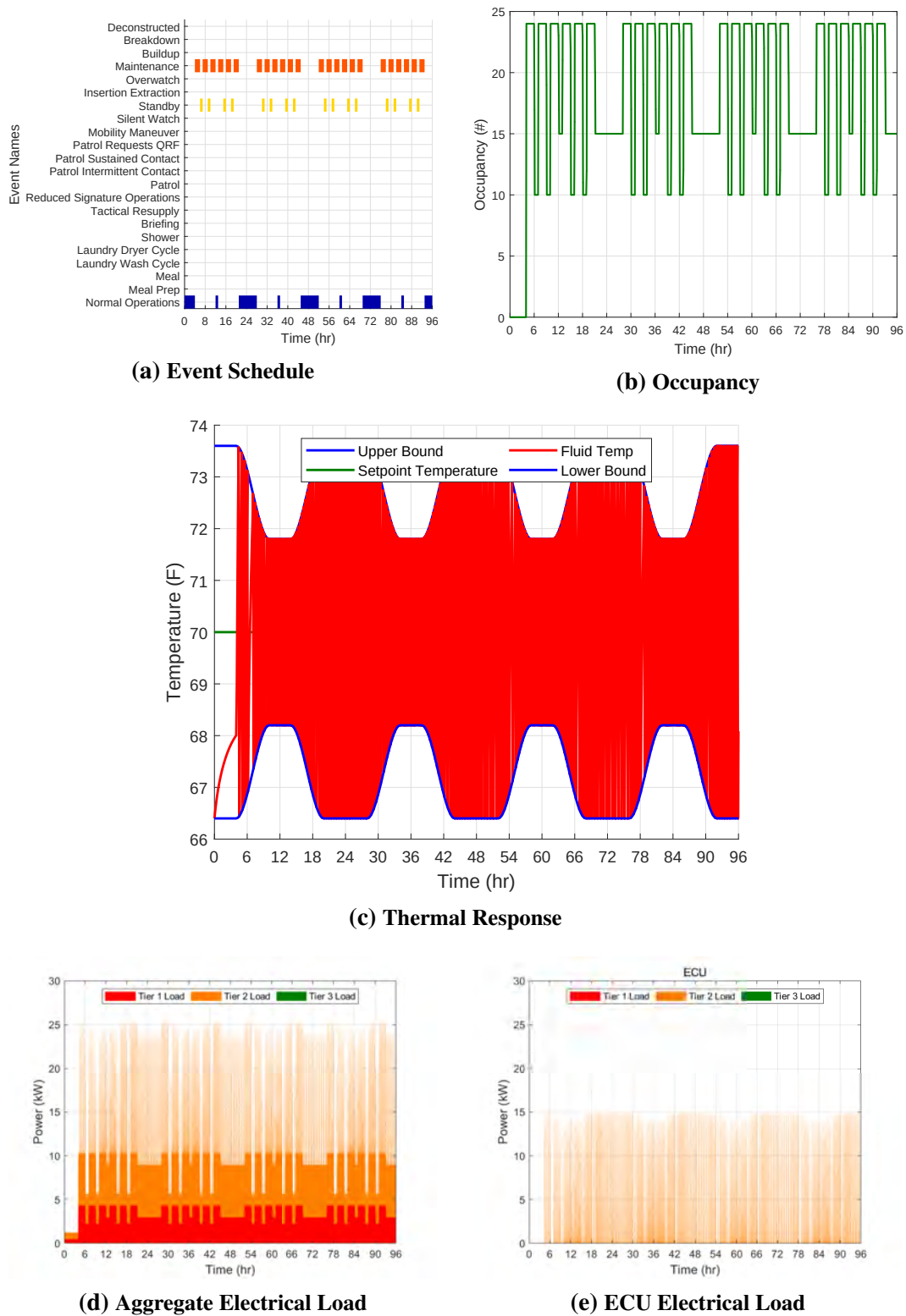
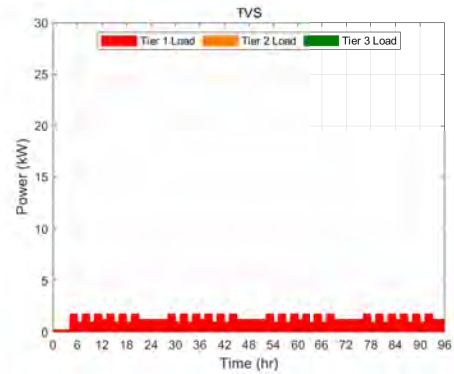


Fig. B-89 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



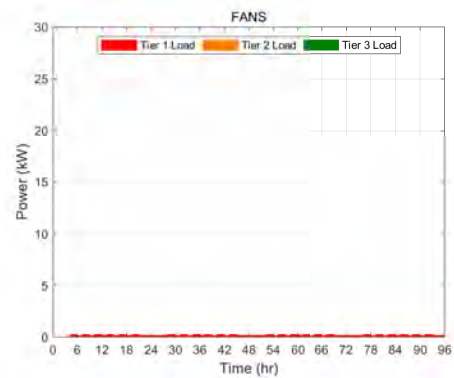
(a) Specialized Equipment Tiered Electrical Load



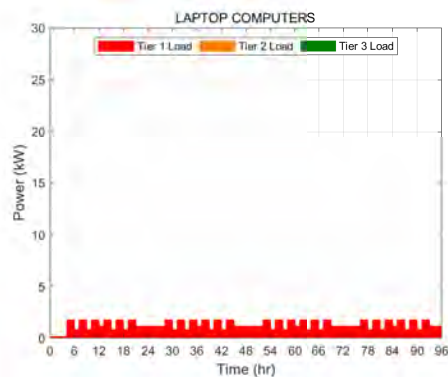
(b) Televisions Tiered Electrical Load



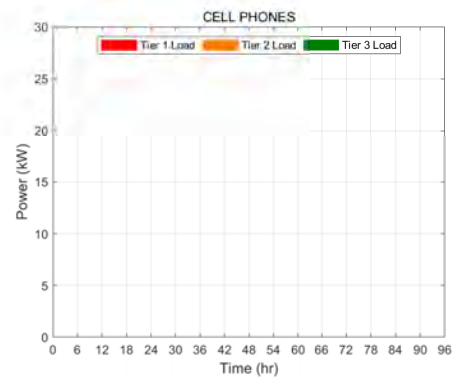
(c) Shop Lights Tiered Electrical Load



(d) Fans Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-90 The electrical components housed within the military shelter

B.45 Office A

The shelter labeled as office A was used as an office. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house miscellaneous electrical equipment that could be used for briefings and miscellaneous other tasks.

The event schedule (Fig. B-91a), the time-varying occupancy (Fig. B-91b), the resulting thermal response (Fig. B-91c), aggregate electrical load (Fig. B-91d), and the ECU electrical load (Fig. B-91e) are provided in Fig. B-91.

The shelter labeled as office A contains six separate electrical components including 1) specialized equipment (Fig. B-92a), 2) televisions (Fig. B-92b), 3) shop lights (Fig. B-92c), 4) fans (Fig. B-92d), 5) laptop computers (Fig. B-92e), and 6) cell phones (Fig. B-92f), all of which is shown in Fig. B-92.

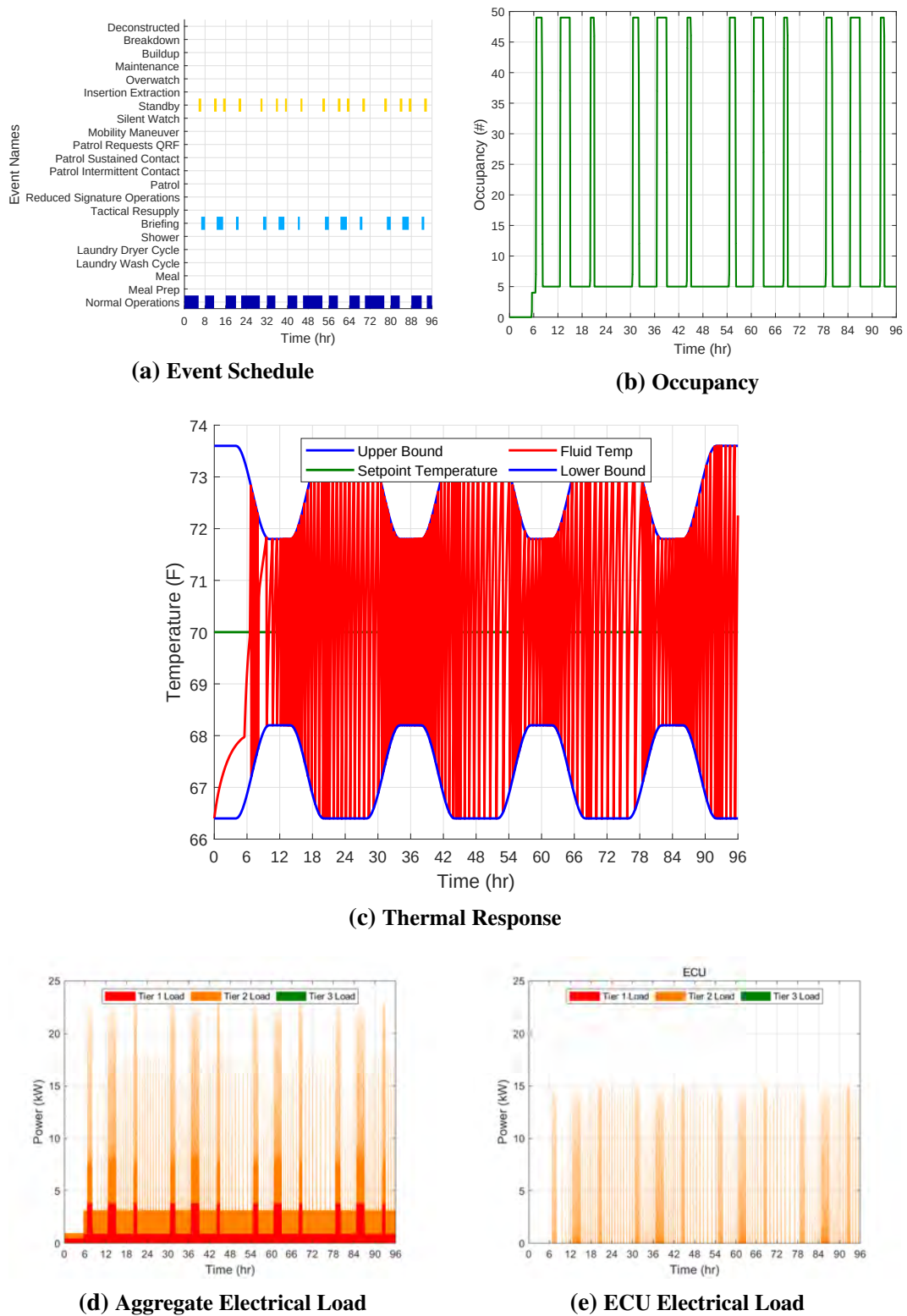
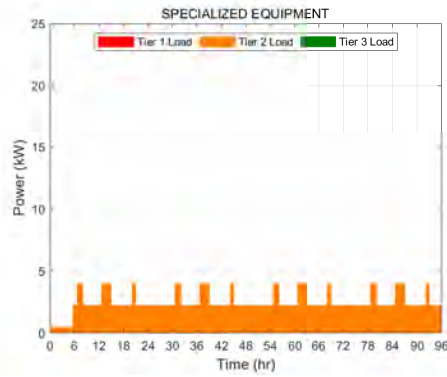
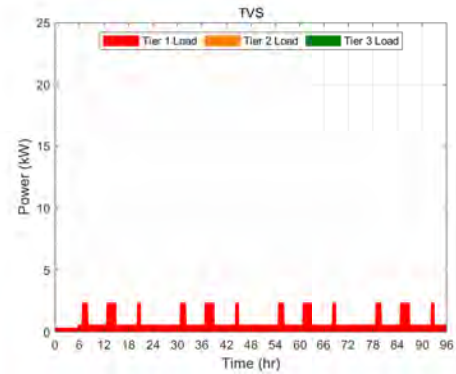


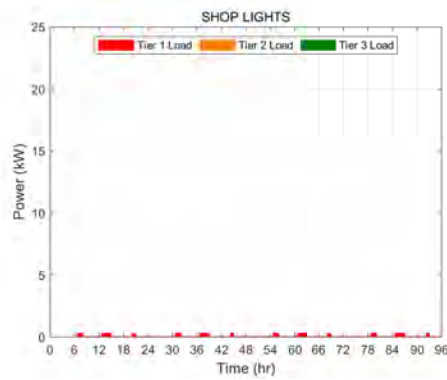
Fig. B-91 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



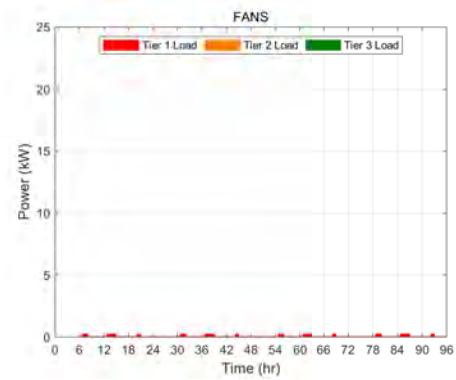
(a) Specialized Equipment Tiered Electrical Load



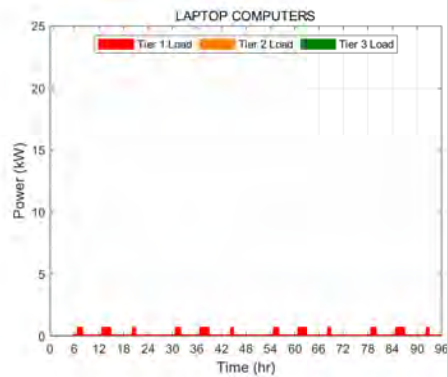
(b) Televisions Tiered Electrical Load



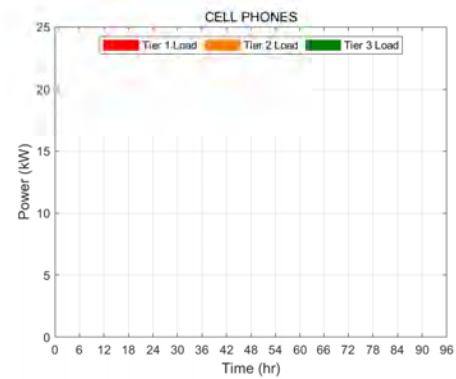
(c) Shop Lights Tiered Electrical Load



(d) Fans Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-92 The electrical components housed within the military shelter

B.46 Office B

The shelter labeled as office B was used as an office. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house miscellaneous electrical equipment that could be used for briefings and miscellaneous other tasks.

The event schedule (Fig. B-93a), the time-varying occupancy (Fig. B-93b), the resulting thermal response (Fig. B-93c), aggregate electrical load (Fig. B-93d), and the ECU electrical load (Fig. B-93e) are provided in Fig. B-93.

The shelter labeled as office B contains six separate electrical components including 1) specialized equipment (Fig. B-94a), 2) televisions (Fig. B-94b), 3) shop lights (Fig. B-94c), 4) fans (Fig. B-94d), 5) laptop computers (Fig. B-94e), and 6) cell phones (Fig. B-94f), all of which is shown in Fig. B-94.

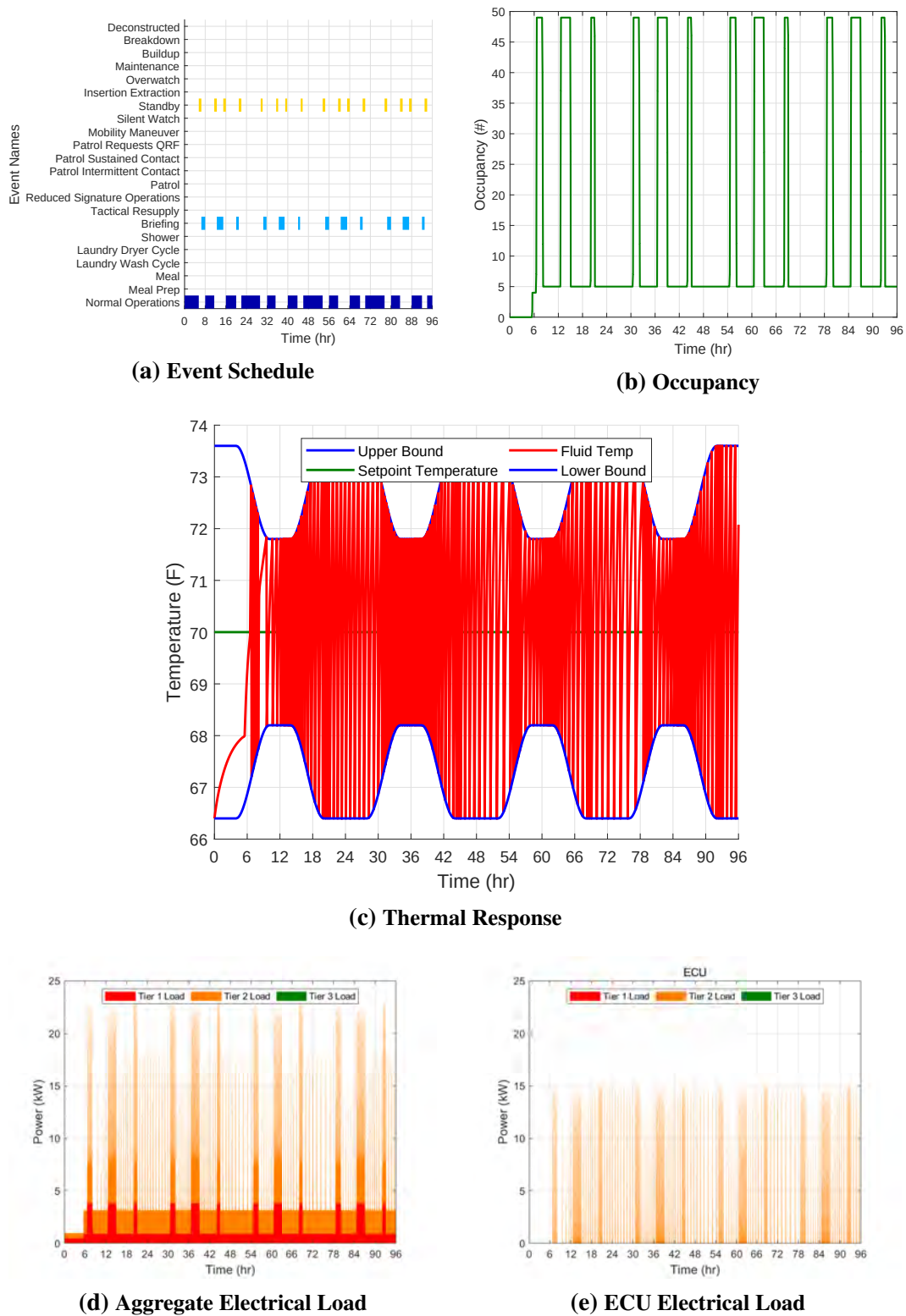
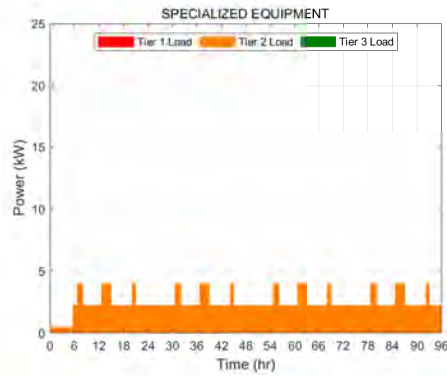
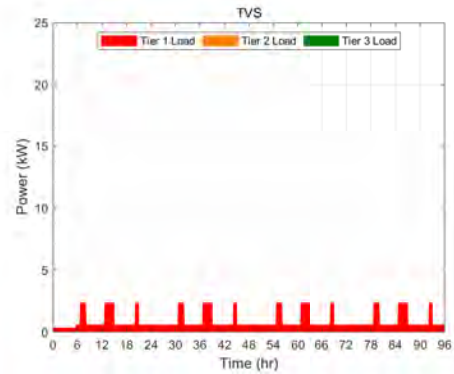


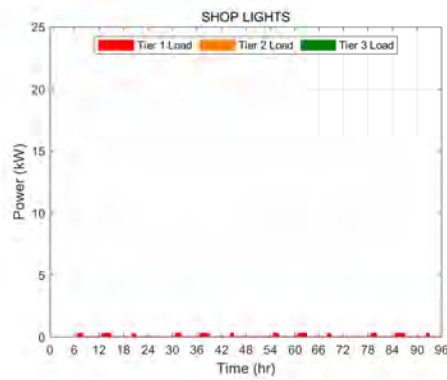
Fig. B-93 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



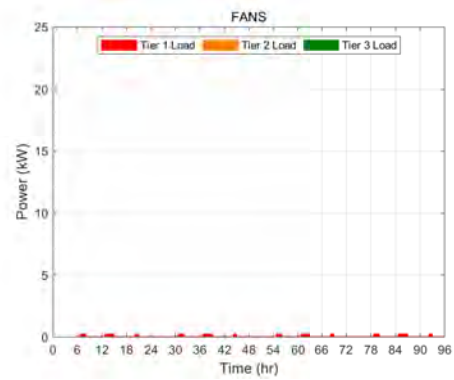
(a) Specialized Equipment Tiered Electrical Load



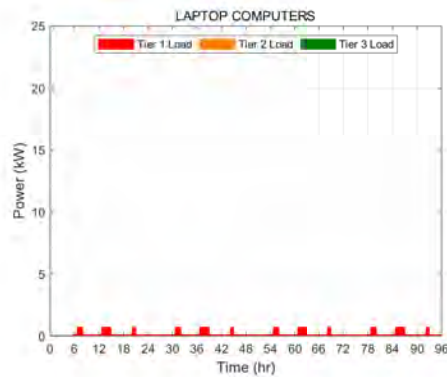
(b) Televisions Tiered Electrical Load



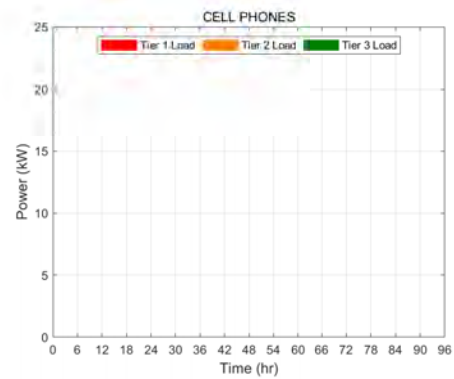
(c) Shop Lights Tiered Electrical Load



(d) Fans Tiered Electrical Load



(e) Laptop Computers Tiered Electrical Load



(f) Cell Phones Tiered Electrical Load

Fig. B-94 The electrical components housed within the military shelter

B.47 Depot A

The shelter labeled as depot A was used a vehicle depot. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house electrical equipment used to conduct maintenance of military vehicles.

The event schedule (Fig. B-95a), the time-varying occupancy (Fig. B-95b), the resulting thermal response (Fig. B-95c), aggregate electrical load (Fig. B-95d), and the ECU electrical load (Fig. B-95e) are provided in Fig. B-95.

The shelter labeled as depot A contains five separate electrical components including 1) specialized equipment (Fig. B-96a), 2) shop lights (Fig. B-96b), 3) fans (Fig. B-96c), 4) laptop computers (Fig. B-96d), and 5) cell phones (Fig. B-96e), all of which is shown in Fig. B-96.

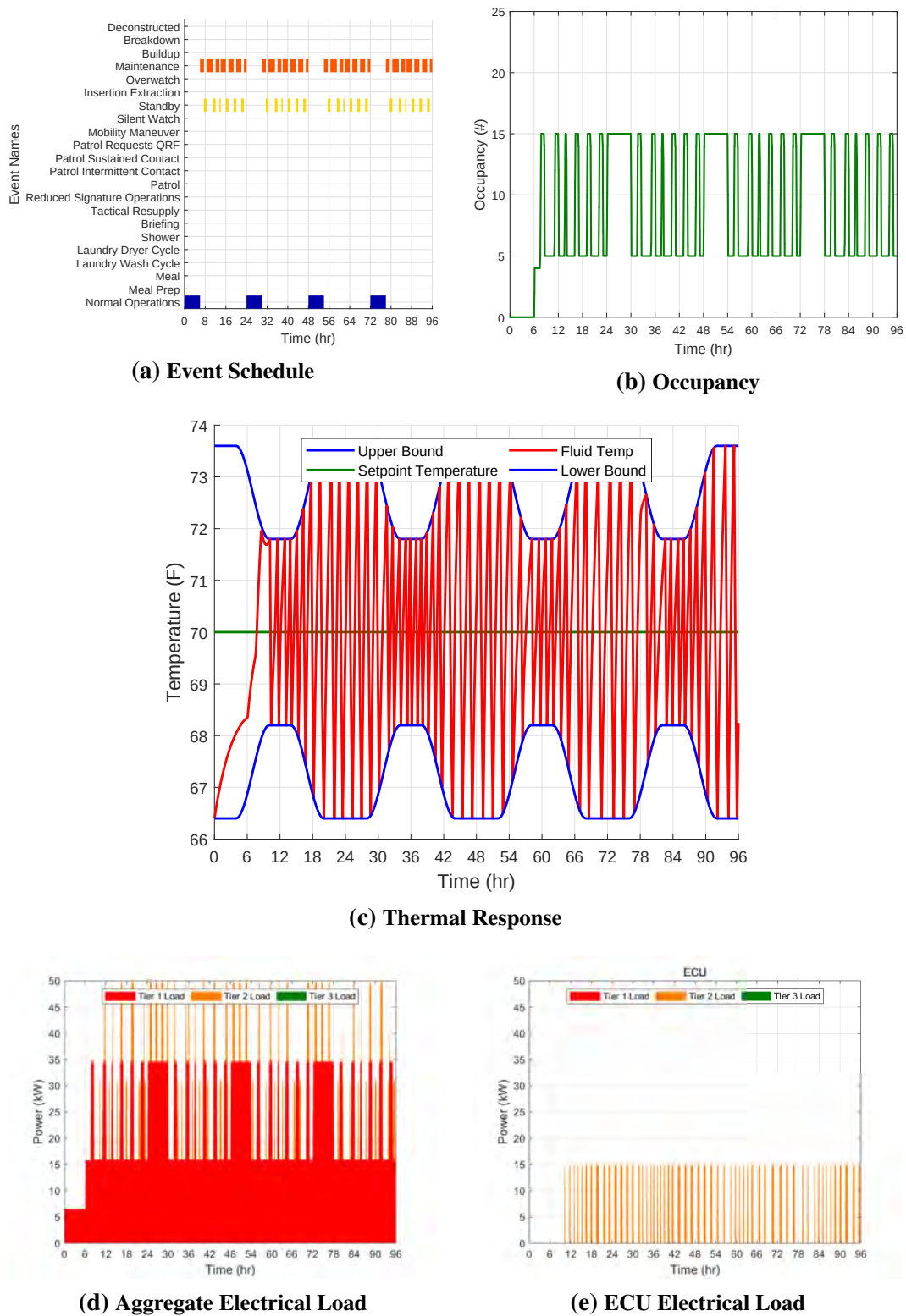
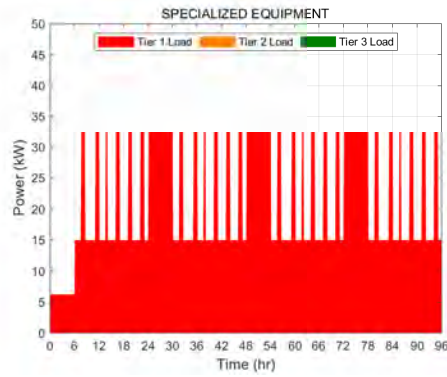


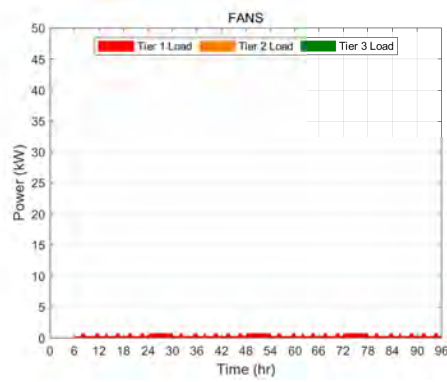
Fig. B-95 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Specialized Equipment Tiered Electrical Load



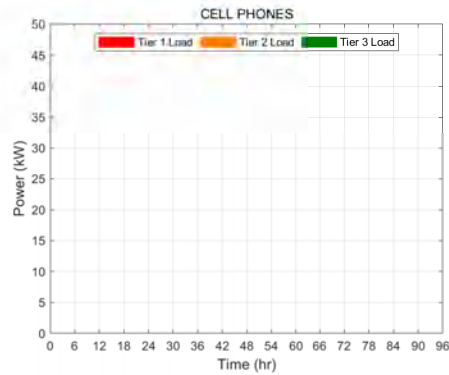
(b) Shop Lights Tiered Electrical Load



(c) Fans Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-96 The electrical components housed within the military shelter

B.48 Depot B

The shelter labeled as depot B was used a vehicle depot. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house electrical equipment used to conduct maintenance of military vehicles.

The event schedule (Fig. B-97a), the time-varying occupancy (Fig. B-97b), the resulting thermal response (Fig. B-97c), aggregate electrical load (Fig. B-97d), and the ECU electrical load (Fig. B-97e) are provided in Fig. B-97.

The shelter labeled as depot B contains five separate electrical components including 1) specialized equipment (Fig. B-98a), 2) shop lights (Fig. B-98b), 3) fans (Fig. B-98c), 4) laptop computers (Fig. B-98d), and 5) cell phones (Fig. B-98e), all of which is shown in Fig. B-98.

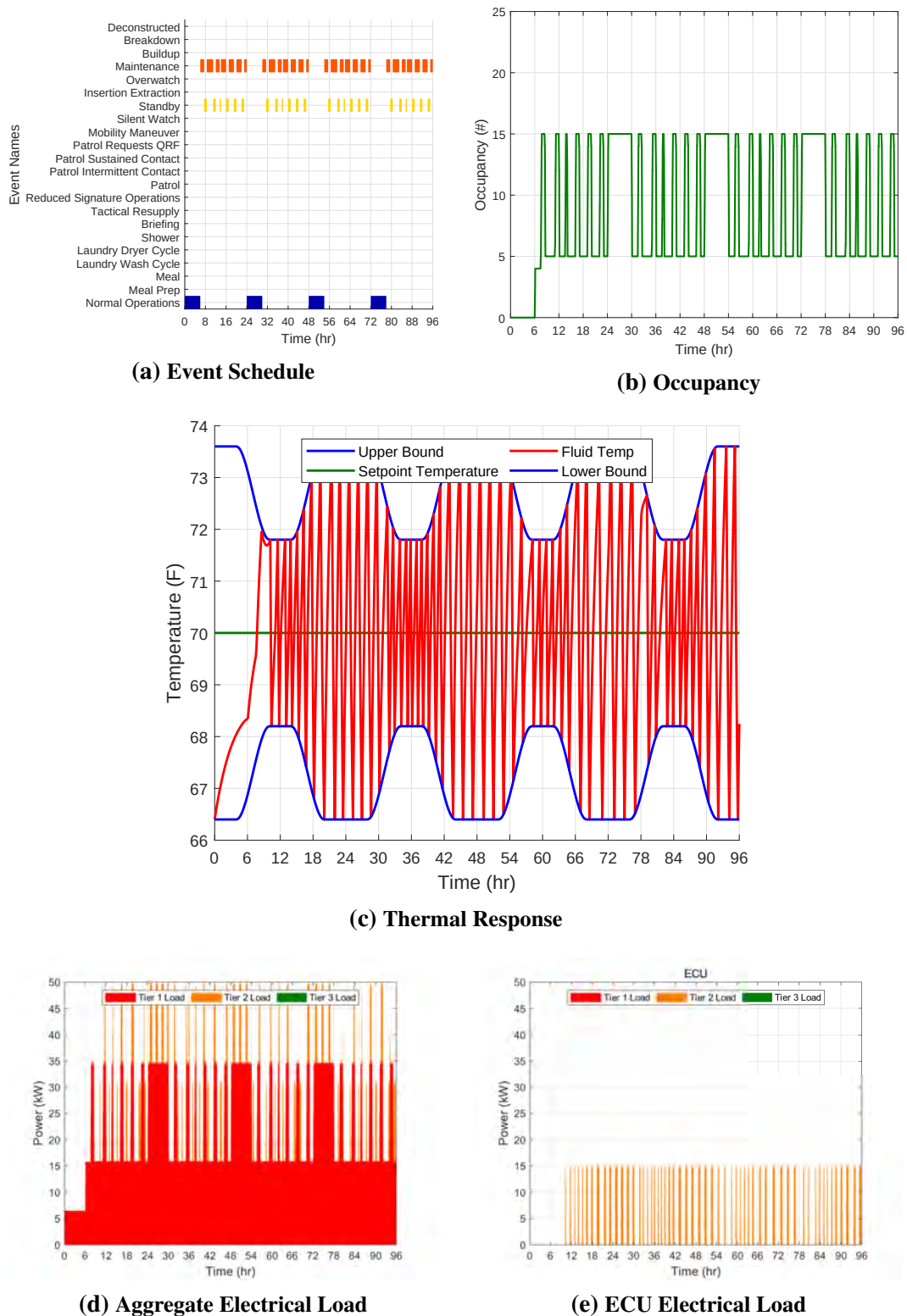
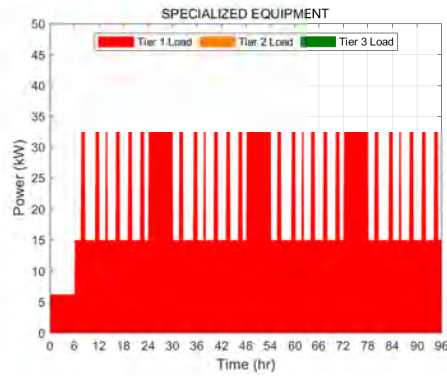


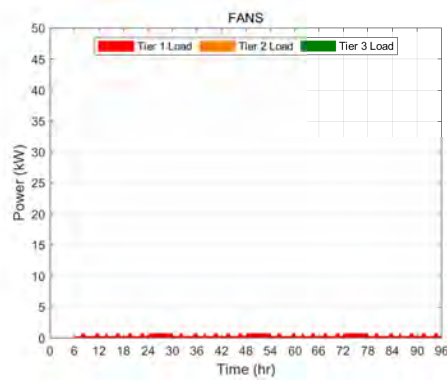
Fig. B-97 The scenario's event schedule, occupancy, thermal response, the aggregate tiered electrical load, and the ECU tiered electrical load



(a) Specialized Equipment Tiered Electrical Load



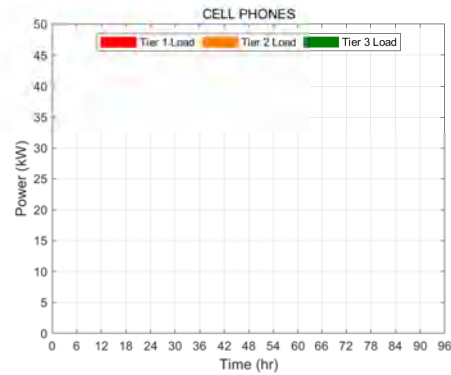
(b) Shop Lights Tiered Electrical Load



(c) Fans Tiered Electrical Load



(d) Laptop Computers Tiered Electrical Load



(e) Cell Phones Tiered Electrical Load

Fig. B-98 The electrical components housed within the military shelter

Appendix C. Limited Tactical Resupply Combat Outpost

Using MATLAB/Simulink, we created a set of blocks that can emulate our various electrical components as shown in Section 5, all of which are contained in various military type shelters as shown in Section 6. The individual shelter results for the limited tactical resupply combat outpost (COP) scenario have been separated into multiple subsections of this appendix. Some of the shelter configurations were essentially duplicated, however, when the parameters were loaded into MATLAB, some of the thermal-based parameters were amended to incorporate randomness. For this scenario, there are 6 guard stations, 20 enlisted billeting shelters, 10 officer billeting shelters, 2 mess shelters, 2 kitchen shelters (kitchen A and B), 2 laundry shelters (laundry a and b), 2 shower shelters, 1 Combat Operations Center (COC) master shelter, 2 COC submaster shelters, 1 Communications (COM) master shelter, 2 COM submaster shelters, 2 office shelters, and 2 depot shelters resulting in 48 shelters. Each of the shelters electrical and thermal responses are highlighted within the subsequent sections as dictated by Tables C-1 through C-3. The aggregation of the E&P response of each shelter is then provided in Section 9.

Table C-1 Summary of shelter results (part 1)

Shelter designation	Section
Guard Station A	C.1
Guard Station B	C.2
Guard Station C	C.3
Guard Station D	C.4
Guard Station E	C.5
Guard Station F	C.6
COC Master	C.7
COM Master	C.8
COC Submaster A	C.9
COM Submaster A	C.10
COC Submaster B	C.11
COM Submaster B	C.12

Table C-2 Summary of shelter results (part 2)

Shelter designation	Section
Officer Billeting A	C.13
Officer Billeting B	C.14
Officer Billeting C	C.15
Officer Billeting D	C.16
Officer Billeting E	C.17
Officer Billeting F	C.18
Enlisted Billeting A	C.19
Enlisted Billeting B	C.20
Enlisted Billeting C	C.21
Enlisted Billeting D	C.22
Enlisted Billeting E	C.23
Enlisted Billeting F	C.24

Table C-3 Summary of shelter results (part 3)

Shelter designation	Section
Office A	C.25
Office B	C.26
Office C	C.27
Office D	C.28
Depot	C.29
MESS A	C.30
MESS B	C.31
Shower A	C.32
Shower B	C.33

C.1 Guard Station A

The shelter labeled as guard station A was configured as a guard station. The maximum capacity of the shelter was estimated to be six Soldiers. The shelter's occupancy is agnostic of the events. Only in cases of high-tend security will the shelter reach its maximum occupancy. For all other times, the shelter remains at half occupancy. The event schedule (Fig. C-1), the time-varying occupancy (Fig. C-2), the resulting thermal response (Fig. C-3), and the aggregate electrical load (Fig. C-4).

The shelter contains four separate electrical components including 1) specialized equipment (Fig. C-5), 2) shop lights (Fig. C-6), 3) laptop computers (Fig. C-7), and

4) cell phones (Fig. C-8).

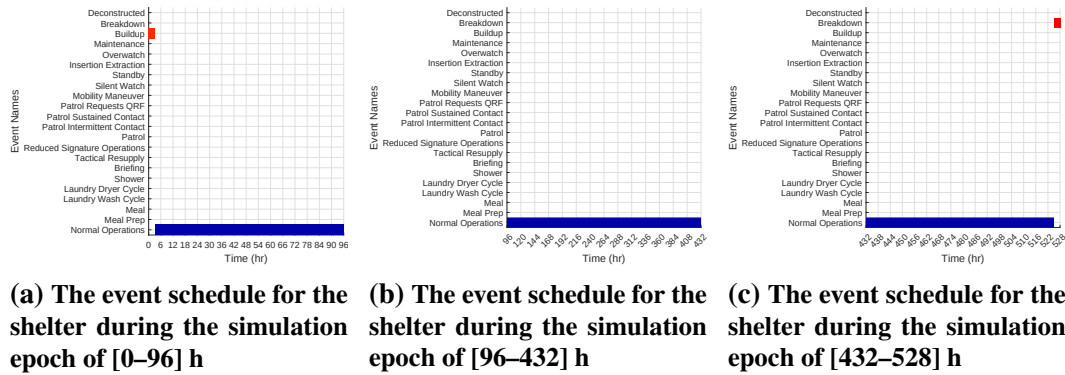


Fig. C-1 The event schedule for the shelter labeled as guard station A

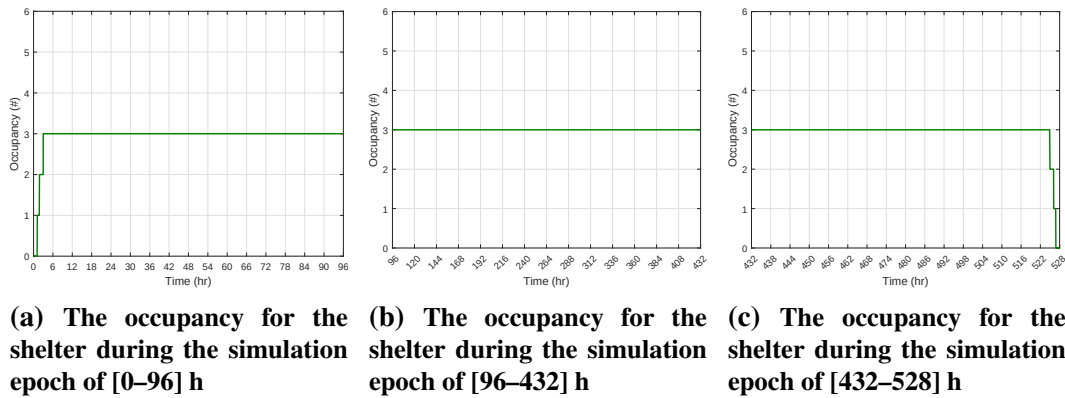


Fig. C-2 The occupancy for the shelter labeled as guard station A

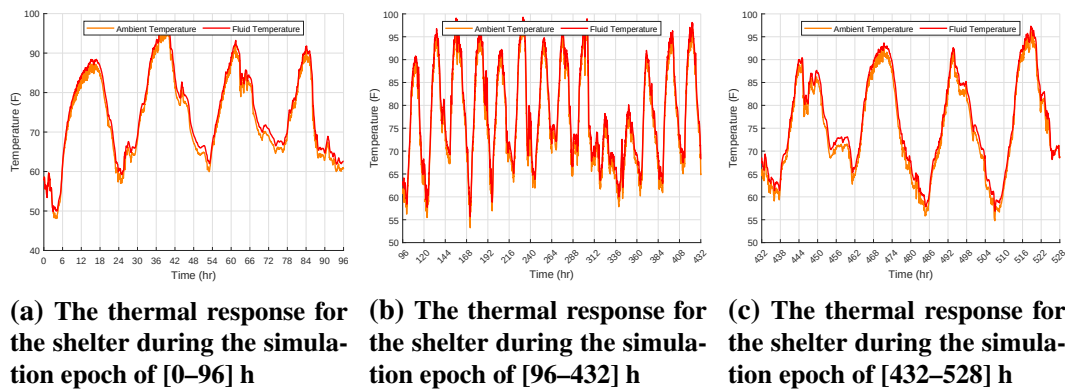


Fig. C-3 The thermal response for the shelter labeled as guard station A

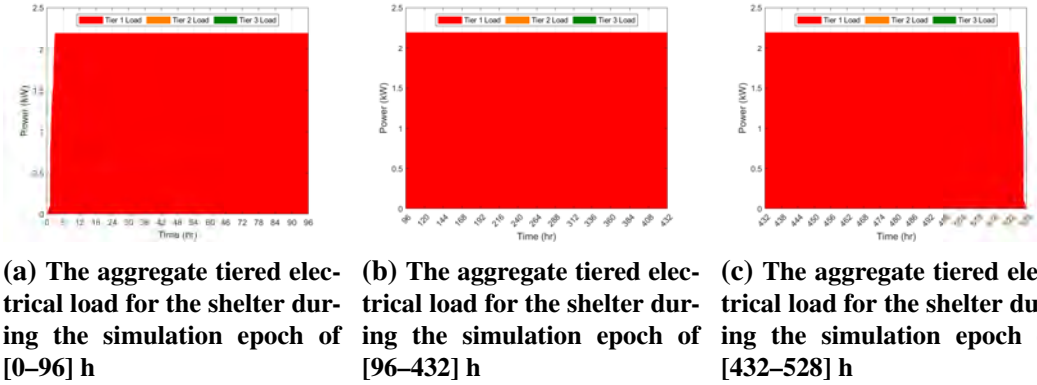


Fig. C-4 The aggregate tiered electrical load for the shelter labeled as guard station A

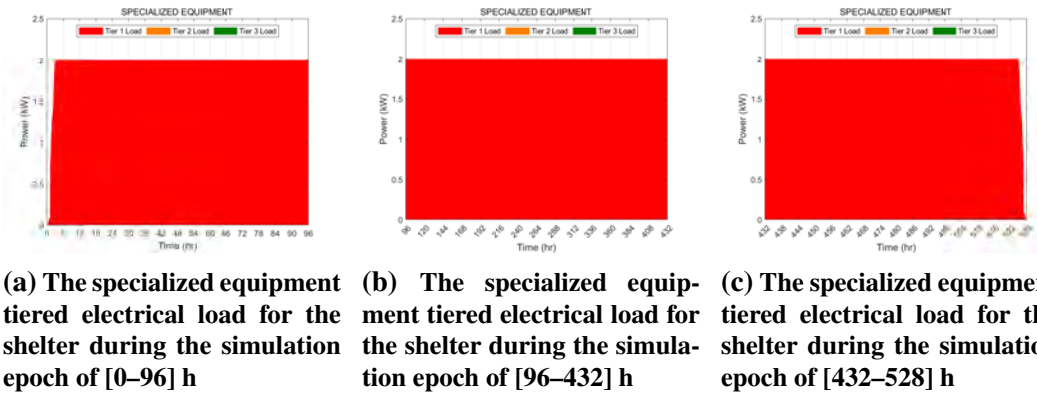
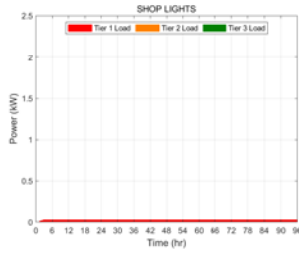
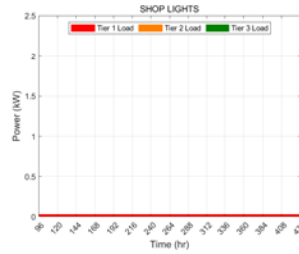


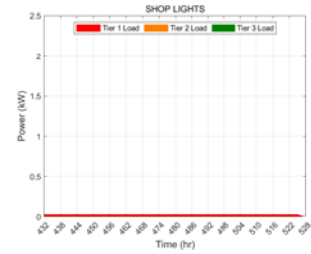
Fig. C-5 The specialized equipment tiered electrical load for the shelter labeled as guard station A



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-6 The shop lights tiered electrical load for the shelter labeled as guard station A



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0–96] h

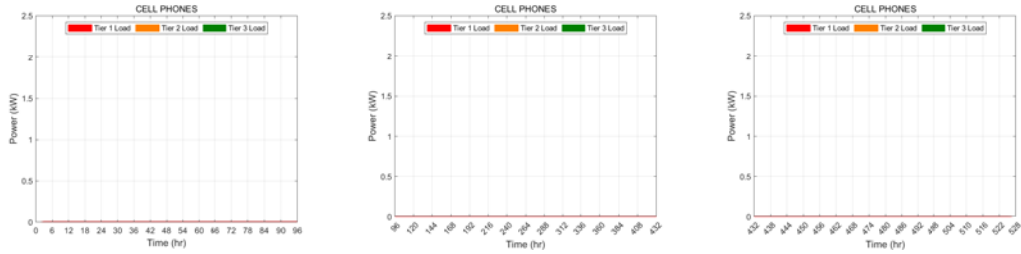


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-7 The laptop computers tiered electrical load for the shelter labeled as guard station A



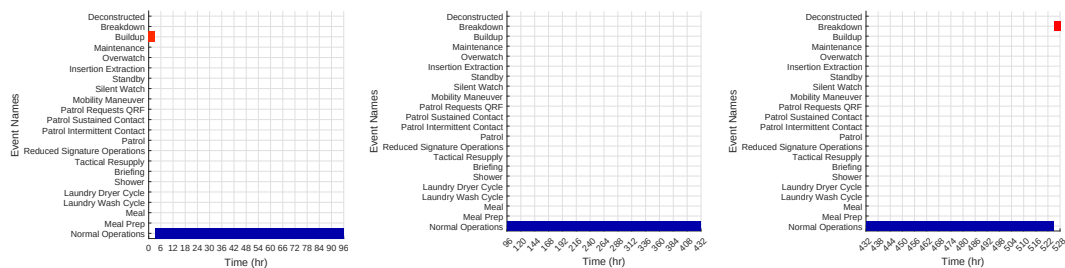
(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-8 The cell phones tiered electrical load for the shelter labeled as guard station A

C.2 Guard Station B

The shelter labeled as guard station B was configured as a guard station. The maximum capacity of the shelter was estimated to be six Soldiers. The shelter’s occupancy is agnostic of the events. Only in cases of high-tend security will the shelter reach its maximum occupancy. For all other times, the shelter remains at half occupancy. The event schedule (Fig. C-9), the time-varying occupancy (Fig. C-10), the resulting thermal response (Fig. C-11), and the aggregate electrical load (Fig. C-12).

The shelter contains four separate electrical components including 1) specialized equipment (Fig. C-13), 2) shop lights (Fig. C-14), 3) laptop computers (Fig. C-15), and 4) cell phones (Fig. C-16).



(a) The event schedule for the shelter during the simulation epoch of [0–96] h (b) The event schedule for the shelter during the simulation epoch of [96–432] h (c) The event schedule for the shelter during the simulation epoch of [432–528] h

Fig. C-9 The event schedule for the shelter labeled as guard station B

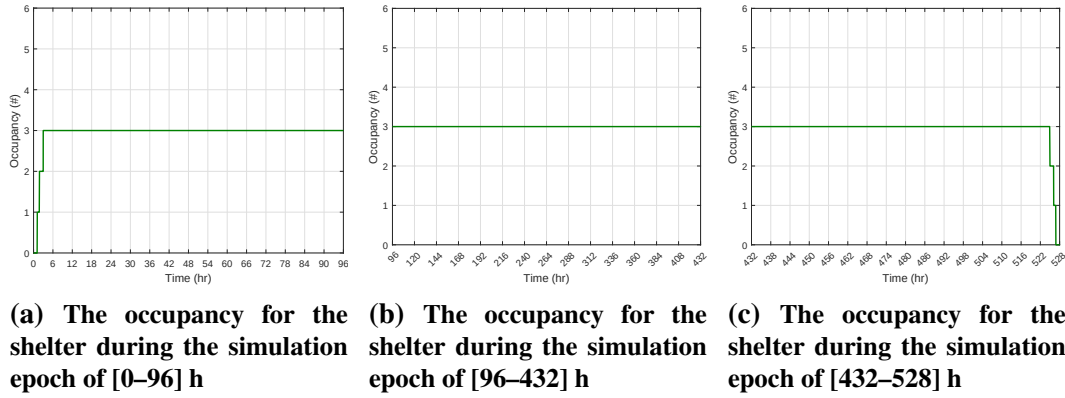


Fig. C-10 The occupancy for the shelter labeled as guard station B

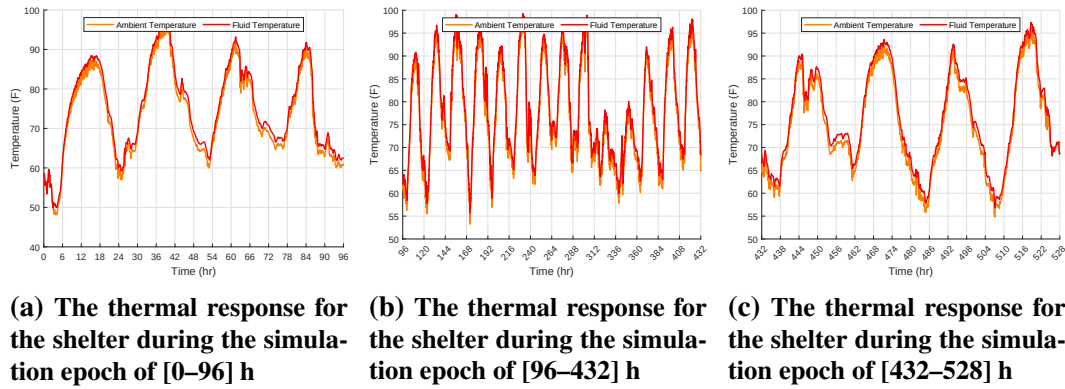


Fig. C-11 The thermal response for the shelter labeled as guard station B

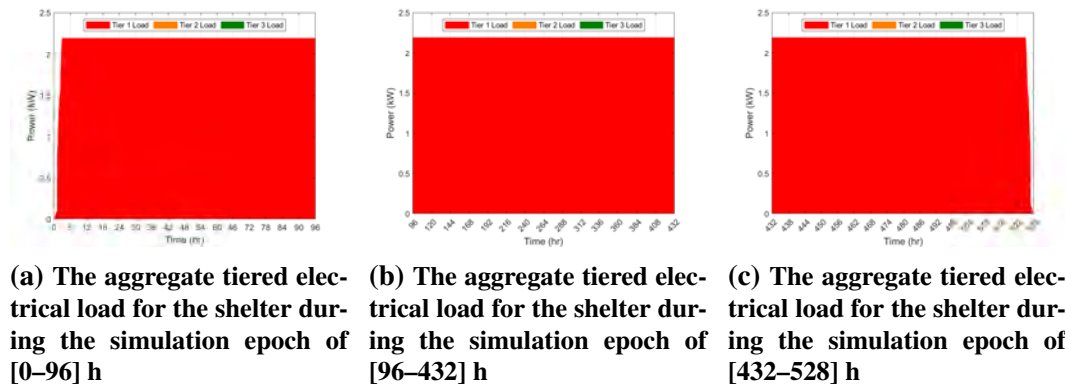


Fig. C-12 The aggregate tiered electrical load for the shelter labeled as guard station B

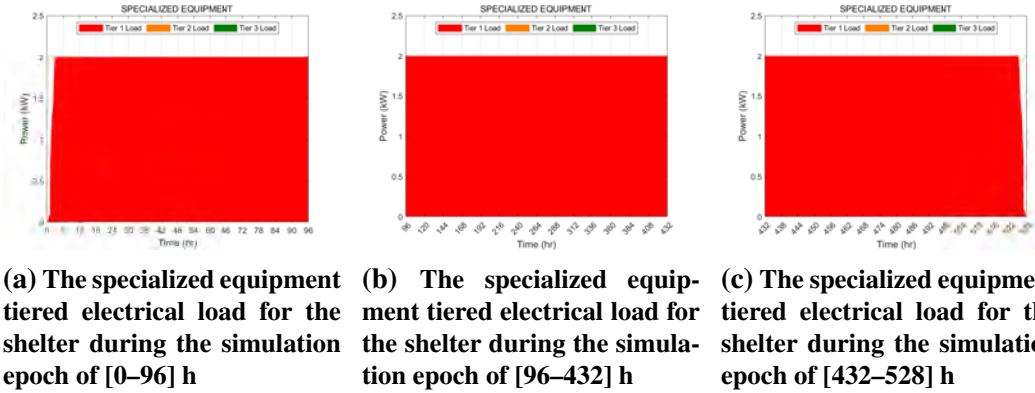


Fig. C-13 The specialized equipment tiered electrical load for the shelter labeled as guard station B

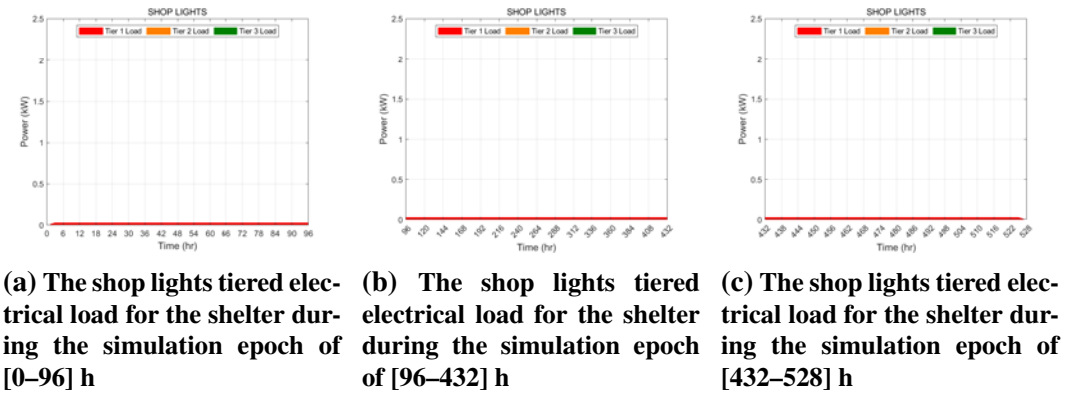


Fig. C-14 The shop lights tiered electrical load for the shelter labeled as guard station B

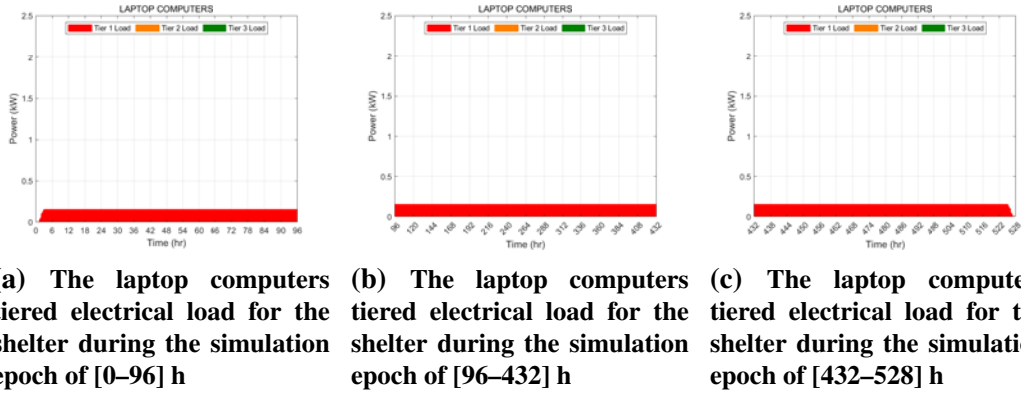


Fig. C-15 The laptop computers tiered electrical load for the shelter labeled as guard station B

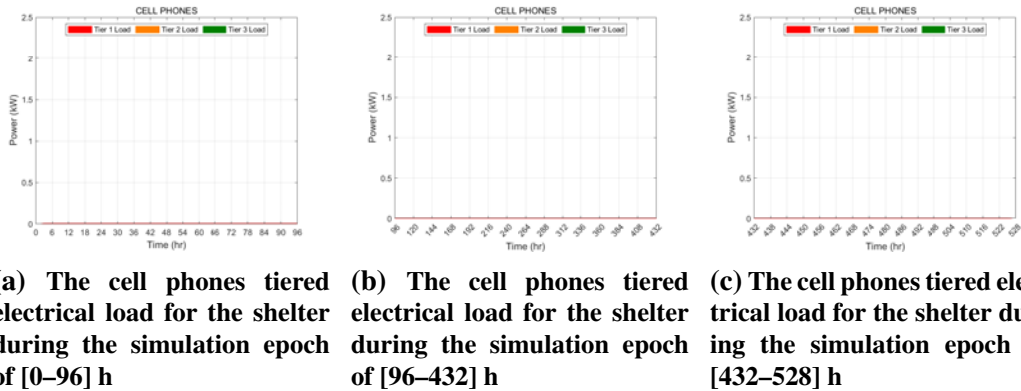


Fig. C-16 The cell phones tiered electrical load for the shelter labeled as guard station B

C.3 Guard Station C

The shelter labeled as guard station C was configured as a guard station. The maximum capacity of the shelter was estimated to be six Soldiers. The shelter's occupancy is agnostic of the events. Only in cases of high-tend security will the shelter reach its maximum occupancy. For all other times, the shelter remains at half occupancy. The event schedule (Fig. C-17), the time-varying occupancy (Fig. C-18), the resulting thermal response (Fig. C-19), and the aggregate electrical load (Fig. C-20).

The shelter contains four separate electrical components including 1) specialized equipment (Fig. C-21), 2) shop lights (Fig. C-22), 3) laptop computers (Fig. C-23),

and 4) cell phones (Fig. C-24).

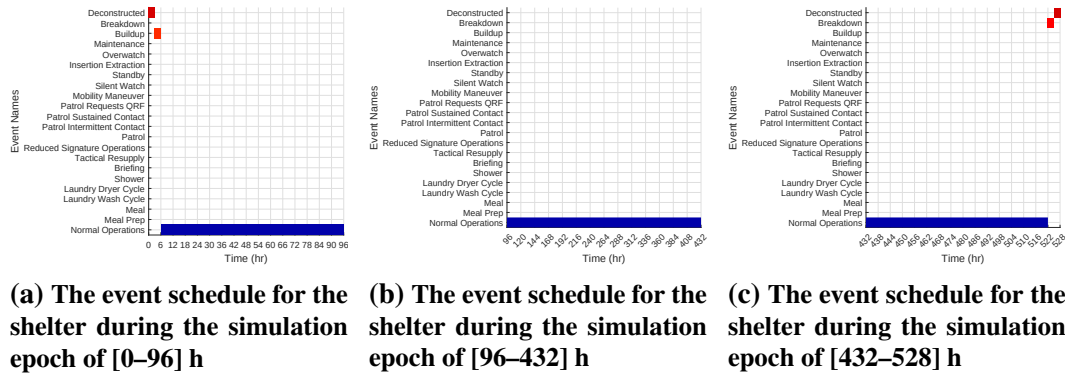


Fig. C-17 The event schedule for the shelter labeled as guard station C

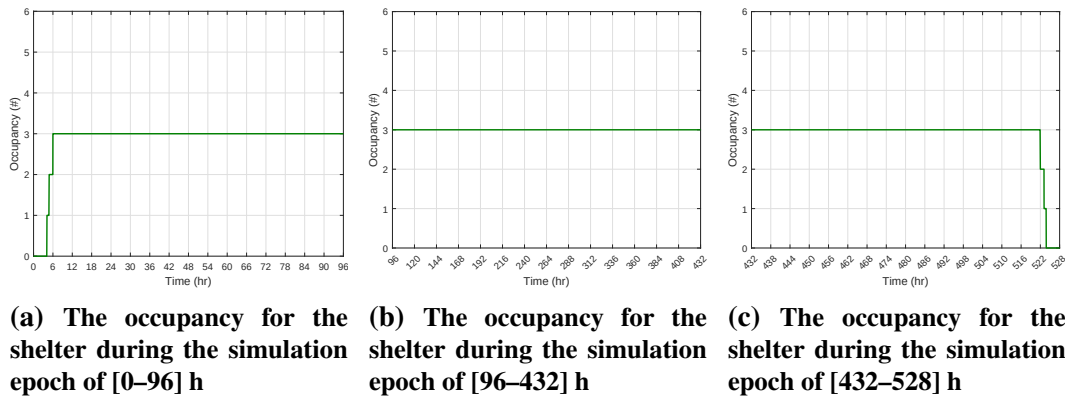


Fig. C-18 The occupancy for the shelter labeled as guard station C

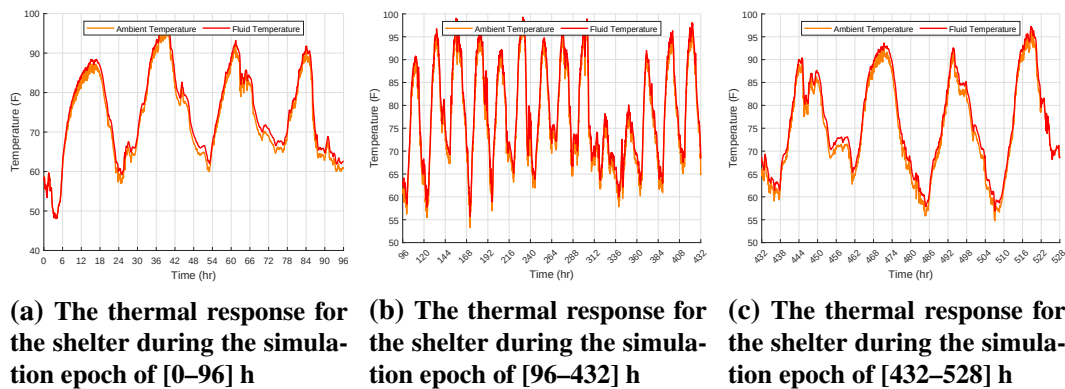


Fig. C-19 The thermal response for the shelter labeled as guard station C

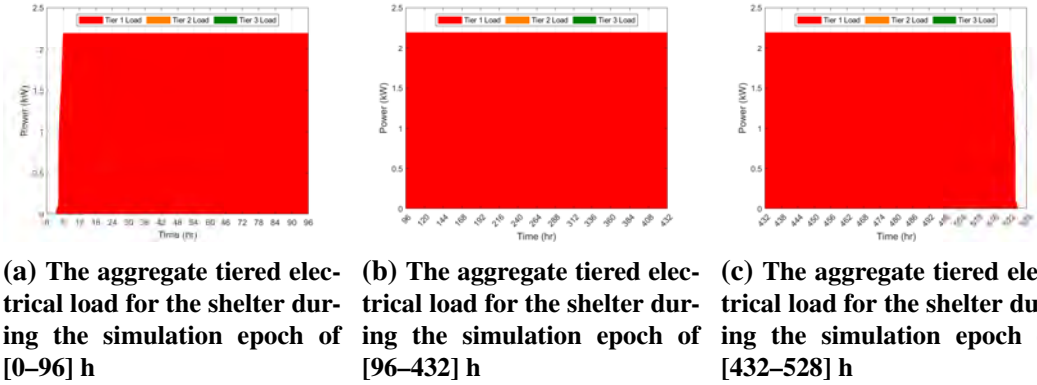


Fig. C-20 The aggregate tiered electrical load for the shelter labeled as guard station C

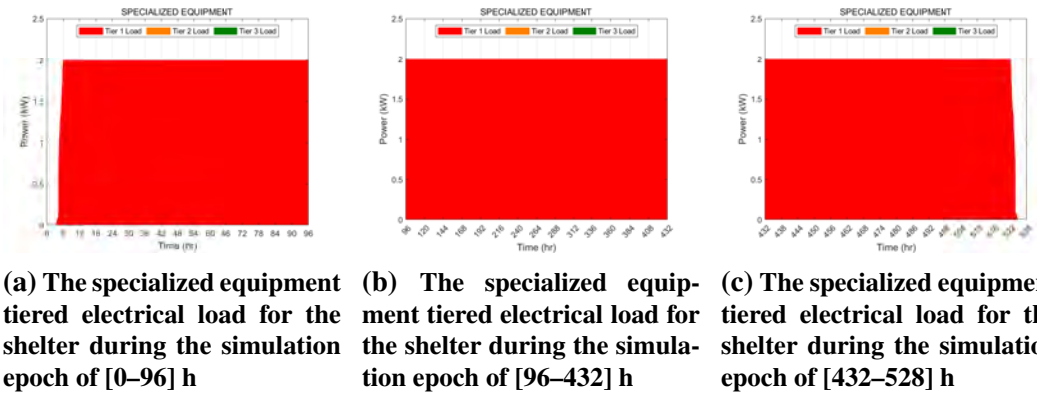
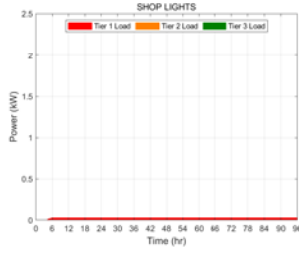
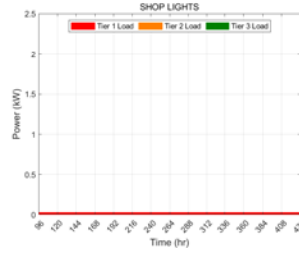


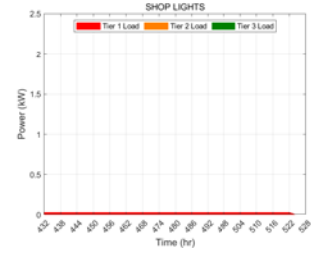
Fig. C-21 The specialized equipment tiered electrical load for the shelter labeled as guard station C



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

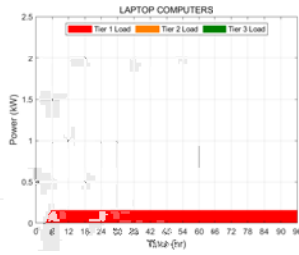


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

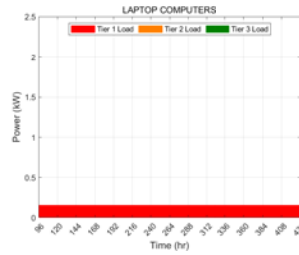


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-22 The shop lights tiered electrical load for the shelter labeled as guard station C



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0–96] h

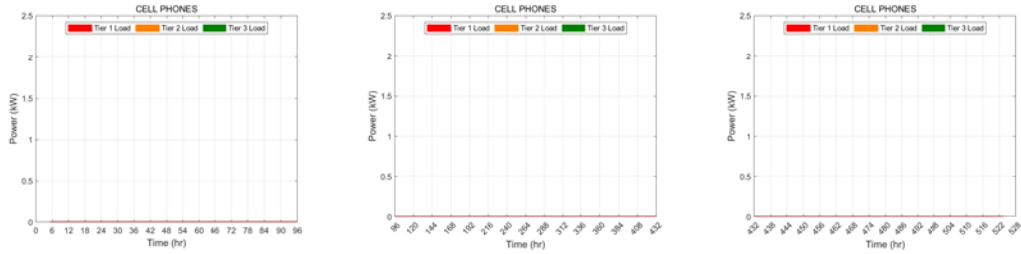


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-23 The laptop computers tiered electrical load for the shelter labeled as guard station C



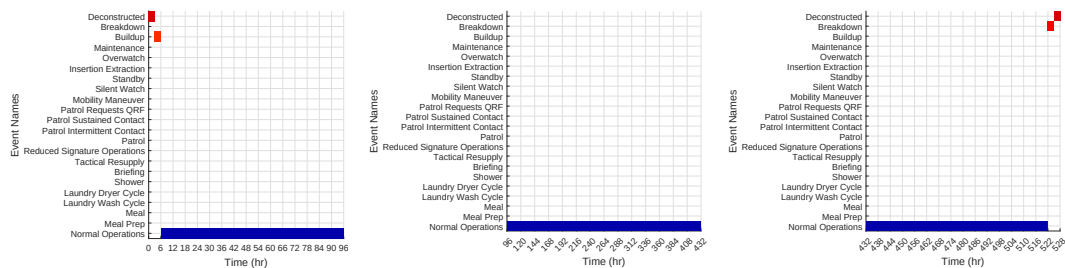
(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-24 The cell phones tiered electrical load for the shelter labeled as guard station C

C.4 Guard Station D

The shelter labeled as guard station D was configured as a guard station. The maximum capacity of the shelter was estimated to be six Soldiers. The shelter's occupancy is agnostic of the events. Only in cases of high-tend security will the shelter reach its maximum occupancy. For all other times, the shelter remains at half occupancy. The event schedule (Fig. C-25), the time-varying occupancy (Fig. C-26), the resulting thermal response (Fig. C-27), and the aggregate electrical load (Fig. C-28).

The shelter contains four separate electrical components including 1) specialized equipment (Fig. C-29), 2) shop lights (Fig. C-30), 3) laptop computers (Fig. C-31), and 4) cell phones (Fig. C-32).



(a) The event schedule for the shelter during the simulation epoch of [0–96] h (b) The event schedule for the shelter during the simulation epoch of [96–432] h (c) The event schedule for the shelter during the simulation epoch of [432–528] h

Fig. C-25 The event schedule for the shelter labeled as guard station D

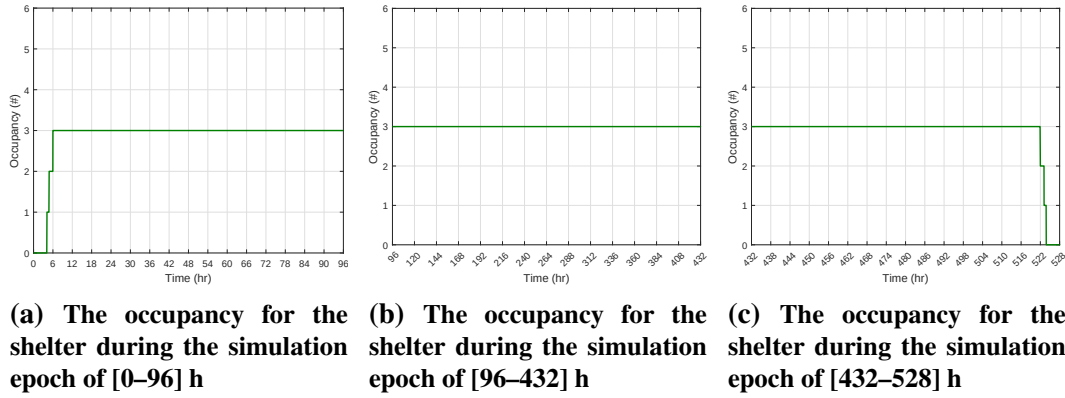


Fig. C-26 The occupancy for the shelter labeled as guard station D

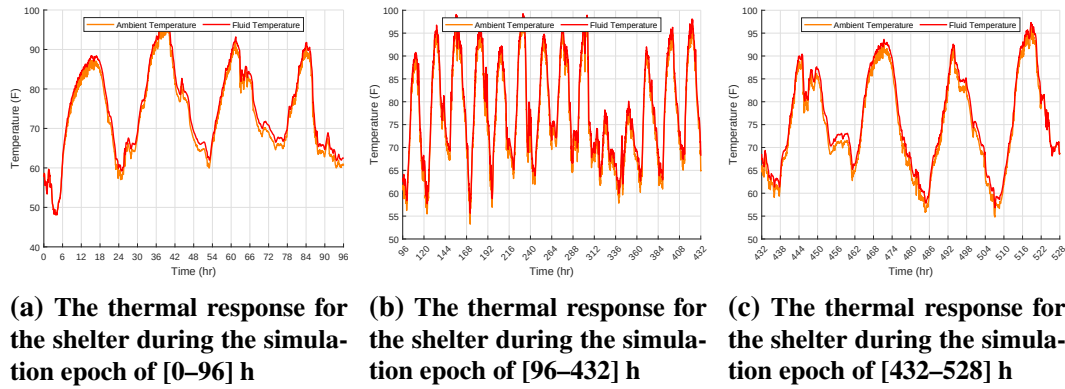


Fig. C-27 The thermal response for the shelter labeled as guard station D

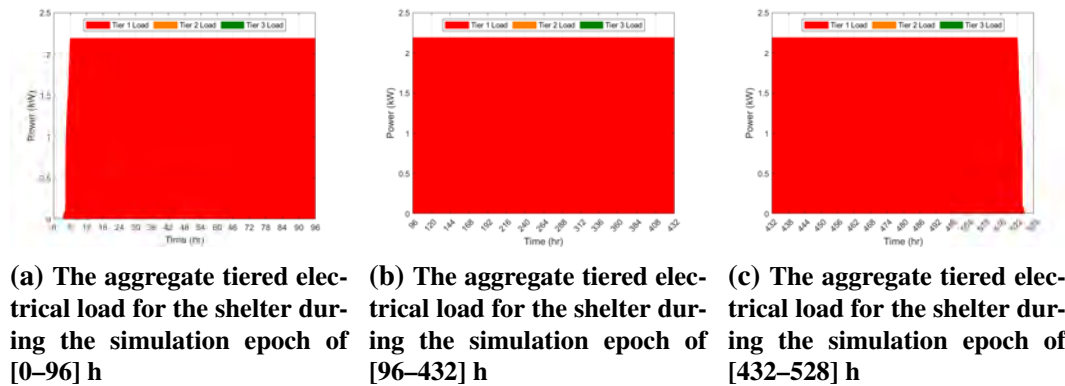


Fig. C-28 The aggregate tiered electrical load for the shelter labeled as guard station D

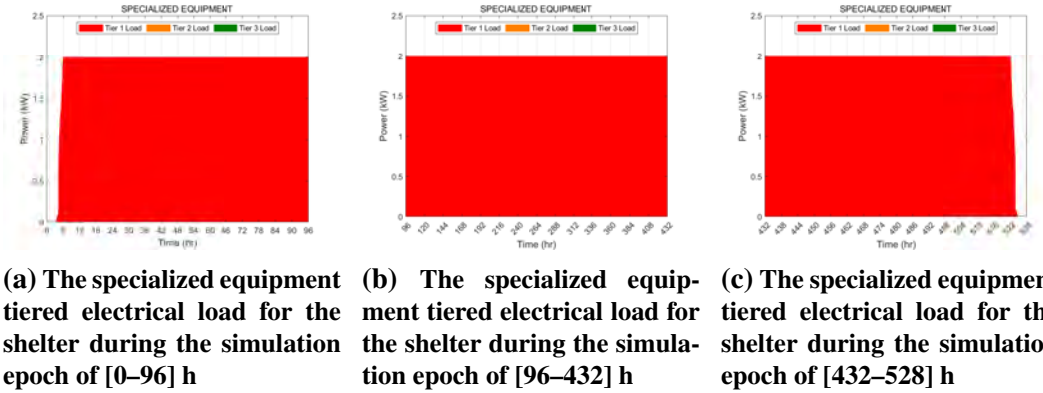


Fig. C-29 The specialized equipment tiered electrical load for the shelter labeled as guard station D

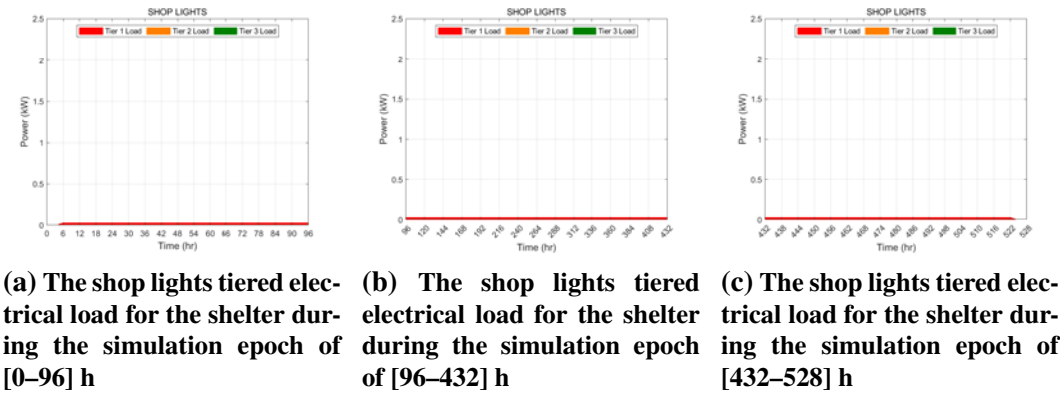


Fig. C-30 The shop lights tiered electrical load for the shelter labeled as guard station D

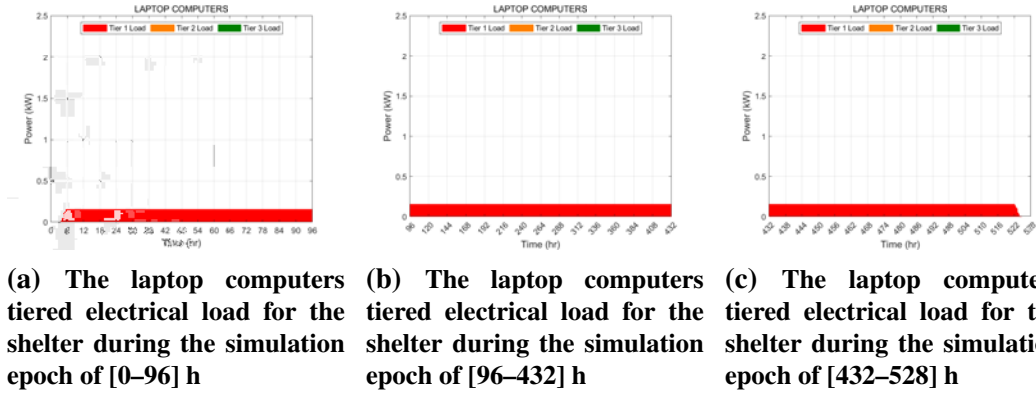


Fig. C-31 The laptop computers tiered electrical load for the shelter labeled as guard station D

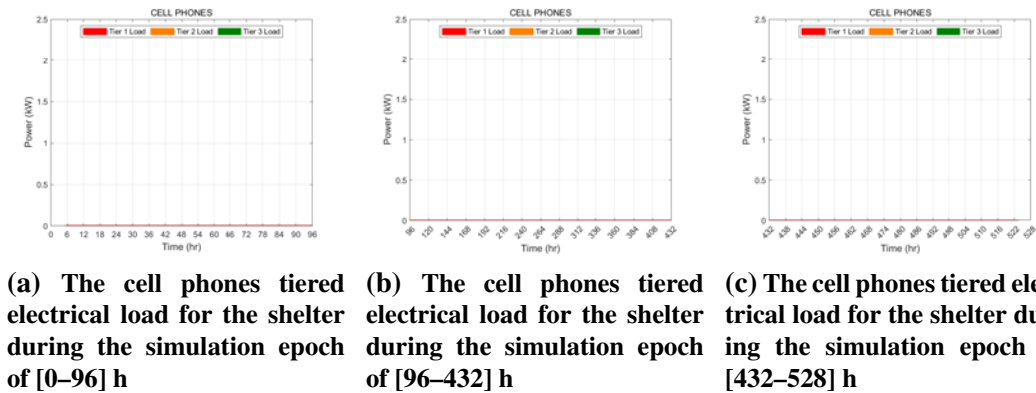


Fig. C-32 The cell phones tiered electrical load for the shelter labeled as guard station D

C.5 Guard Station E

The shelter labeled as guard station E was configured as a guard station. The maximum capacity of the shelter was estimated to be six Soldiers. The shelter's occupancy is agnostic of the events. Only in cases of high-tend security will the shelter reach its maximum occupancy. For all other times, the shelter remains at half occupancy. The event schedule (Fig. C-33), the time-varying occupancy (Fig. C-34), the resulting thermal response (Fig. C-35), and the aggregate electrical load (Fig. C-36).

The shelter contains four separate electrical components including 1) specialized equipment (Fig. C-37), 2) shop lights (Fig. C-38), 3) laptop computers (Fig. C-39),

and 4) cell phones (Fig. C-40).

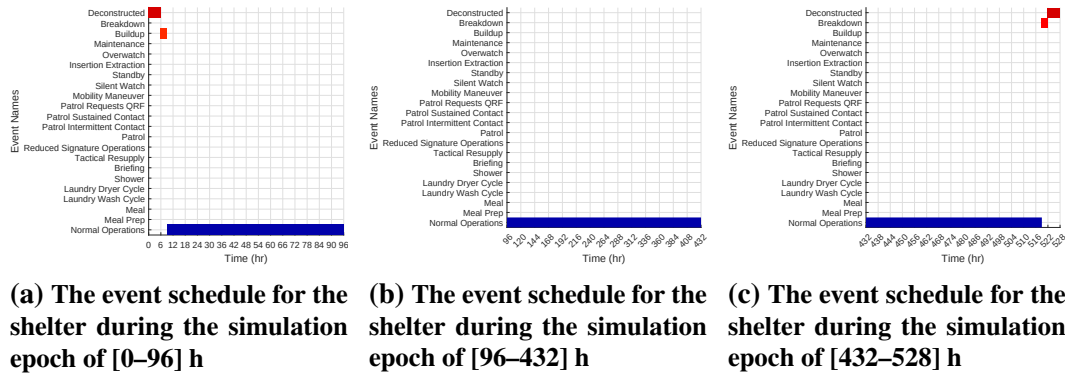


Fig. C-33 The event schedule for the shelter labeled as guard station E

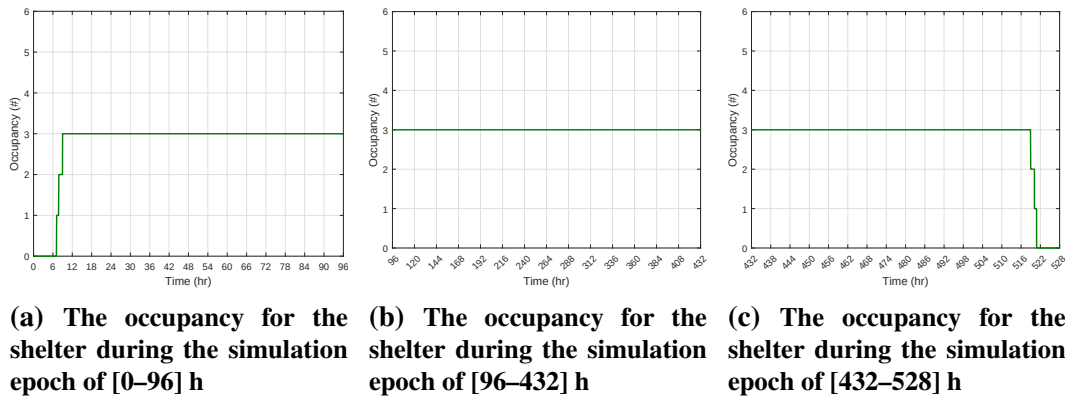


Fig. C-34 The occupancy for the shelter labeled as guard station E

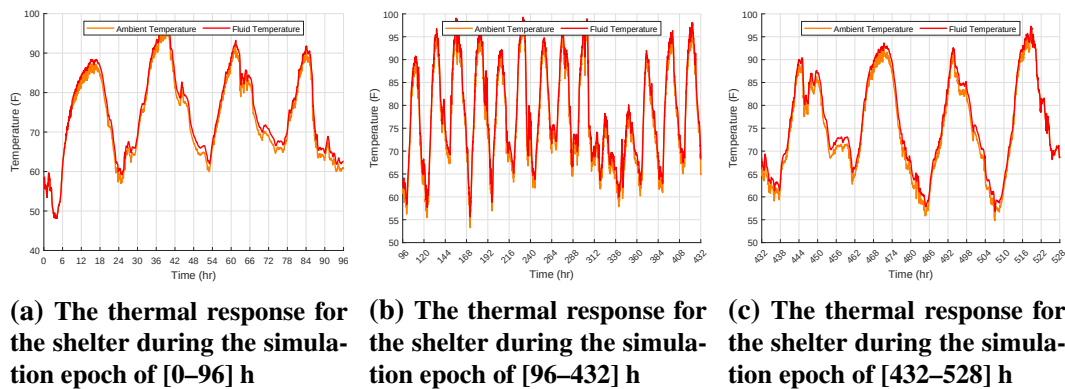


Fig. C-35 The thermal response for the shelter labeled as guard station E

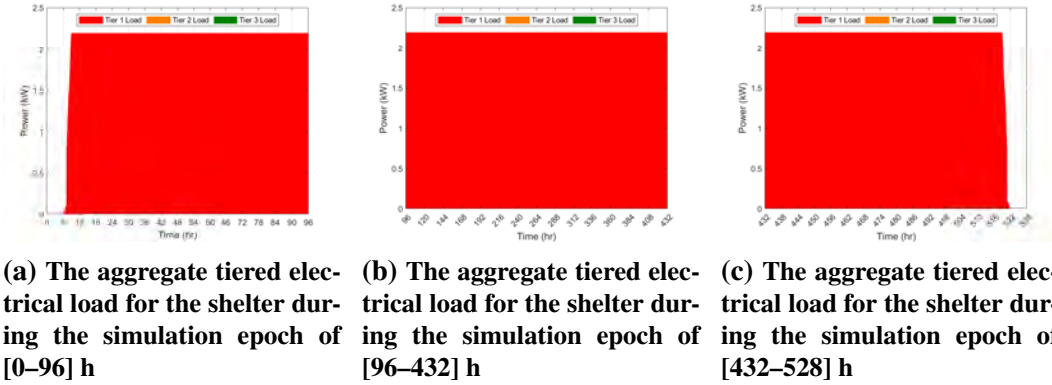


Fig. C-36 The aggregate tiered electrical load for the shelter labeled as guard station E

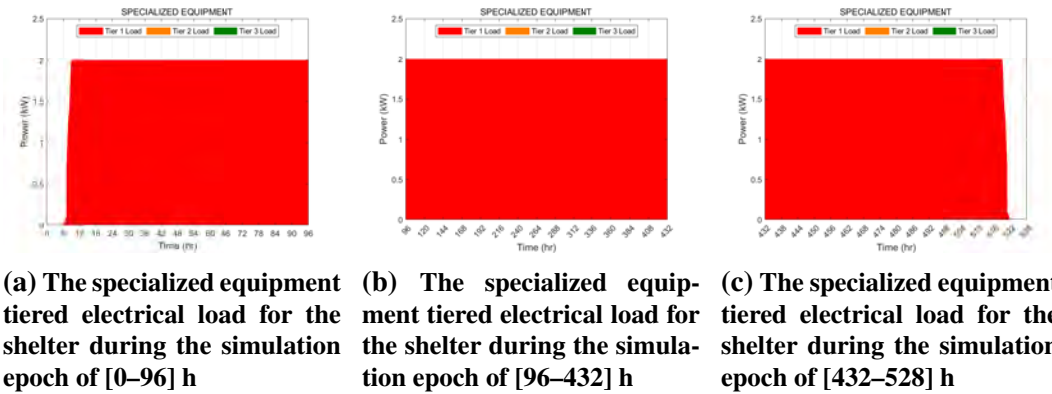
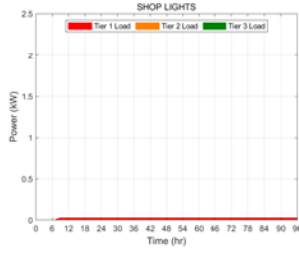
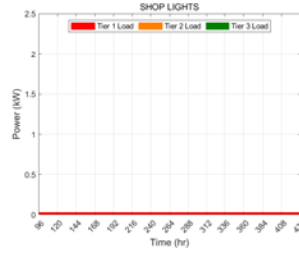


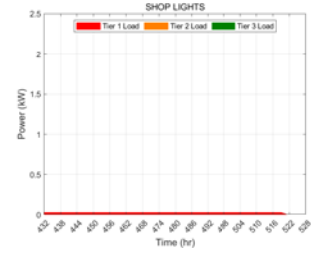
Fig. C-37 The specialized equipment tiered electrical load for the shelter labeled as guard station E



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0-96] h

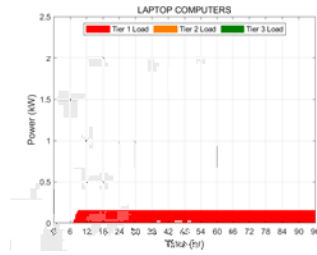


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96-432] h

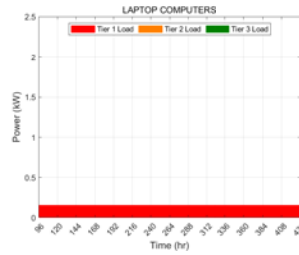


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-38 The shop lights tiered electrical load for the shelter labeled as guard station E



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h

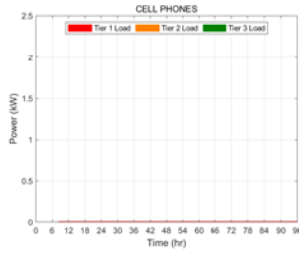


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h

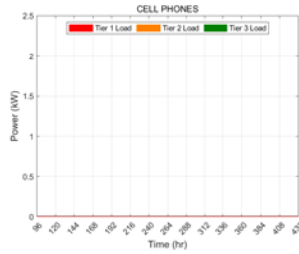


(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

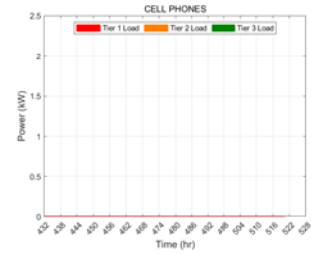
Fig. C-39 The laptop computers tiered electrical load for the shelter labeled as guard station E



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h



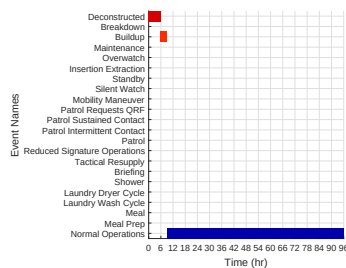
(c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-40 The cell phones tiered electrical load for the shelter labeled as guard station E

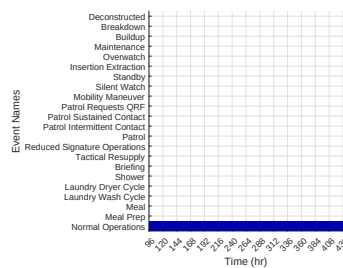
C.6 Guard Station F

The shelter labeled as guard station F was configured as a guard station. The maximum capacity of the shelter was estimated to be six Soldiers. The shelter's occupancy is agnostic of the events. Only in cases of high-tend security will the shelter reach its maximum occupancy. For all other times, the shelter remains at half occupancy. The event schedule (Fig. C-41), the time-varying occupancy (Fig. C-42), the resulting thermal response (Fig. C-43), and the aggregate electrical load (Fig. C-44).

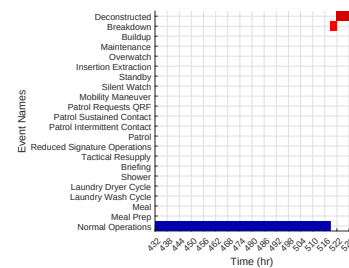
The shelter contains four separate electrical components including 1) specialized equipment (Fig. C-45), 2) shop lights (Fig. C-46), 3) laptop computers (Fig. C-47), and 4) cell phones (Fig. C-48).



(a) The event schedule for the shelter during the simulation epoch of [0–96] h



(b) The event schedule for the shelter during the simulation epoch of [96–432] h



(c) The event schedule for the shelter during the simulation epoch of [432–528] h

Fig. C-41 The event schedule for the shelter labeled as guard station F

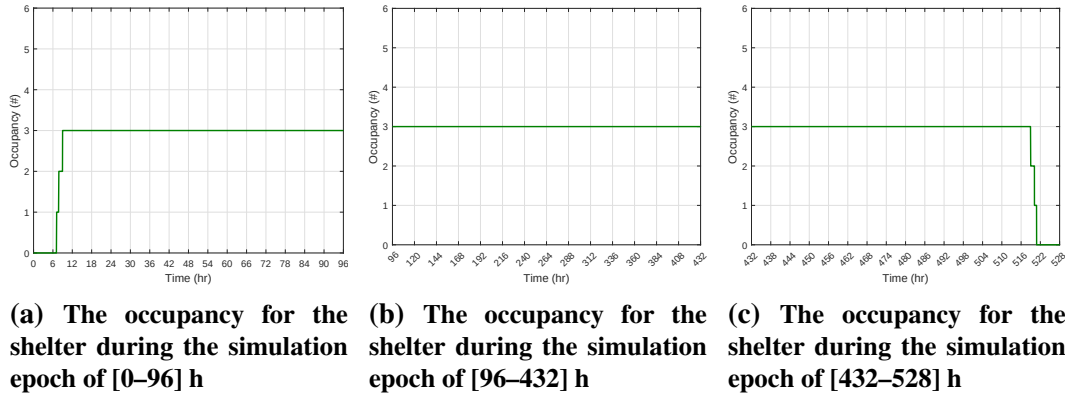


Fig. C-42 The occupancy for the shelter labeled as guard station F

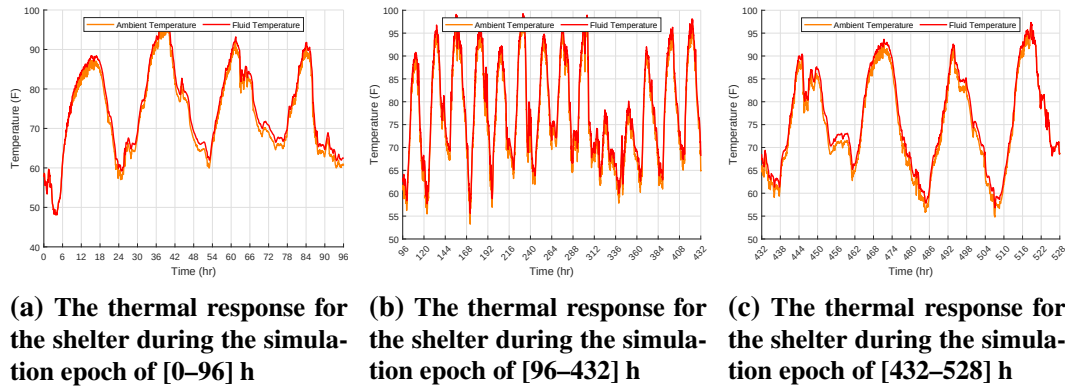


Fig. C-43 The thermal response for the shelter labeled as guard station F

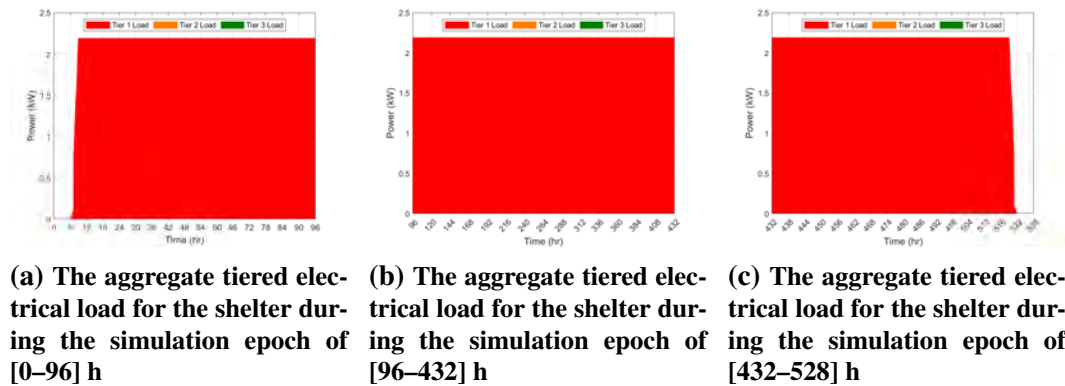


Fig. C-44 The aggregate tiered electrical load for the shelter labeled as guard station F

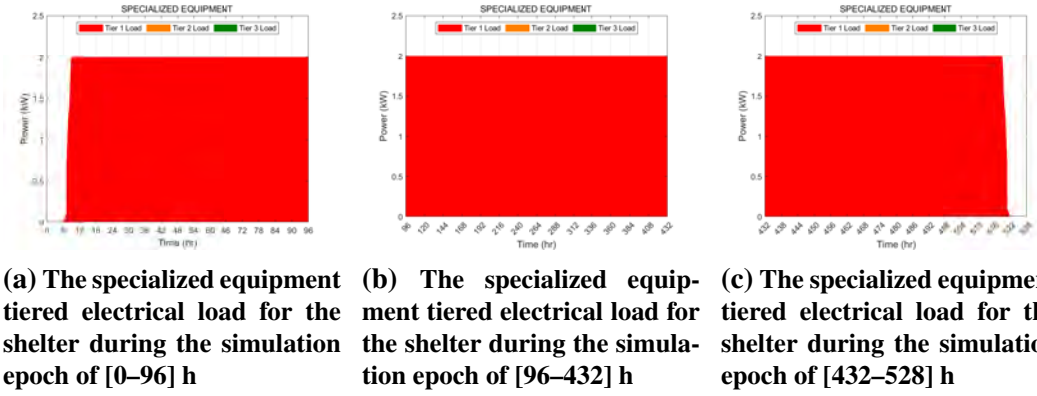


Fig. C-45 The specialized equipment tiered electrical load for the shelter labeled as guard station F

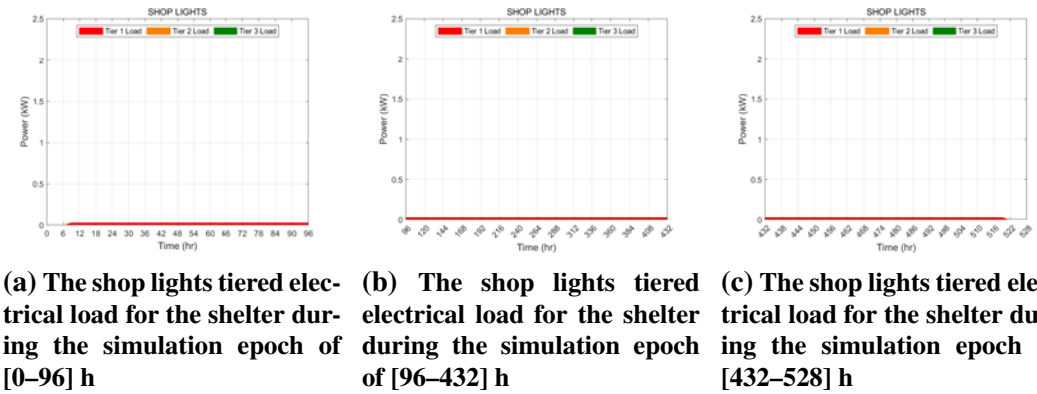


Fig. C-46 The shop lights tiered electrical load for the shelter labeled as guard station F

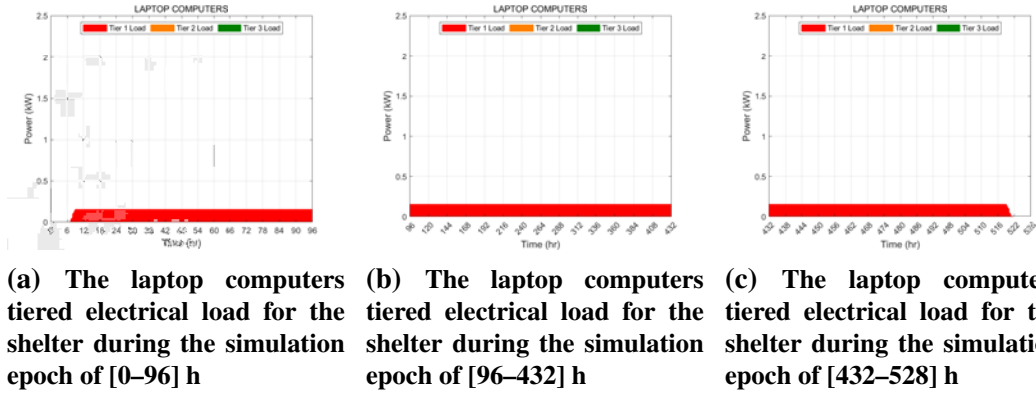


Fig. C-47 The laptop computers tiered electrical load for the shelter labeled as guard station F

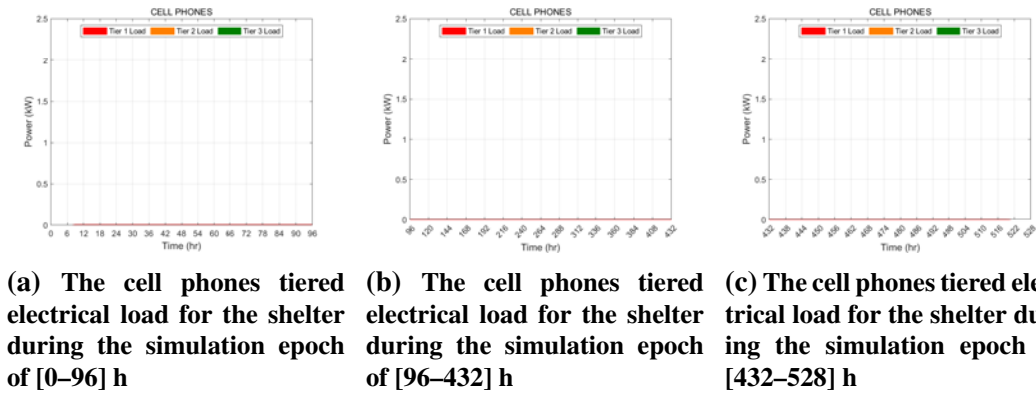


Fig. C-48 The cell phones tiered electrical load for the shelter labeled as guard station F

C.7 COC Master

The shelter labeled as COC master was used as the primary COC shelter. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to manage the energy network's operation.

The event schedule (Fig. C-49), the time-varying occupancy (Fig. C-50), the resulting thermal response (Fig. C-51), aggregate electrical load (Fig. C-52), and the ECU electrical load (Fig. C-53).

The shelter labeled as COC master contains eight separate electrical components including 1) specialized equipment (Fig. C-54), 2) televisions (Fig. C-55), 3) shop lights (Fig. C-56), 4) fans (Fig. C-57), 5) laptop computers (Fig. C-58), 6) cell phones (Fig. C-59), 7) microwaves (Fig. C-60), and 8) hot plates (Fig. C-61).

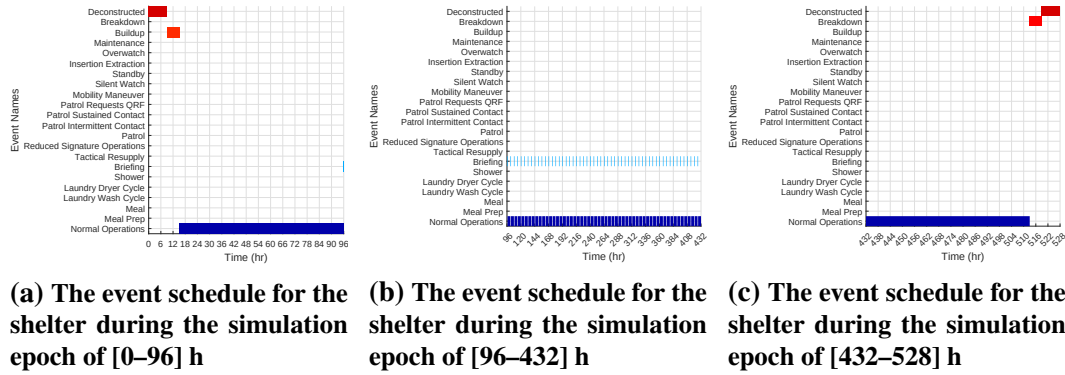


Fig. C-49 The event schedule for the shelter labeled as COC master

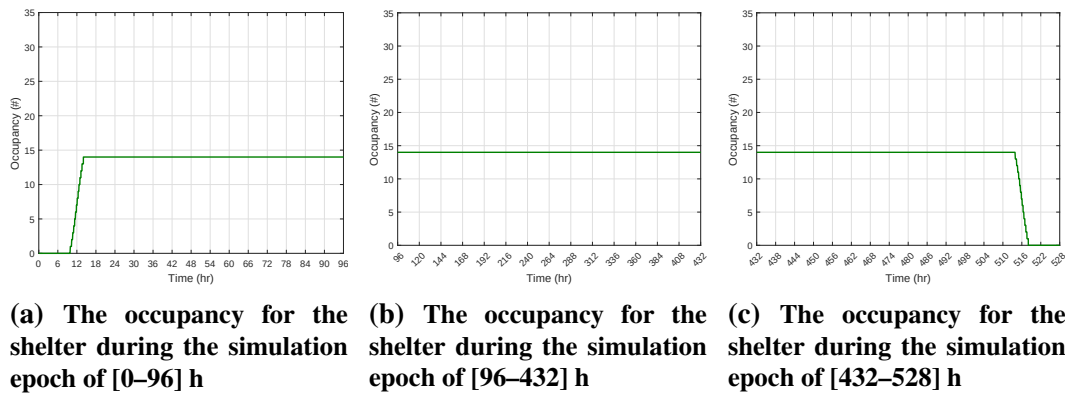


Fig. C-50 The occupancy for the shelter labeled as COC master

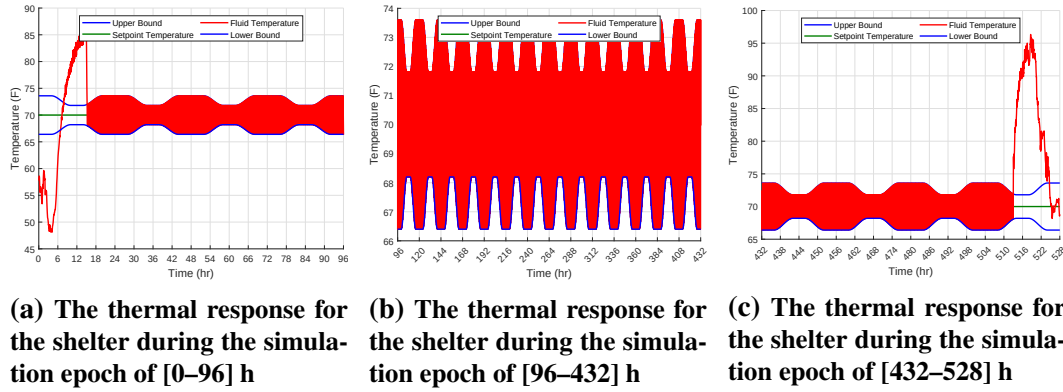


Fig. C-51 The thermal response for the shelter labeled as COC master

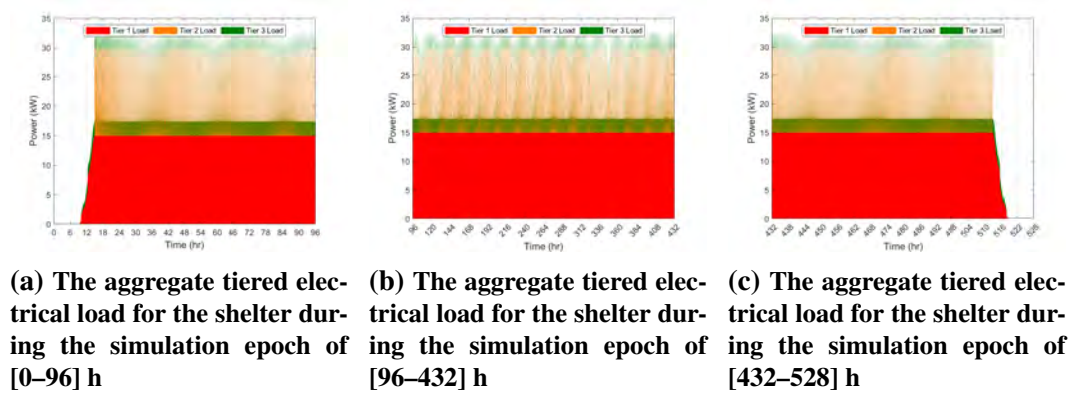


Fig. C-52 The aggregate tiered electrical load for the shelter labeled as COC master

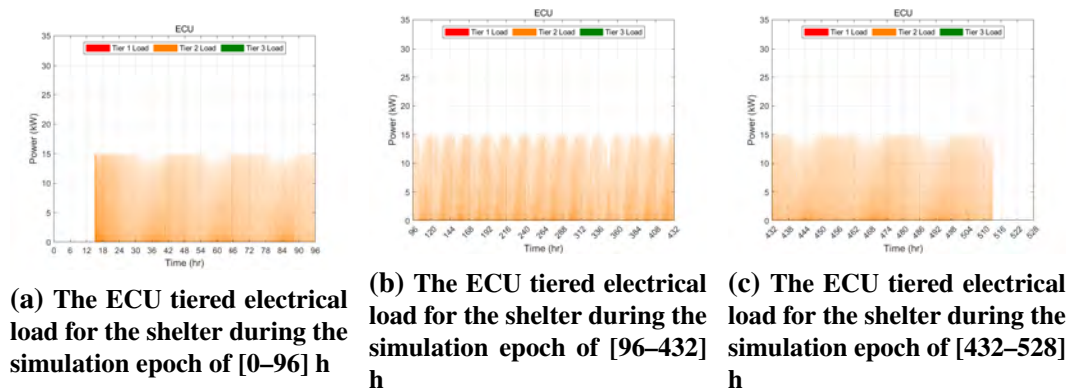


Fig. C-53 The ECU tiered electrical load for the shelter labeled as COC master

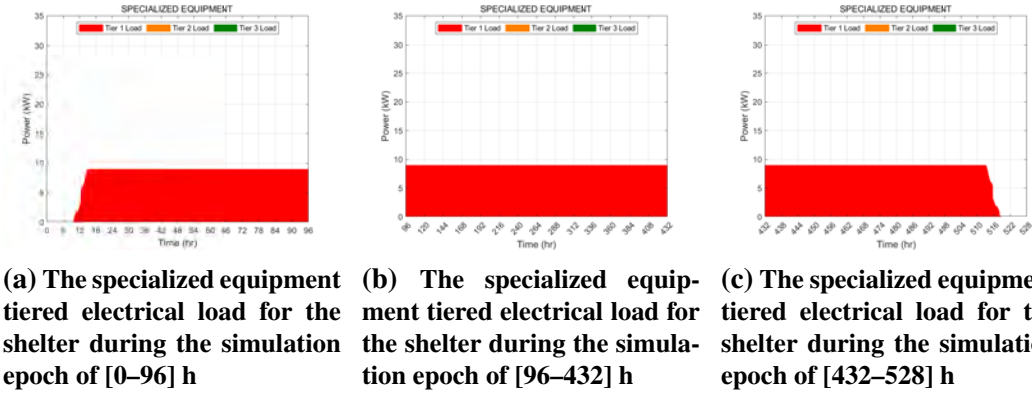


Fig. C-54 The specialized equipment tiered electrical load for the shelter labeled as COC master

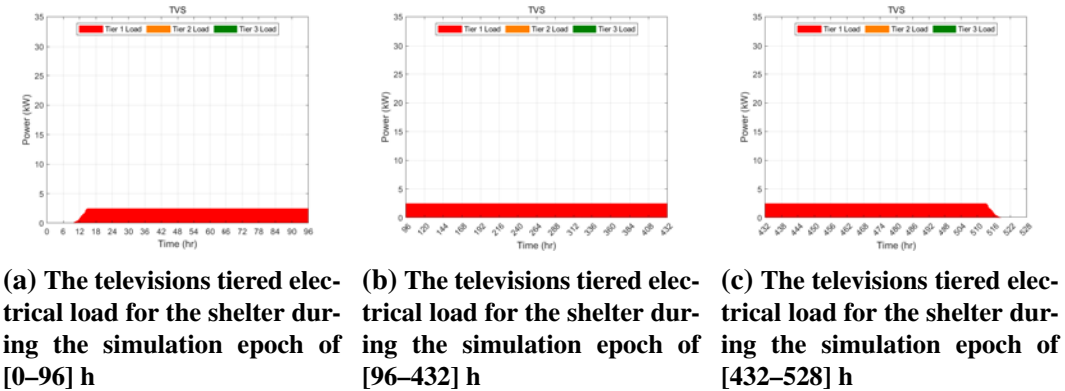


Fig. C-55 The televisions tiered electrical load for the shelter labeled as COC master

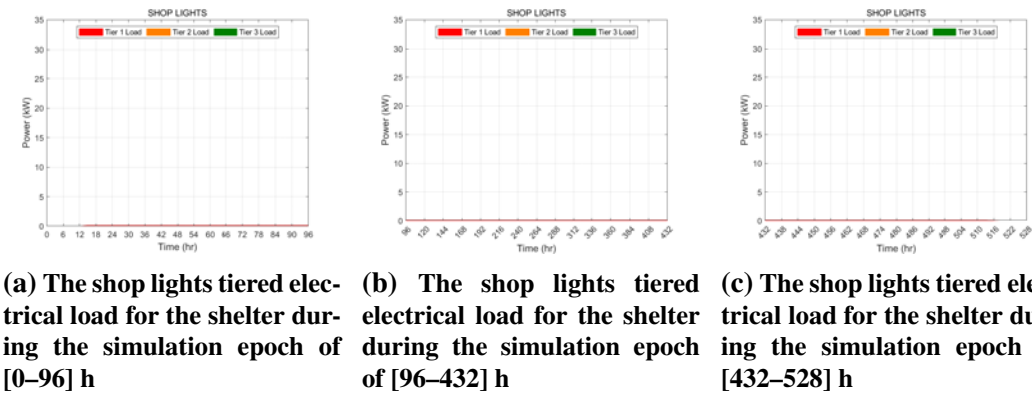
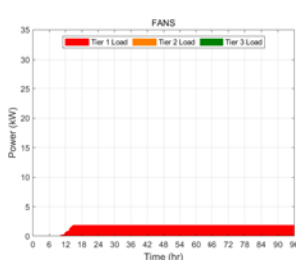
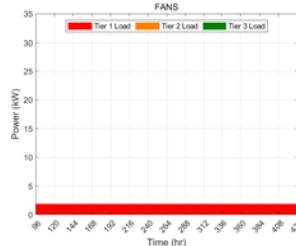


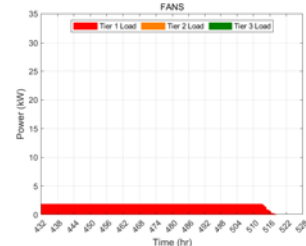
Fig. C-56 The shop lights tiered electrical load for the shelter labeled as COC master



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-57 The fans tiered electrical load for the shelter labeled as COC master



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h

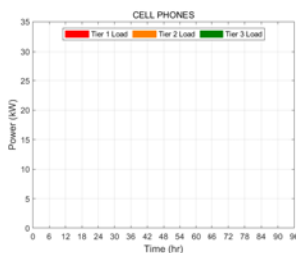


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h

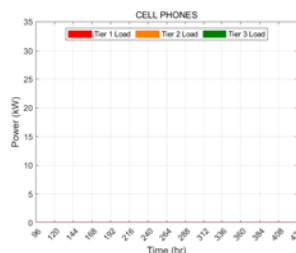


(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

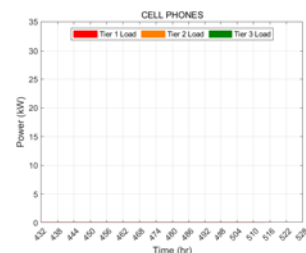
Fig. C-58 The laptop computers tiered electrical load for the shelter labeled as COC master



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-59 The cell phones tiered electrical load for the shelter labeled as COC master

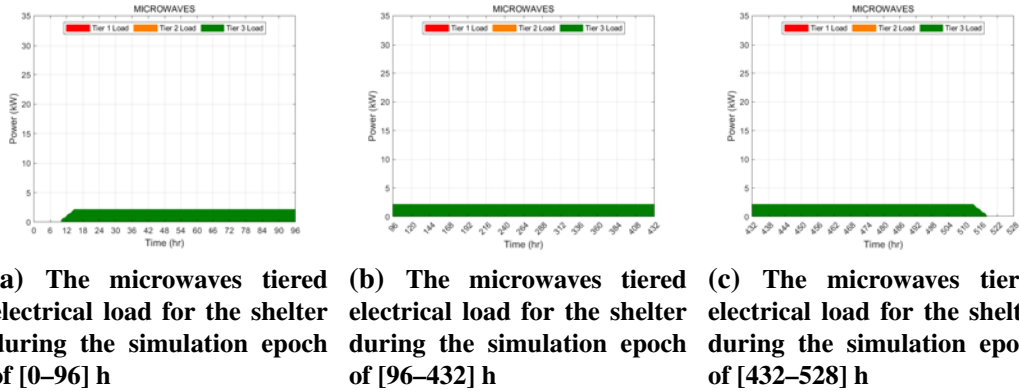


Fig. C-60 The microwaves tiered electrical load for the shelter labeled as COC master

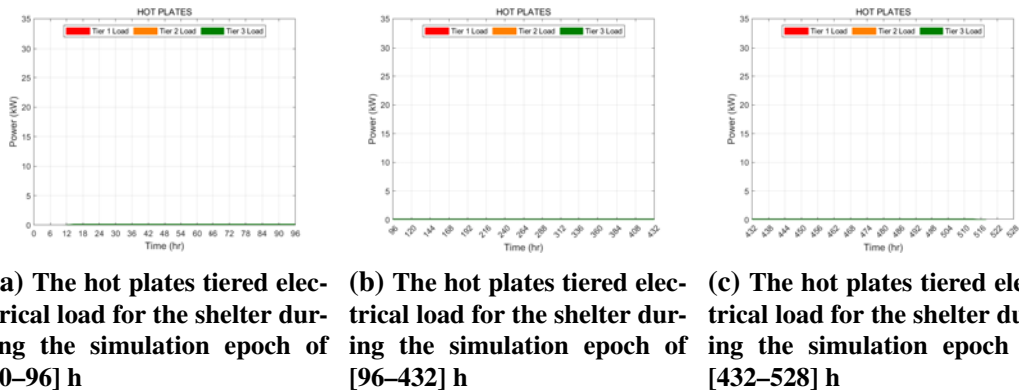


Fig. C-61 The hot plates tiered electrical load for the shelter labeled as COC master

C.8 COM Master

The shelter labeled as COM master was used as the primary COM shelter. The maximum capacity of the shelter was estimated to be 35 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to manage the energy network's communications.

The event schedule (Fig. C-62), the time-varying occupancy (Fig. C-63), the resulting thermal response (Fig. C-64), aggregate electrical load (Fig. C-65), and the ECU electrical load (Fig. C-66).

The shelter labeled as COM master contains eight separate electrical components including 1) specialized equipment (Fig. C-67), 2) televisions (Fig. C-68), 3) shop lights (Fig. C-69), 4) fans (Fig. C-70), 5) laptop computers (Fig. C-71), 6) cell phones (Fig. C-72), 7) microwaves (Fig. C-73), and 8) hot plates (Fig. C-74).

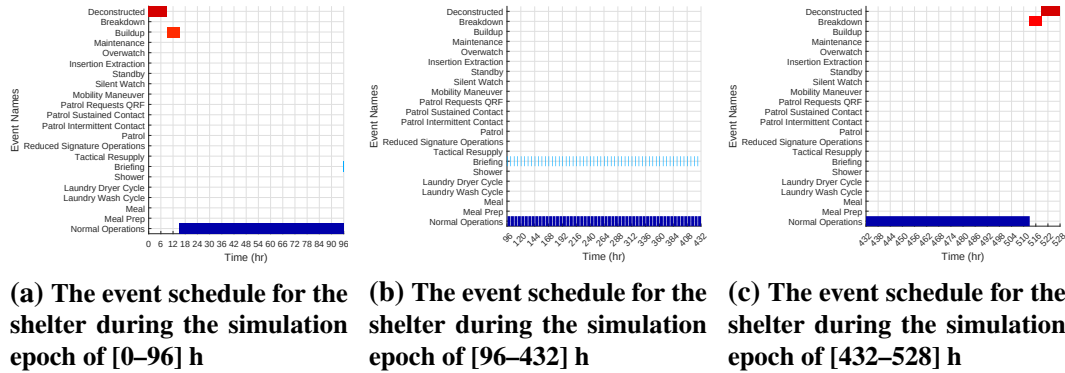


Fig. C-62 The event schedule for the shelter labeled as COM master

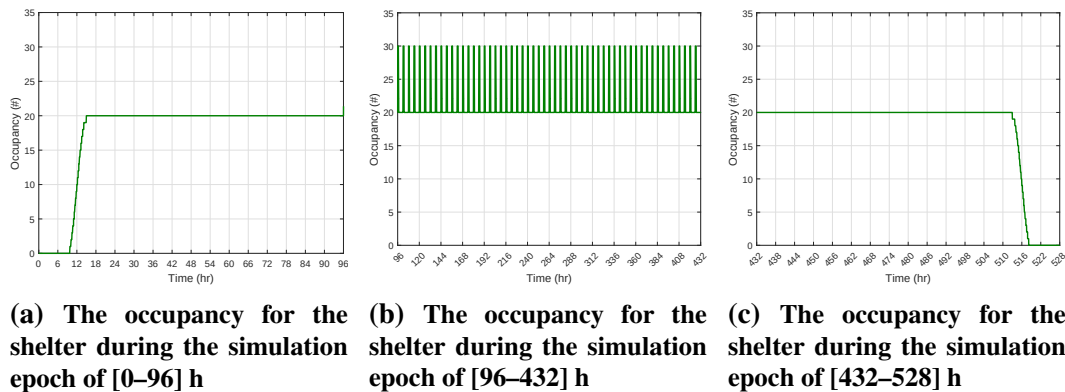
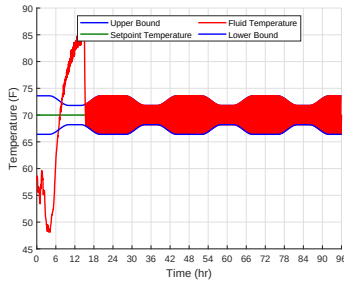
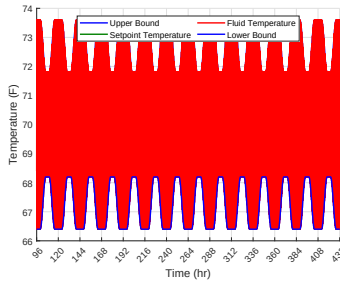


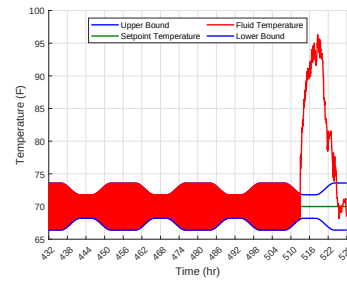
Fig. C-63 The occupancy for the shelter labeled as COM master



(a) The thermal response for the shelter during the simulation epoch of [0-96] h

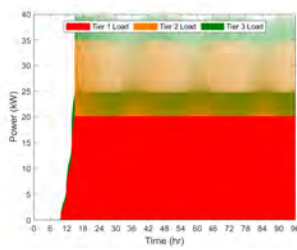


(b) The thermal response for the shelter during the simulation epoch of [96-432] h

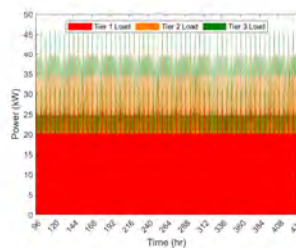


(c) The thermal response for the shelter during the simulation epoch of [432-528] h

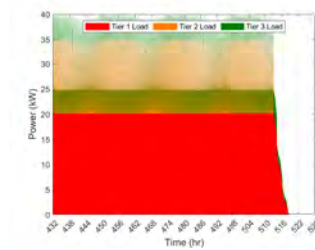
Fig. C-64 The thermal response for the shelter labeled as COM master



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

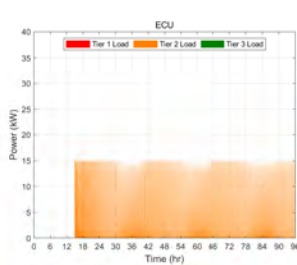


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

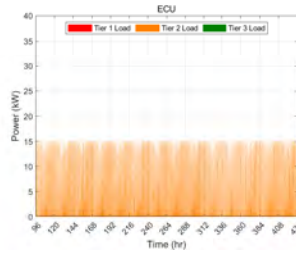


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

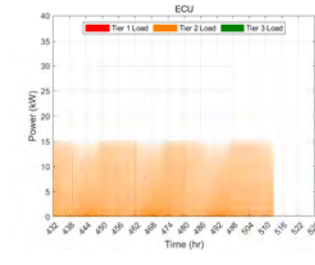
Fig. C-65 The aggregate tiered electrical load for the shelter labeled as COM master



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-66 The ECU tiered electrical load for the shelter labeled as COM master

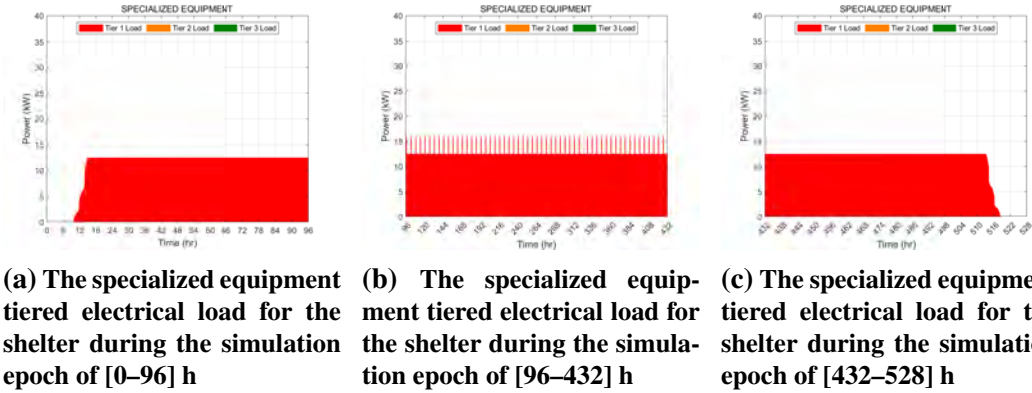


Fig. C-67 The specialized equipment tiered electrical load for the shelter labeled as COM master

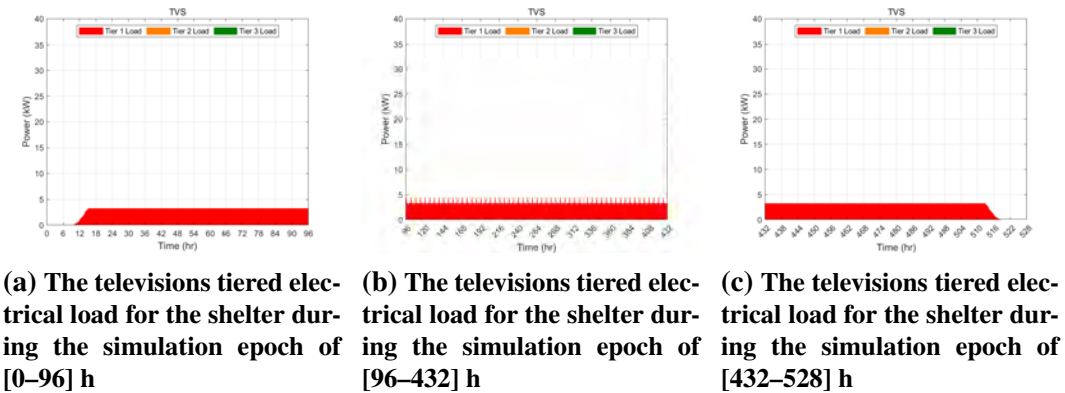


Fig. C-68 The televisions tiered electrical load for the shelter labeled as COM master

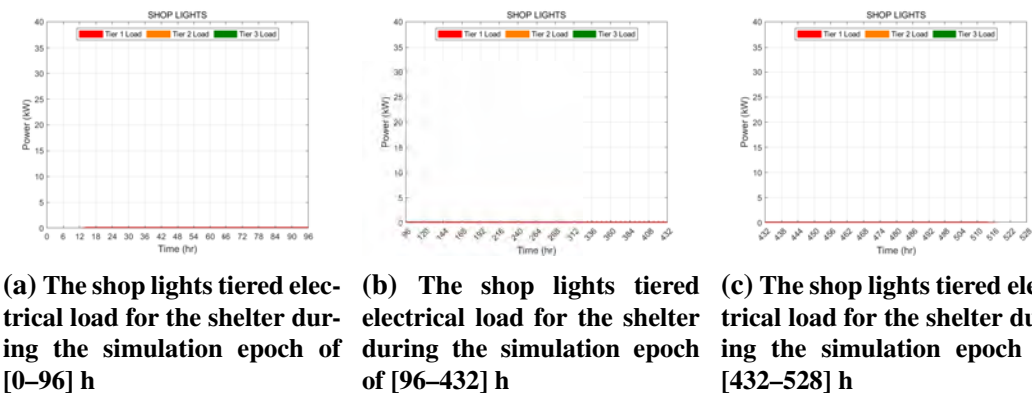
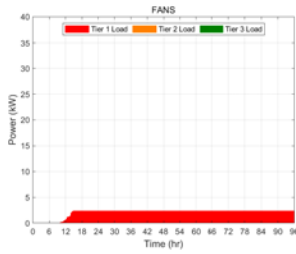
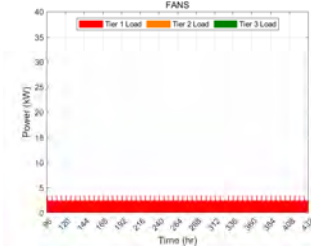


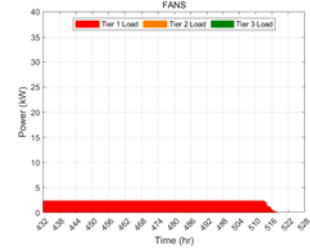
Fig. C-69 The shop lights tiered electrical load for the shelter labeled as COM master



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h

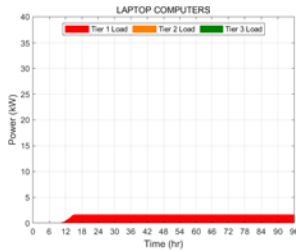


(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h

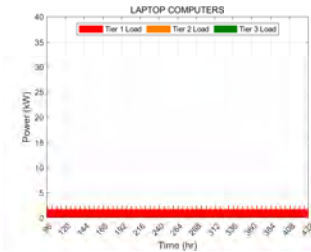


(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-70 The fans tiered electrical load for the shelter labeled as COM master



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0–96] h

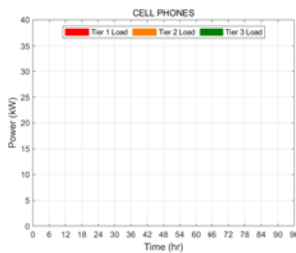


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96–432] h

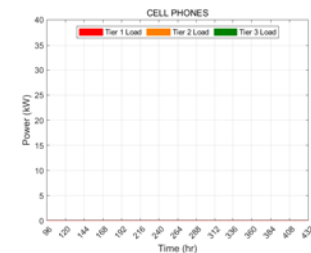


(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432–528] h

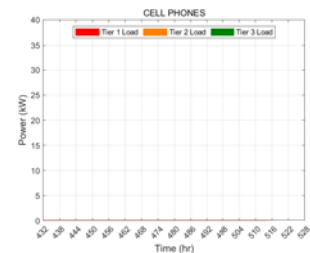
Fig. C-71 The laptop computers tiered electrical load for the shelter labeled as COM master



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-72 The cell phones tiered electrical load for the shelter labeled as COM master

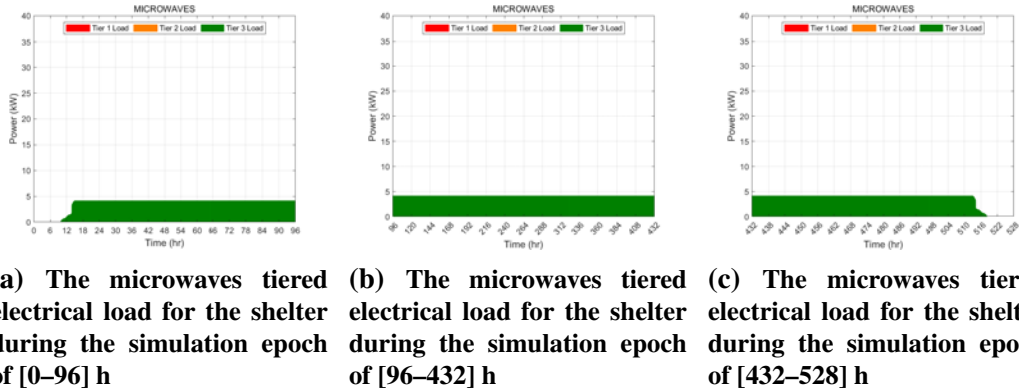


Fig. C-73 The microwaves tiered electrical load for the shelter labeled as COM master

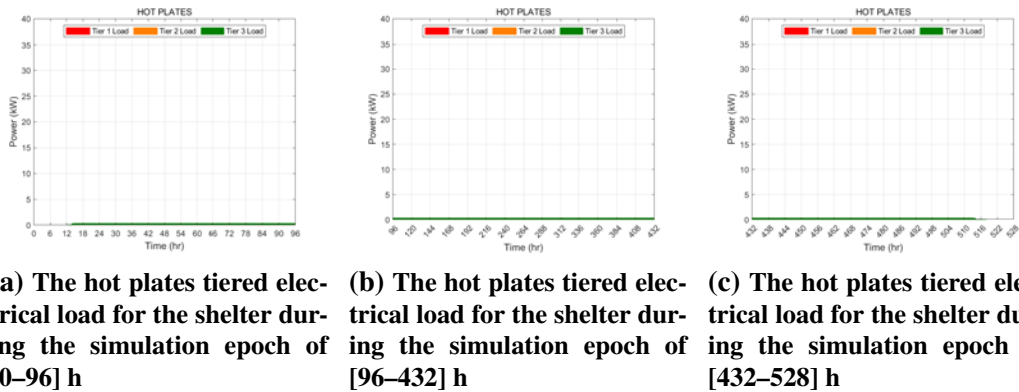


Fig. C-74 The hot plates tiered electrical load for the shelter labeled as COM master

C.9 COC Submaster A

The shelter labeled as COC submaster A was used as a secondary COC shelter. The maximum capacity of the shelter was estimated to be 35 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to assist the master COC shelter to manage the energy network's operation.

The event schedule (Fig. C-75), the time-varying occupancy (Fig. C-76), the resulting thermal response (Fig. C-77), aggregate electrical load (Fig. C-78), and the ECU electrical load (Fig. C-79).

The shelter labeled as COC submaster A contains six separate electrical components including 1) specialized equipment (Fig. C-80), 2) televisions (Fig. C-81), 3) shop lights (Fig. C-82), 4) fans (Fig. C-83), 5) laptop computers (Fig. C-84), and 6) cell phones (Fig. C-85).

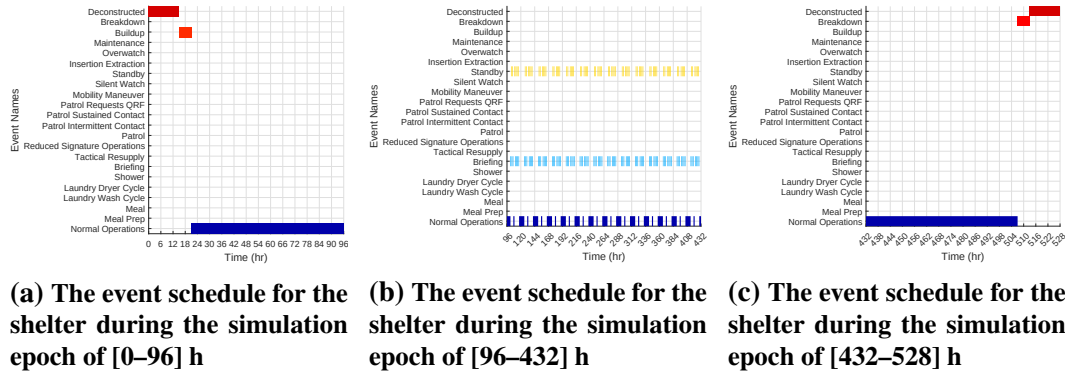


Fig. C-75 The event schedule for the shelter labeled as COC submaster A

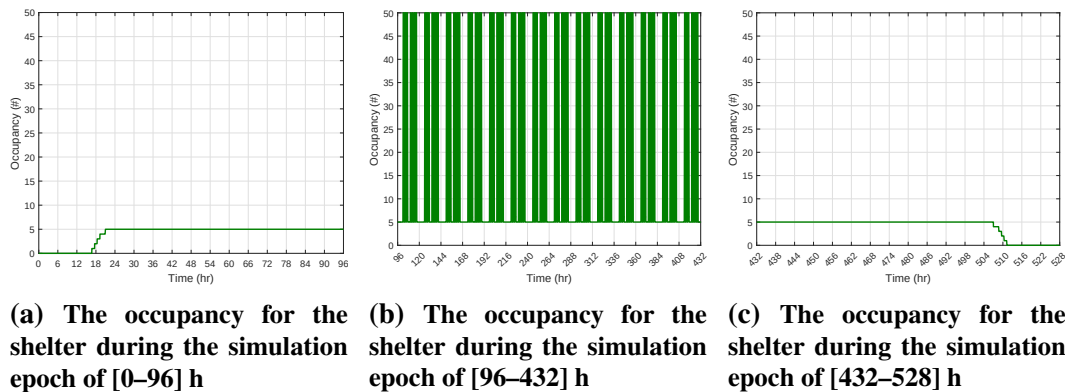


Fig. C-76 The occupancy for the shelter labeled as COC submaster A

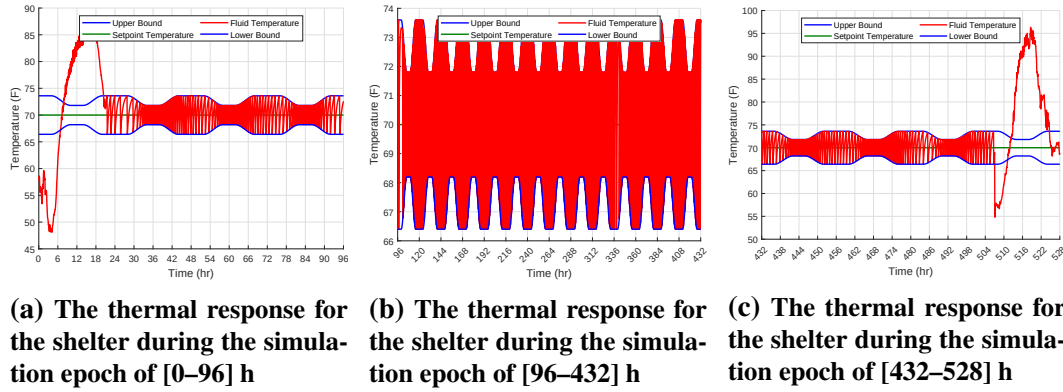


Fig. C-77 The thermal response for the shelter labeled as COC submaster A

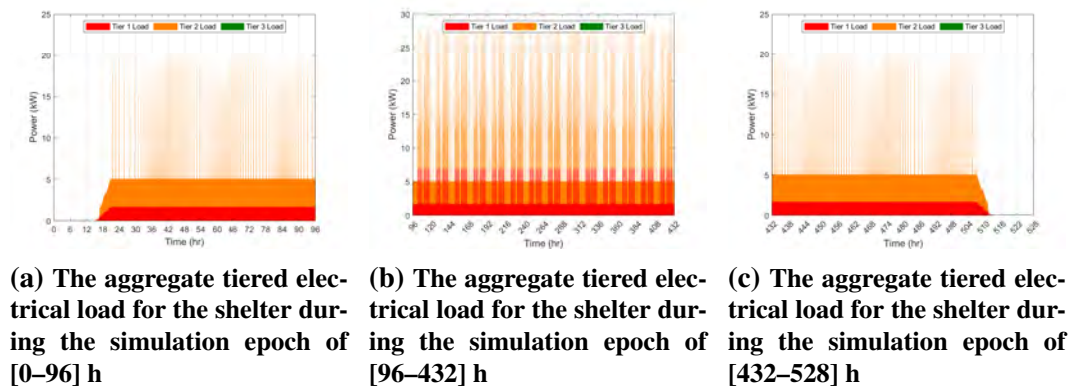


Fig. C-78 The aggregate tiered electrical load for the shelter labeled as COC submaster A

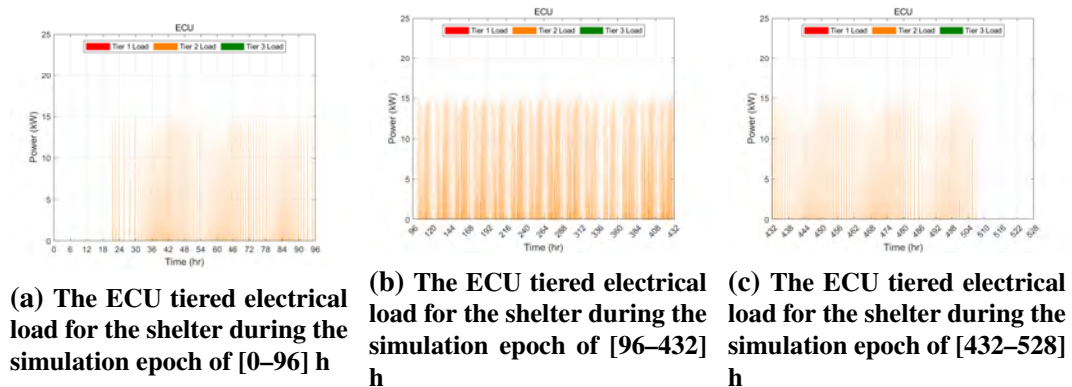
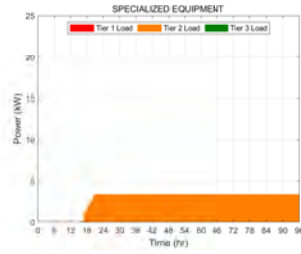
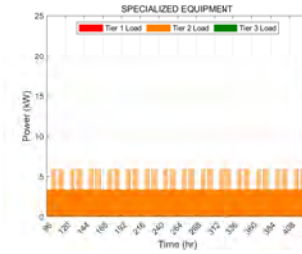


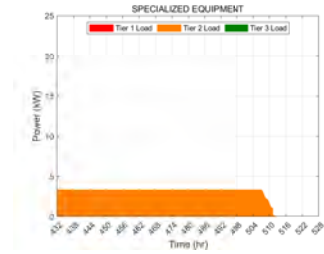
Fig. C-79 The ECU tiered electrical load for the shelter labeled as COC submaster A



(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0–96] h

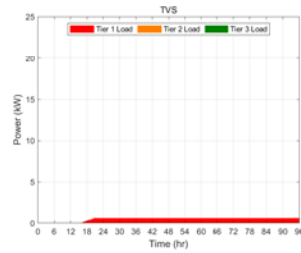


(b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96–432] h

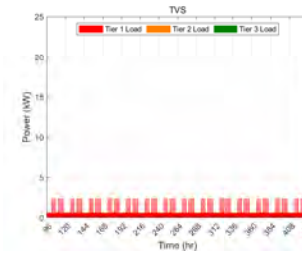


(c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432–528] h

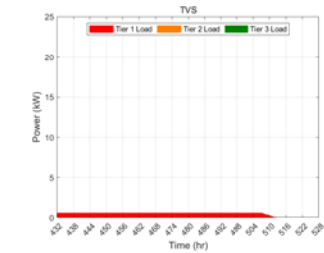
Fig. C-80 The specialized equipment tiered electrical load for the shelter labeled as COC submaster A



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

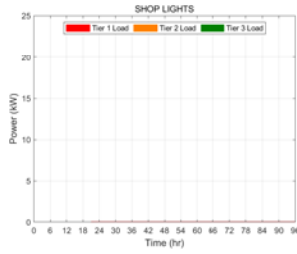


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

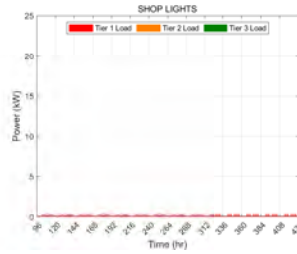


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

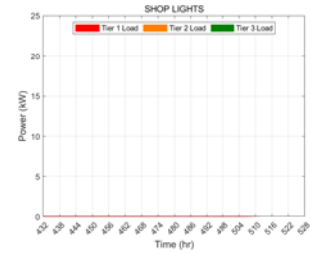
Fig. C-81 The televisions tiered electrical load for the shelter labeled as COC submaster A



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

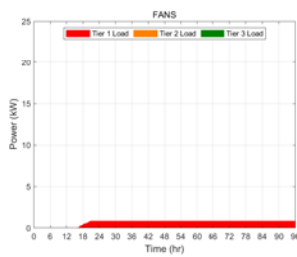


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

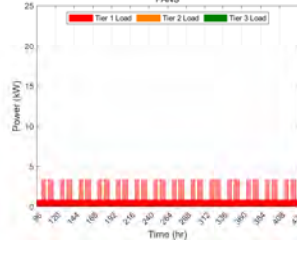


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

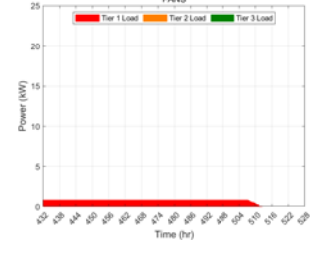
Fig. C-82 The shop lights tiered electrical load for the shelter labeled as COC submaster A



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-83 The fans tiered electrical load for the shelter labeled as COC submaster A

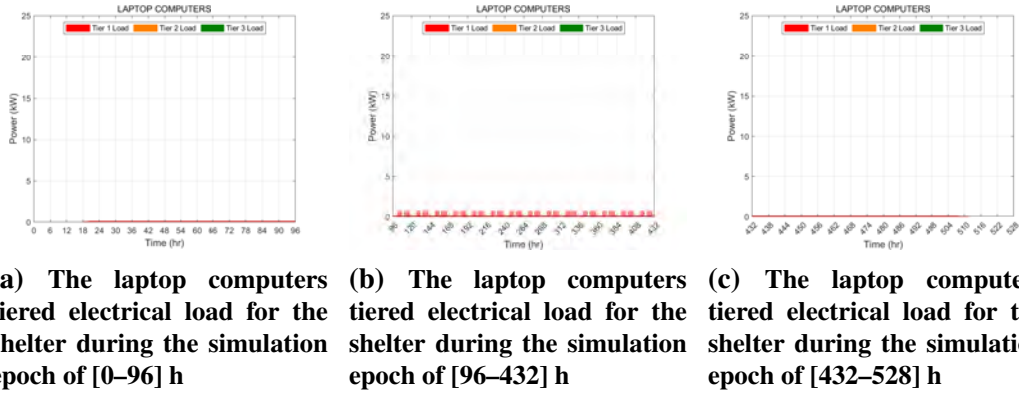


Fig. C-84 The laptop computers tiered electrical load for the shelter labeled as COC submaster A

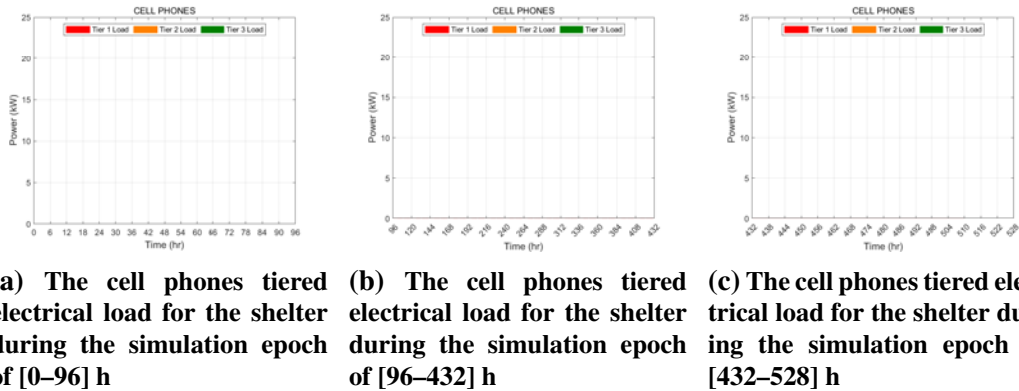


Fig. C-85 The cell phones tiered electrical load for the shelter labeled as COC submaster A

C.10 COM Submaster A

The shelter labeled as COM submaster A was used as a secondary COM shelter. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to assist the master COM shelter to manage the energy network's communications.

The event schedule (Fig. C-86), the time-varying occupancy (Fig. C-87), the resulting thermal response (Fig. C-88), aggregate electrical load (Fig. C-89), and the ECU electrical load (Fig. C-90).

The shelter labeled as COM submaster A contains six separate electrical components including 1) specialized equipment (Fig. C-91), 2) televisions (Fig. C-92), 3) shop lights (Fig. C-93), 4) fans (Fig. C-94), 5) laptop computers (Fig. C-95), and 6) cell phones (Fig. C-96).

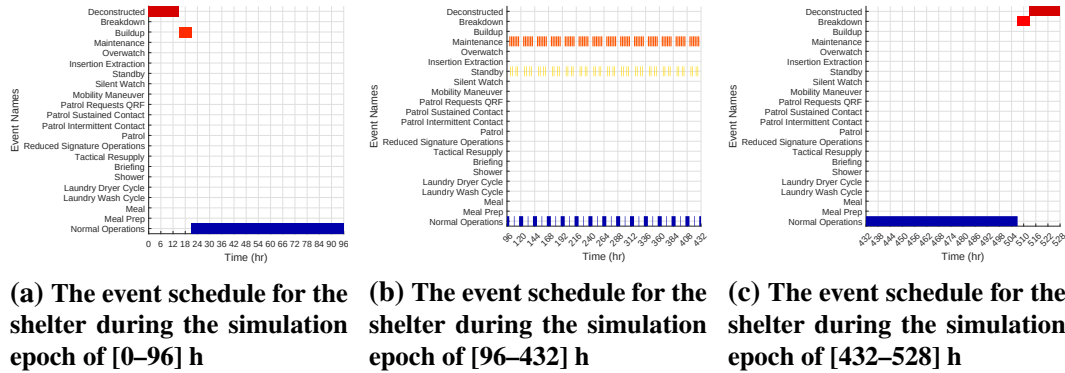


Fig. C-86 The event schedule for the shelter labeled as COM submaster A

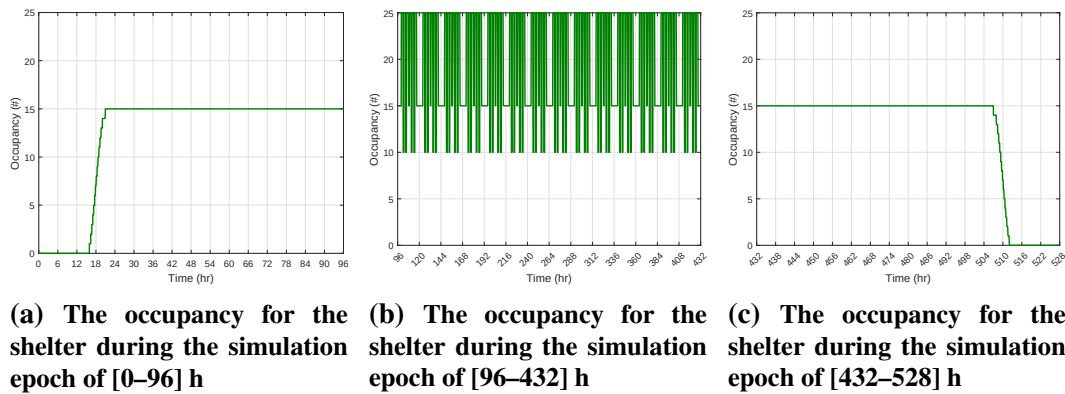


Fig. C-87 The occupancy for the shelter labeled as COM submaster A

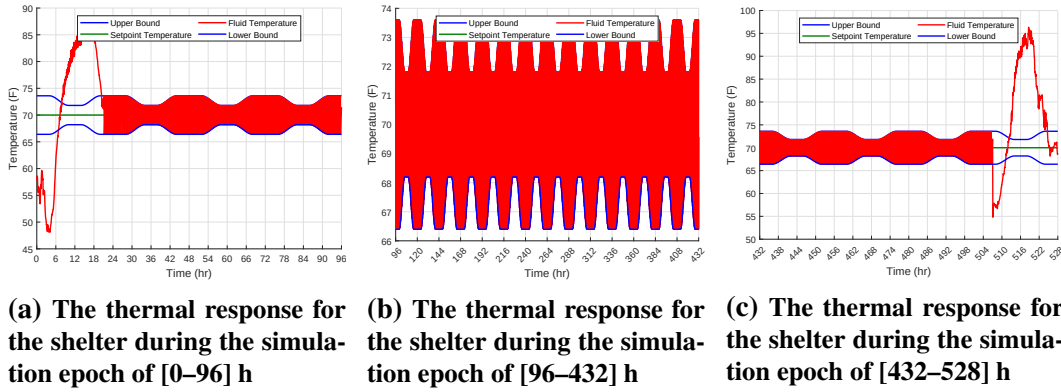


Fig. C-88 The thermal response for the shelter labeled as COM submaster A

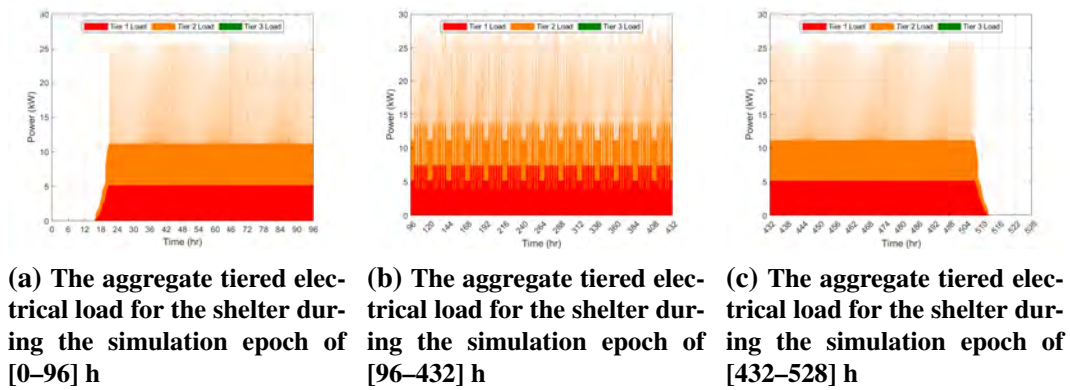


Fig. C-89 The aggregate tiered electrical load for the shelter labeled as COM submaster A

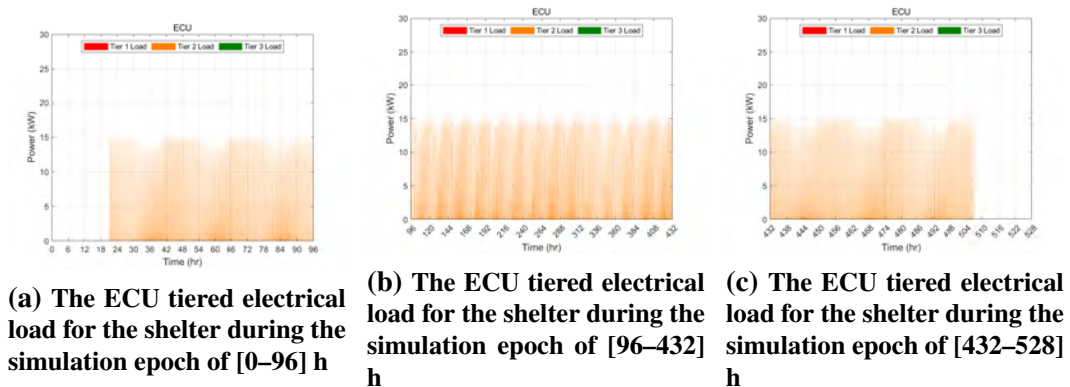


Fig. C-90 The ECU tiered electrical load for the shelter labeled as COM submaster A

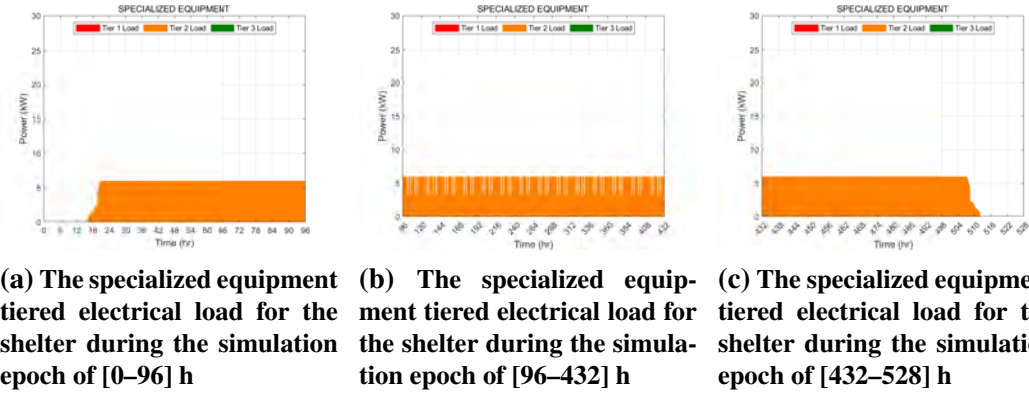


Fig. C-91 The specialized equipment tiered electrical load for the shelter labeled as COM submaster A

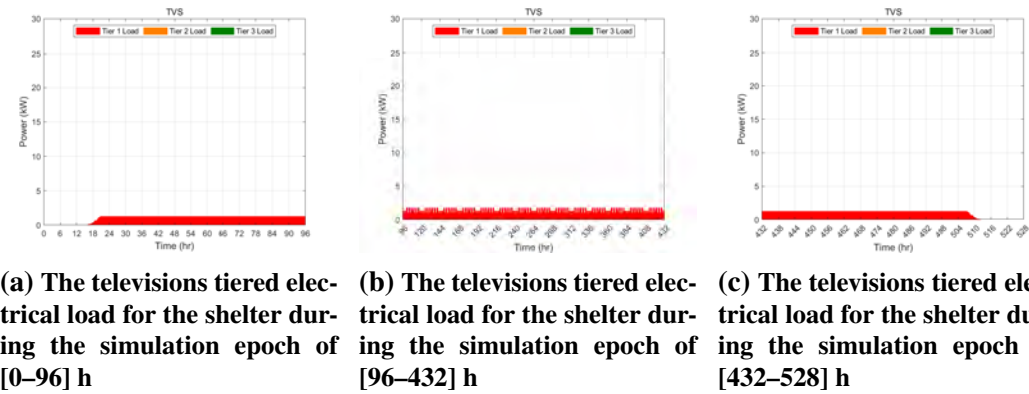
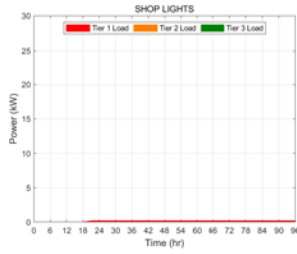
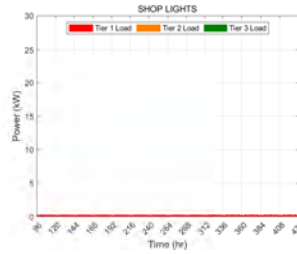


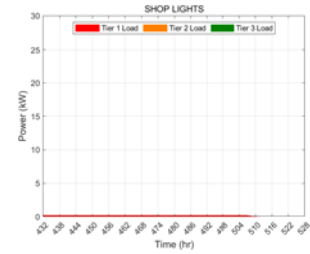
Fig. C-92 The televisions tiered electrical load for the shelter labeled as COM submaster A



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

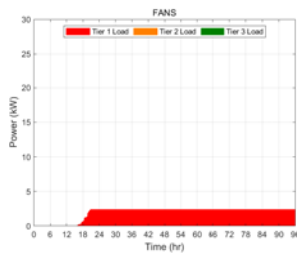


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

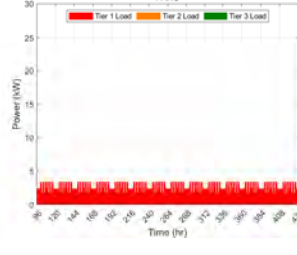


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

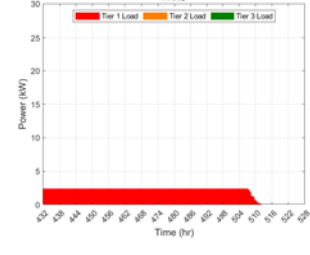
Fig. C-93 The shop lights tiered electrical load for the shelter labeled as COM submaster A



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-94 The fans tiered electrical load for the shelter labeled as COM submaster A

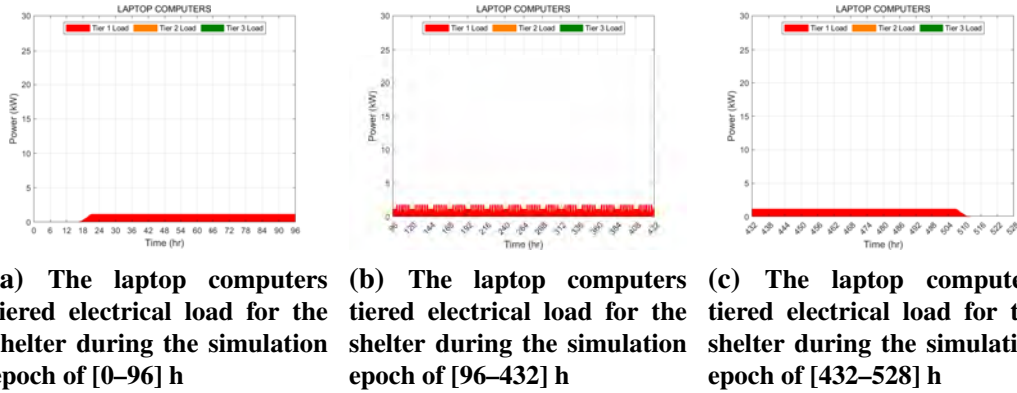


Fig. C-95 The laptop computers tiered electrical load for the shelter labeled as COM submaster A

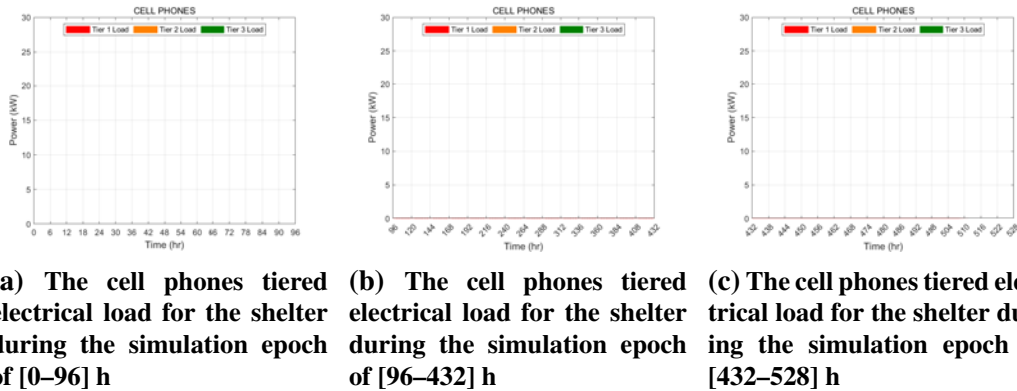


Fig. C-96 The cell phones tiered electrical load for the shelter labeled as COM submaster A

C.11 COC Submaster B

The shelter labeled as COC submaster B was used as a secondary COC shelter. The maximum capacity of the shelter was estimated to be 35 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to assist the master COC shelter to manage the energy network's operation.

The event schedule (Fig. C-97), the time-varying occupancy (Fig. C-98), the resulting thermal response (Fig. C-99), aggregate electrical load (Fig. C-100), and the ECU electrical load (Fig. C-101).

The shelter labeled as COC submaster B contains six separate electrical components including 1) specialized equipment (Fig. C-102), 2) televisions (Fig. C-103), 3) shop lights (Fig. C-104), 4) fans (Fig. C-105), 5) laptop computers (Fig. C-106), and 6) cell phones (Fig. C-107).

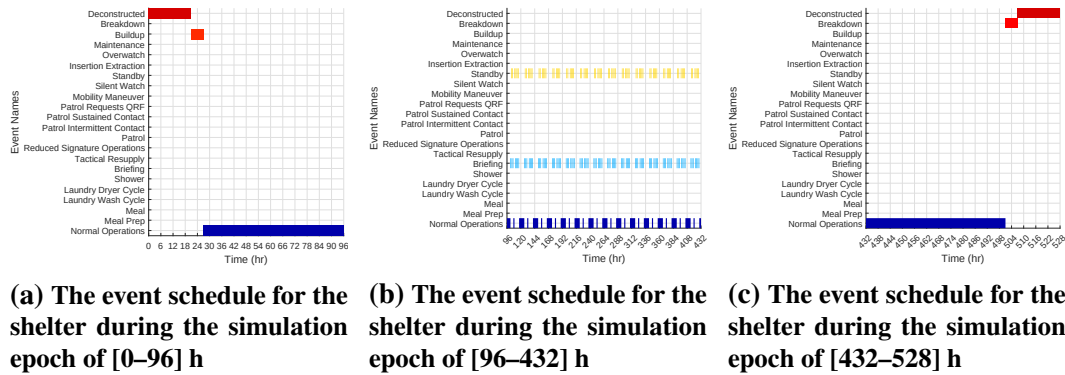


Fig. C-97 The event schedule for the shelter labeled as COC submaster B

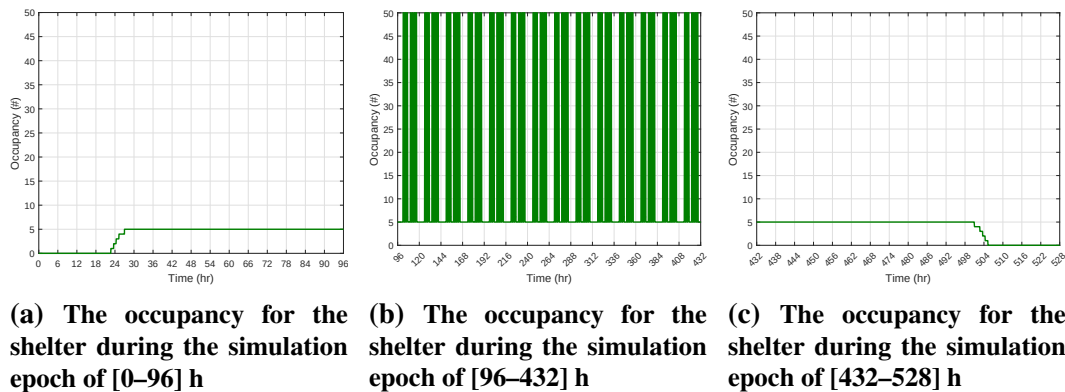


Fig. C-98 The occupancy for the shelter labeled as COC submaster B

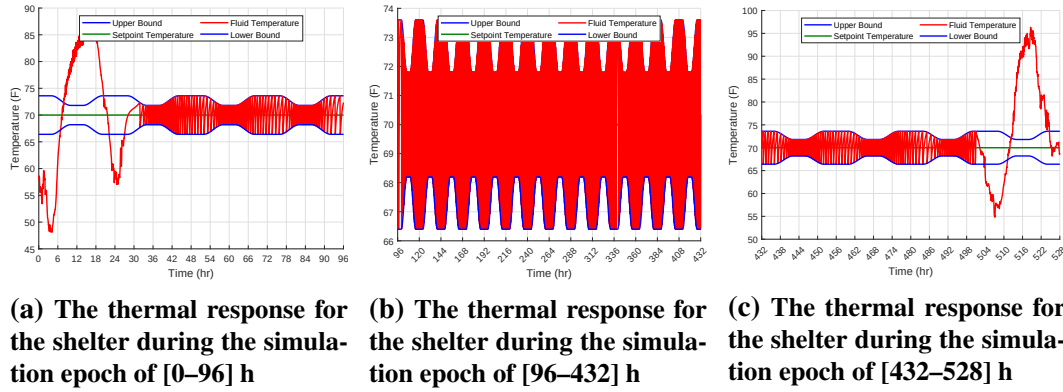


Fig. C-99 The thermal response for the shelter labeled as COC submaster B

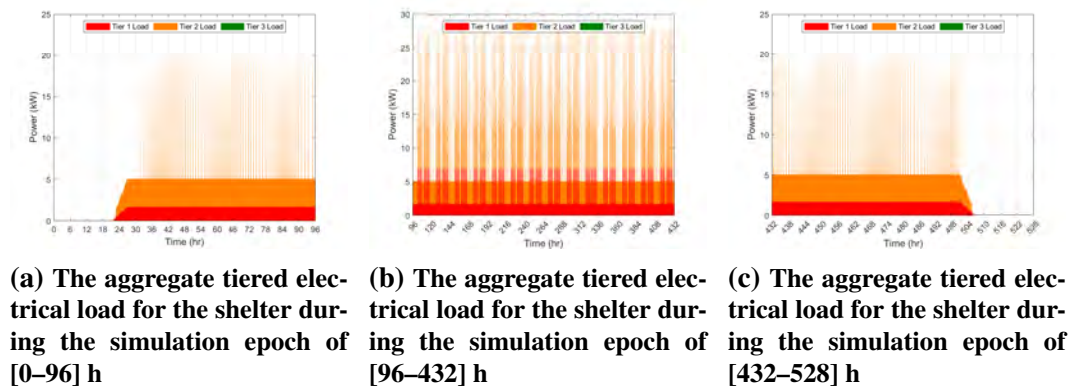


Fig. C-100 The aggregate tiered electrical load for the shelter labeled as COC submaster B

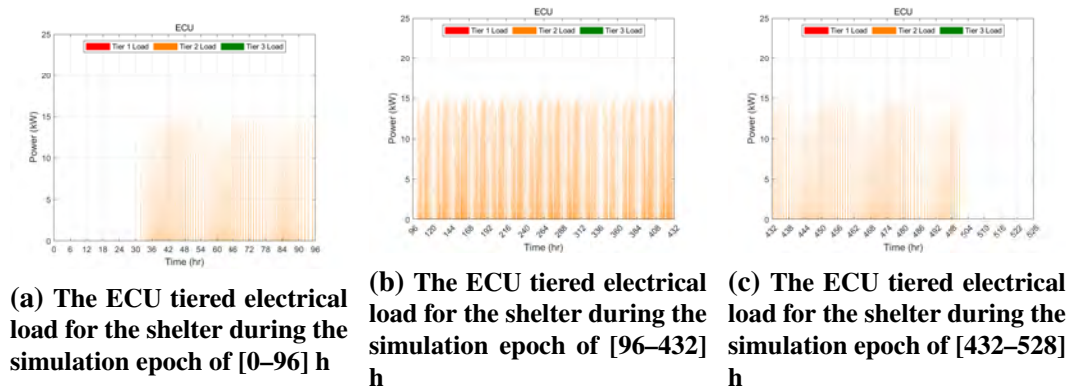
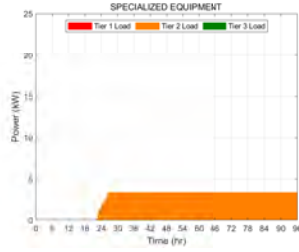
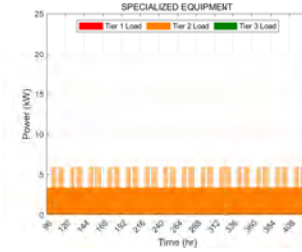


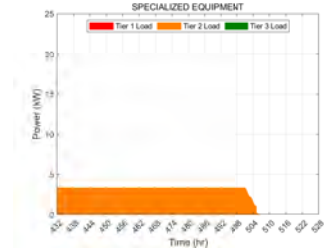
Fig. C-101 The ECU tiered electrical load for the shelter labeled as COC submaster B



(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0-96] h

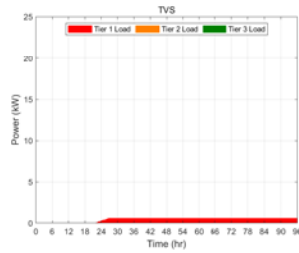


(b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96-432] h

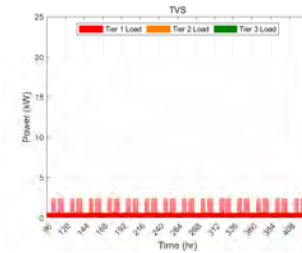


(c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432-528] h

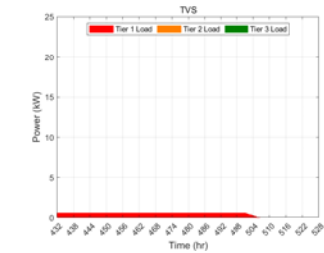
Fig. C-102 The specialized equipment tiered electrical load for the shelter labeled as COC submaster B



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0-96] h

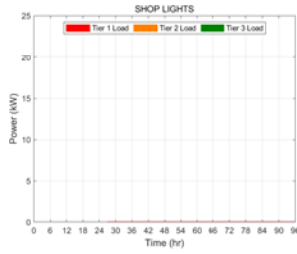


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96-432] h

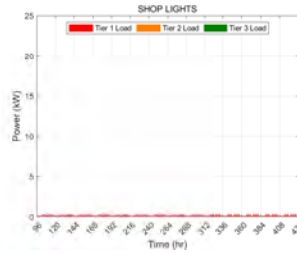


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432-528] h

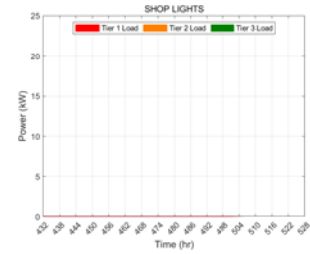
Fig. C-103 The televisions tiered electrical load for the shelter labeled as COC submaster B



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0-96] h

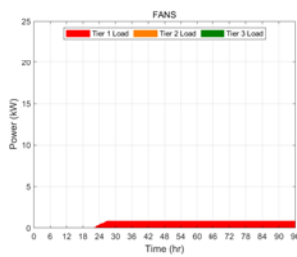


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96-432] h

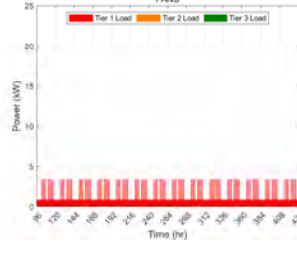


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432-528] h

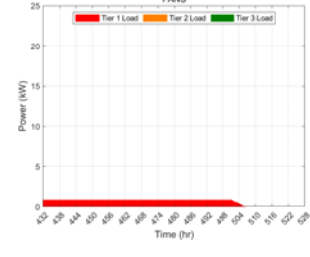
Fig. C-104 The shop lights tiered electrical load for the shelter labeled as COC submaster B



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-105 The fans tiered electrical load for the shelter labeled as COC submaster B

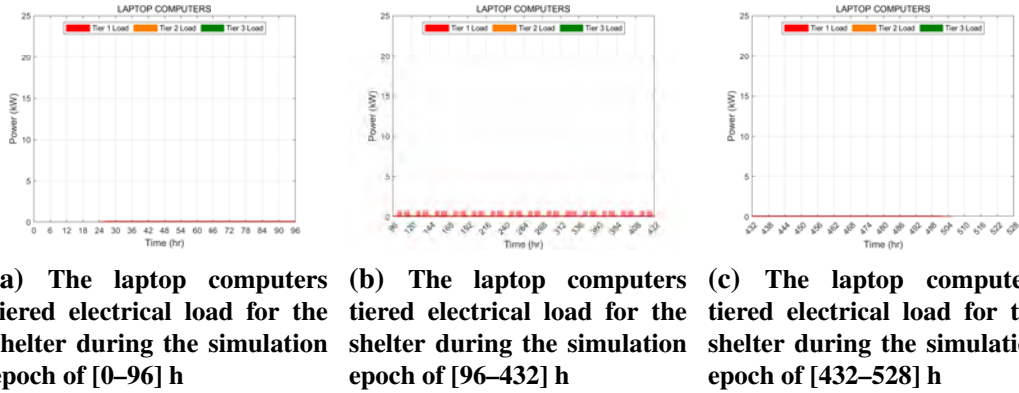


Fig. C-106 The laptop computers tiered electrical load for the shelter labeled as COC submaster B

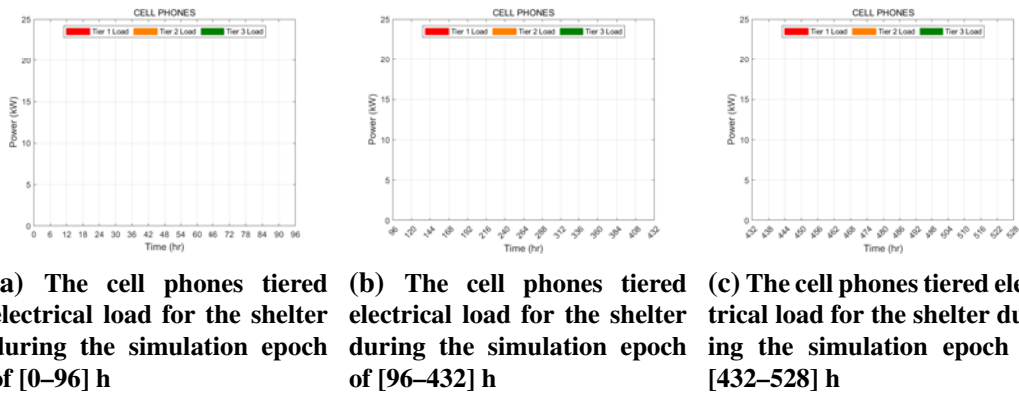


Fig. C-107 The cell phones tiered electrical load for the shelter labeled as COC submaster B

C.12 COM Submaster B

The shelter labeled as COM submaster B was used as a secondary COM shelter. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house the critical operational technology required to assist the master COM shelter to manage the energy network's communications.

The event schedule (Fig. C-108), the time-varying occupancy (Fig. C-109), the resulting thermal response (Fig. C-110), aggregate electrical load (Fig. C-111), and the ECU electrical load (Fig. C-112).

The shelter labeled as COM submaster B contains six separate electrical components including 1) specialized equipment (Fig. C-113), 2) televisions (Fig. C-114), 3) shop lights (Fig. C-115), 4) fans (Fig. C-116), 5) laptop computers (Fig. C-117), and 6) cell phones (Fig. C-118).

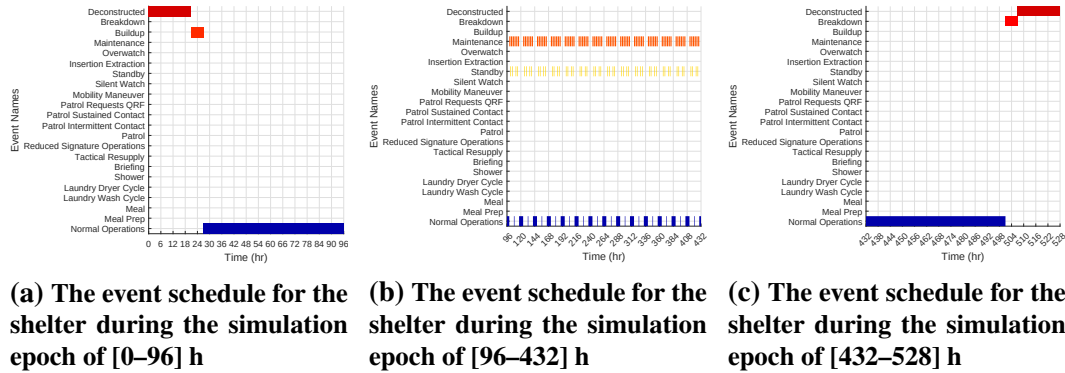


Fig. C-108 The event schedule for the shelter labeled as COM submaster B

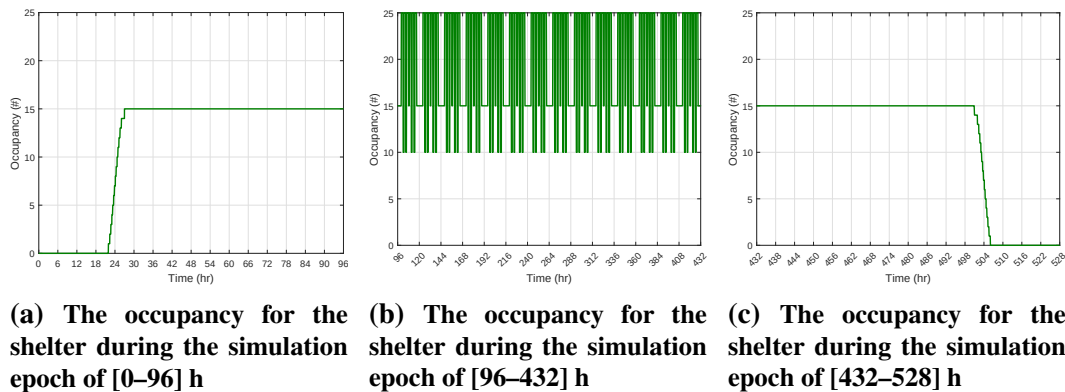


Fig. C-109 The occupancy for the shelter labeled as COM submaster B

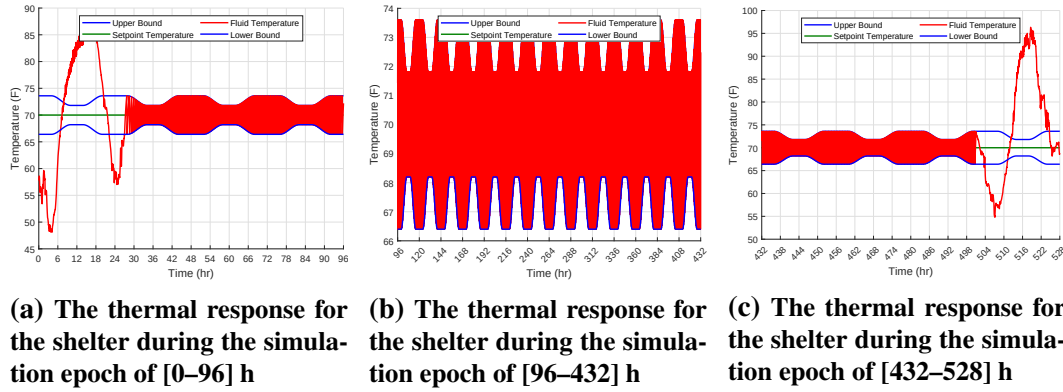


Fig. C-110 The thermal response for the shelter labeled as COM submaster B

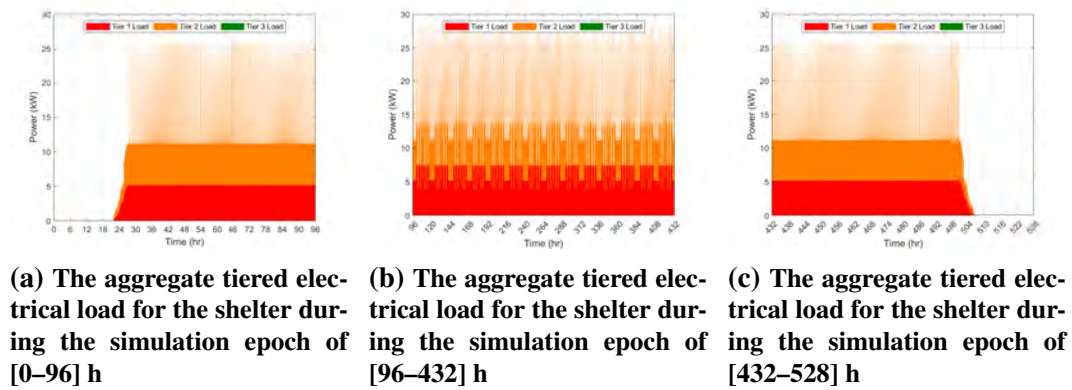


Fig. C-111 The aggregate tiered electrical load for the shelter labeled as COM submaster B

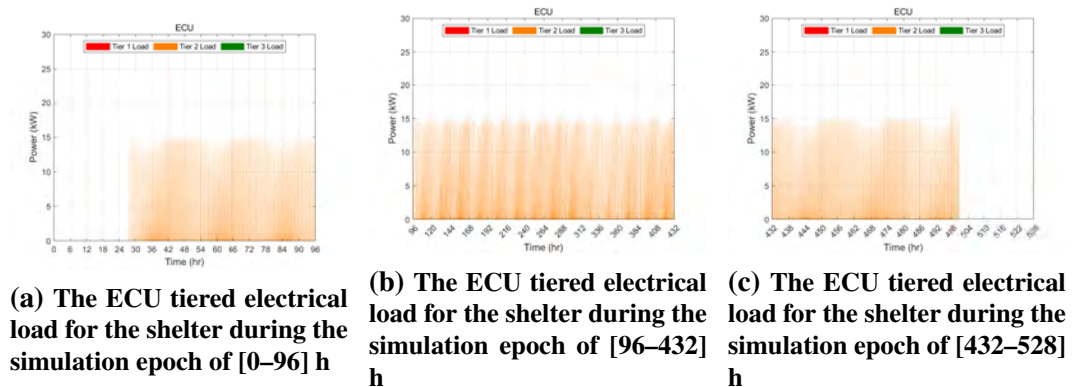


Fig. C-112 The ECU tiered electrical load for the shelter labeled as COM submaster B

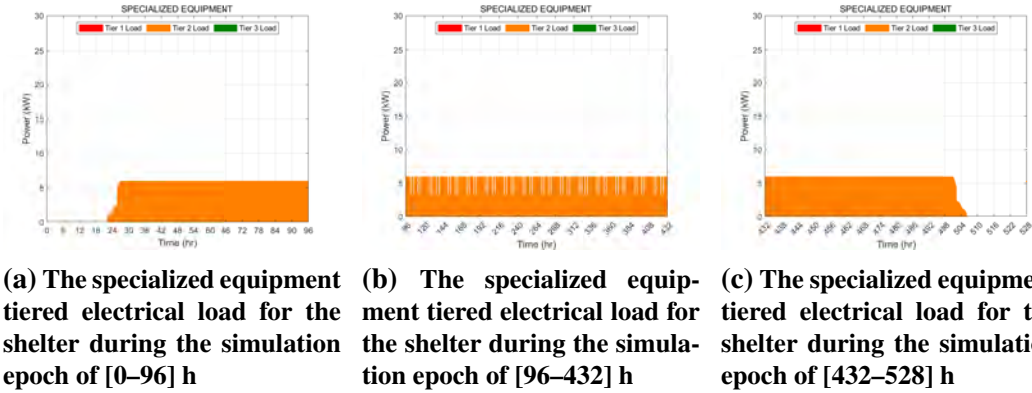


Fig. C-113 The specialized equipment tiered electrical load for the shelter labeled as COM submaster B

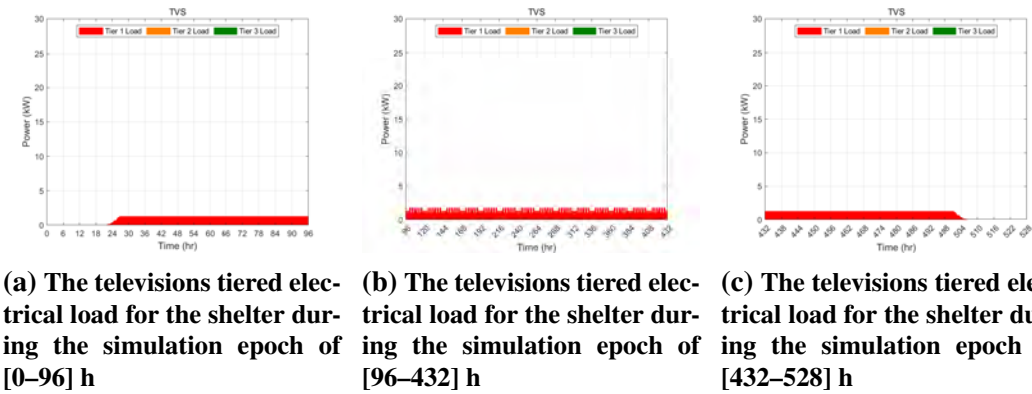
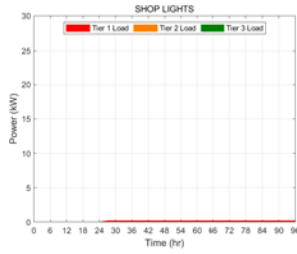
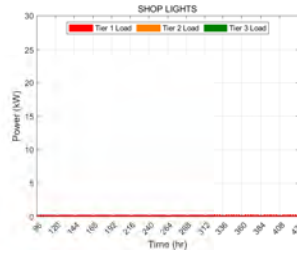


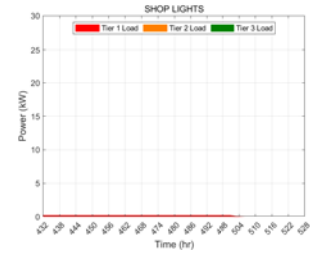
Fig. C-114 The televisions tiered electrical load for the shelter labeled as COM submaster B



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0-96] h

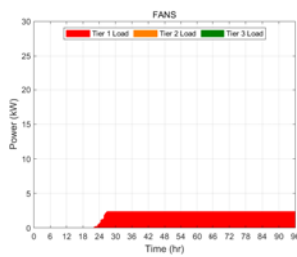


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96-432] h

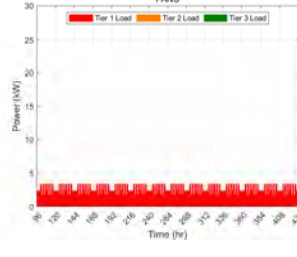


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432-528] h

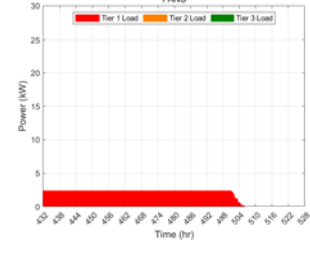
Fig. C-115 The shop lights tiered electrical load for the shelter labeled as COM submaster B



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-116 The fans tiered electrical load for the shelter labeled as COM submaster B

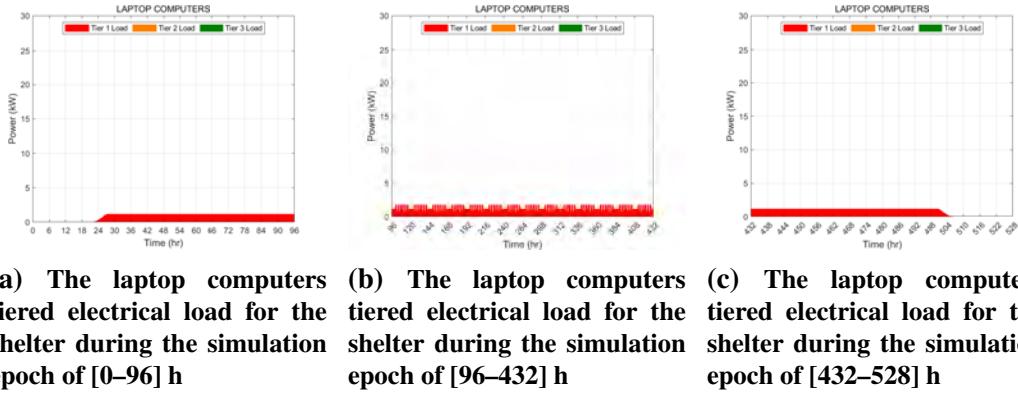


Fig. C-117 The laptop computers tiered electrical load for the shelter labeled as COM submaster B

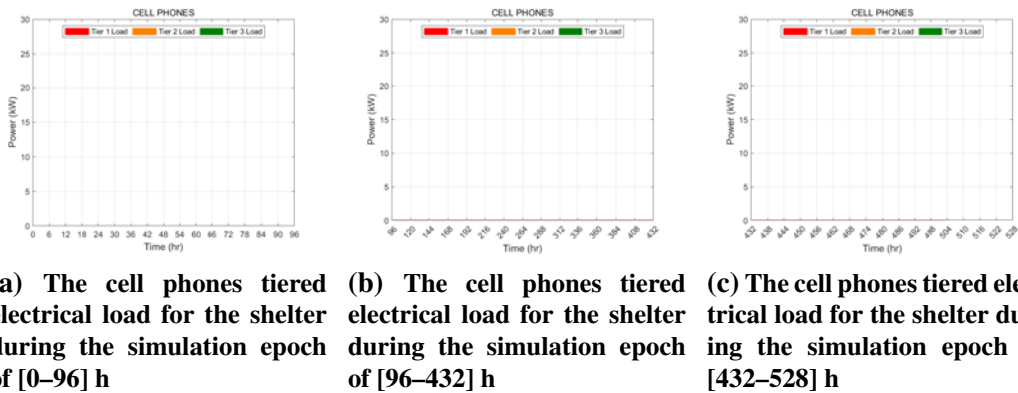


Fig. C-118 The cell phones tiered electrical load for the shelter labeled as COM submaster B

C.13 Officer Billeting A

The shelter labeled as officer billeting A houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter's occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-119), the time-varying occupancy (Fig. C-120), the re-

sulting thermal response (Fig. C-121), aggregate electrical load (Fig. C-122), and the ECU electrical load (Fig. C-123).

The shelter labeled as officer billeting A contains five separate electrical components including 1) televisions (Fig. C-124), 2) fans (Fig. C-126), 3) shop lights (Fig. C-125), 4) laptop computers (Fig. C-127), and 5) cell phones (Fig. C-128).

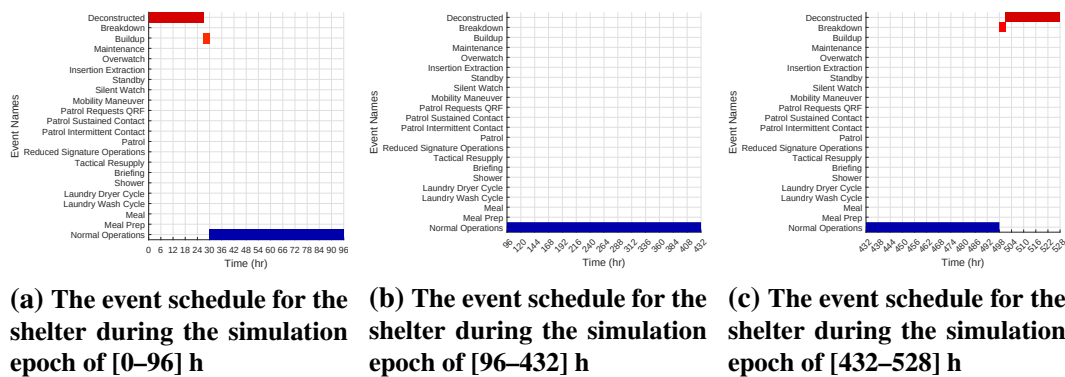


Fig. C-119 The event schedule for the shelter labeled as officer billeting A

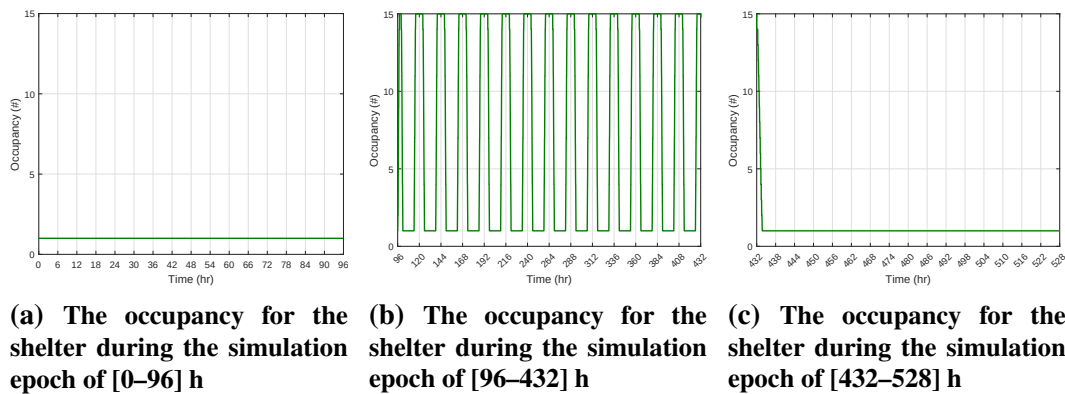


Fig. C-120 The occupancy for the shelter labeled as officer billeting A

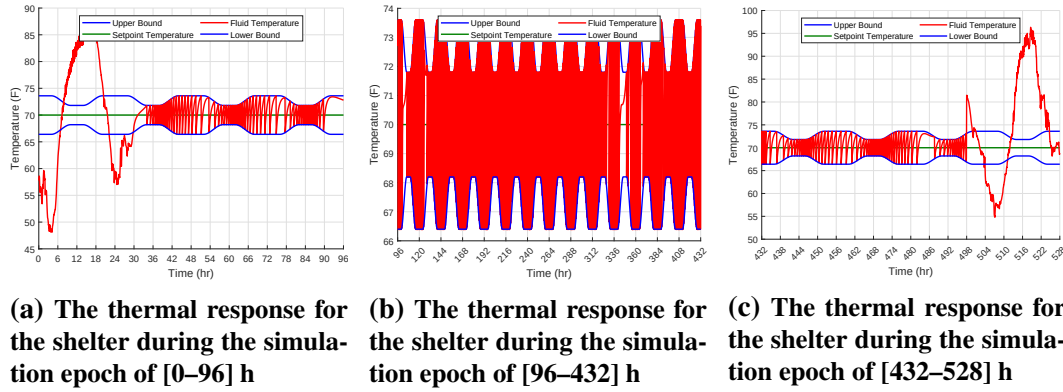


Fig. C-121 The thermal response for the shelter labeled as officer billeting A

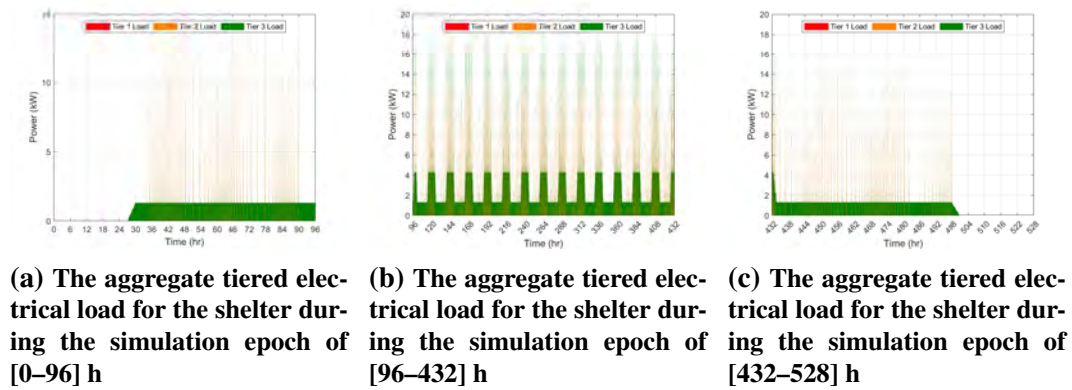


Fig. C-122 The aggregate tiered electrical load for the shelter labeled as officer billeting A

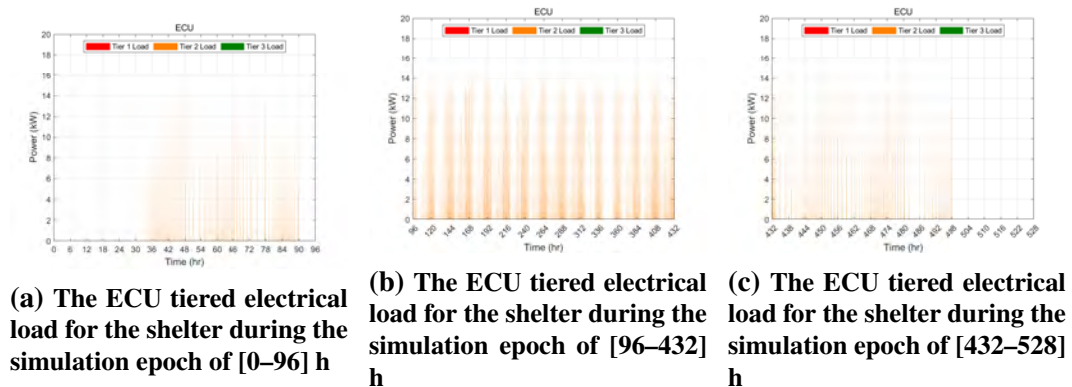
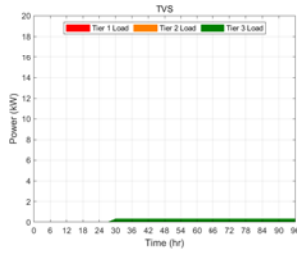
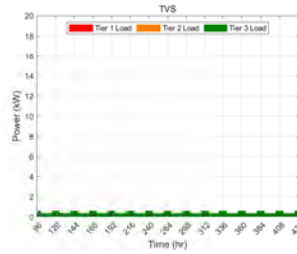


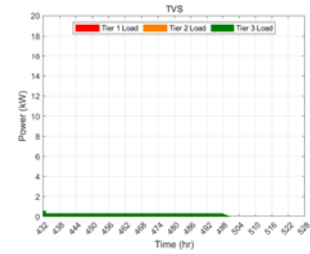
Fig. C-123 The ECU tiered electrical load for the shelter labeled as officer billeting A



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

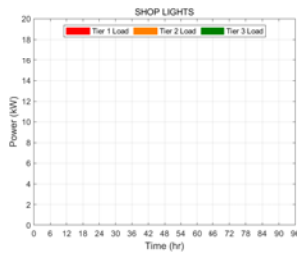


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

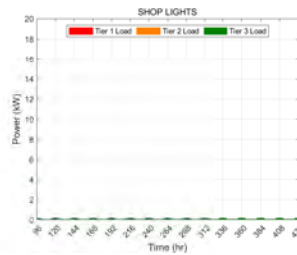


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-124 The televisions tiered electrical load for the shelter labeled as officer billeting A



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

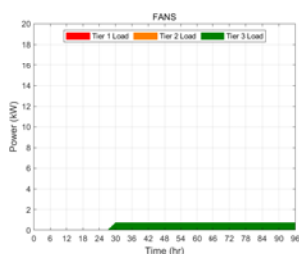


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

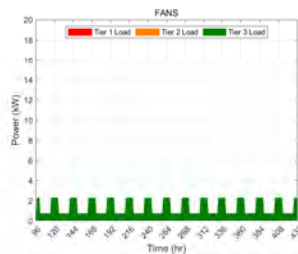


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

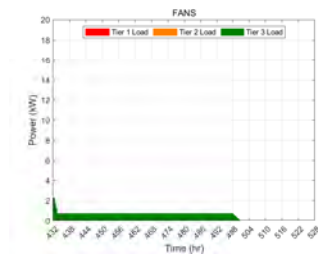
Fig. C-125 The shop lights tiered electrical load for the shelter labeled as officer billeting A



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-126 The fans tiered electrical load for the shelter labeled as officer billeting A



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-127 The laptop computers tiered electrical load for the shelter labeled as officer billeting A

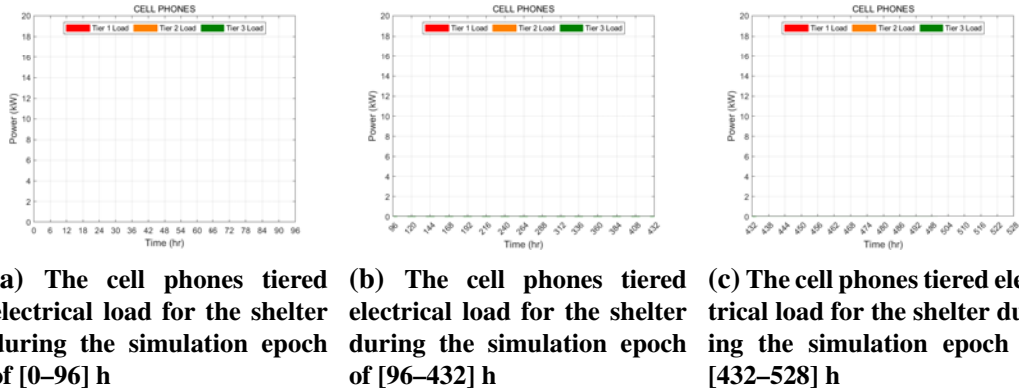


Fig. C-128 The cell phones tiered electrical load for the shelter labeled as officer billeting A

C.14 Officer Billeting B

The shelter labeled as officer billeting B houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter’s occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter’s occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-129), the time-varying occupancy (Fig. C-130), the resulting thermal response (Fig. C-131), aggregate electrical load (Fig. C-132), and the ECU electrical load (Fig. C-133).

The shelter labeled as officer billeting B contains five separate electrical components including 1) televisions (Fig. C-134), 2) fans (Fig. C-136), 3) shop lights (Fig. C-135), 4) laptop computers (Fig. C-137), and 5) cell phones (Fig. C-138).

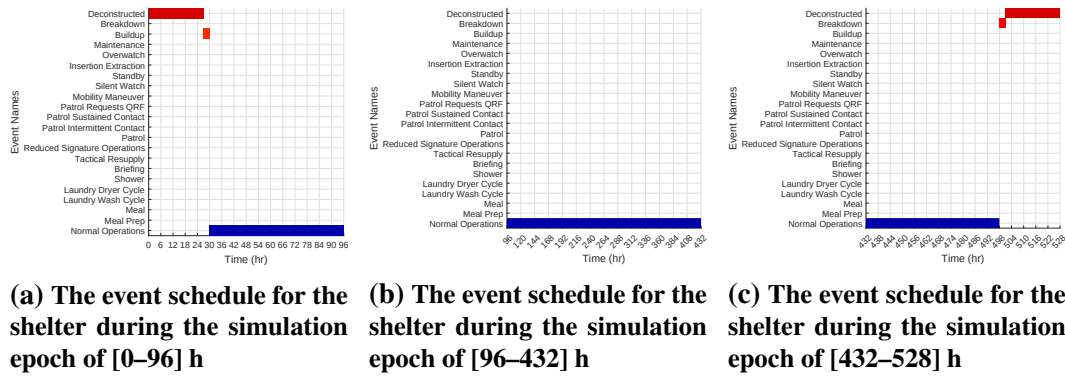


Fig. C-129 The event schedule for the shelter labeled as officer billeting B

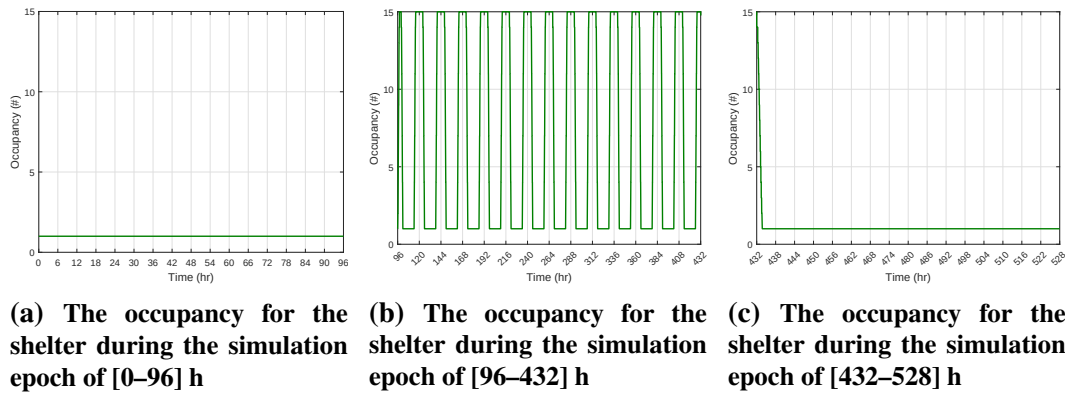


Fig. C-130 The occupancy for the shelter labeled as officer billeting B

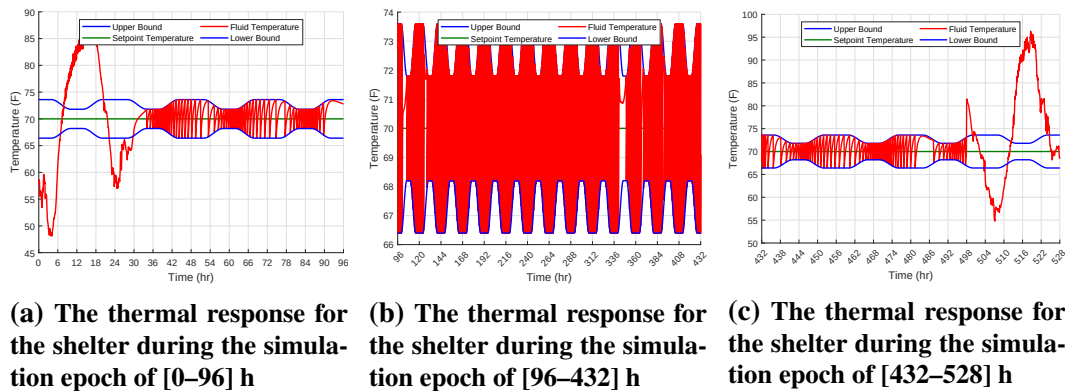
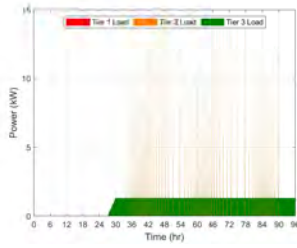
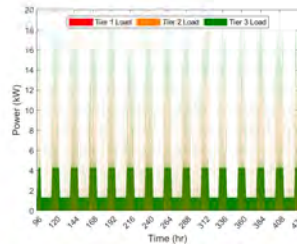


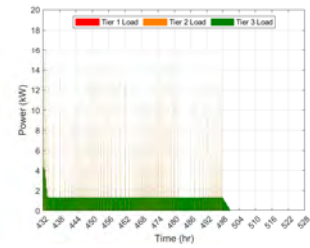
Fig. C-131 The thermal response for the shelter labeled as officer billeting B



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

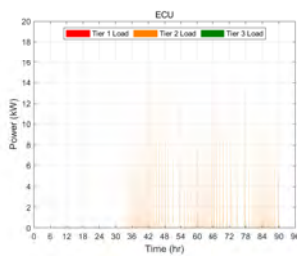


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

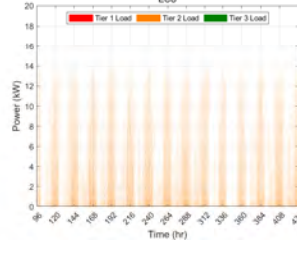


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

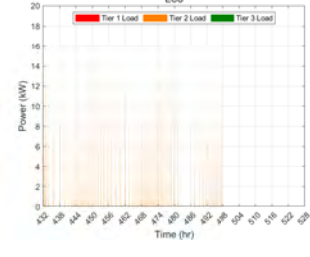
Fig. C-132 The aggregate tiered electrical load for the shelter labeled as officer billeting B



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

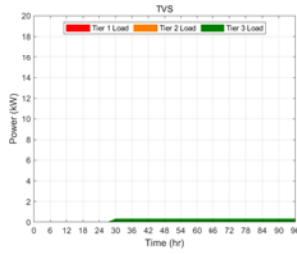


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

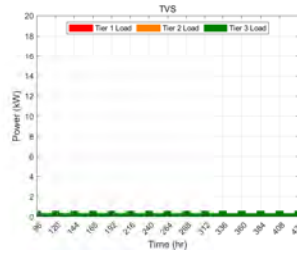


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

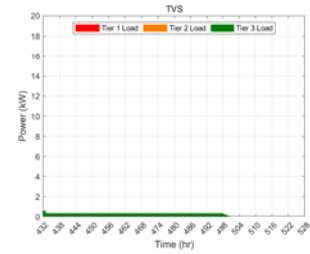
Fig. C-133 The ECU tiered electrical load for the shelter labeled as officer billeting B



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

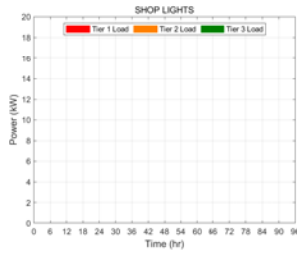


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-134 The televisions tiered electrical load for the shelter labeled as officer billeting B



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

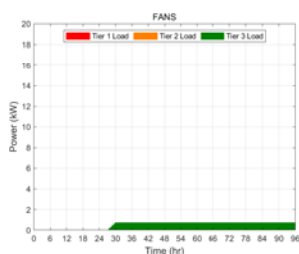


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

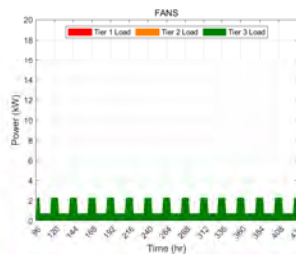


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

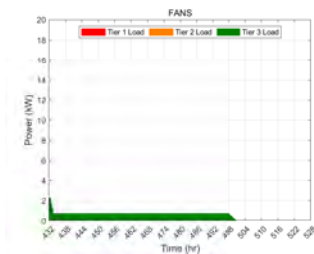
Fig. C-135 The shop lights tiered electrical load for the shelter labeled as officer billeting B



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-136 The fans tiered electrical load for the shelter labeled as officer billeting B



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0–96] h

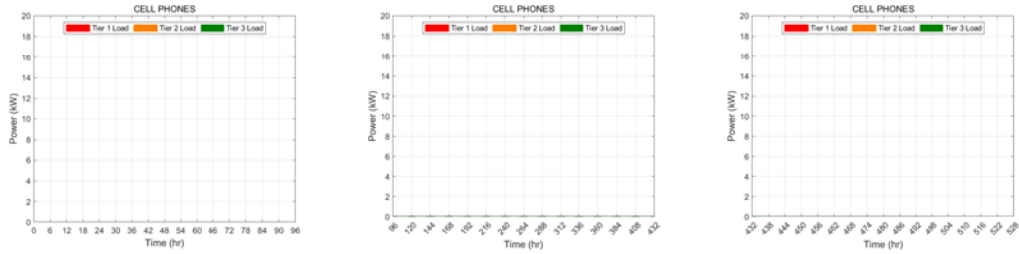


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-137 The laptop computers tiered electrical load for the shelter labeled as officer billeting B



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-138 The cell phones tiered electrical load for the shelter labeled as officer billeting B

C.15 Officer Billeting C

The shelter labeled as officer billeting C houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter’s occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter’s occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-139), the time-varying occupancy (Fig. C-140), the resulting thermal response (Fig. C-141), aggregate electrical load (Fig. C-142), and the ECU electrical load (Fig. C-143).

The shelter labeled as officer billeting C contains five separate electrical components including 1) televisions (Fig. C-144), 2) fans (Fig. C-146), 3) shop lights (Fig. C-145), 4) laptop computers (Fig. C-147), and 5) cell phones (Fig. C-148).

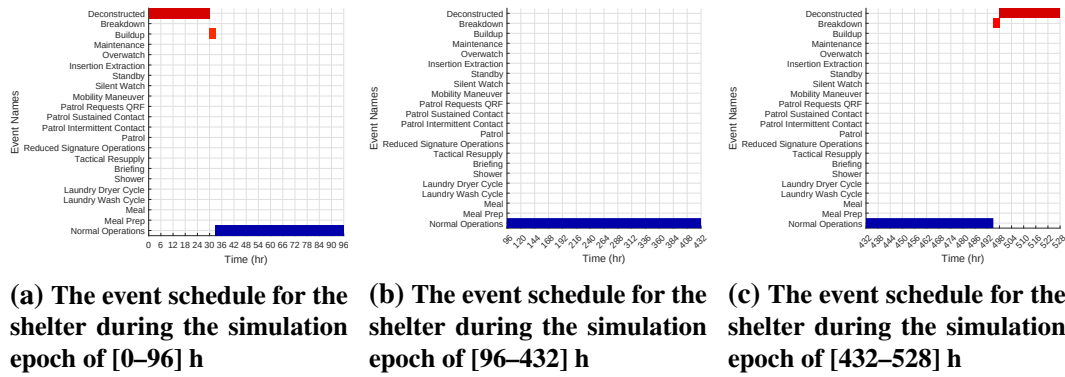


Fig. C-139 The event schedule for the shelter labeled as officer billeting C

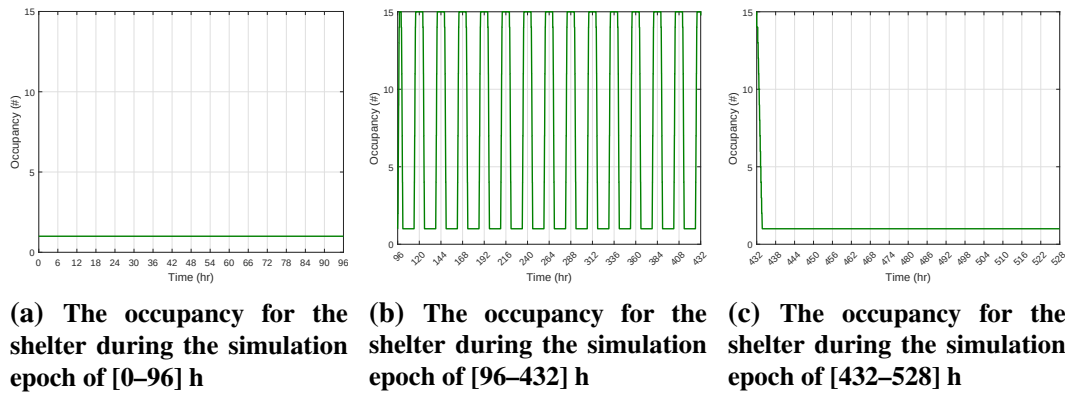


Fig. C-140 The occupancy for the shelter labeled as officer billeting C

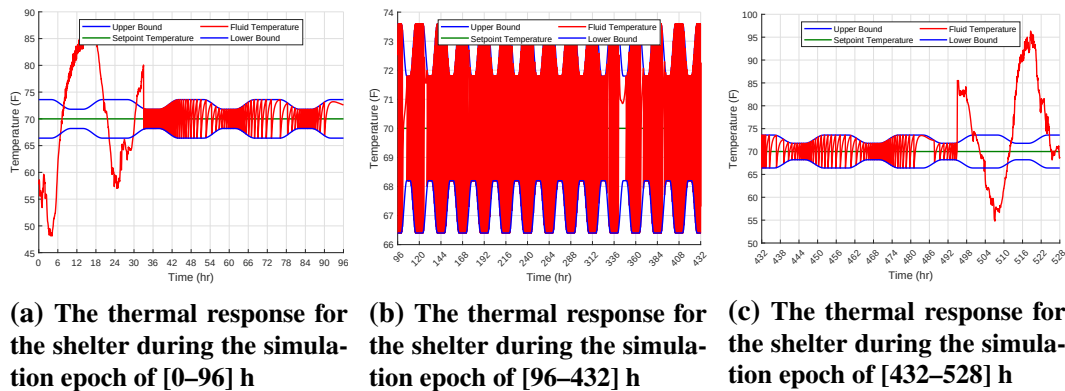
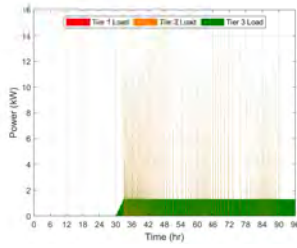
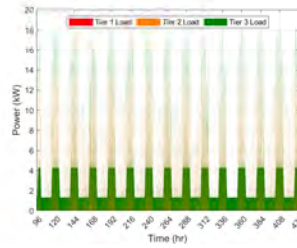


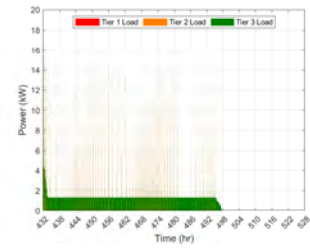
Fig. C-141 The thermal response for the shelter labeled as officer billeting C



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

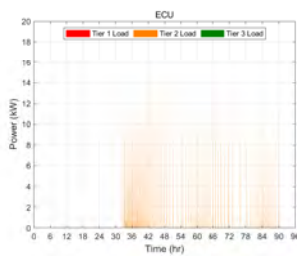


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

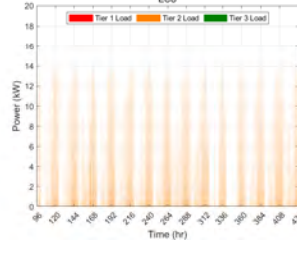


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

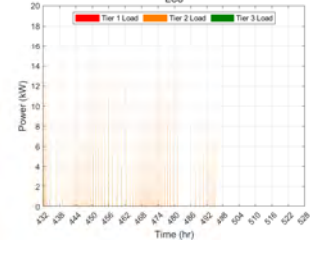
Fig. C-142 The aggregate tiered electrical load for the shelter labeled as officer billeting C



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

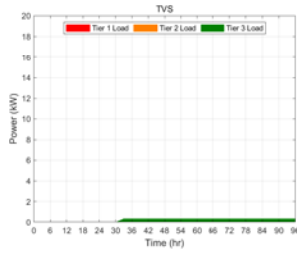


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

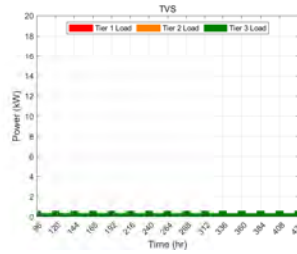


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

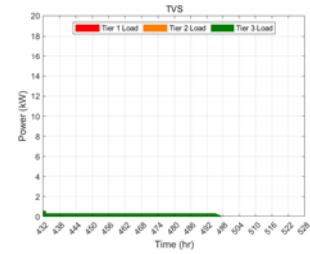
Fig. C-143 The ECU tiered electrical load for the shelter labeled as officer billeting C



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

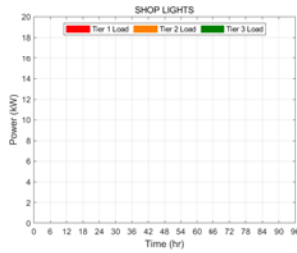


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-144 The televisions tiered electrical load for the shelter labeled as officer billeting C



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

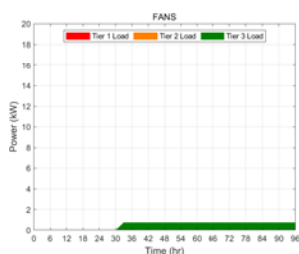


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

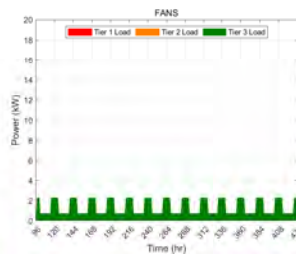


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

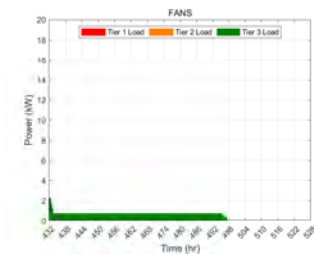
Fig. C-145 The shop lights tiered electrical load for the shelter labeled as officer billeting C



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-146 The fans tiered electrical load for the shelter labeled as officer billeting C



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h

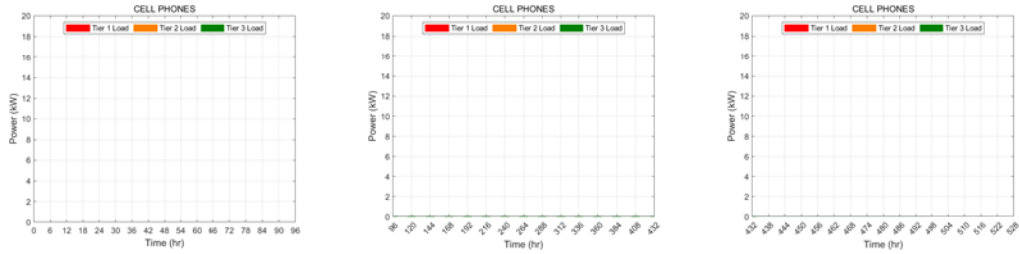


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-147 The laptop computers tiered electrical load for the shelter labeled as officer billeting C



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-148 The cell phones tiered electrical load for the shelter labeled as officer billeting C

C.16 Officer Billeting D

The shelter labeled as officer billeting D houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter’s occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter’s occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-149), the time-varying occupancy (Fig. C-150), the resulting thermal response (Fig. C-151), aggregate electrical load (Fig. C-152), and the ECU electrical load (Fig. C-153).

The shelter labeled as officer billeting D contains five separate electrical components including 1) televisions (Fig. C-154), 2) fans (Fig. C-156), 3) shop lights (Fig. C-155), 4) laptop computers (Fig. C-157), and 5) cell phones (Fig. C-158).

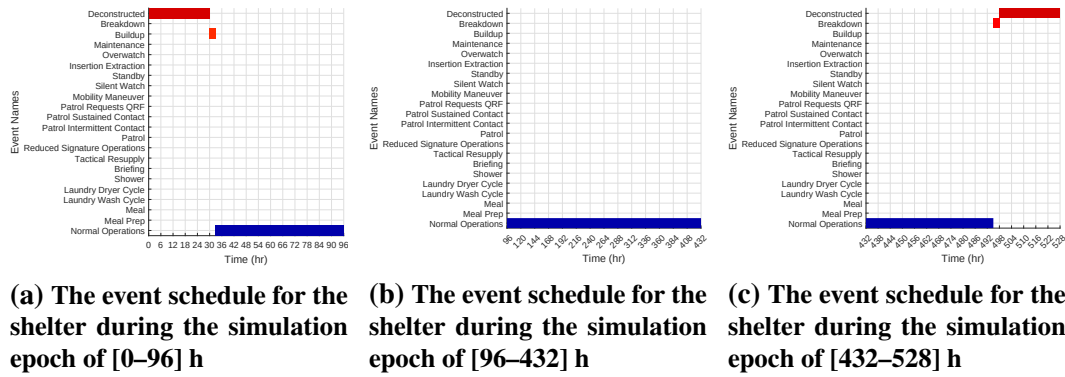


Fig. C-149 The event schedule for the shelter labeled as officer billeting D

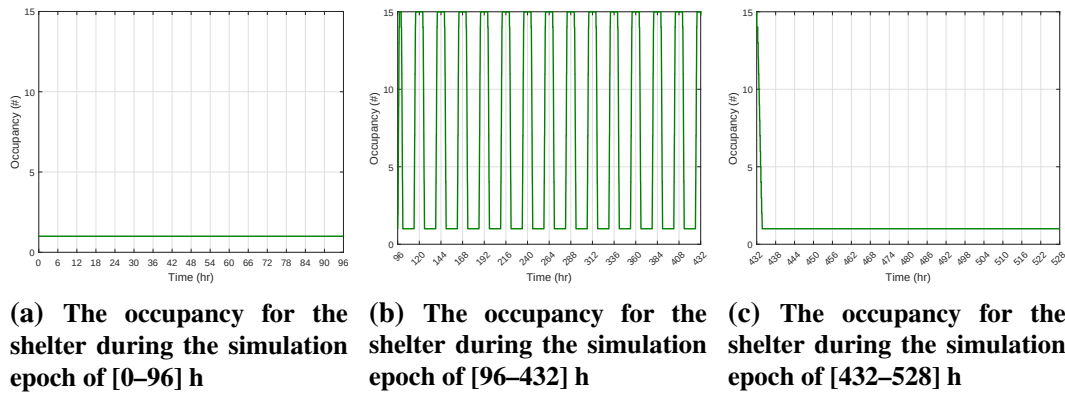


Fig. C-150 The occupancy for the shelter labeled as officer billeting D

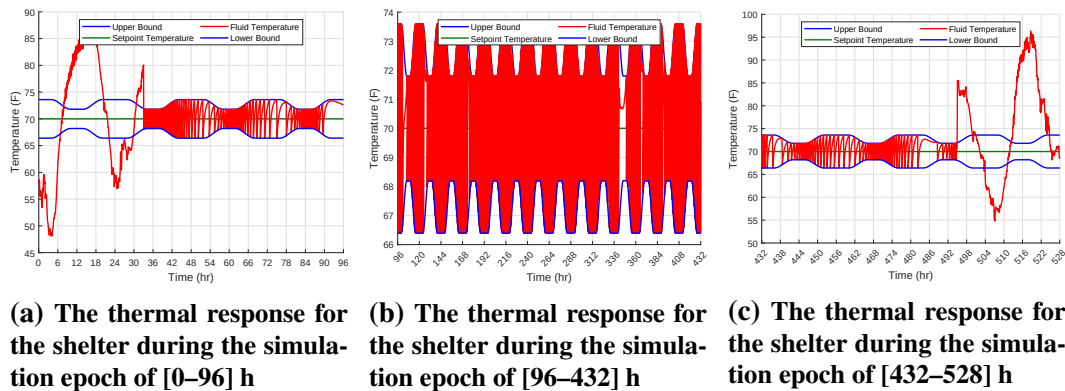
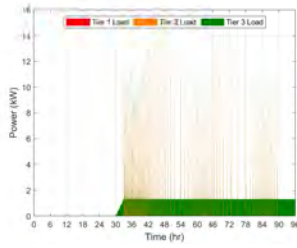
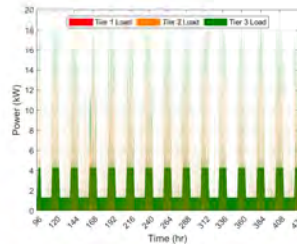


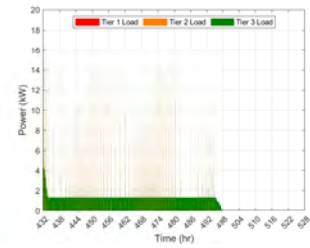
Fig. C-151 The thermal response for the shelter labeled as officer billeting D



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

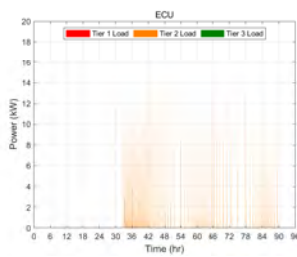


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

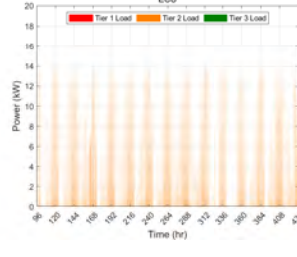


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

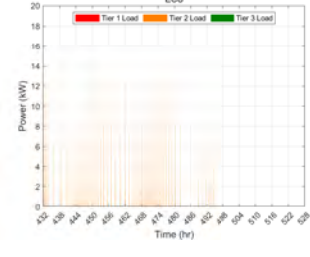
Fig. C-152 The aggregate tiered electrical load for the shelter labeled as officer billeting D



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

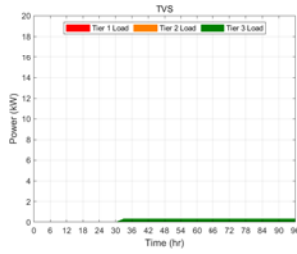


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

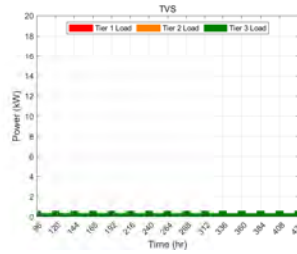


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

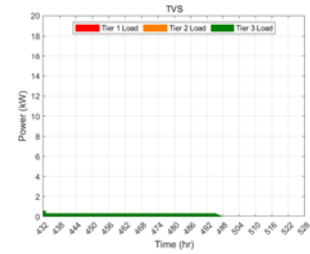
Fig. C-153 The ECU tiered electrical load for the shelter labeled as officer billeting D



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

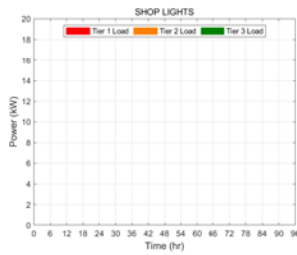


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

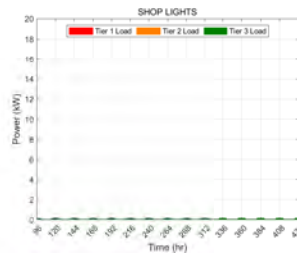


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-154 The televisions tiered electrical load for the shelter labeled as officer billeting D



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

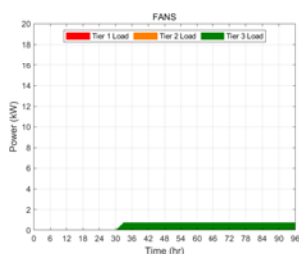


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

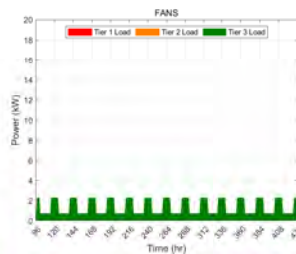


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

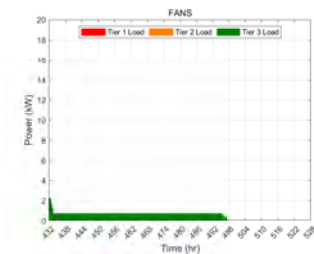
Fig. C-155 The shop lights tiered electrical load for the shelter labeled as officer billeting D



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-156 The fans tiered electrical load for the shelter labeled as officer billeting D



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h

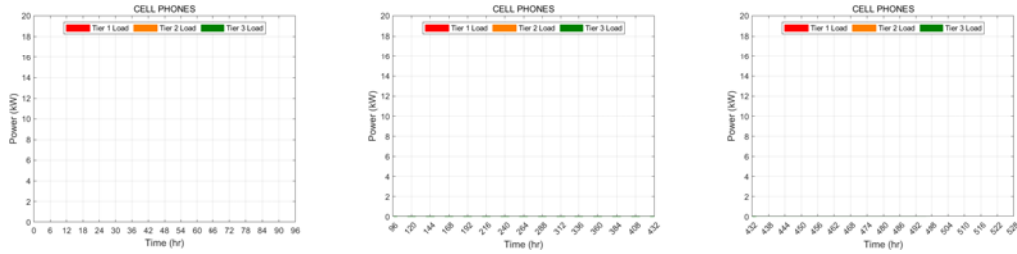


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-157 The laptop computers tiered electrical load for the shelter labeled as officer billeting D



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-158 The cell phones tiered electrical load for the shelter labeled as officer billeting D

C.17 Officer Billeting E

The shelter labeled as officer billeting E houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter’s occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter’s occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-159), the time-varying occupancy (Fig. C-160), the resulting thermal response (Fig. C-161), aggregate electrical load (Fig. C-162), and the ECU electrical load (Fig. C-163).

The shelter labeled as officer billeting E contains five separate electrical components including 1) televisions (Fig. C-164), 2) fans (Fig. C-166), 3) shop lights (Fig. C-165), 4) laptop computers (Fig. C-167), and 5) cell phones (Fig. C-168).

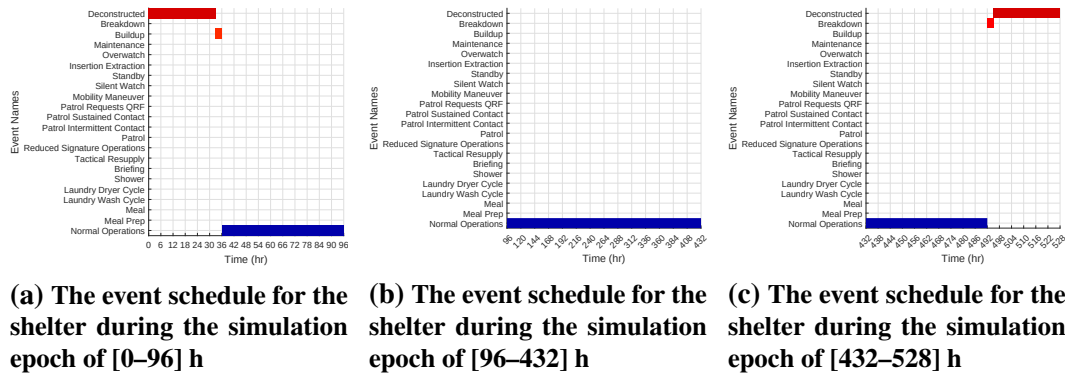


Fig. C-159 The event schedule for the shelter labeled as officer billeting E

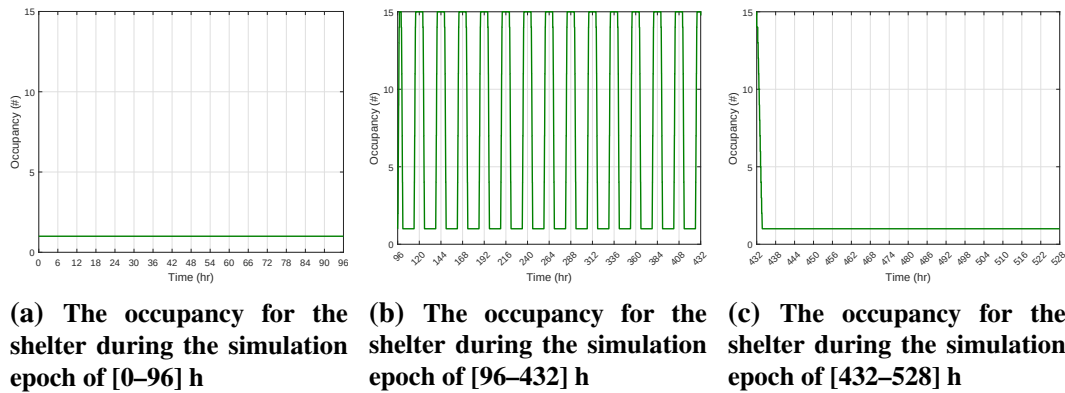


Fig. C-160 The occupancy for the shelter labeled as officer billeting E

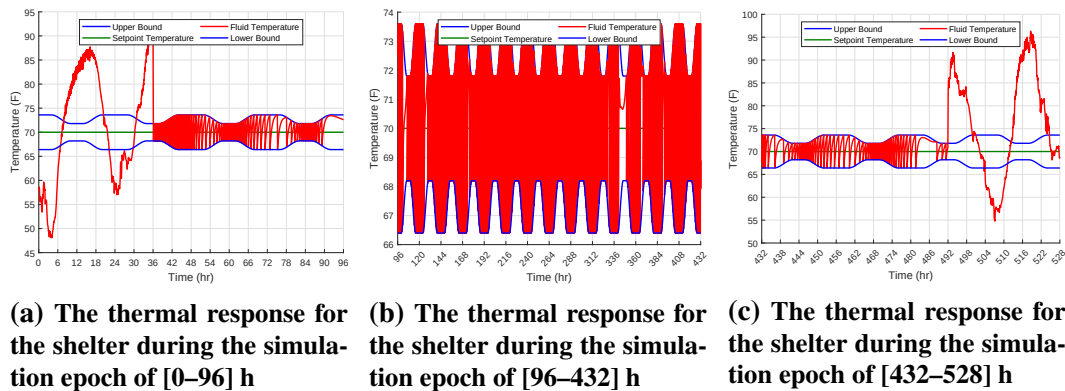
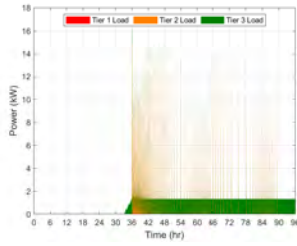
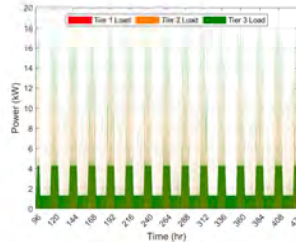


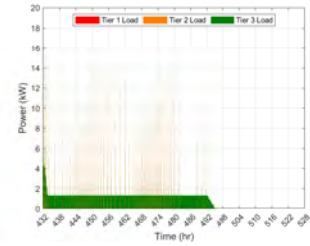
Fig. C-161 The thermal response for the shelter labeled as officer billeting E



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

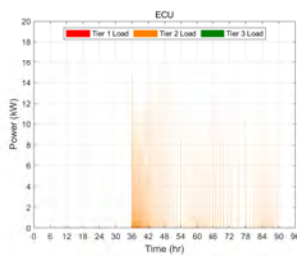


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

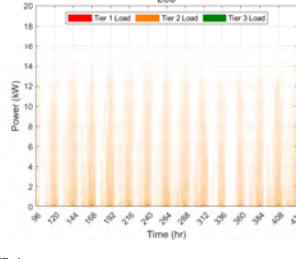


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

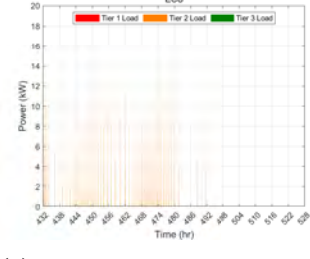
Fig. C-162 The aggregate tiered electrical load for the shelter labeled as officer billeting E



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

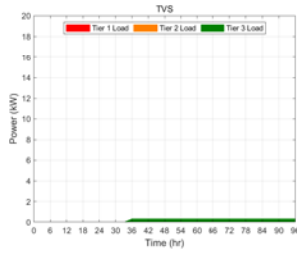


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

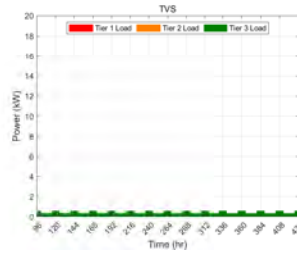


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

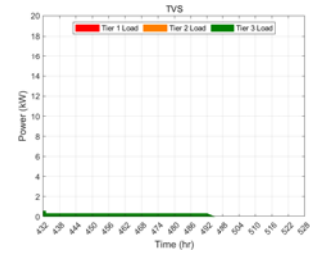
Fig. C-163 The ECU tiered electrical load for the shelter labeled as officer billeting E



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0-96] h

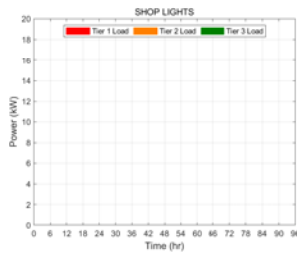


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96-432] h

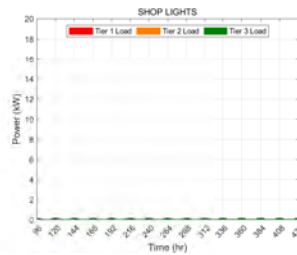


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-164 The televisions tiered electrical load for the shelter labeled as officer billeting E



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0-96] h

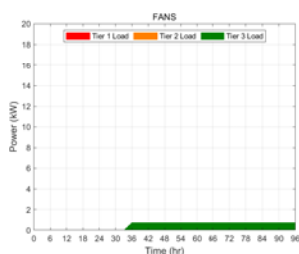


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96-432] h

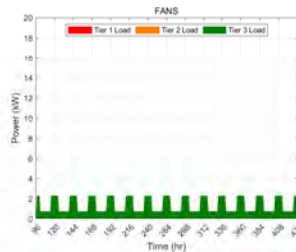


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432-528] h

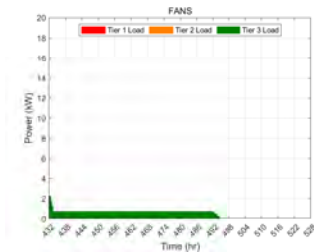
Fig. C-165 The shop lights tiered electrical load for the shelter labeled as officer billeting E



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-166 The fans tiered electrical load for the shelter labeled as officer billeting E



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-167 The laptop computers tiered electrical load for the shelter labeled as officer billeting E

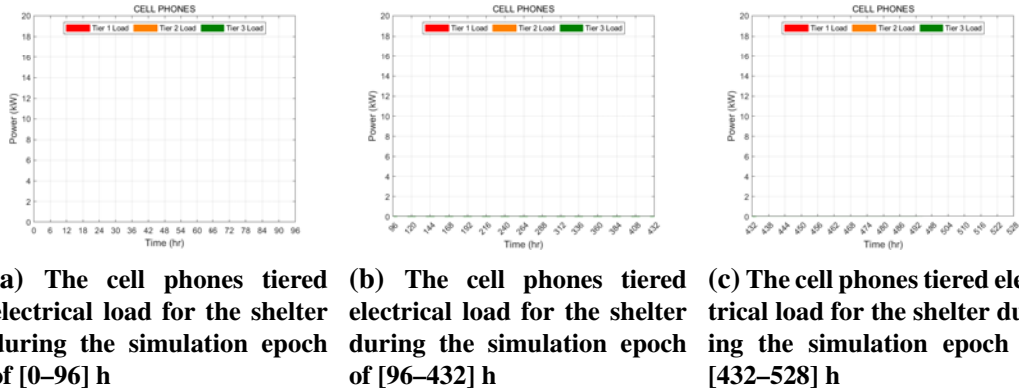


Fig. C-168 The cell phones tiered electrical load for the shelter labeled as officer billeting E

C.18 Officer Billeting F

The shelter labeled as officer billeting F houses the officer Soldiers. The maximum capacity of the shelter was estimated to be 15 Soldiers. The shelter’s occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter’s occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-169), the time-varying occupancy (Fig. C-170), the resulting thermal response (Fig. C-171), aggregate electrical load (Fig. C-172), and the ECU electrical load (Fig. C-173).

The shelter labeled as officer billeting F contains five separate electrical components including 1) televisions (Fig. C-174), 2) fans (Fig. C-176), 3) shop lights (Fig. C-175), 4) laptop computers (Fig. C-177), and 5) cell phones (Fig. C-178).

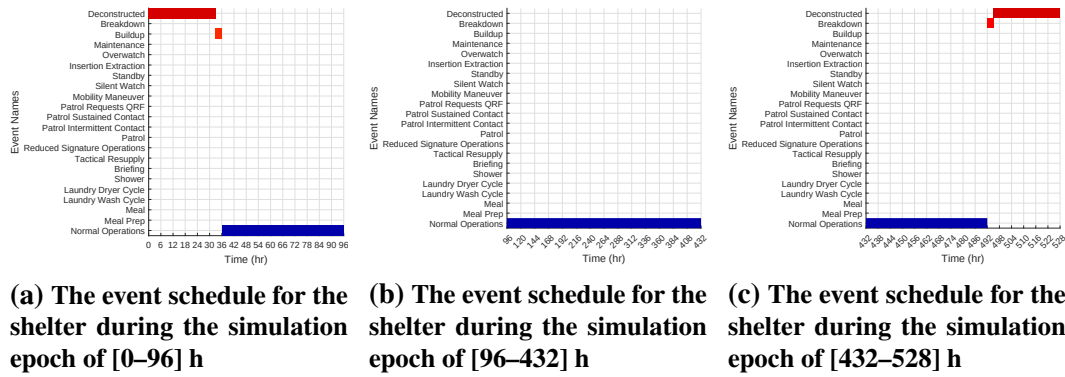


Fig. C-169 The event schedule for the shelter labeled as officer billeting F

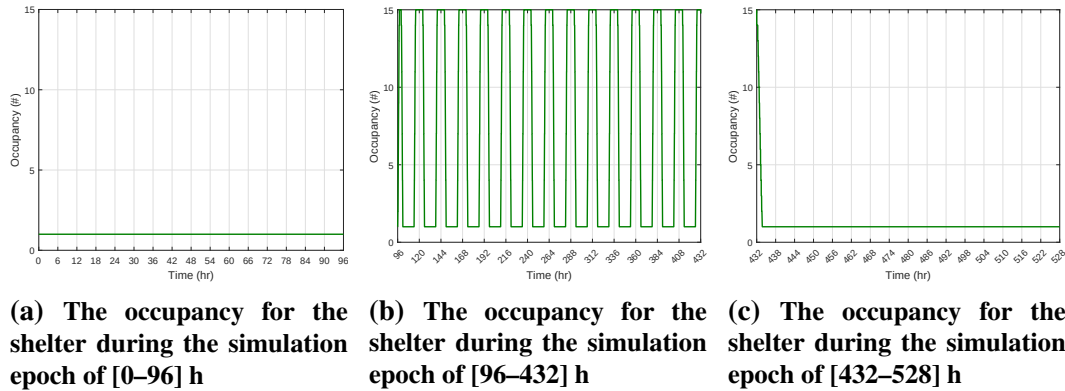


Fig. C-170 The occupancy for the shelter labeled as officer billeting F

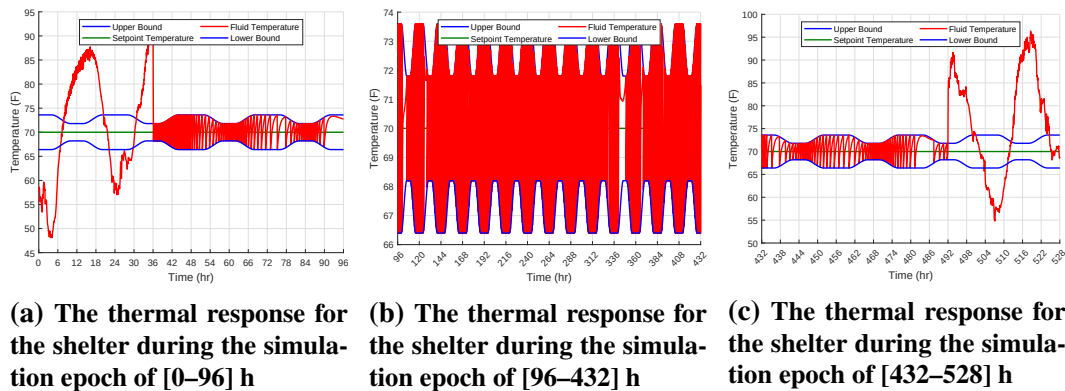
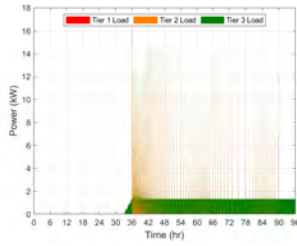
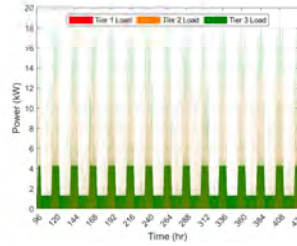


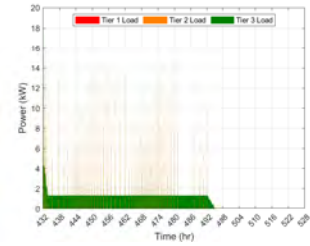
Fig. C-171 The thermal response for the shelter labeled as officer billeting F



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

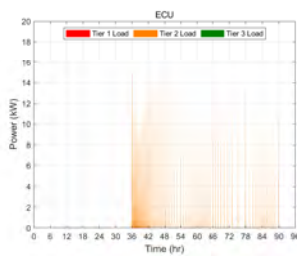


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

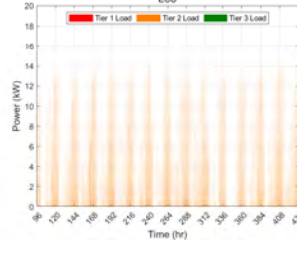


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

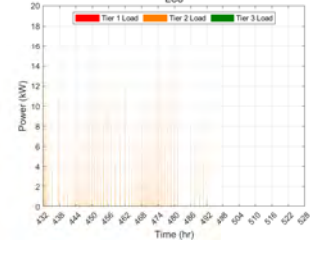
Fig. C-172 The aggregate tiered electrical load for the shelter labeled as officer billeting F



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

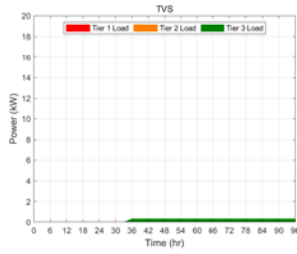


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

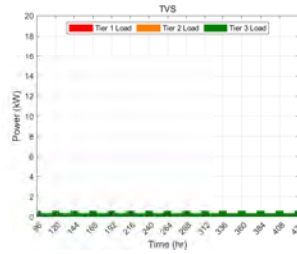


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

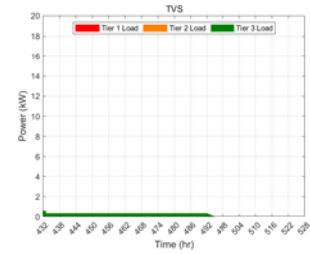
Fig. C-173 The ECU tiered electrical load for the shelter labeled as officer billeting F



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0-96] h

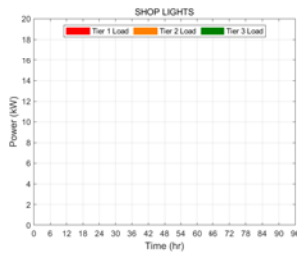


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96-432] h

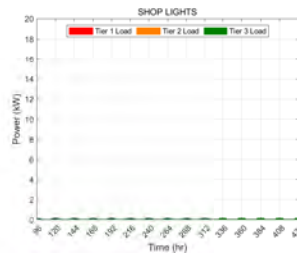


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-174 The televisions tiered electrical load for the shelter labeled as officer billeting F



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0-96] h

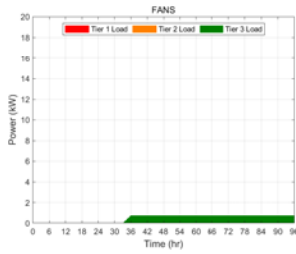


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96-432] h

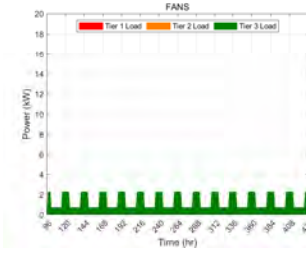


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432-528] h

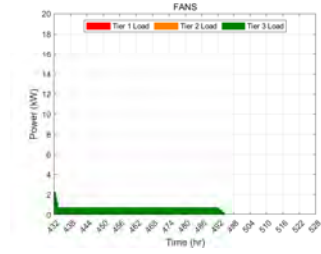
Fig. C-175 The shop lights tiered electrical load for the shelter labeled as officer billeting F



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h

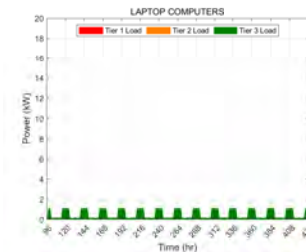


(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

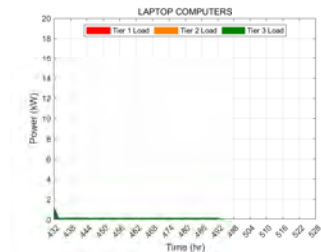
Fig. C-176 The fans tiered electrical load for the shelter labeled as officer billeting F



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h

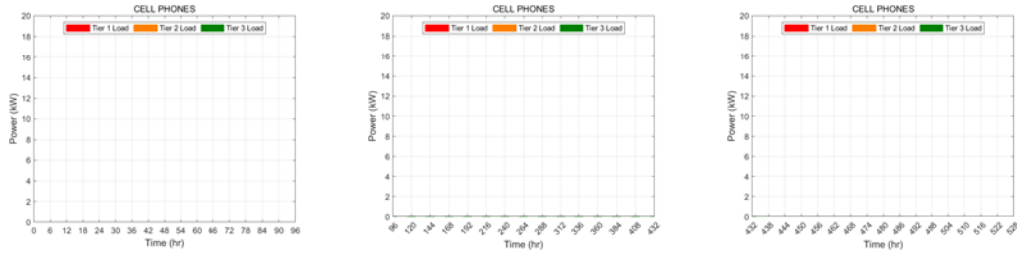


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-177 The laptop computers tiered electrical load for the shelter labeled as officer billeting F



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

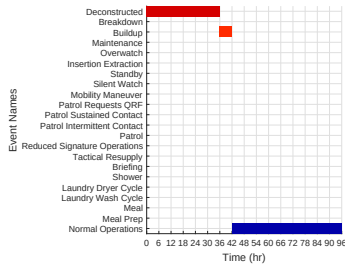
Fig. C-178 The cell phones tiered electrical load for the shelter labeled as officer billeting F

C.19 Enlisted Billeting A

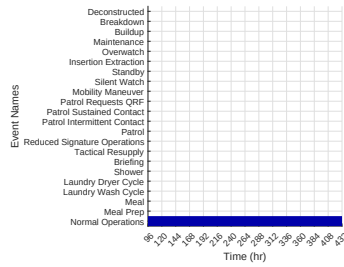
The shelter labeled as enlisted billeting A houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter’s occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter’s occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-179), the time-varying occupancy (Fig. C-180), the resulting thermal response (Fig. C-181), aggregate electrical load (Fig. C-182), and the ECU electrical load (Fig. C-183).

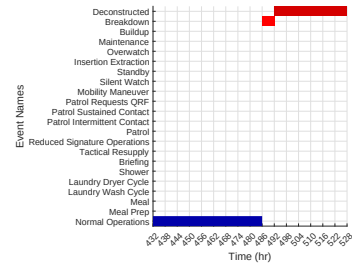
The shelter labeled as enlisted billeting A contains six separate electrical components including 1) televisions (Fig. C-184), 2) game consoles (Fig. C-185), 3) fans (Fig. C-187), 4) shop lights (Fig. C-186), 5) laptop computers (Fig. C-188), and 6) cell phones (Fig. C-189).



(a) The event schedule for the shelter during the simulation epoch of [0-96] h

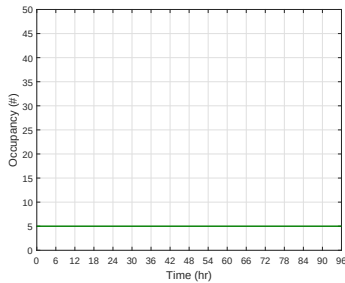


(b) The event schedule for the shelter during the simulation epoch of [96-432] h

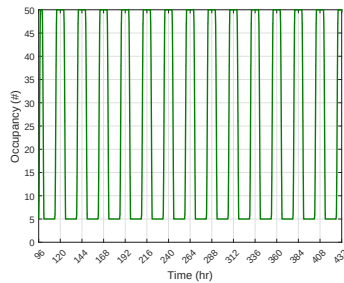


(c) The event schedule for the shelter during the simulation epoch of [432-528] h

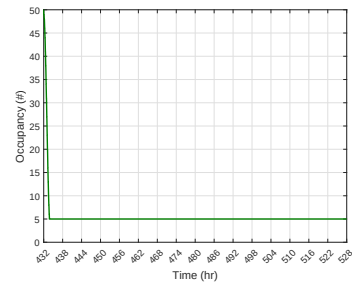
Fig. C-179 The event schedule for the shelter labeled as enlisted billeting A



(a) The occupancy for the shelter during the simulation epoch of [0-96] h

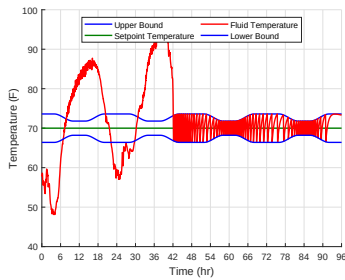


(b) The occupancy for the shelter during the simulation epoch of [96-432] h

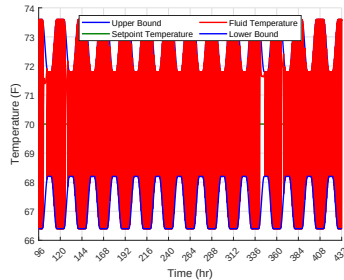


(c) The occupancy for the shelter during the simulation epoch of [432-528] h

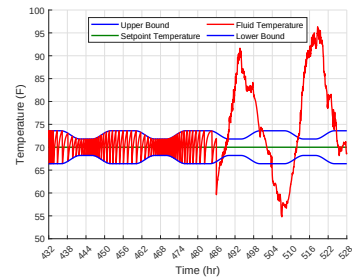
Fig. C-180 The occupancy for the shelter labeled as enlisted billeting A



(a) The thermal response for the shelter during the simulation epoch of [0-96] h

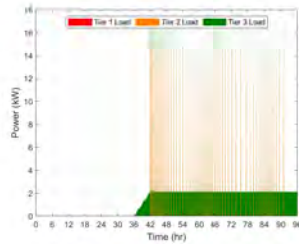


(b) The thermal response for the shelter during the simulation epoch of [96-432] h

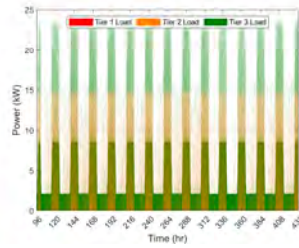


(c) The thermal response for the shelter during the simulation epoch of [432-528] h

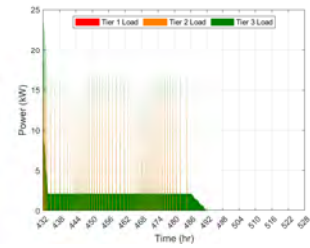
Fig. C-181 The thermal response for the shelter labeled as enlisted billeting A



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

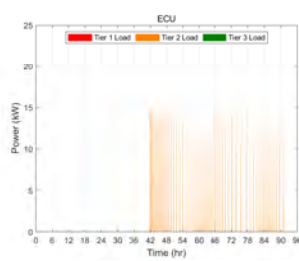


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

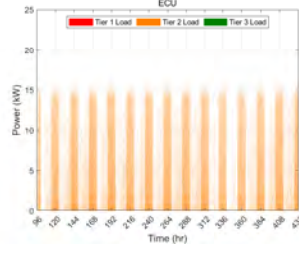


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

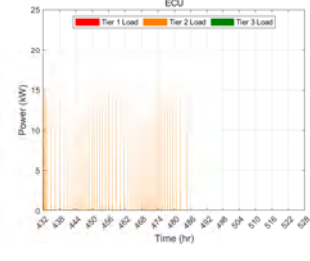
Fig. C-182 The aggregate tiered electrical load for the shelter labeled as enlisted billeting A



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

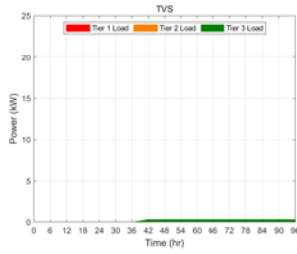


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

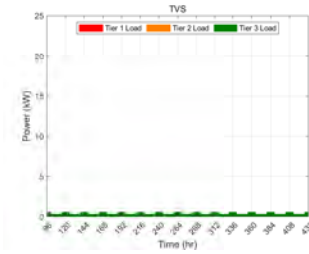


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

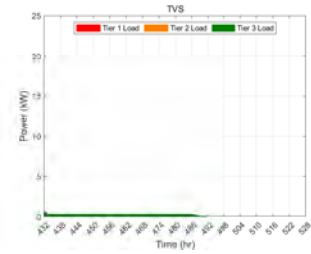
Fig. C-183 The ECU tiered electrical load for the shelter labeled as enlisted billeting A



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

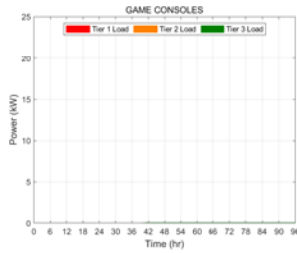


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

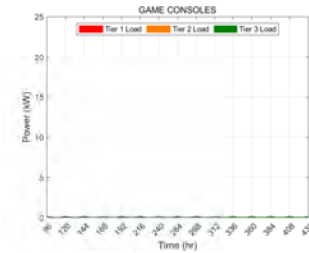


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-184 The televisions tiered electrical load for the shelter labeled as enlisted billeting A



(a) The game consoles tiered electrical load for the shelter during the simulation epoch of [0–96] h

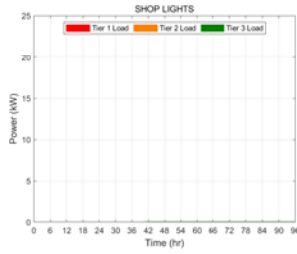


(b) The game consoles tiered electrical load for the shelter during the simulation epoch of [96–432] h

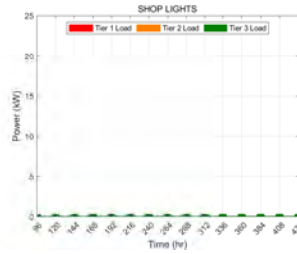


(c) The game consoles tiered electrical load for the shelter during the simulation epoch of [432–528] h

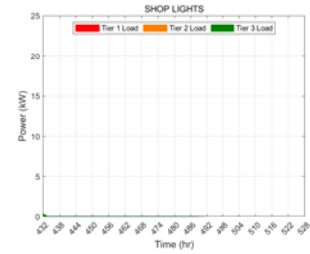
Fig. C-185 The game consoles tiered electrical load for the shelter labeled as enlisted billeting A



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

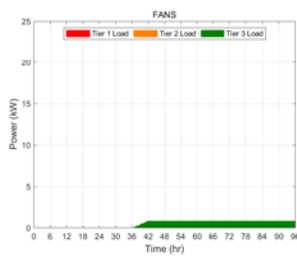


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

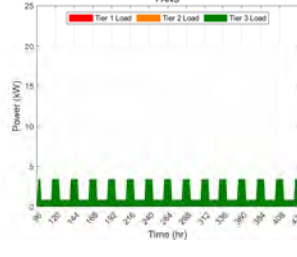


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

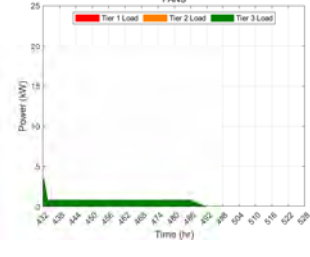
Fig. C-186 The shop lights tiered electrical load for the shelter labeled as enlisted billeting A



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-187 The fans tiered electrical load for the shelter labeled as enlisted billeting A

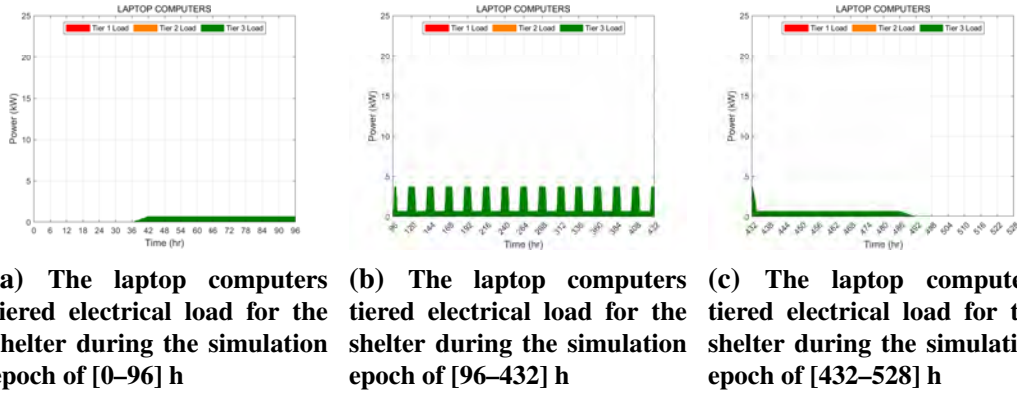


Fig. C-188 The laptop computers tiered electrical load for the shelter labeled as enlisted billeting A

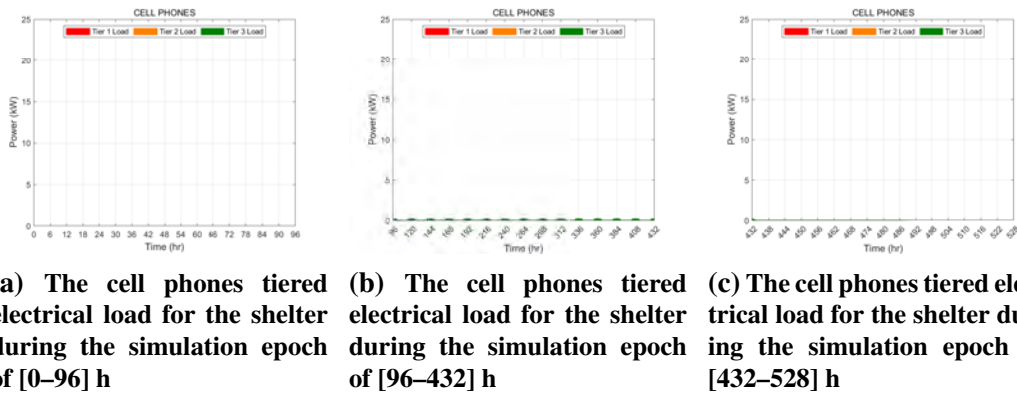


Fig. C-189 The cell phones tiered electrical load for the shelter labeled as enlisted billeting A

C.20 Enlisted Billeting B

The shelter labeled as enlisted billeting B houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-190), the time-varying occupancy (Fig. C-191), the re-

sulting thermal response (Fig. C-192), aggregate electrical load (Fig. C-193), and the ECU electrical load (Fig. C-194).

The shelter labeled as enlisted billeting B contains six separate electrical components including 1) televisions (Fig. C-195), 2) game consoles (Fig. C-196), 3) fans (Fig. C-198), 4) shop lights (Fig. C-197), 5) laptop computers (Fig. C-199), and 6) cell phones (Fig. C-200).

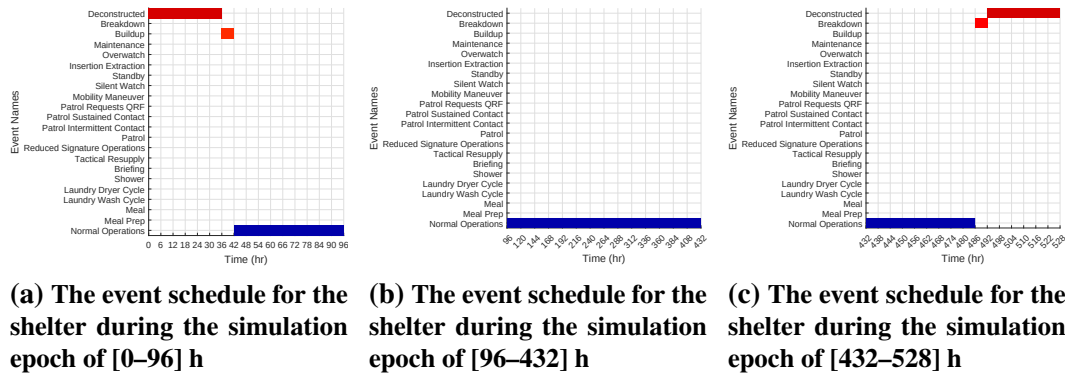


Fig. C-190 The event schedule for the shelter labeled as enlisted billeting B

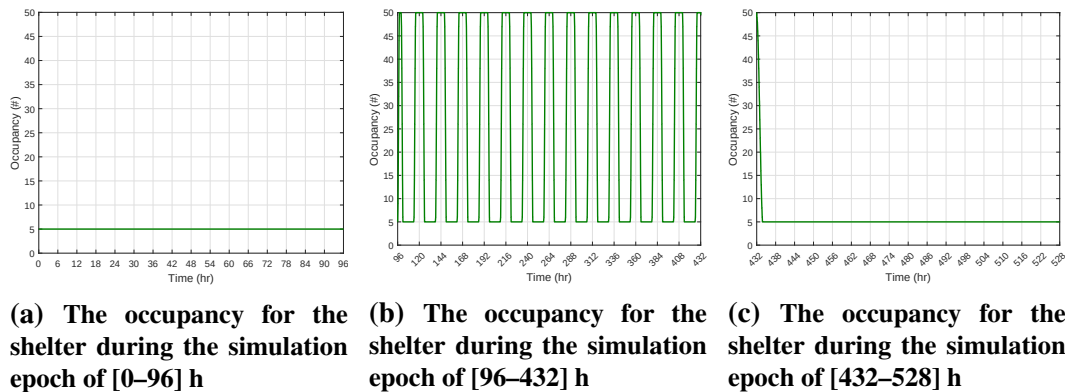


Fig. C-191 The occupancy for the shelter labeled as enlisted billeting B

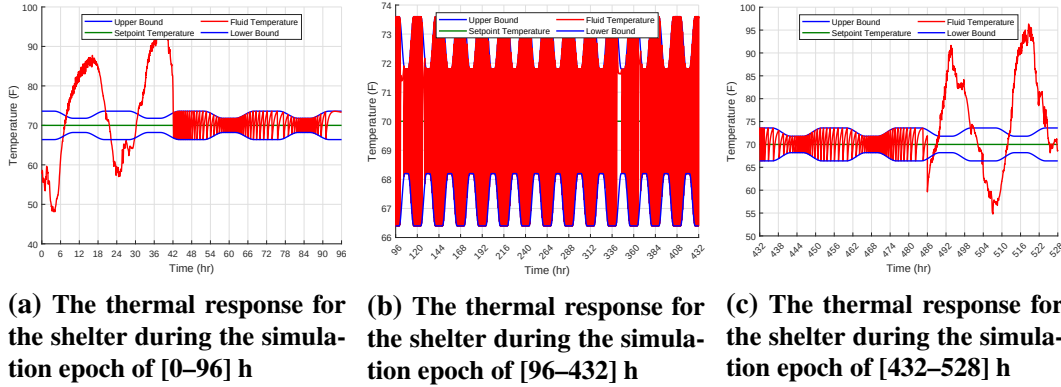


Fig. C-192 The thermal response for the shelter labeled as enlisted billeting B

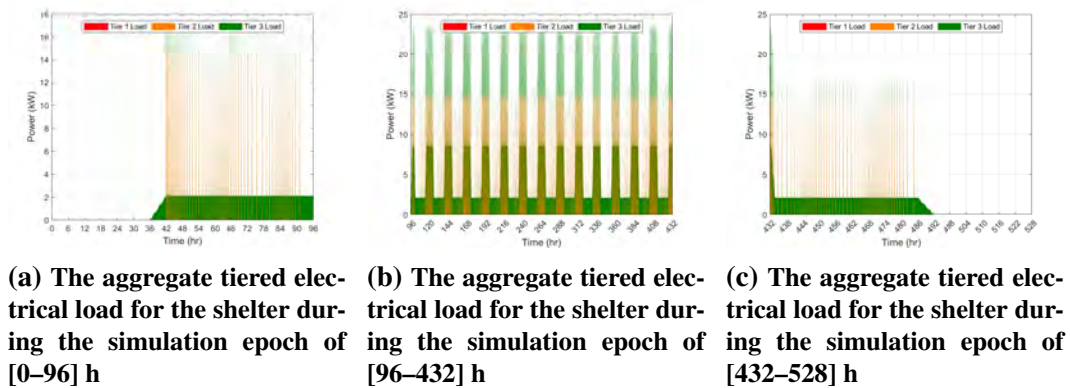


Fig. C-193 The aggregate tiered electrical load for the shelter labeled as enlisted billeting B

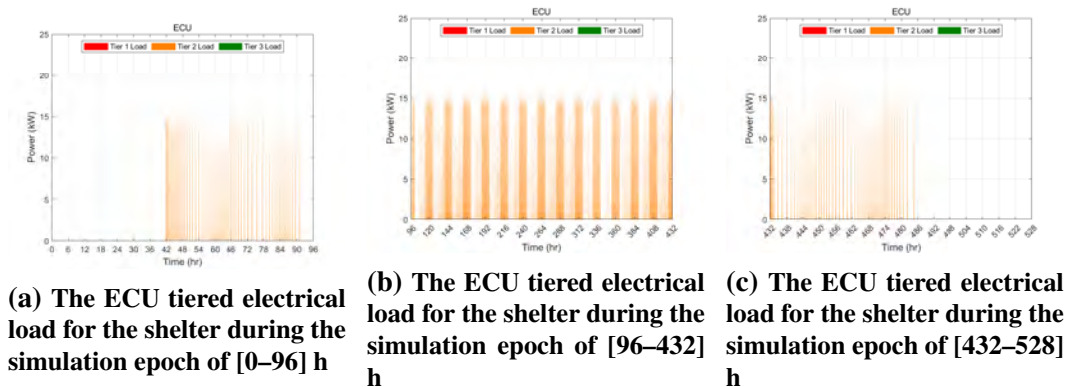
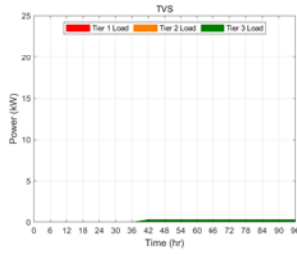
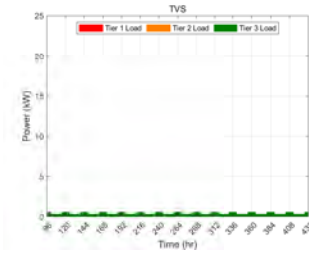


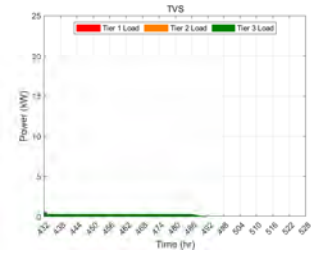
Fig. C-194 The ECU tiered electrical load for the shelter labeled as enlisted billeting B



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

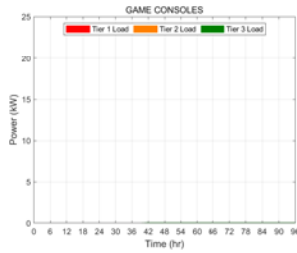


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

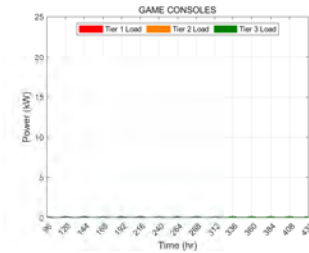


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-195 The televisions tiered electrical load for the shelter labeled as enlisted billeting B



(a) The game consoles tiered electrical load for the shelter during the simulation epoch of [0–96] h

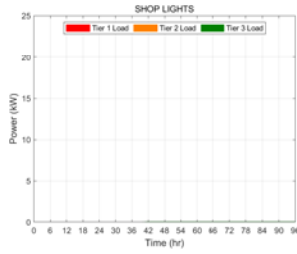


(b) The game consoles tiered electrical load for the shelter during the simulation epoch of [96–432] h

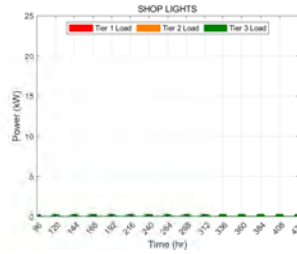


(c) The game consoles tiered electrical load for the shelter during the simulation epoch of [432–528] h

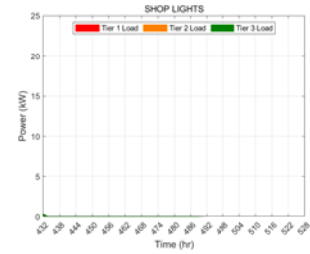
Fig. C-196 The game consoles tiered electrical load for the shelter labeled as enlisted billeting B



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

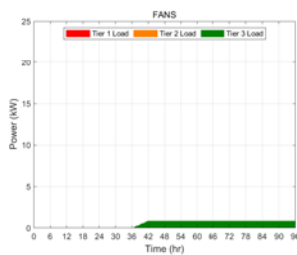


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

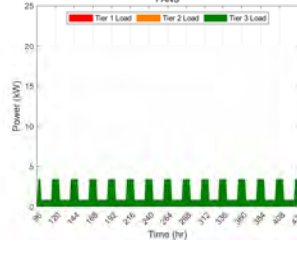


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

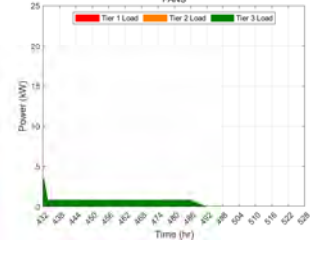
Fig. C-197 The shop lights tiered electrical load for the shelter labeled as enlisted billeting B



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-198 The fans tiered electrical load for the shelter labeled as enlisted billeting B

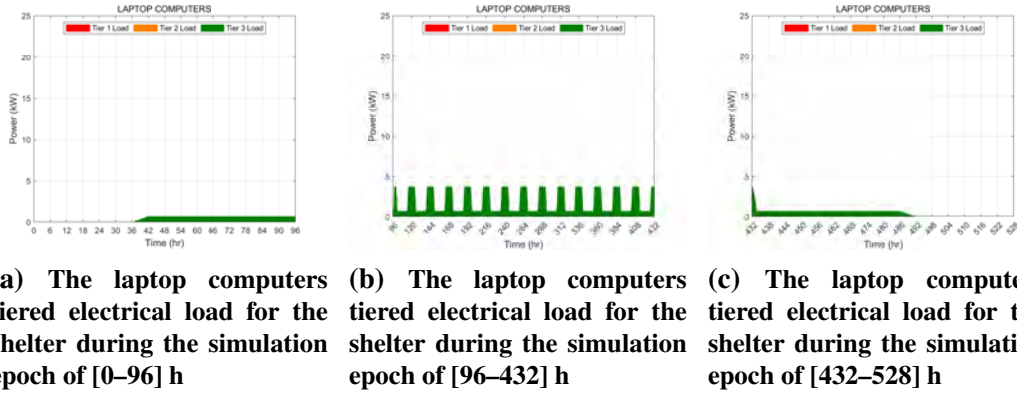


Fig. C-199 The laptop computers tiered electrical load for the shelter labeled as enlisted billeting B

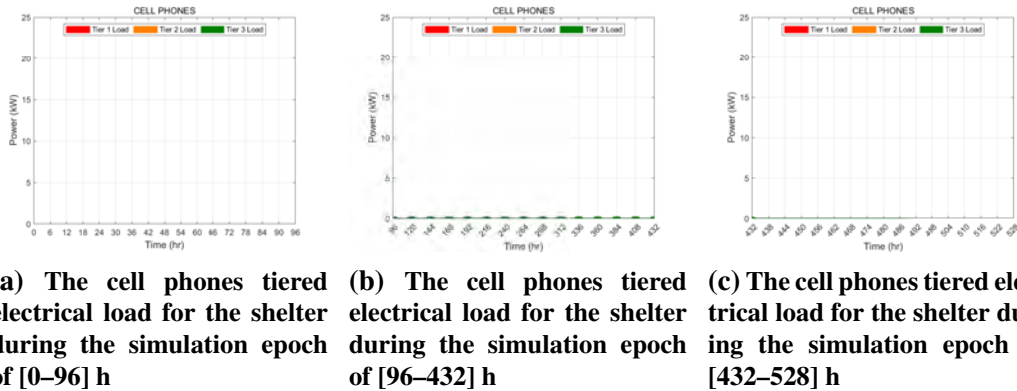


Fig. C-200 The cell phones tiered electrical load for the shelter labeled as enlisted billeting B

C.21 Enlisted Billeting C

The shelter labeled as enlisted billeting C houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-201), the time-varying occupancy (Fig. C-202), the re-

sulting thermal response (Fig. C-203), aggregate electrical load (Fig. C-204), and the ECU electrical load (Fig. C-205).

The shelter labeled as enlisted billeting C contains six separate electrical components including 1) televisions (Fig. C-206), 2) game consoles (Fig. C-207), 3) fans (Fig. C-209), 4) shop lights (Fig. C-208), 5) laptop computers (Fig. C-210), and 6) cell phones (Fig. C-211).

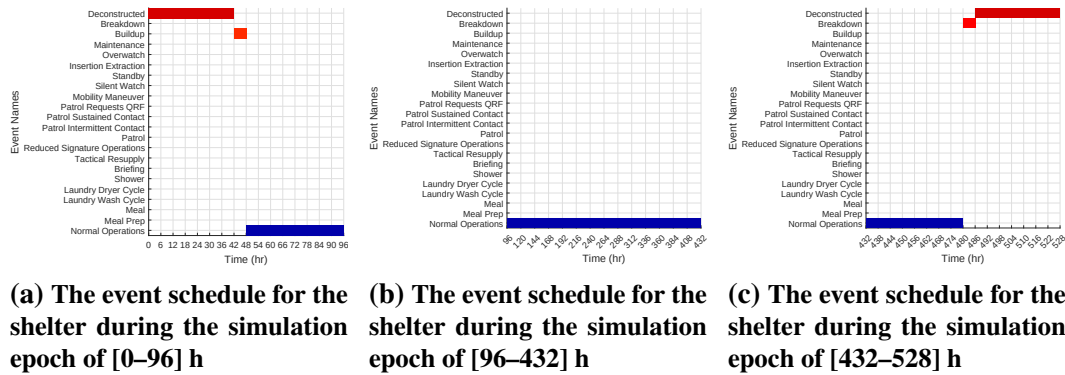


Fig. C-201 The event schedule for the shelter labeled as enlisted billeting C

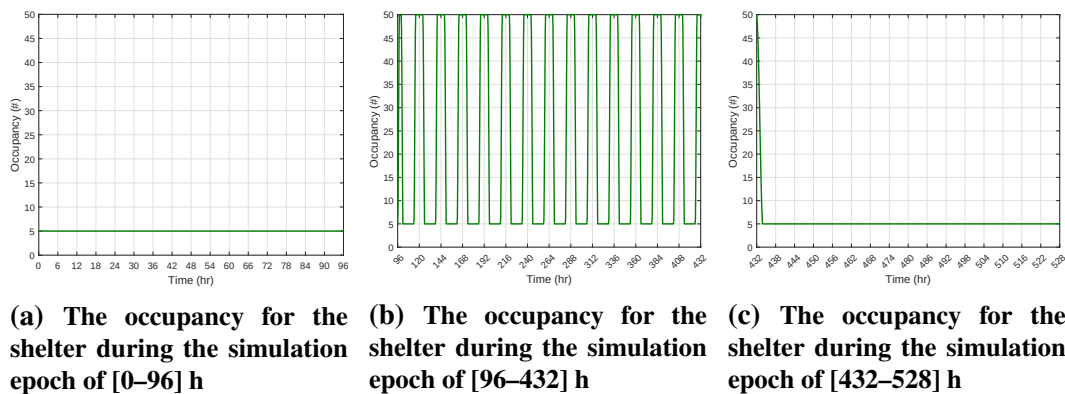


Fig. C-202 The occupancy for the shelter labeled as enlisted billeting C

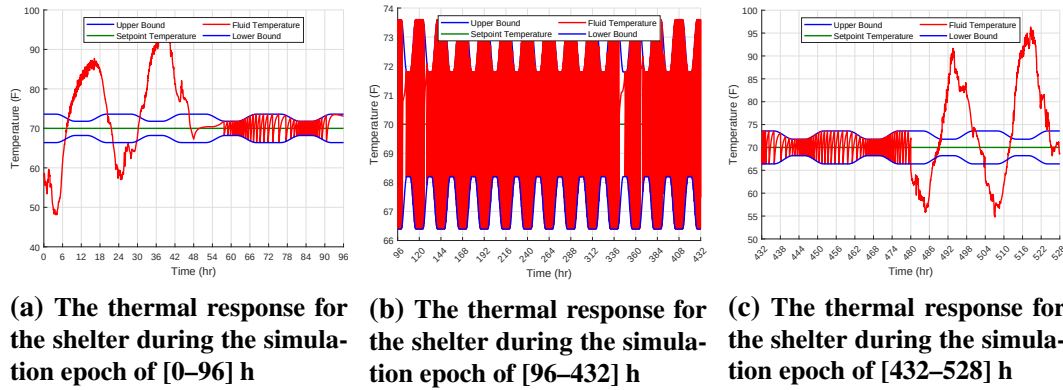


Fig. C-203 The thermal response for the shelter labeled as enlisted billeting C

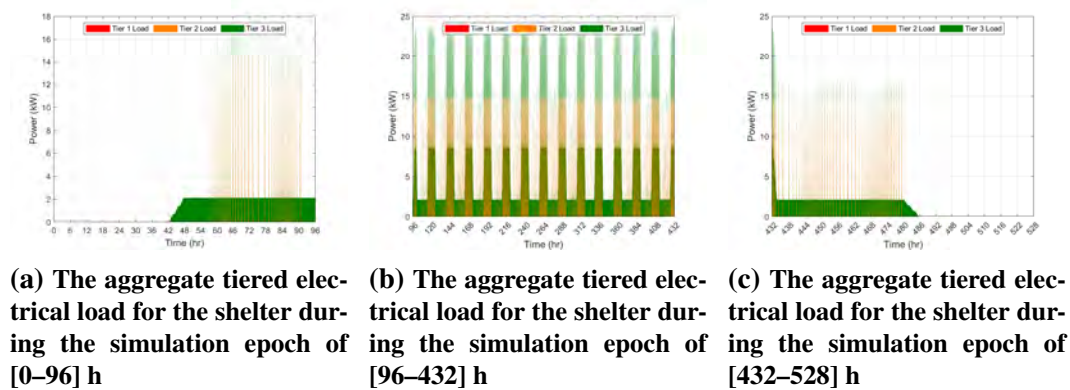


Fig. C-204 The aggregate tiered electrical load for the shelter labeled as enlisted billeting C

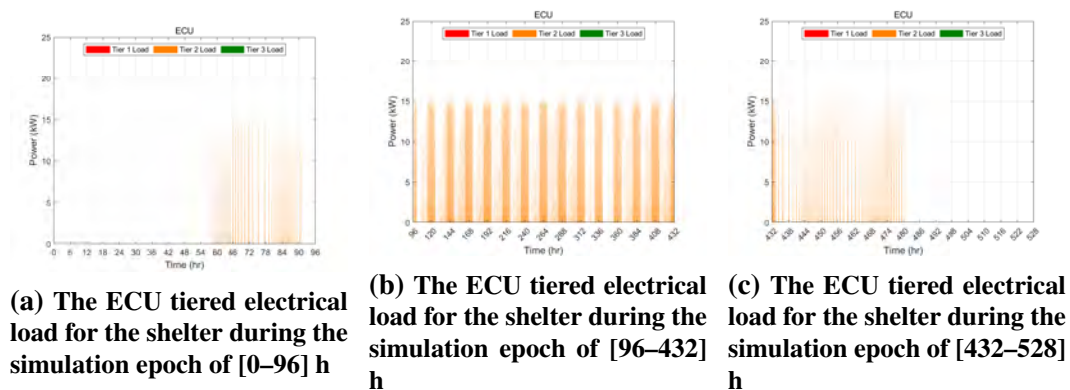
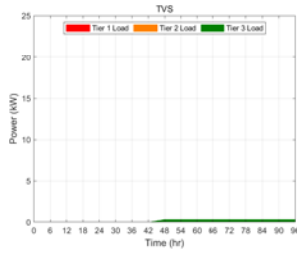
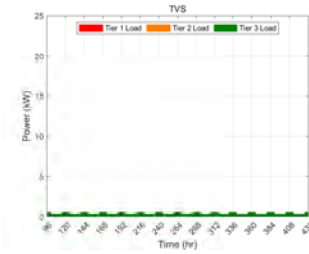


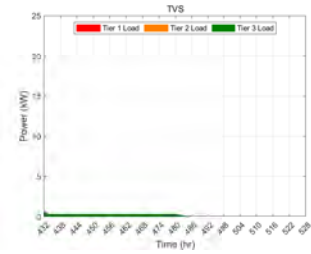
Fig. C-205 The ECU tiered electrical load for the shelter labeled as enlisted billeting C



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

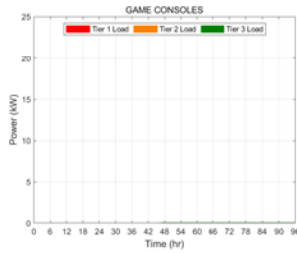


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

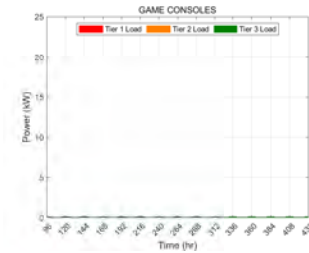


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-206 The televisions tiered electrical load for the shelter labeled as enlisted billeting C



(a) The game consoles tiered electrical load for the shelter during the simulation epoch of [0–96] h

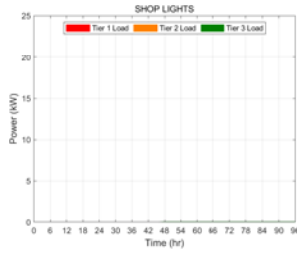


(b) The game consoles tiered electrical load for the shelter during the simulation epoch of [96–432] h

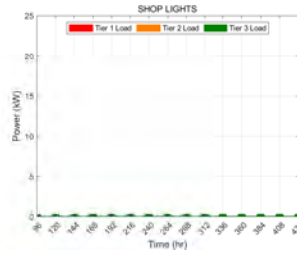


(c) The game consoles tiered electrical load for the shelter during the simulation epoch of [432–528] h

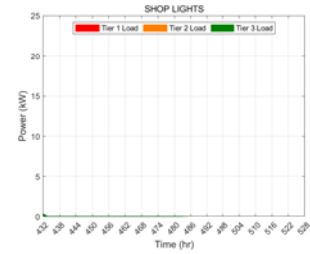
Fig. C-207 The game consoles tiered electrical load for the shelter labeled as enlisted billeting C



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

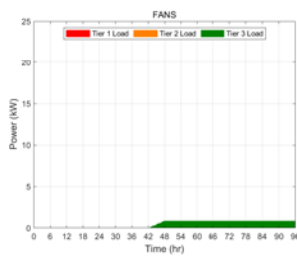


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

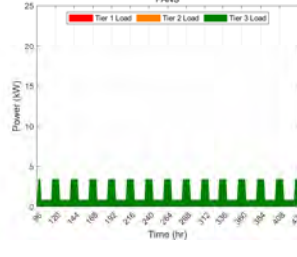


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

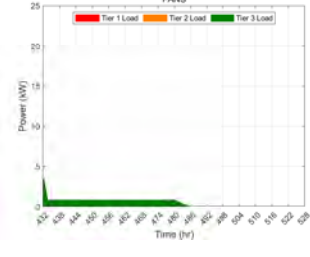
Fig. C-208 The shop lights tiered electrical load for the shelter labeled as enlisted billeting C



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-209 The fans tiered electrical load for the shelter labeled as enlisted billeting C

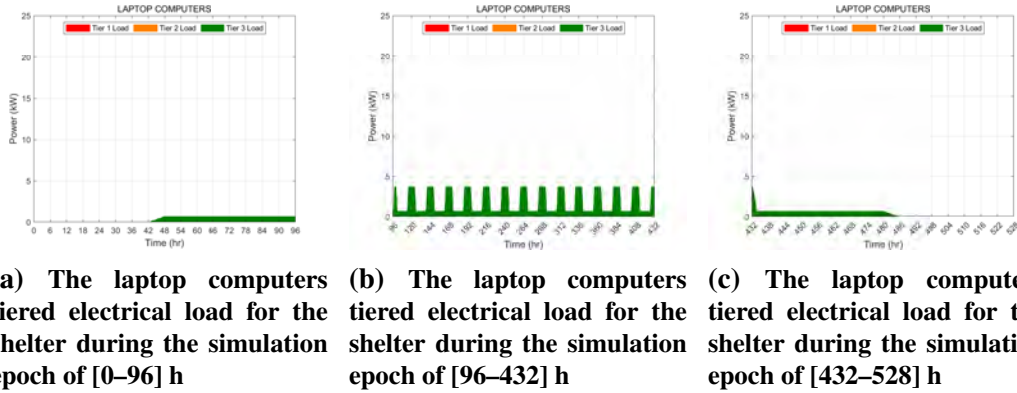


Fig. C-210 The laptop computers tiered electrical load for the shelter labeled as enlisted billeting C

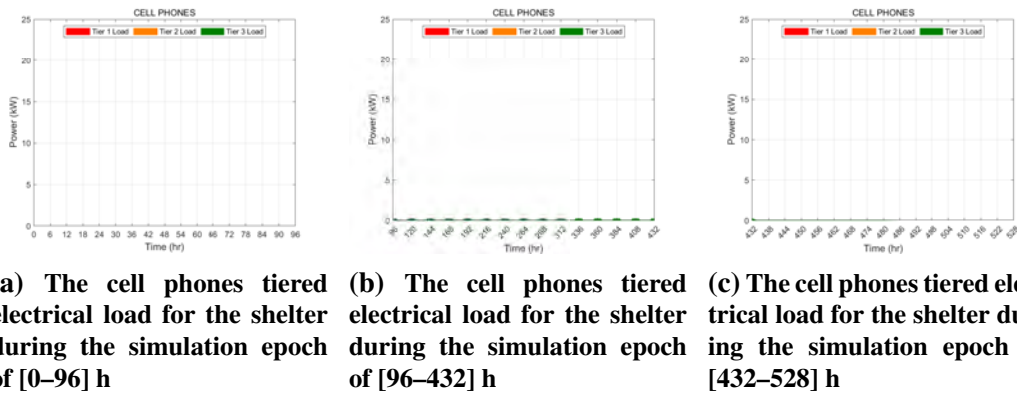


Fig. C-211 The cell phones tiered electrical load for the shelter labeled as enlisted billeting C

C.22 Enlisted Billeting D

The shelter labeled as enlisted billeting D houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-212), the time-varying occupancy (Fig. C-213), the re-

sulting thermal response (Fig. C-214), aggregate electrical load (Fig. C-215), and the ECU electrical load (Fig. C-216).

The shelter labeled as enlisted billeting D contains six separate electrical components including 1) televisions (Fig. C-217), 2) game consoles (Fig. C-218), 3) fans (Fig. C-220), 4) shop lights (Fig. C-219), 5) laptop computers (Fig. C-221), and 6) cell phones (Fig. C-222).

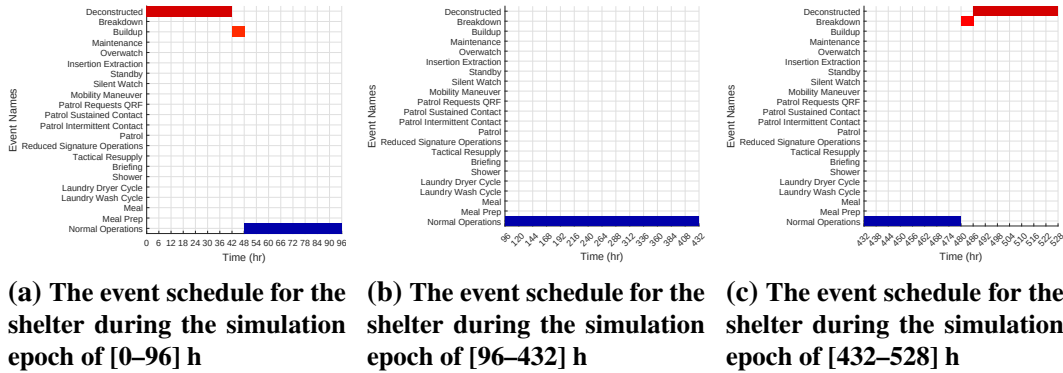


Fig. C-212 The event schedule for the shelter labeled as enlisted billeting D

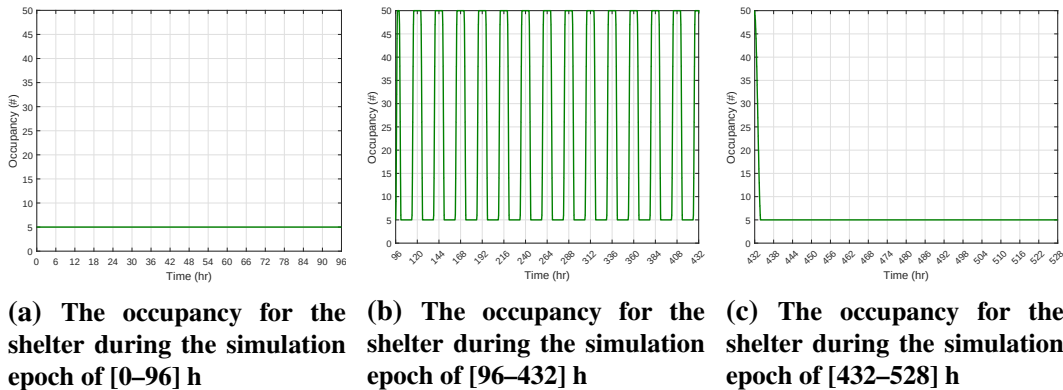


Fig. C-213 The occupancy for the shelter labeled as enlisted billeting D

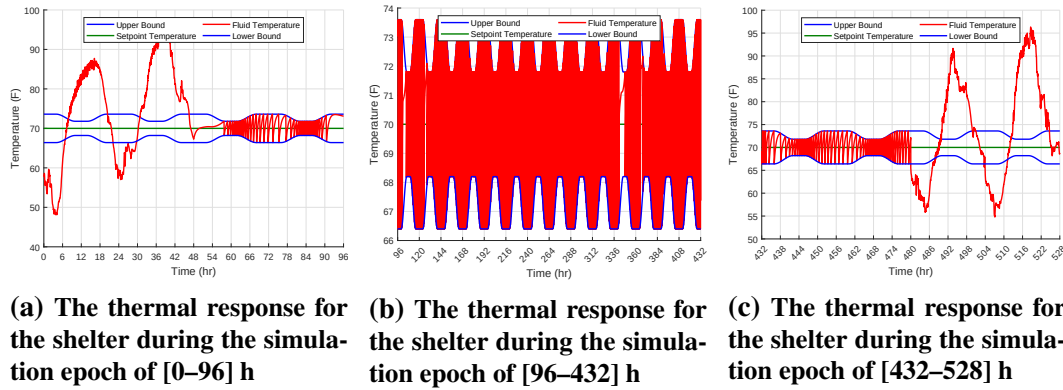


Fig. C-214 The thermal response for the shelter labeled as enlisted billeting D

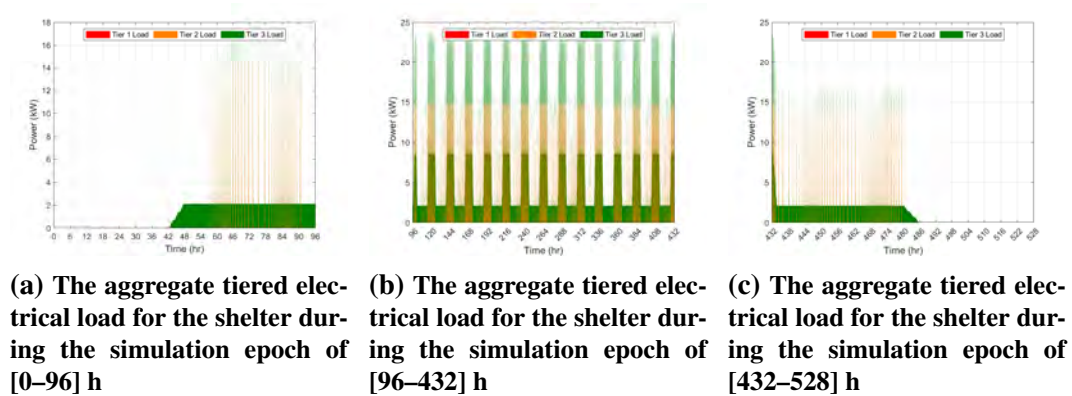


Fig. C-215 The aggregate tiered electrical load for the shelter labeled as enlisted billeting D

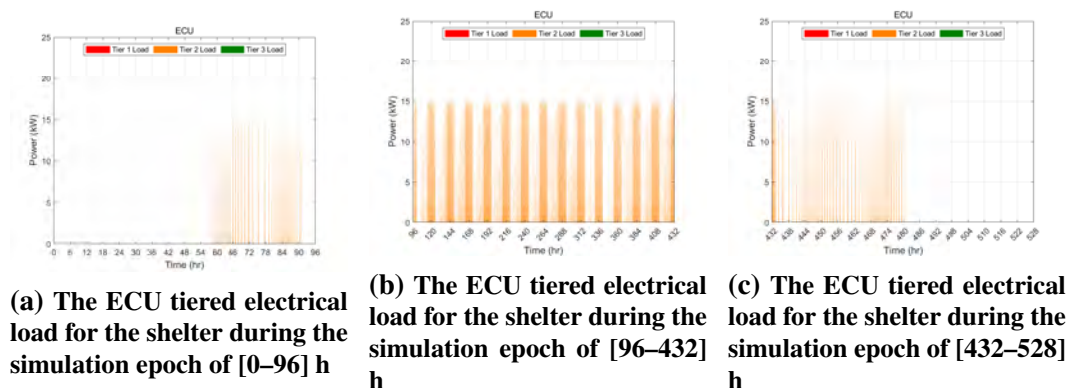
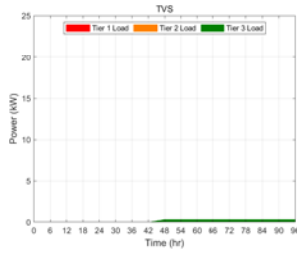
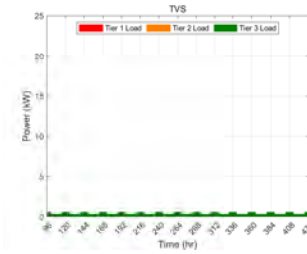


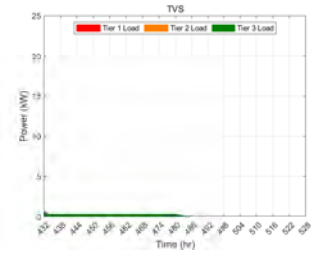
Fig. C-216 The ECU tiered electrical load for the shelter labeled as enlisted billeting D



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

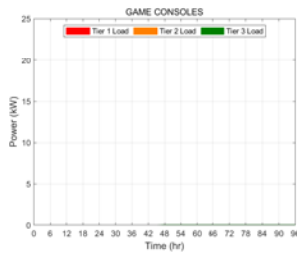


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

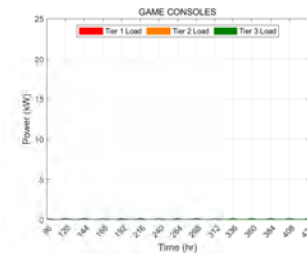


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-217 The televisions tiered electrical load for the shelter labeled as enlisted billeting D



(a) The game consoles tiered electrical load for the shelter during the simulation epoch of [0–96] h

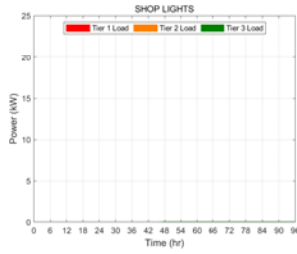


(b) The game consoles tiered electrical load for the shelter during the simulation epoch of [96–432] h

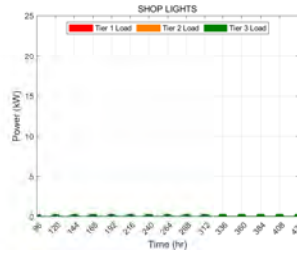


(c) The game consoles tiered electrical load for the shelter during the simulation epoch of [432–528] h

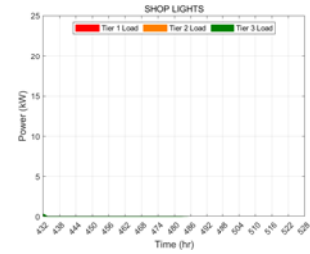
Fig. C-218 The game consoles tiered electrical load for the shelter labeled as enlisted billeting D



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

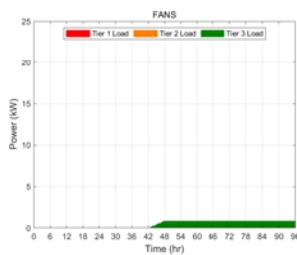


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

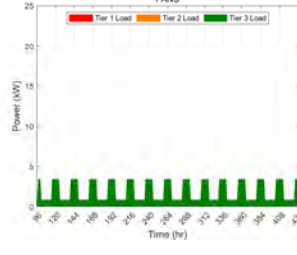


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

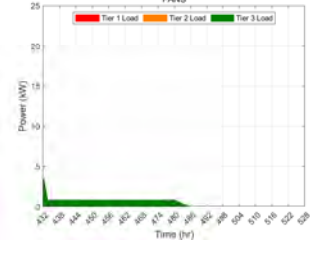
Fig. C-219 The shop lights tiered electrical load for the shelter labeled as enlisted billeting D



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-220 The fans tiered electrical load for the shelter labeled as enlisted billeting D

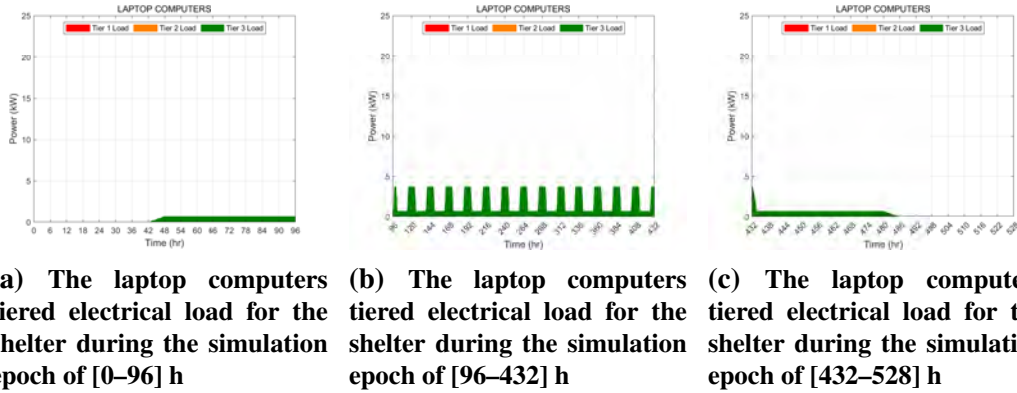


Fig. C-221 The laptop computers tiered electrical load for the shelter labeled as enlisted billeting D

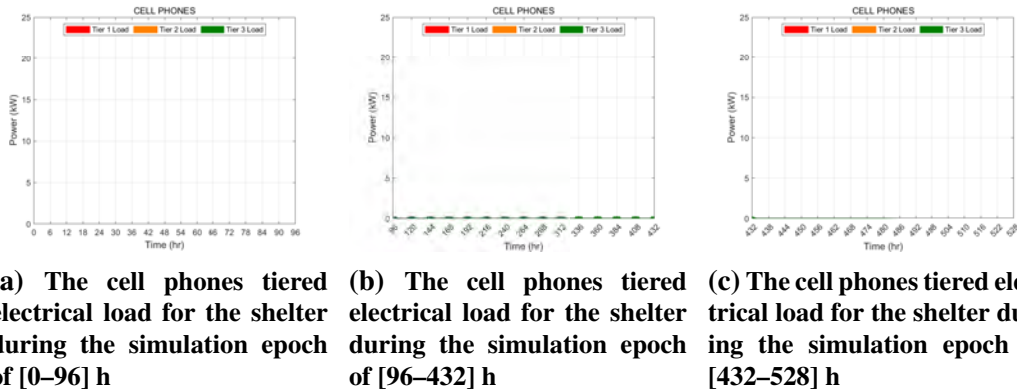


Fig. C-222 The cell phones tiered electrical load for the shelter labeled as enlisted billeting D

C.23 Enlisted Billeting E

The shelter labeled as enlisted billeting E houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-223), the time-varying occupancy (Fig. C-224), the re-

sulting thermal response (Fig. C-225), aggregate electrical load (Fig. C-226), and the ECU electrical load (Fig. C-227).

The shelter labeled as enlisted billeting E contains six separate electrical components including 1) televisions (Fig. C-228), 2) game consoles (Fig. C-229), 3) fans (Fig. C-231), 4) shop lights (Fig. C-230), 5) laptop computers (Fig. C-232), and 6) cell phones (Fig. C-233).

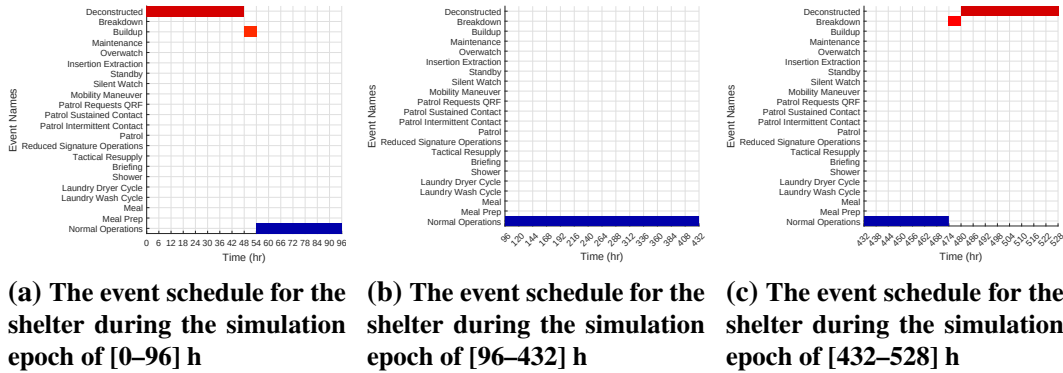


Fig. C-223 The event schedule for the shelter labeled as enlisted billeting E

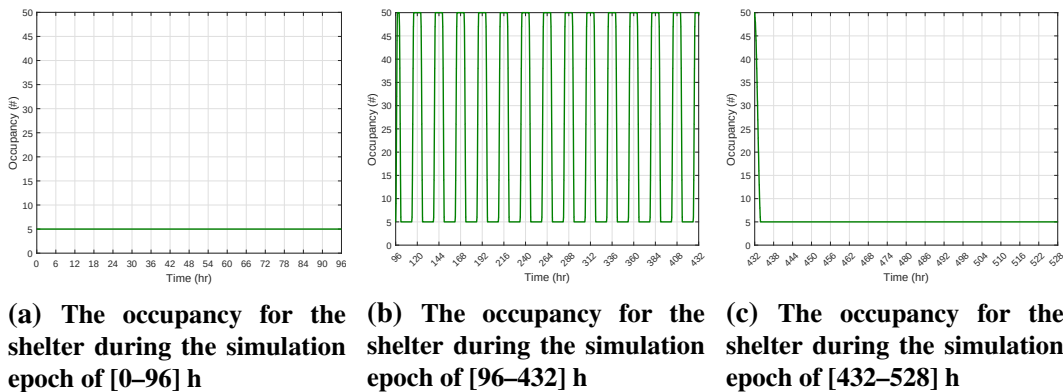


Fig. C-224 The occupancy for the shelter labeled as enlisted billeting E

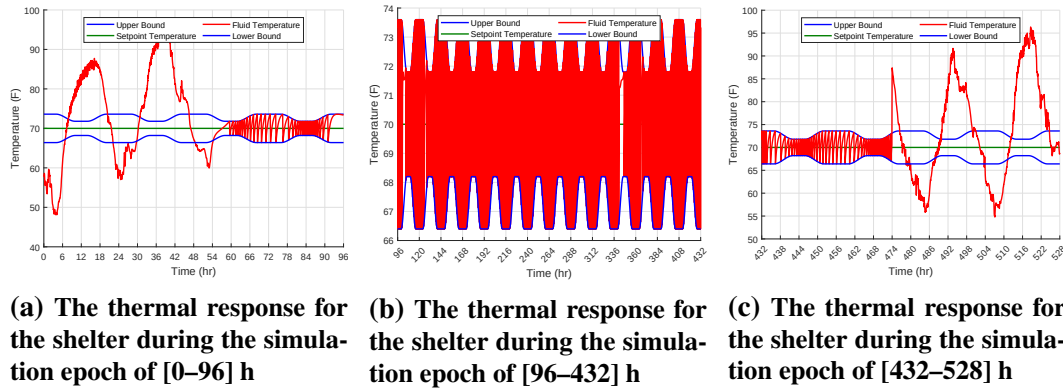


Fig. C-225 The thermal response for the shelter labeled as enlisted billeting E

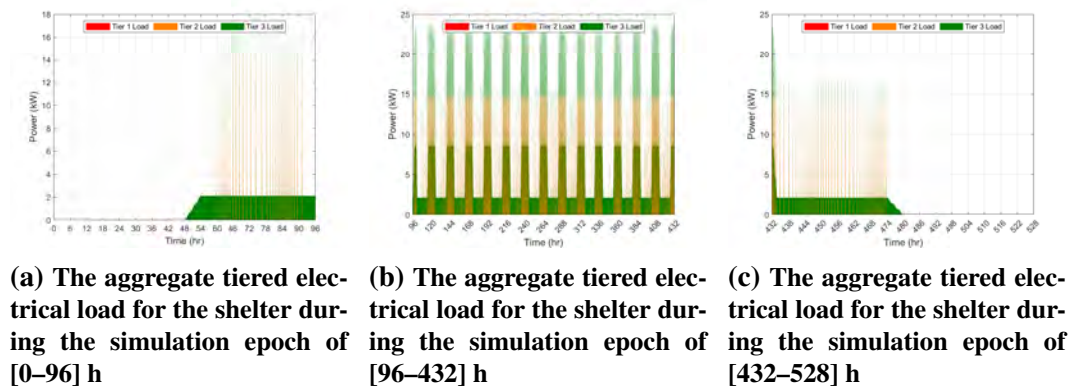


Fig. C-226 The aggregate tiered electrical load for the shelter labeled as enlisted billeting E

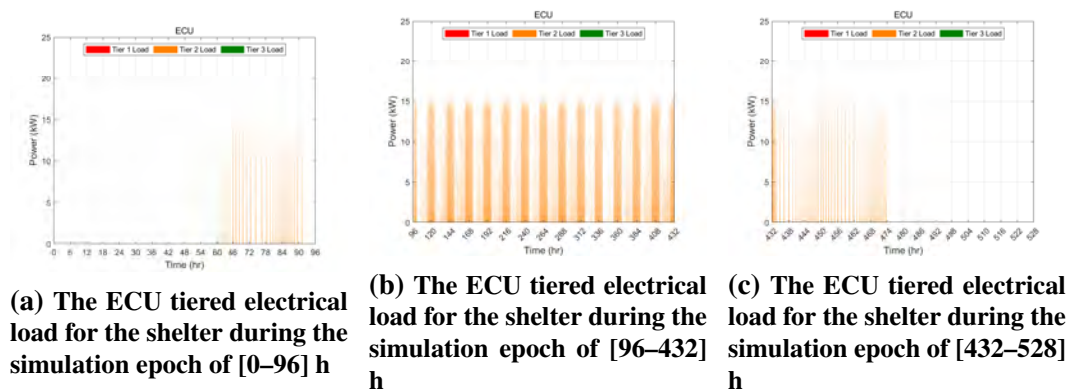
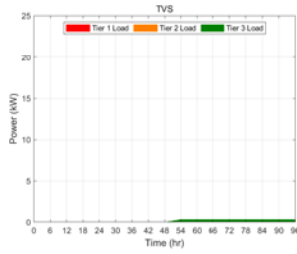
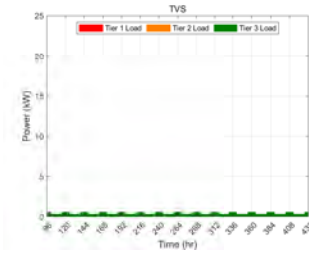


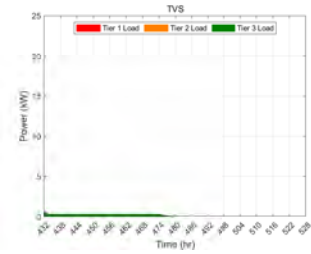
Fig. C-227 The ECU tiered electrical load for the shelter labeled as enlisted billeting E



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

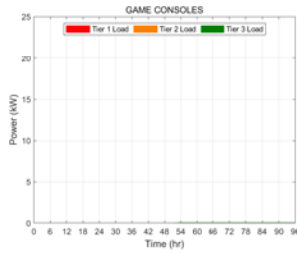


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

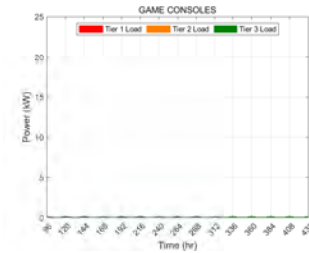


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-228 The televisions tiered electrical load for the shelter labeled as enlisted billeting E



(a) The game consoles tiered electrical load for the shelter during the simulation epoch of [0–96] h

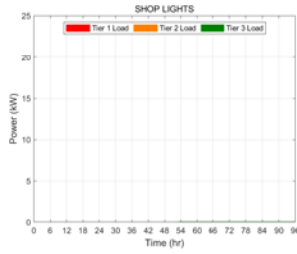


(b) The game consoles tiered electrical load for the shelter during the simulation epoch of [96–432] h

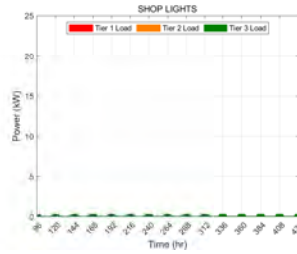


(c) The game consoles tiered electrical load for the shelter during the simulation epoch of [432–528] h

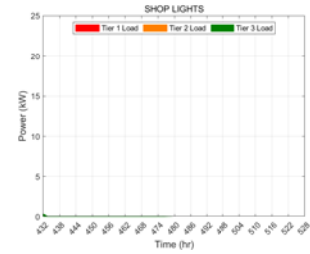
Fig. C-229 The game consoles tiered electrical load for the shelter labeled as enlisted billeting E



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

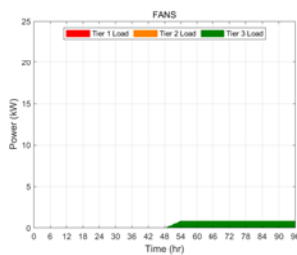


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

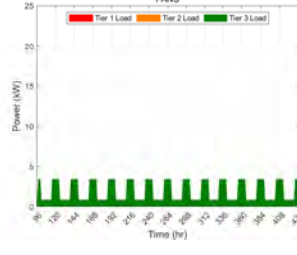


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

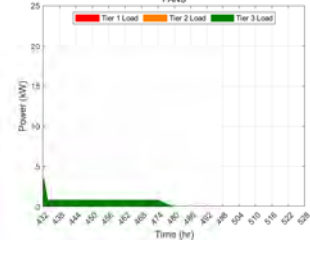
Fig. C-230 The shop lights tiered electrical load for the shelter labeled as enlisted billeting E



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-231 The fans tiered electrical load for the shelter labeled as enlisted billeting E

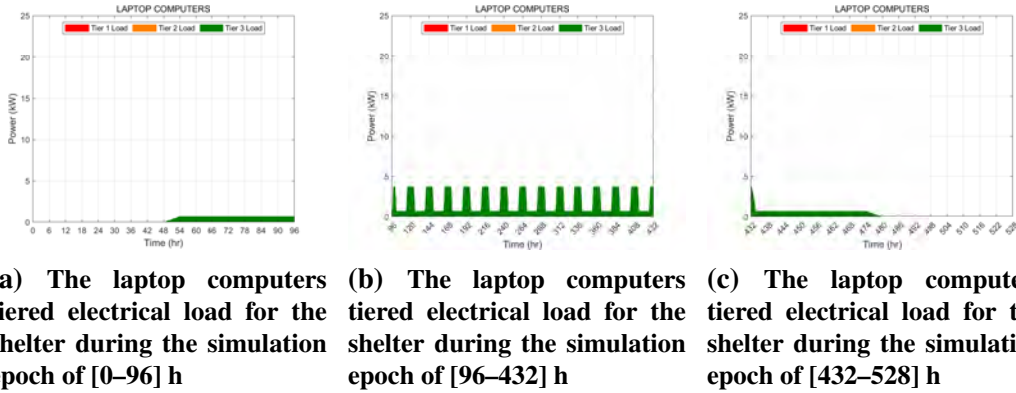


Fig. C-232 The laptop computers tiered electrical load for the shelter labeled as enlisted billeting E

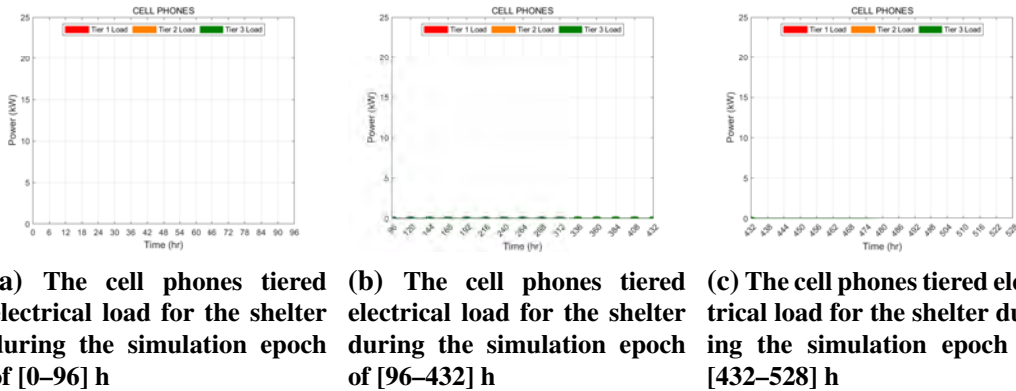


Fig. C-233 The cell phones tiered electrical load for the shelter labeled as enlisted billeting E

C.24 Enlisted Billeting F

The shelter labeled as enlisted billeting F houses the enlisted Soldiers. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was primarily driven by the time of day. During the morning or late evening hours, the shelter was assumed to be close to maximum capacity. During the late morning or early evening hours, the shelter was relatively unoccupied as the majority of the shelter's occupants were occupying other shelters or conducting various other military-related missions around the energy network.

The event schedule (Fig. C-234), the time-varying occupancy (Fig. C-235), the re-

sulting thermal response (Fig. C-236), aggregate electrical load (Fig. C-237), and the ECU electrical load (Fig. C-238).

The shelter labeled as enlisted billeting F contains six separate electrical components including 1) televisions (Fig. C-239), 2) game consoles (Fig. C-240), 3) fans (Fig. C-242), 4) shop lights (Fig. C-241), 5) laptop computers (Fig. C-243), and 6) cell phones (Fig. C-244).

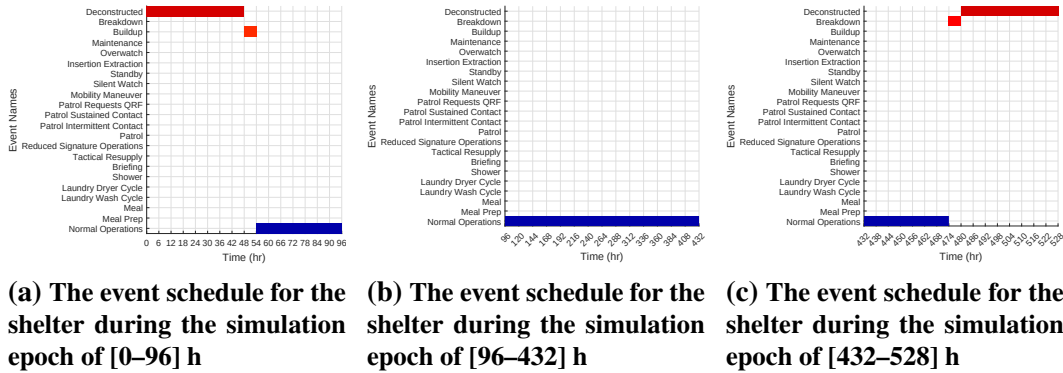


Fig. C-234 The event schedule for the shelter labeled as enlisted billeting F

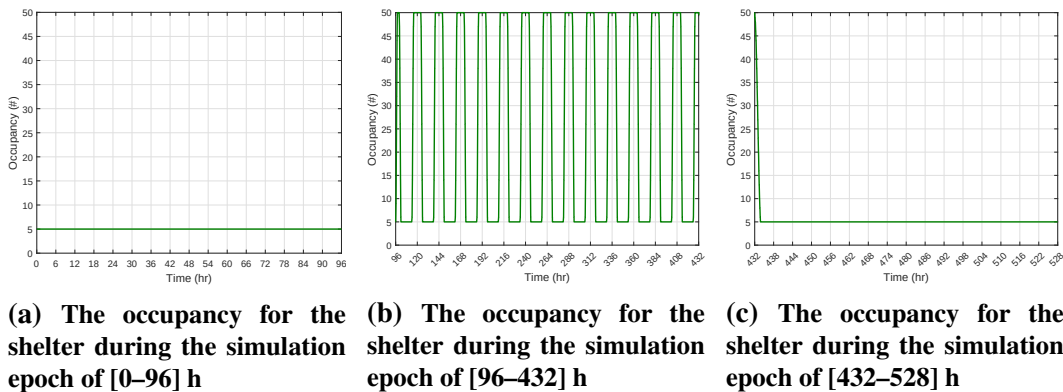


Fig. C-235 The occupancy for the shelter labeled as enlisted billeting F

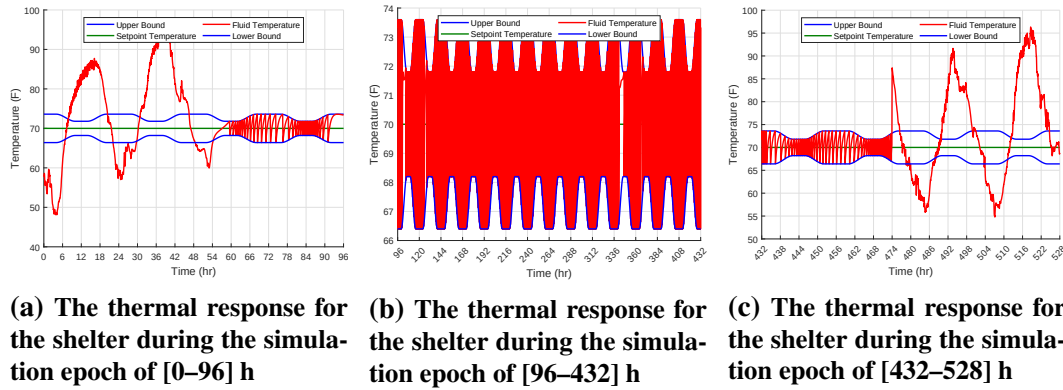


Fig. C-236 The thermal response for the shelter labeled as enlisted billeting F

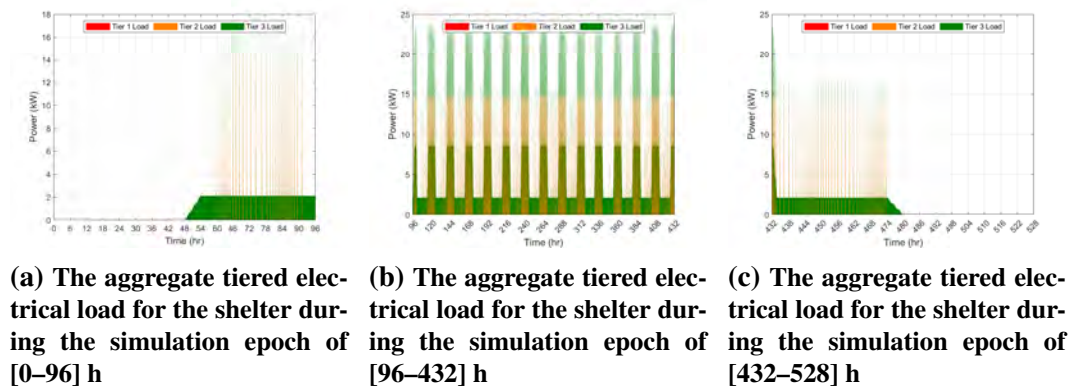


Fig. C-237 The aggregate tiered electrical load for the shelter labeled as enlisted billeting F

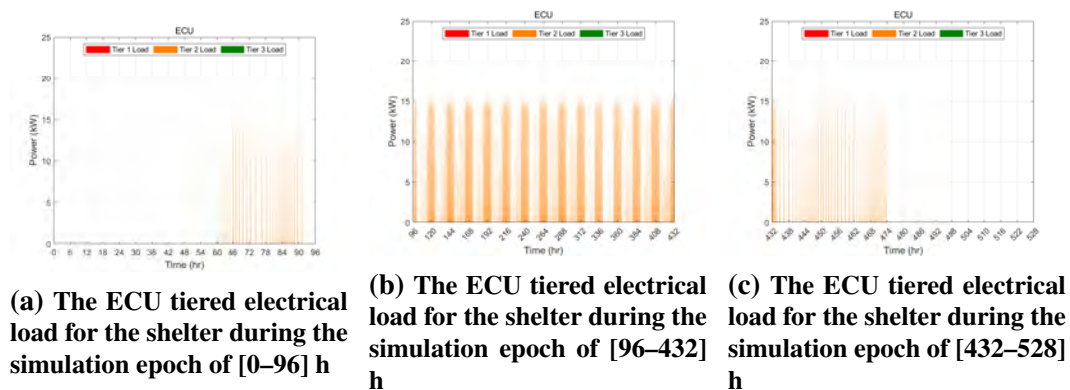
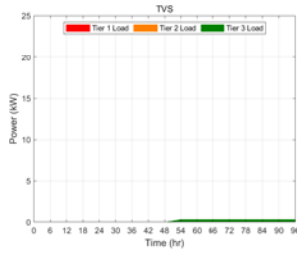
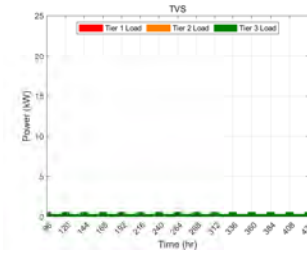


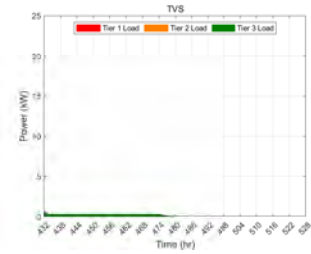
Fig. C-238 The ECU tiered electrical load for the shelter labeled as enlisted billeting F



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

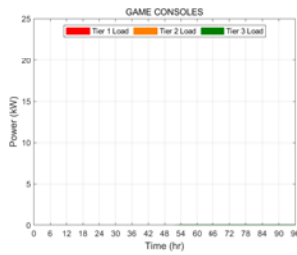


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

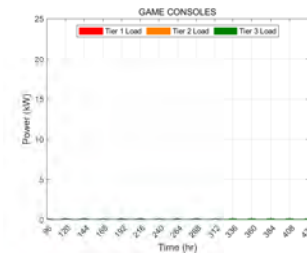


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-239 The televisions tiered electrical load for the shelter labeled as enlisted billeting F



(a) The game consoles tiered electrical load for the shelter during the simulation epoch of [0–96] h

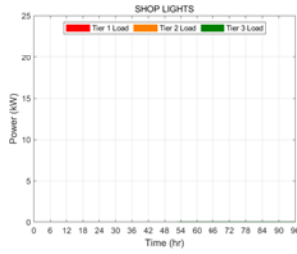


(b) The game consoles tiered electrical load for the shelter during the simulation epoch of [96–432] h

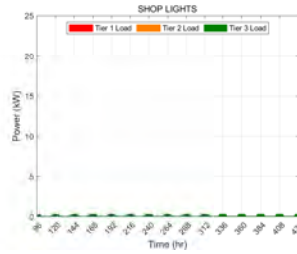


(c) The game consoles tiered electrical load for the shelter during the simulation epoch of [432–528] h

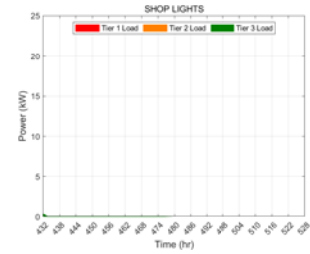
Fig. C-240 The game consoles tiered electrical load for the shelter labeled as enlisted billeting F



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

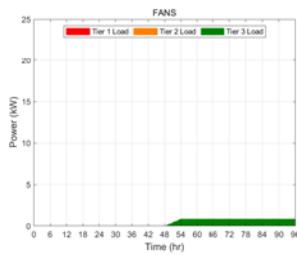


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

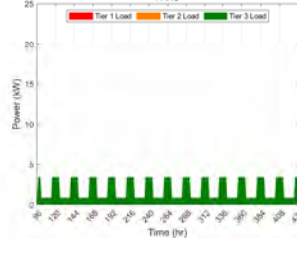


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

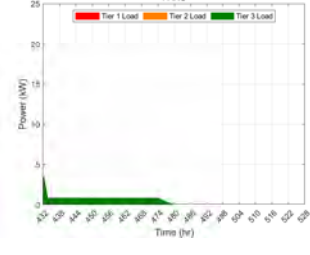
Fig. C-241 The shop lights tiered electrical load for the shelter labeled as enlisted billeting F



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-242 The fans tiered electrical load for the shelter labeled as enlisted billeting F

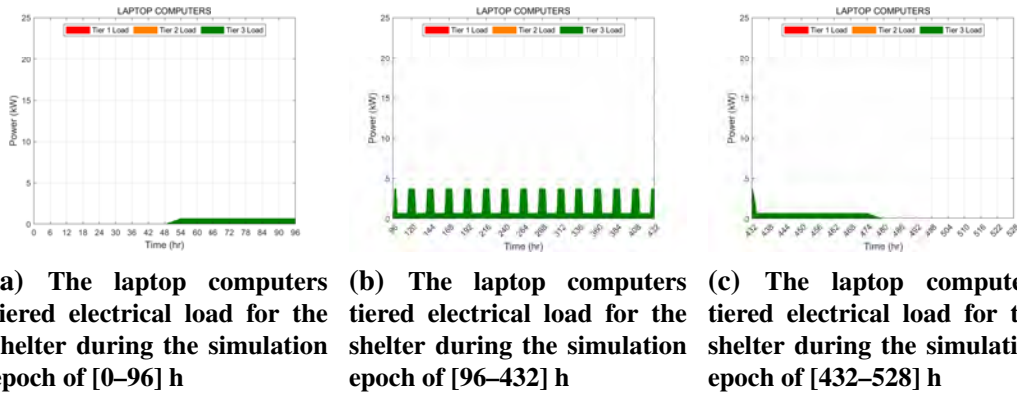


Fig. C-243 The laptop computers tiered electrical load for the shelter labeled as enlisted billeting F

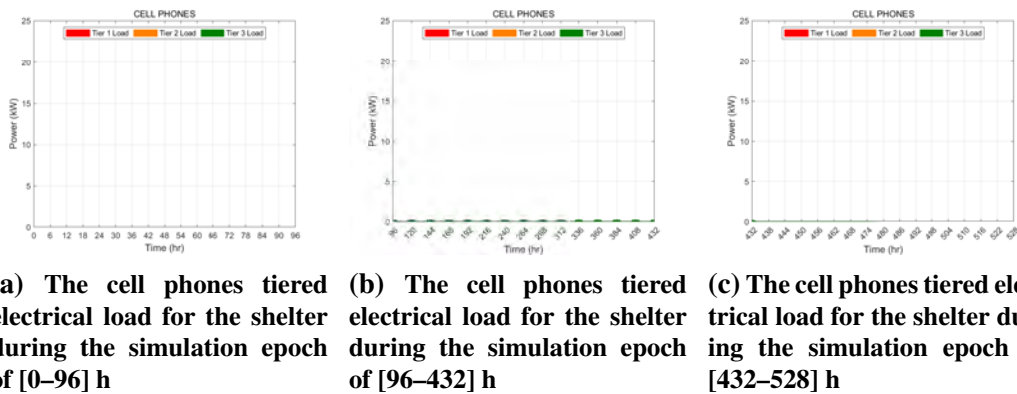


Fig. C-244 The cell phones tiered electrical load for the shelter labeled as enlisted billeting F

C.25 Office A

The shelter labeled as office A was used as an office. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house miscellaneous electrical equipment that could be used for briefings and miscellaneous other tasks.

The event schedule (Fig. C-245), the time-varying occupancy (Fig. C-246), the resulting thermal response (Fig. C-247), aggregate electrical load (Fig. C-248), and the ECU electrical load (Fig. C-249).

The shelter labeled as office A contains six separate electrical components including 1) specialized equipment (Fig. C-250), 2) televisions (Fig. C-251), 3) shop lights (Fig. C-252), 4) fans (Fig. C-253), 5) laptop computers (Fig. C-254), and 6) cell phones (Fig. C-255).

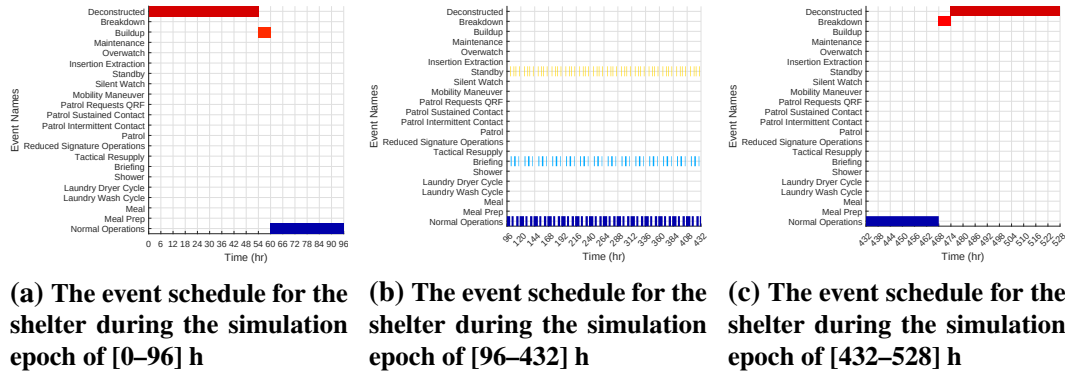


Fig. C-245 The event schedule for the shelter labeled as office A

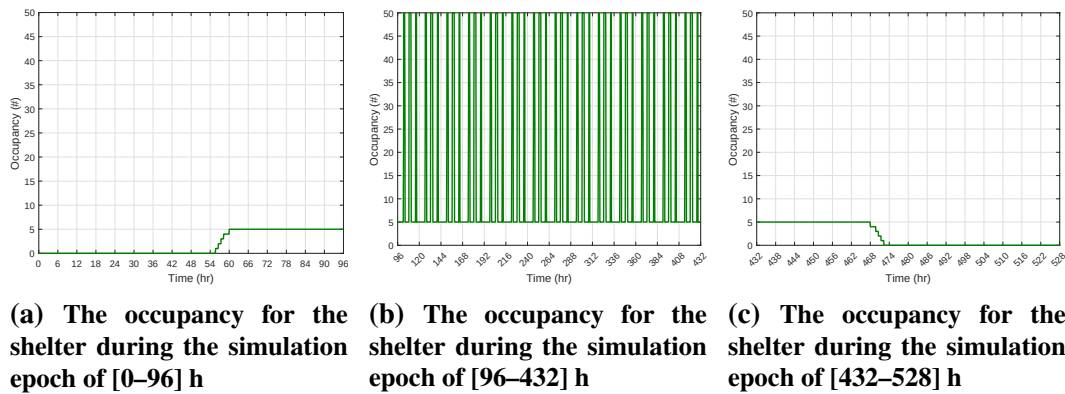
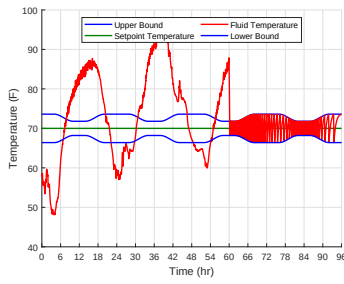
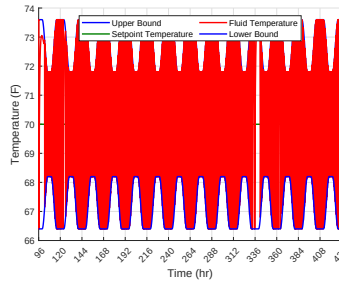


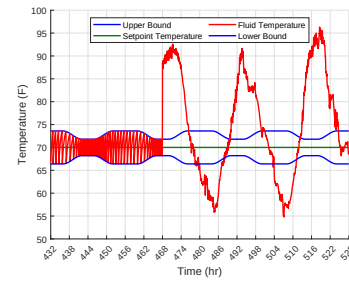
Fig. C-246 The occupancy for the shelter labeled as office A



(a) The thermal response for the shelter during the simulation epoch of [0-96] h

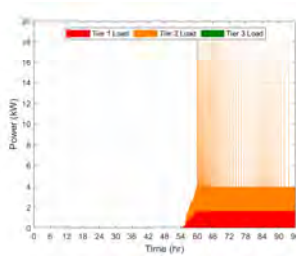


(b) The thermal response for the shelter during the simulation epoch of [96-432] h

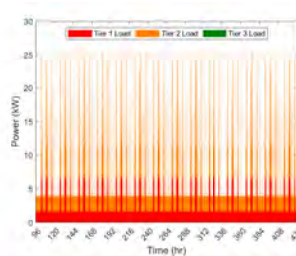


(c) The thermal response for the shelter during the simulation epoch of [432-528] h

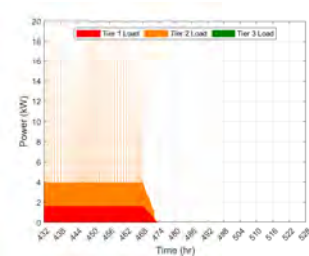
Fig. C-247 The thermal response for the shelter labeled as office A



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

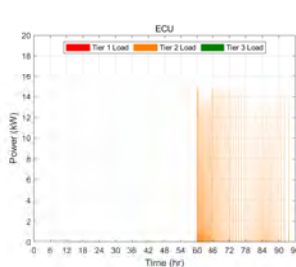


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

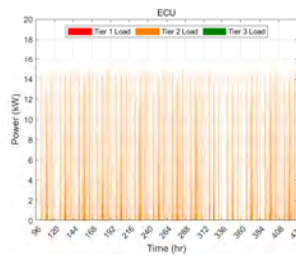


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

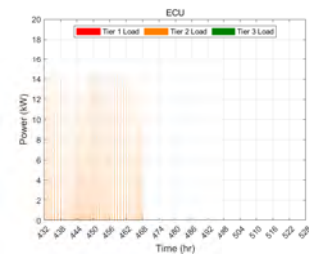
Fig. C-248 The aggregate tiered electrical load for the shelter labeled as office A



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

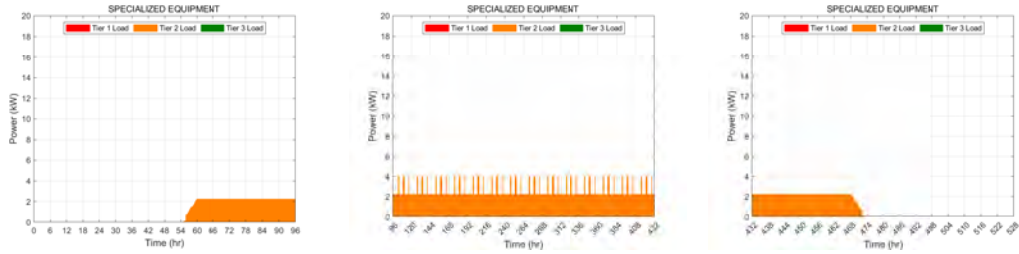


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h



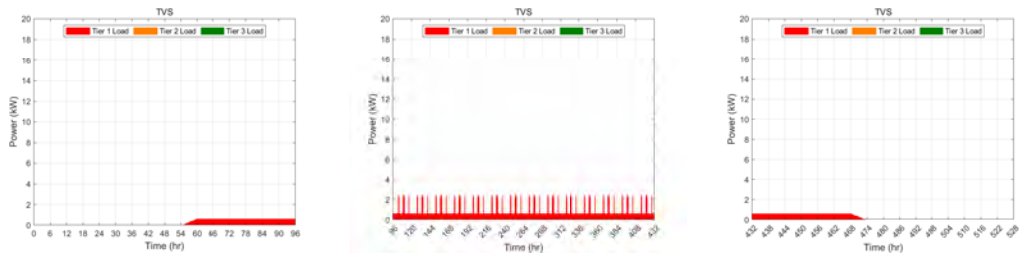
(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-249 The ECU tiered electrical load for the shelter labeled as office A



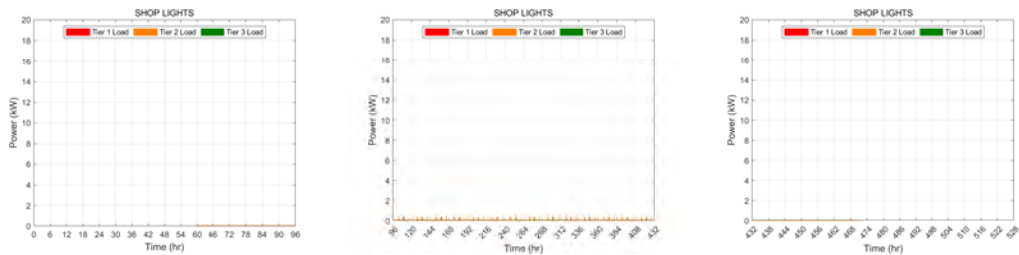
(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-250 The specialized equipment tiered electrical load for the shelter labeled as office A



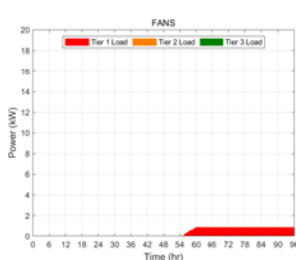
(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-251 The televisions tiered electrical load for the shelter labeled as office A

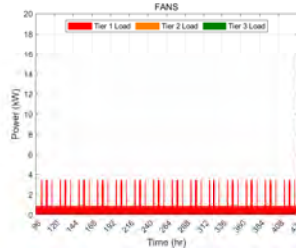


(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

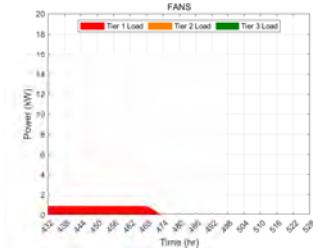
Fig. C-252 The shop lights tiered electrical load for the shelter labeled as office A



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-253 The fans tiered electrical load for the shelter labeled as office A



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h

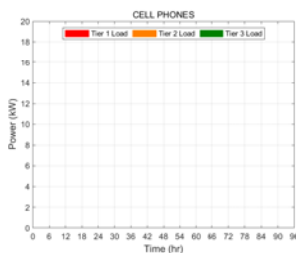


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h

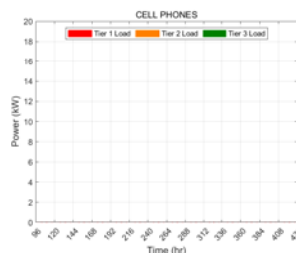


(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

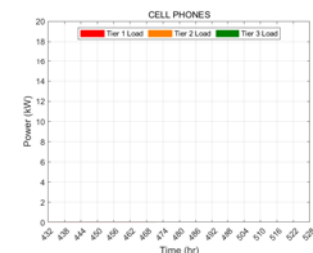
Fig. C-254 The laptop computers tiered electrical load for the shelter labeled as office A



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-255 The cell phones tiered electrical load for the shelter labeled as office A

C.26 Office B

The shelter labeled as office B was used as an office. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house miscellaneous electrical equipment that could be used for briefings and miscellaneous other tasks.

The event schedule (Fig. C-256), the time-varying occupancy (Fig. C-257), the resulting thermal response (Fig. C-258), aggregate electrical load (Fig. C-259), and the ECU electrical load (Fig. C-260).

The shelter labeled as office B contains six separate electrical components including 1) specialized equipment (Fig. C-261), 2) televisions (Fig. C-262), 3) shop lights (Fig. C-263), 4) fans (Fig. C-264), 5) laptop computers (Fig. C-265), and 6) cell phones (Fig. C-266).

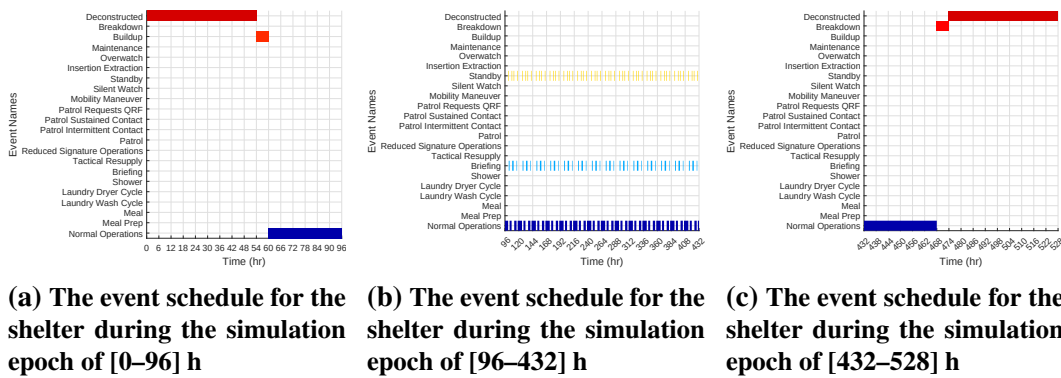


Fig. C-256 The event schedule for the shelter labeled as office B

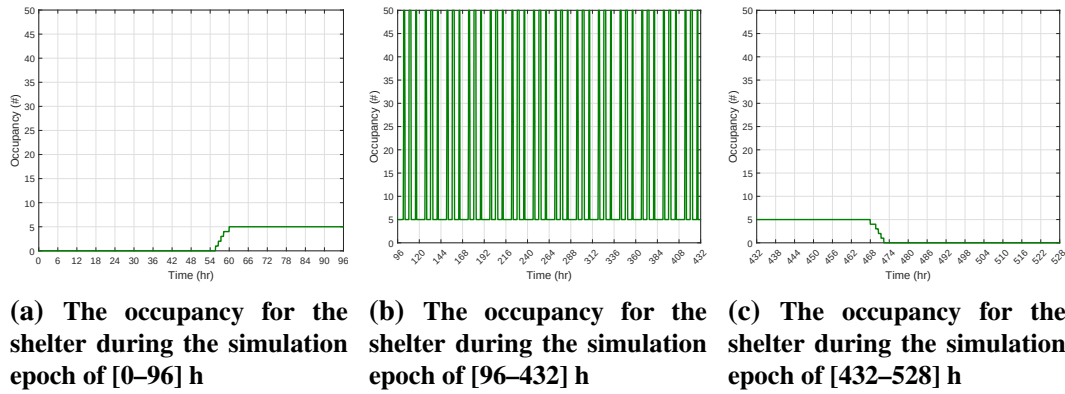


Fig. C-257 The occupancy for the shelter labeled as office B

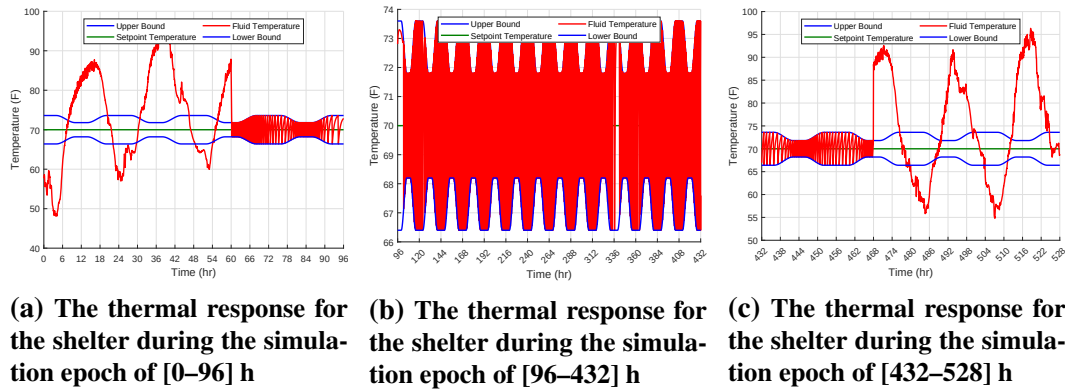


Fig. C-258 The thermal response for the shelter labeled as office B

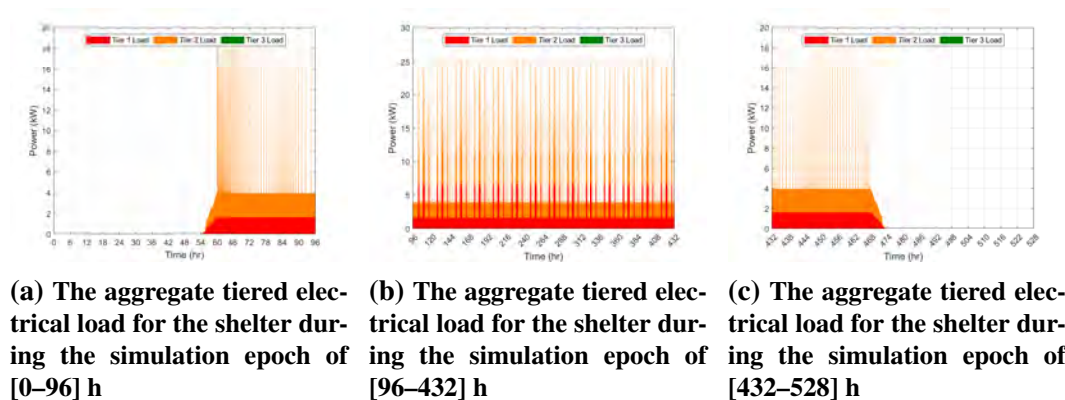
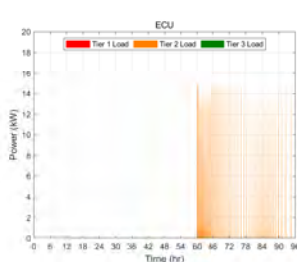
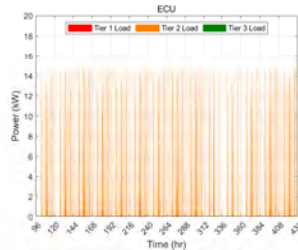


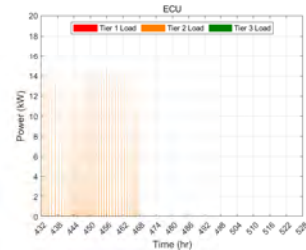
Fig. C-259 The aggregate tiered electrical load for the shelter labeled as office B



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

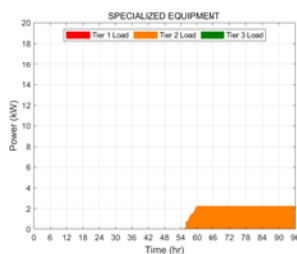


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

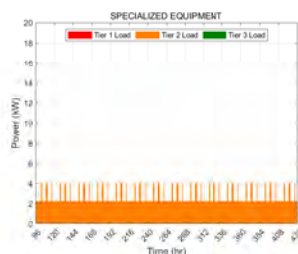


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

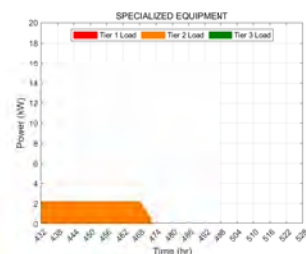
Fig. C-260 The ECU tiered electrical load for the shelter labeled as office B



(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0-96] h

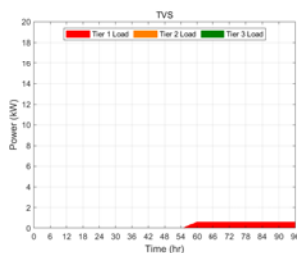


(b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96-432] h

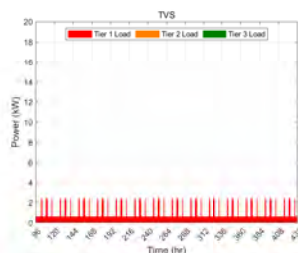


(c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432-528] h

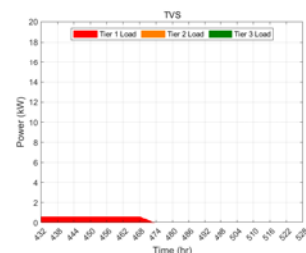
Fig. C-261 The specialized equipment tiered electrical load for the shelter labeled as office B



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0-96] h

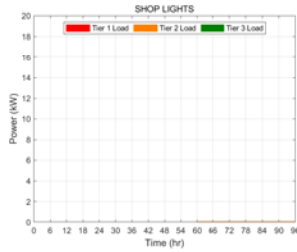


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96-432] h

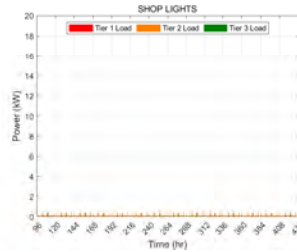


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432-528] h

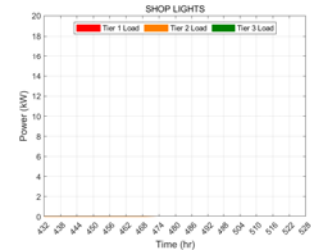
Fig. C-262 The televisions tiered electrical load for the shelter labeled as office B



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

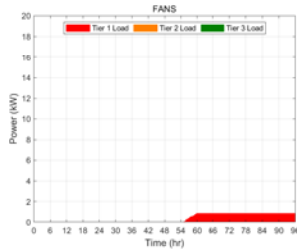


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

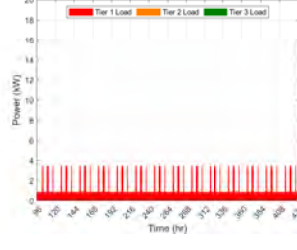


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

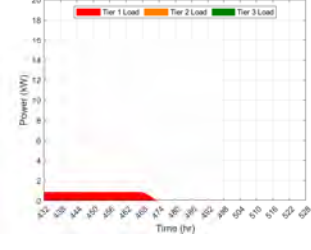
Fig. C-263 The shop lights tiered electrical load for the shelter labeled as office B



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-264 The fans tiered electrical load for the shelter labeled as office B



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0–96] h

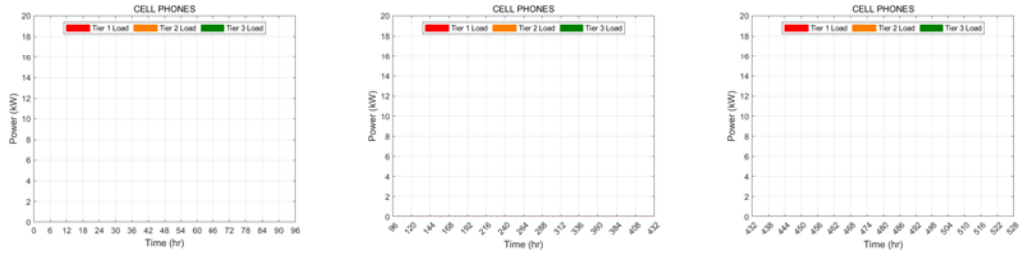


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-265 The laptop computers tiered electrical load for the shelter labeled as office B



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-266 The cell phones tiered electrical load for the shelter labeled as office B

C.27 Office C

The shelter labeled as office C was used as an office. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter’s occupancy was driven by various other events. This shelter was configured to house miscellaneous electrical equipment that could be used for briefings and miscellaneous other tasks.

The event schedule (Fig. C-267), the time-varying occupancy (Fig. C-268), the resulting thermal response (Fig. C-269), aggregate electrical load (Fig. C-270), and the ECU electrical load (Fig. C-271).

The shelter labeled as office C contains six separate electrical components including 1) specialized equipment (Fig. C-272), 2) televisions (Fig. C-273), 3) shop lights (Fig. C-274), 4) fans (Fig. C-275), 5) laptop computers (Fig. C-276), and 6) cell phones (Fig. C-277).

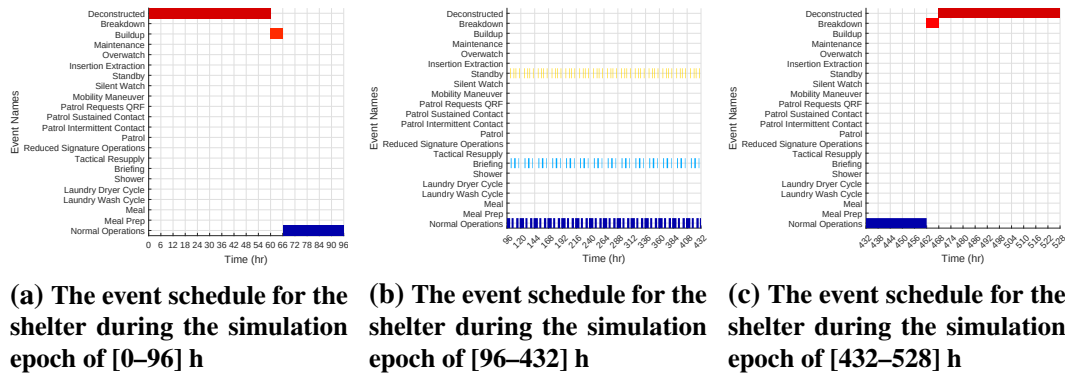


Fig. C-267 The event schedule for the shelter labeled as office C

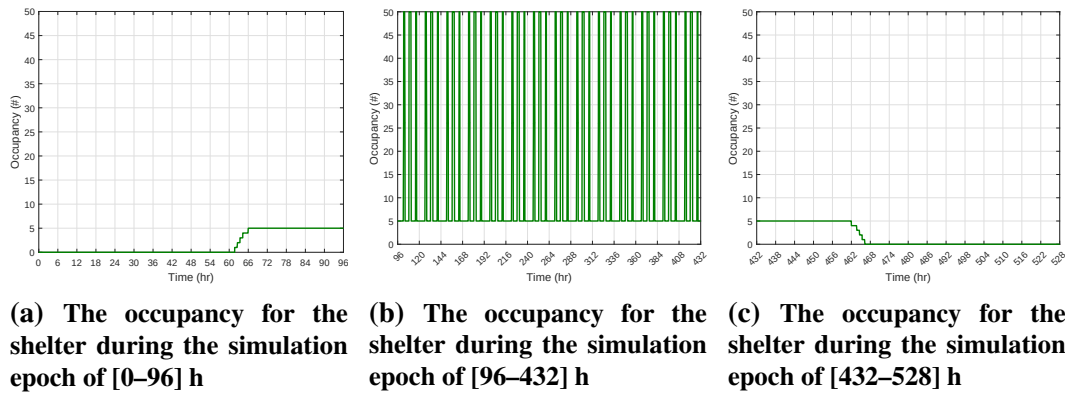


Fig. C-268 The occupancy for the shelter labeled as office C

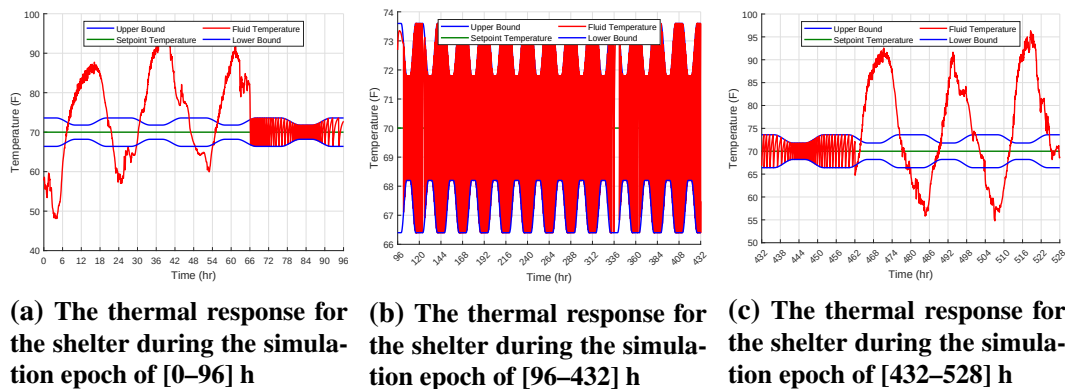
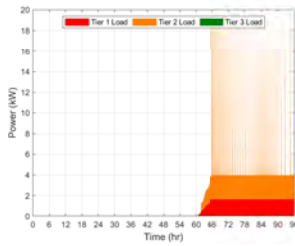
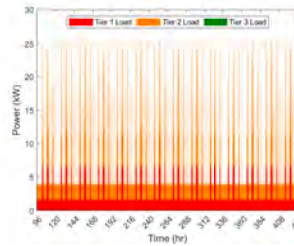


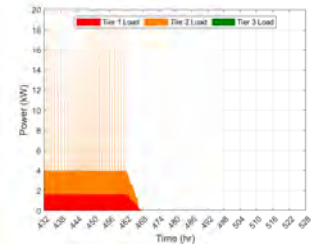
Fig. C-269 The thermal response for the shelter labeled as office C



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

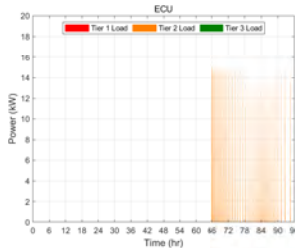


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

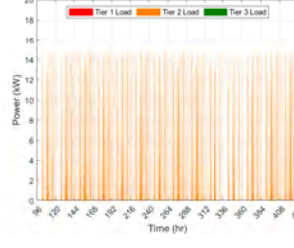


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

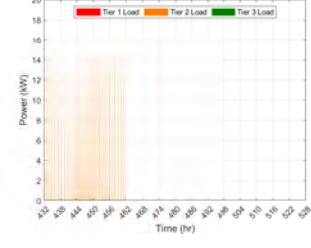
Fig. C-270 The aggregate tiered electrical load for the shelter labeled as office C



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

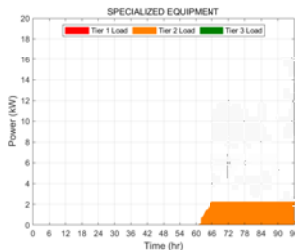


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

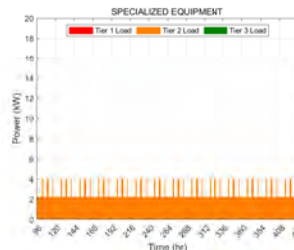


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

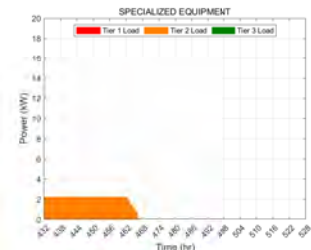
Fig. C-271 The ECU tiered electrical load for the shelter labeled as office C



(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0-96] h

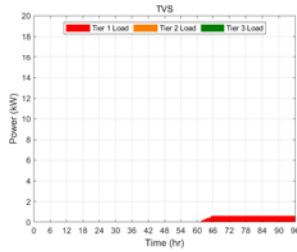


(b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96-432] h

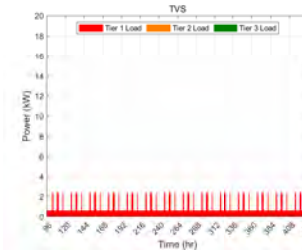


(c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432-528] h

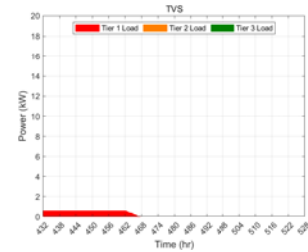
Fig. C-272 The specialized equipment tiered electrical load for the shelter labeled as office C



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

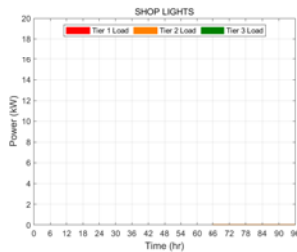


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

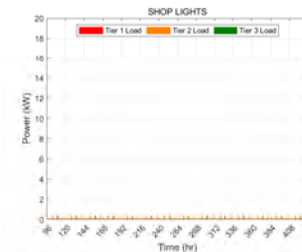


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

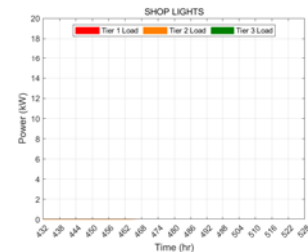
Fig. C-273 The televisions tiered electrical load for the shelter labeled as office C



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

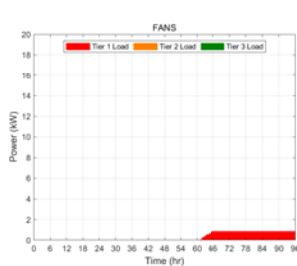


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

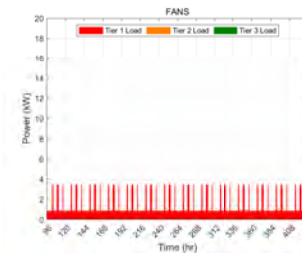


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

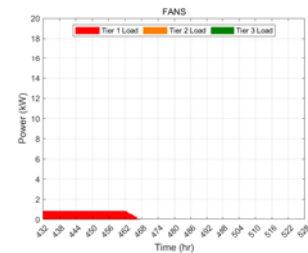
Fig. C-274 The shop lights tiered electrical load for the shelter labeled as office C



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-275 The fans tiered electrical load for the shelter labeled as office C

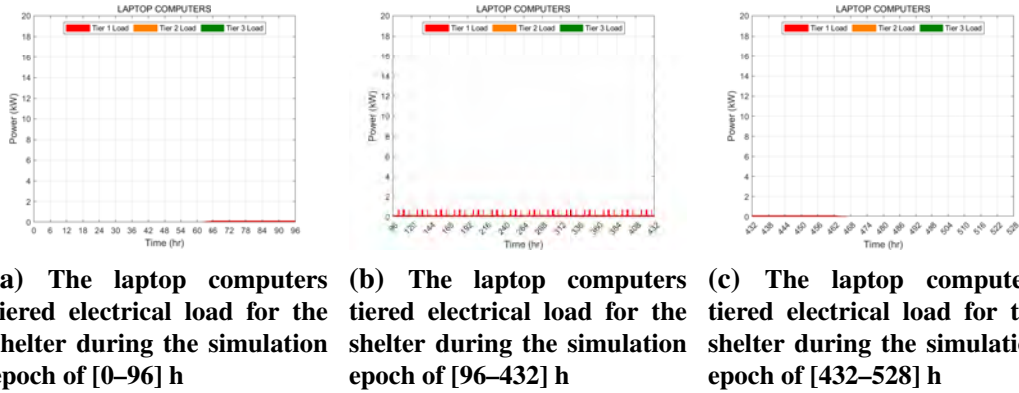


Fig. C-276 The laptop computers tiered electrical load for the shelter labeled as office C

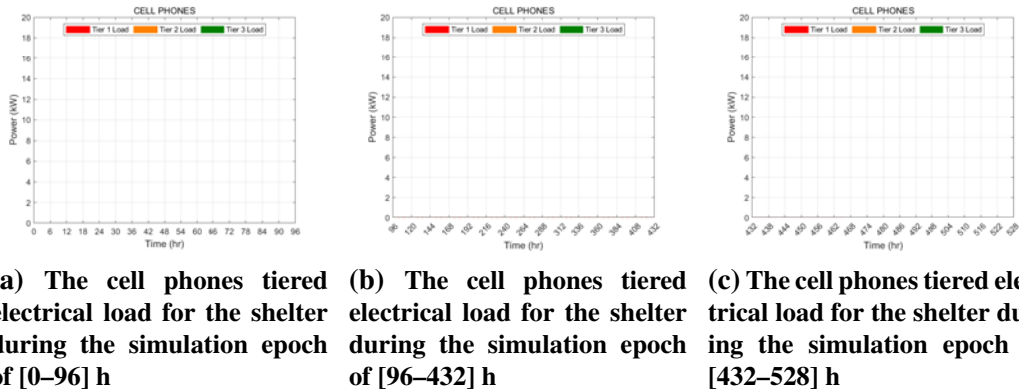


Fig. C-277 The cell phones tiered electrical load for the shelter labeled as office C

C.28 Office D

The shelter labeled as office D was used as an office. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house miscellaneous electrical equipment that could be used for briefings and miscellaneous other tasks.

The event schedule (Fig. C-278), the time-varying occupancy (Fig. C-279), the resulting thermal response (Fig. C-280), aggregate electrical load (Fig. C-281), and the ECU electrical load (Fig. C-282).

The shelter labeled as office D contains six separate electrical components including

1) specialized equipment (Fig. C-283), 2) televisions (Fig. C-284), 3) shop lights (Fig. C-285), 4) fans (Fig. C-286), 5) laptop computers (Fig. C-287), and 6) cell phones (Fig. C-288).

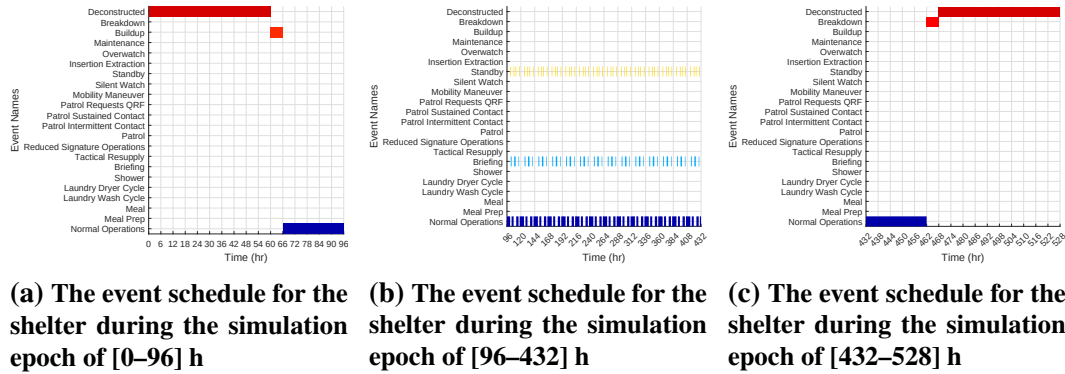


Fig. C-278 The event schedule for the shelter labeled as office D

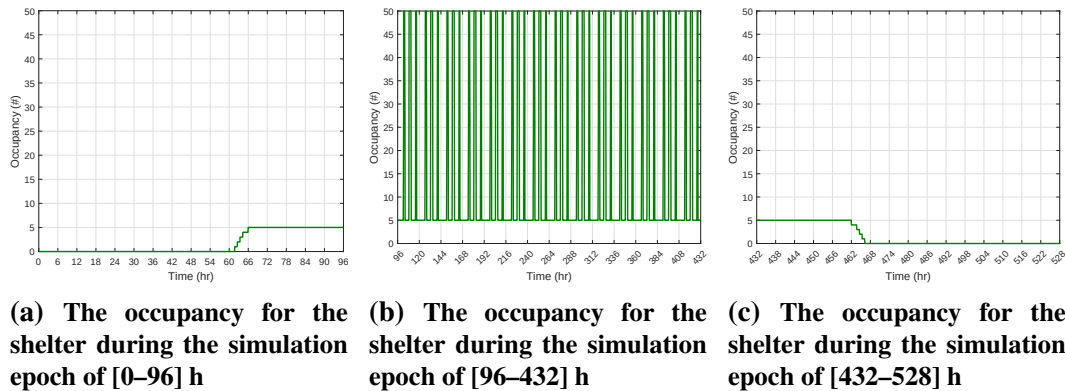
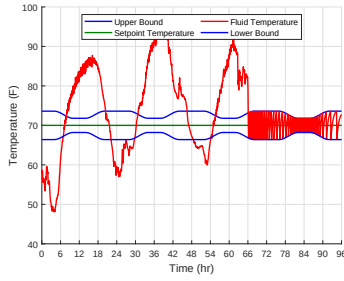
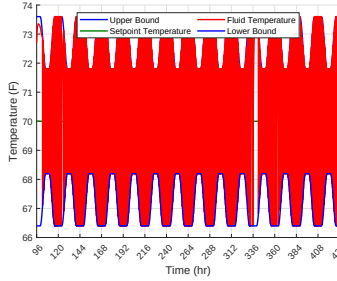


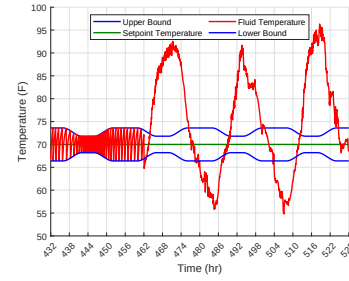
Fig. C-279 The occupancy for the shelter labeled as office D



(a) The thermal response for the shelter during the simulation epoch of [0-96] h

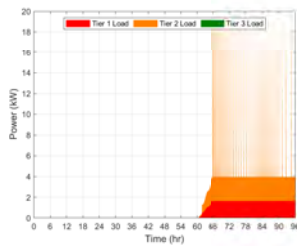


(b) The thermal response for the shelter during the simulation epoch of [96-432] h

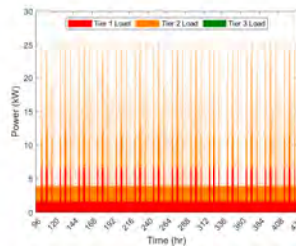


(c) The thermal response for the shelter during the simulation epoch of [432-528] h

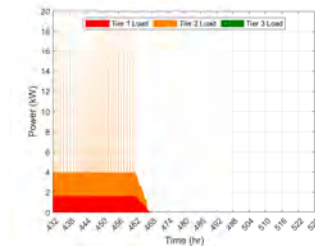
Fig. C-280 The thermal response for the shelter labeled as office D



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

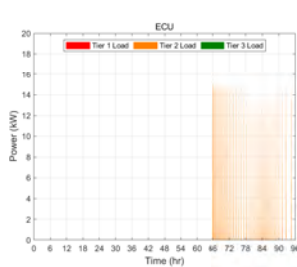


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

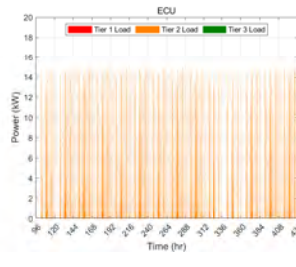


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

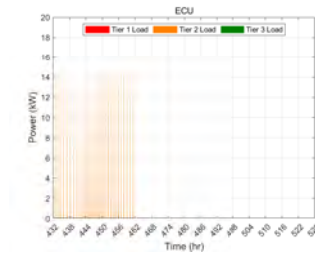
Fig. C-281 The aggregate tiered electrical load for the shelter labeled as office D



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

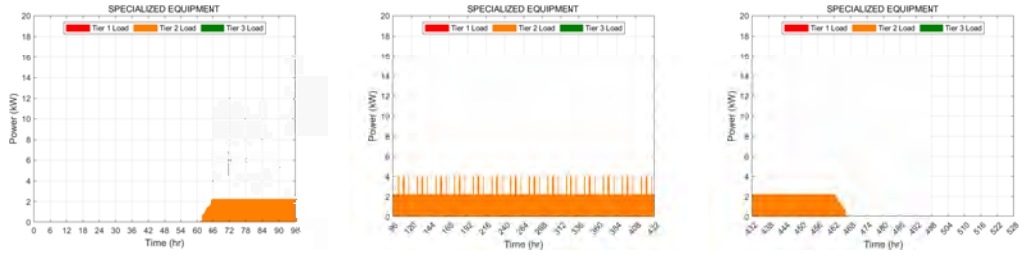


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h



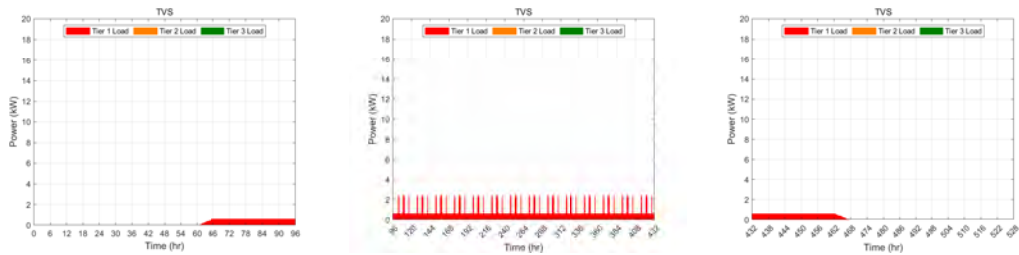
(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-282 The ECU tiered electrical load for the shelter labeled as office D



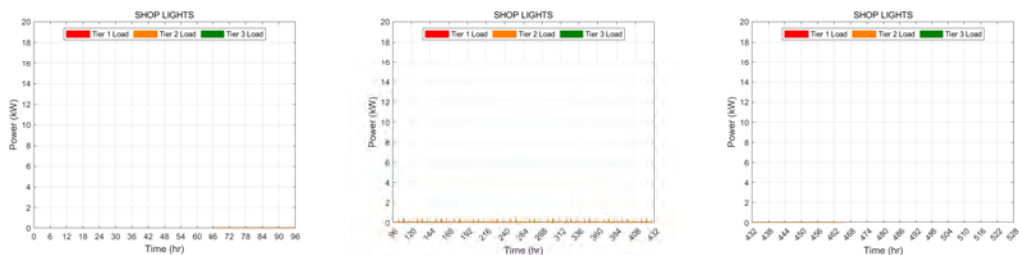
(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-283 The specialized equipment tiered electrical load for the shelter labeled as office D



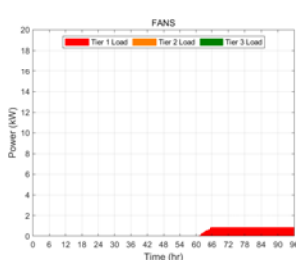
(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-284 The televisions tiered electrical load for the shelter labeled as office D

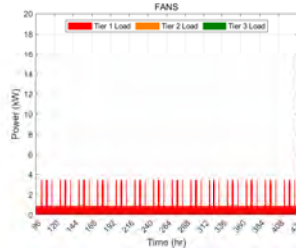


(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

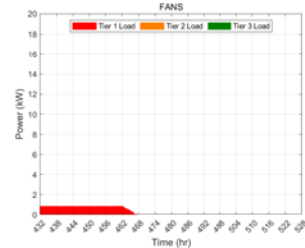
Fig. C-285 The shop lights tiered electrical load for the shelter labeled as office D



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-286 The fans tiered electrical load for the shelter labeled as office D



(a) The laptop computers tiered electrical load for the shelter during the simulation epoch of [0-96] h

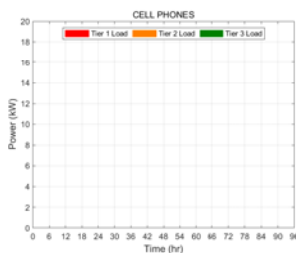


(b) The laptop computers tiered electrical load for the shelter during the simulation epoch of [96-432] h

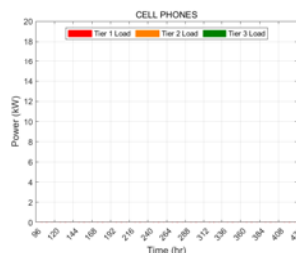


(c) The laptop computers tiered electrical load for the shelter during the simulation epoch of [432-528] h

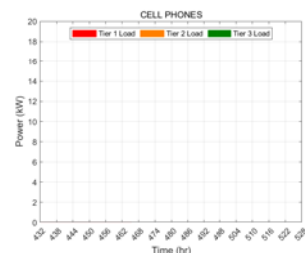
Fig. C-287 The laptop computers tiered electrical load for the shelter labeled as office D



(a) The cell phones tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The cell phones tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The cell phones tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-288 The cell phones tiered electrical load for the shelter labeled as office D

C.29 Depot

The shelter labeled as depot was used a vehicle depot. The maximum capacity of the shelter was estimated to be 25 Soldiers. The shelter's occupancy was driven by various other events. This shelter was configured to house electrical equipment used to conduct maintenance of military vehicles.

The event schedule (Fig. C-289), the time-varying occupancy (Fig. C-290), the resulting thermal response (Fig. C-291), aggregate electrical load (Fig. C-292), and the ECU electrical load (Fig. C-293).

The shelter labeled as depot contains five separate electrical components including 1) specialized equipment (Fig. C-294), 2) shop lights (Fig. C-295), 3) fans (Fig. C-296), 4) laptop computers (Fig. C-297), and 5) cell phones (Fig. C-298).

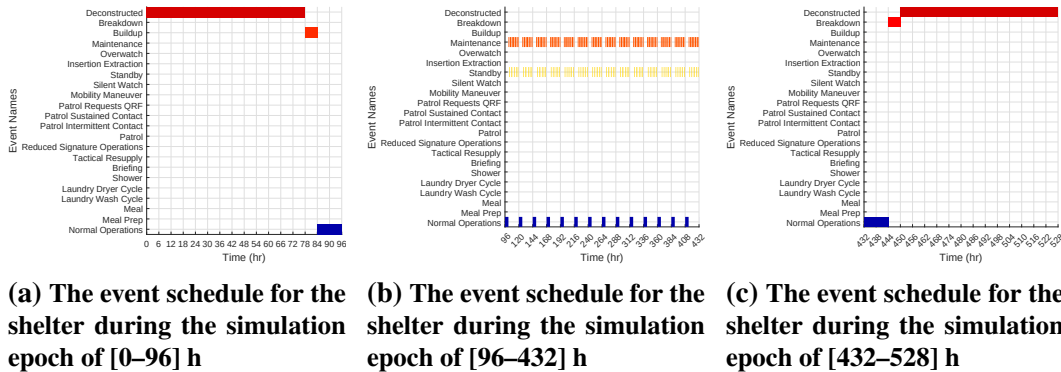


Fig. C-289 The event schedule for the shelter labeled as depot

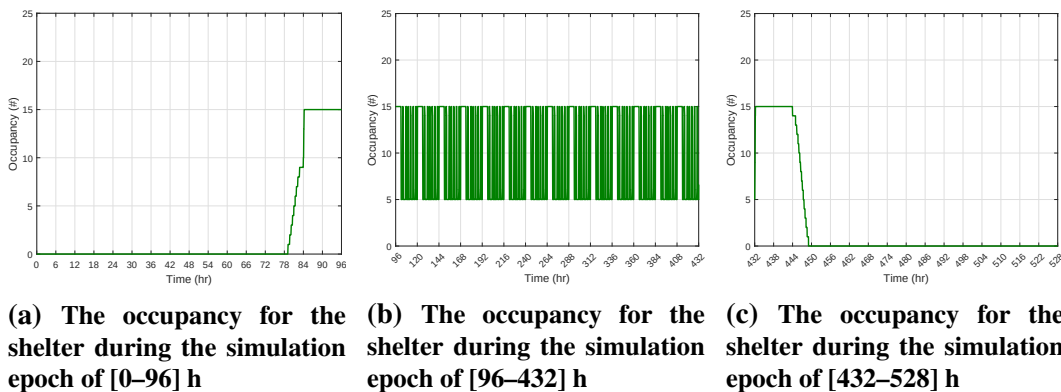
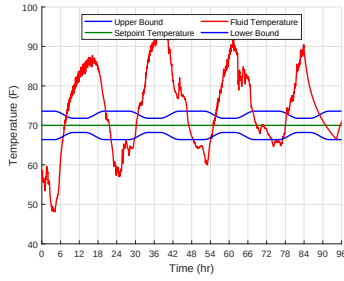
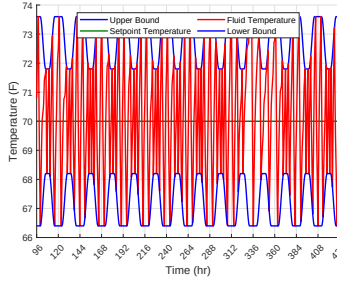


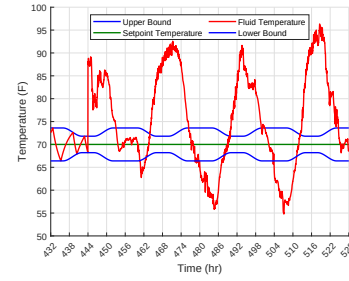
Fig. C-290 The occupancy for the shelter labeled as depot



(a) The thermal response for the shelter during the simulation epoch of [0-96] h

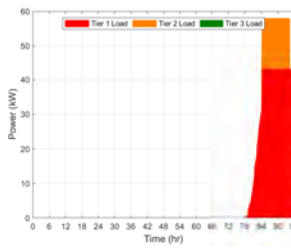


(b) The thermal response for the shelter during the simulation epoch of [96-432] h

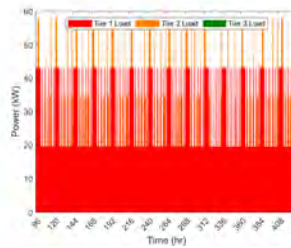


(c) The thermal response for the shelter during the simulation epoch of [432-528] h

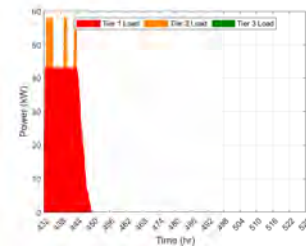
Fig. C-291 The thermal response for the shelter labeled as depot



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

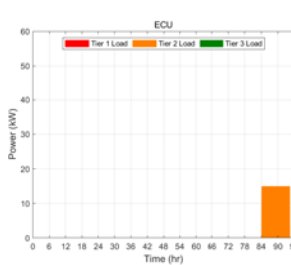


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

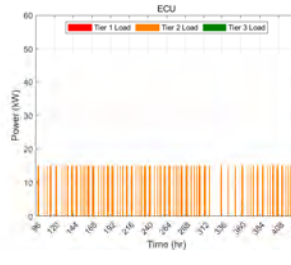


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

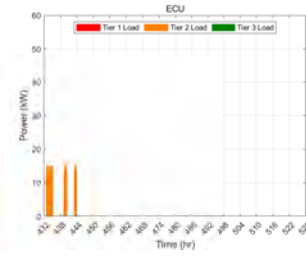
Fig. C-292 The aggregate tiered electrical load for the shelter labeled as depot



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

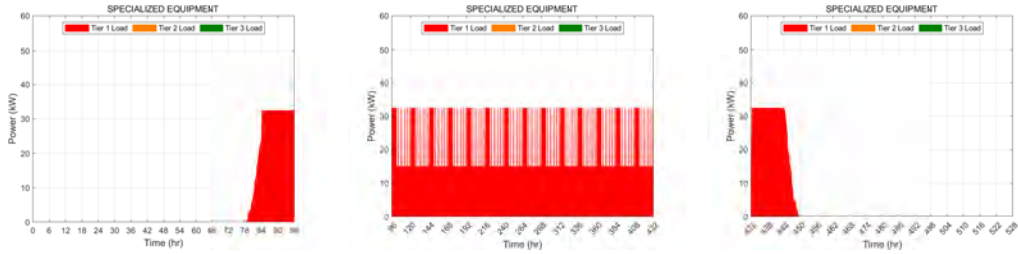


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h



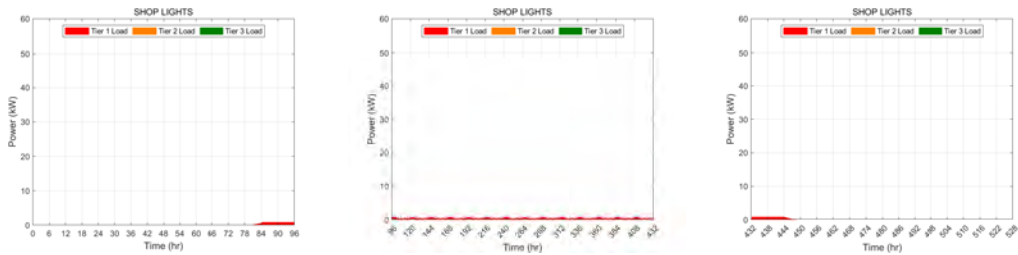
(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-293 The ECU tiered electrical load for the shelter labeled as depot



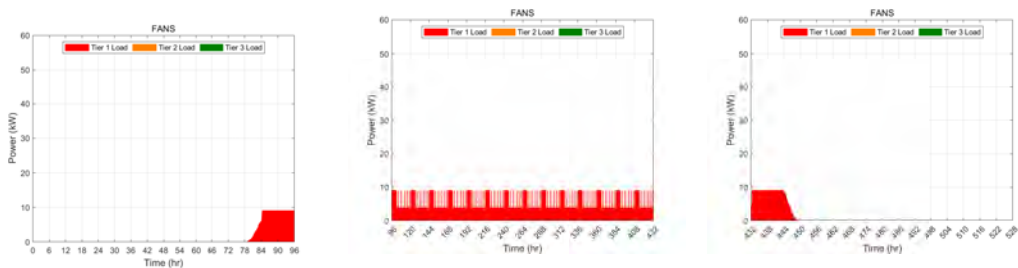
(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-294 The specialized equipment tiered electrical load for the shelter labeled as depot



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-295 The shop lights tiered electrical load for the shelter labeled as depot



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-296 The fans tiered electrical load for the shelter labeled as depot

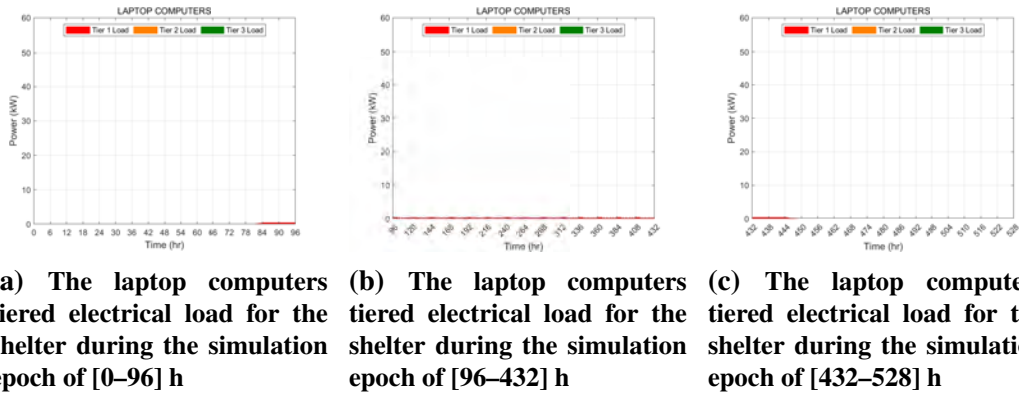


Fig. C-297 The laptop computers tiered electrical load for the shelter labeled as depot

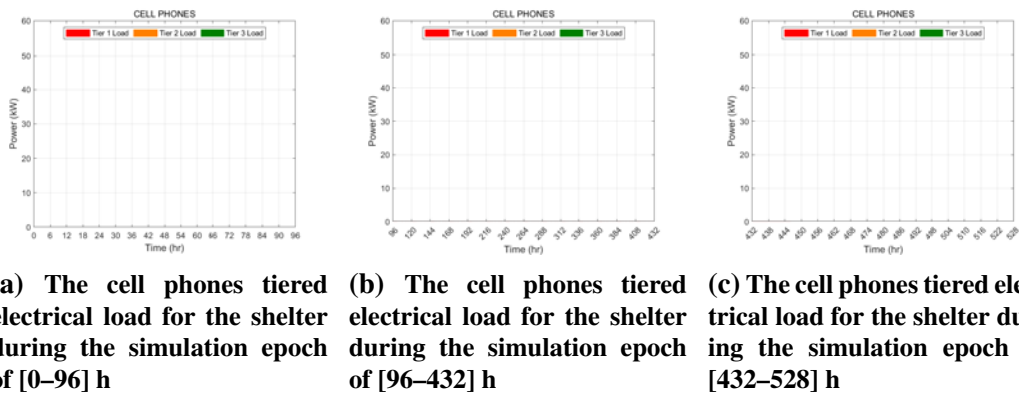


Fig. C-298 The cell phones tiered electrical load for the shelter labeled as depot

C.30 Mess A

The shelter labeled as Mess A was used to feed Soldier. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by meal-related events. In the event of a meal event, the occupancy increases; when the meal event has concluded, the occupancy decreases to the nominal level of occupancy.

The event schedule (Fig. C-299), the time-varying occupancy (Fig. C-300), the resulting thermal response (Fig. C-301), aggregate electrical load (Fig. C-302), and the ECU electrical load (Fig. C-303).

The shelter labeled as Mess A contains six separate electrical components including 1) specialized electrical equipment (Fig. C-304), 2) televisions (Fig. C-305), 3) shop lights (Fig. C-306), 4) fans (Fig. C-307), 5) microwaves (Fig. C-308), and 6) hot plates (Fig. C-309).

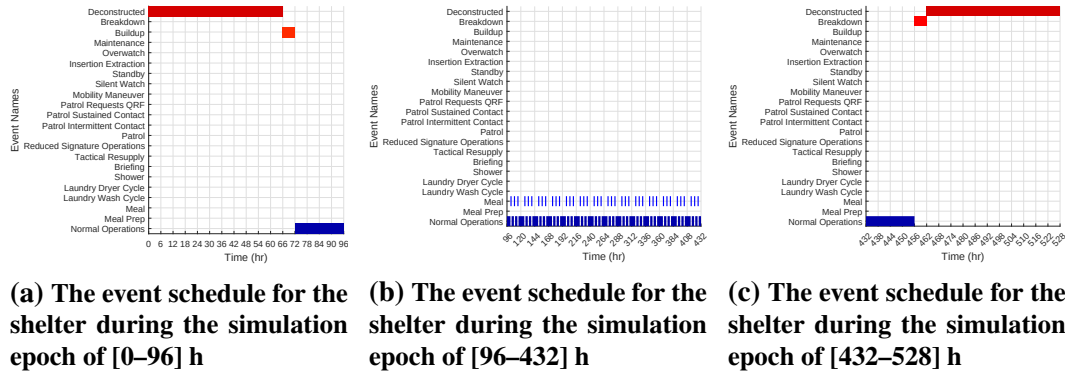


Fig. C-299 The event schedule for the shelter labeled as Mess A

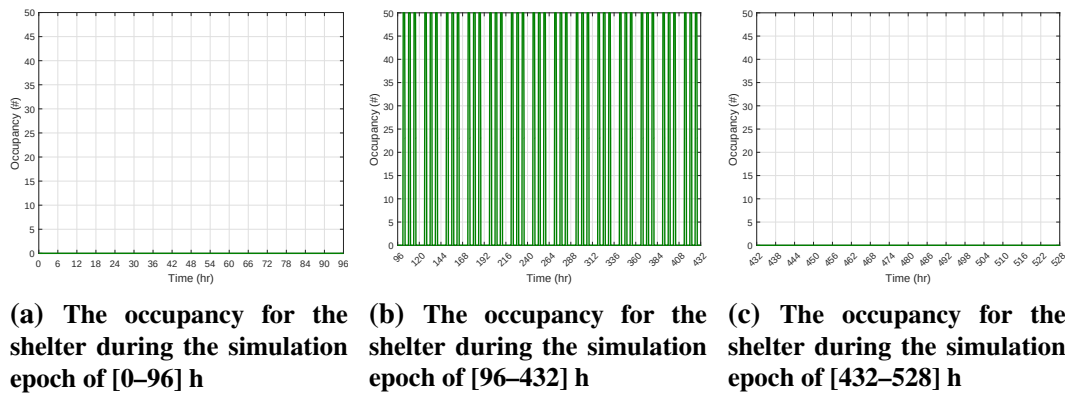


Fig. C-300 The occupancy for the shelter labeled as Mess A

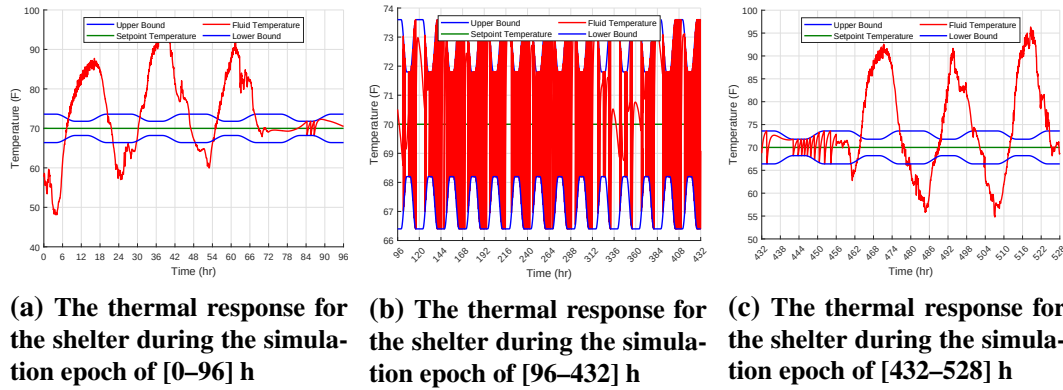


Fig. C-301 The thermal response for the shelter labeled as Mess A

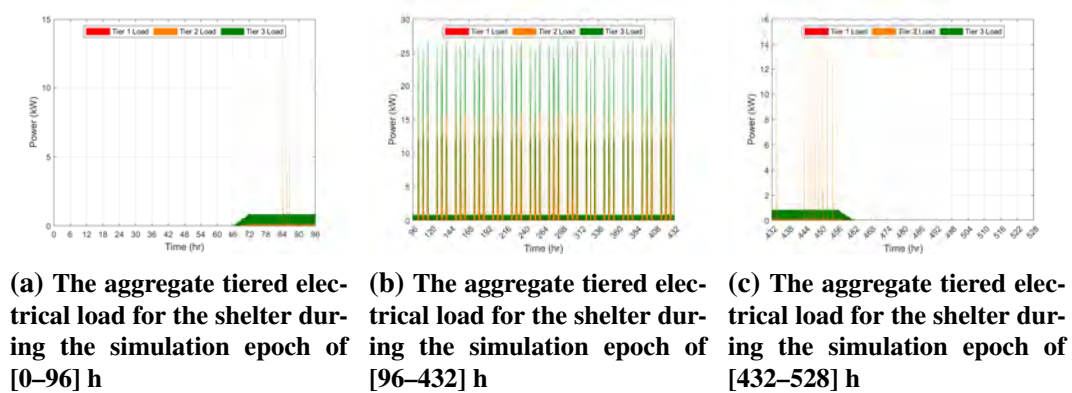


Fig. C-302 The aggregate tiered electrical load for the shelter labeled as Mess A

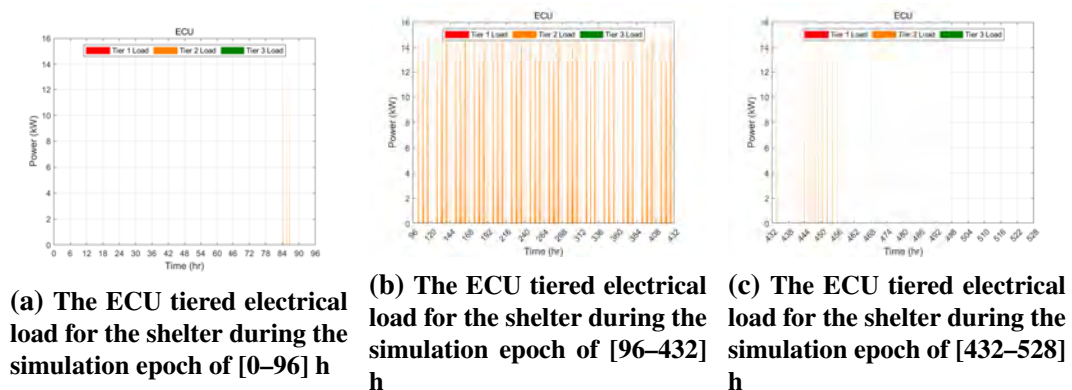
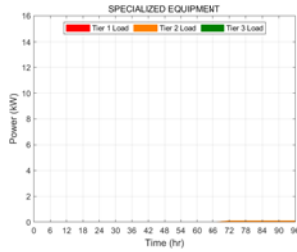
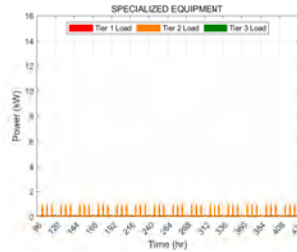


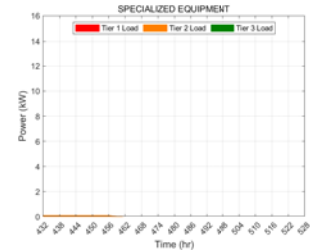
Fig. C-303 The ECU tiered electrical load for the shelter labeled as Mess A



(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0–96] h

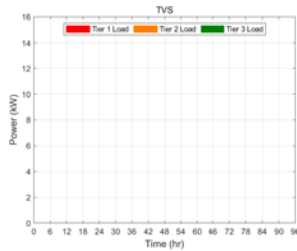


(b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96–432] h

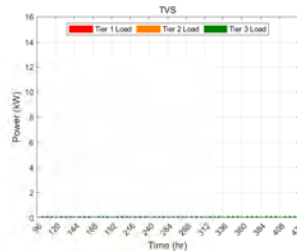


(c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432–528] h

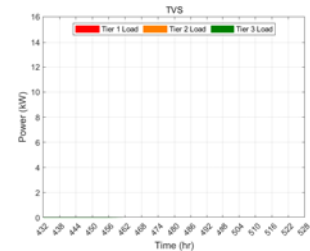
Fig. C-304 The specialized equipment tiered electrical load for the shelter labeled as Mess A



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0–96] h

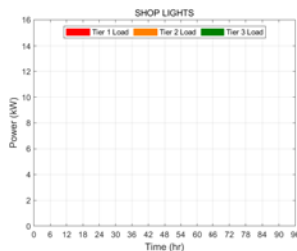


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96–432] h

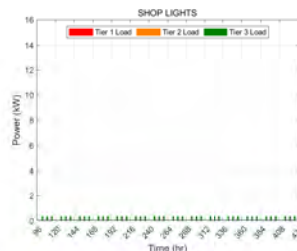


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432–528] h

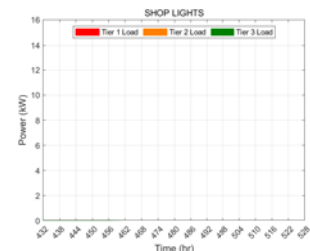
Fig. C-305 The televisions tiered electrical load for the shelter labeled as Mess A



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0–96] h

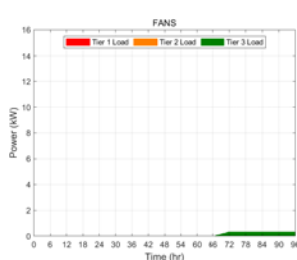


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96–432] h

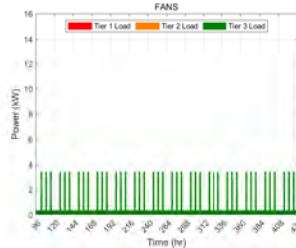


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432–528] h

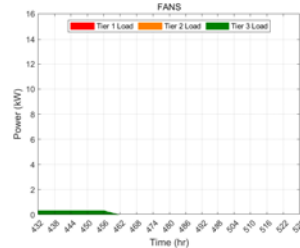
Fig. C-306 The shop lights tiered electrical load for the shelter labeled as Mess A



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h

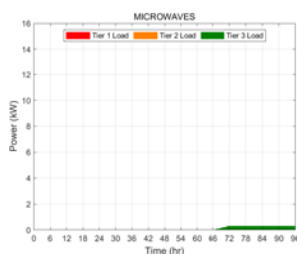


(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h

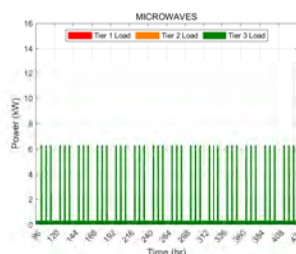


(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

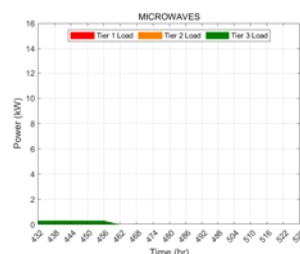
Fig. C-307 The fans tiered electrical load for the shelter labeled as Mess A



(a) The microwaves tiered electrical load for the shelter during the simulation epoch of [0-96] h

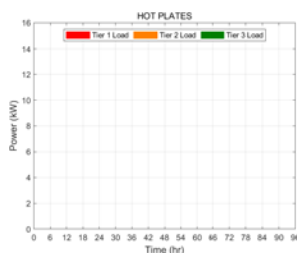


(b) The microwaves tiered electrical load for the shelter during the simulation epoch of [96-432] h

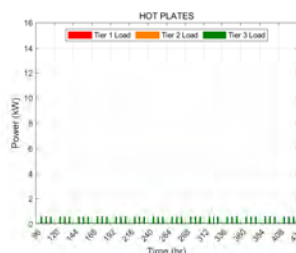


(c) The microwaves tiered electrical load for the shelter during the simulation epoch of [432-528] h

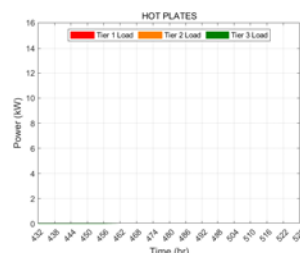
Fig. C-308 The microwaves tiered electrical load for the shelter labeled as Mess A



(a) The hot plates tiered electrical load for the shelter during the simulation epoch of [0-96] h



(b) The hot plates tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The hot plates tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-309 The hot plates tiered electrical load for the shelter labeled as Mess A

C.31 Mess B

The shelter labeled as Mess B was used to feed Soldier. The maximum capacity of the shelter was estimated to be 50 Soldiers. The shelter's occupancy was driven by meal-related events. In the event of a meal event, the occupancy increases; when the meal event has concluded, the occupancy decreases to the nominal level of occupancy.

The event schedule (Fig. C-310), the time-varying occupancy (Fig. C-311), the resulting thermal response (Fig. C-312), aggregate electrical load (Fig. C-313), and the ECU electrical load (Fig. C-314).

The shelter labeled as Mess B contains six separate electrical components including 1) specialized electrical equipment (Fig. C-315), 2) televisions (Fig. C-316), 3) shop lights (Fig. C-317), 4) fans (Fig. C-318), 5) microwaves (Fig. C-319), and 6) hot plates (Fig. C-320).

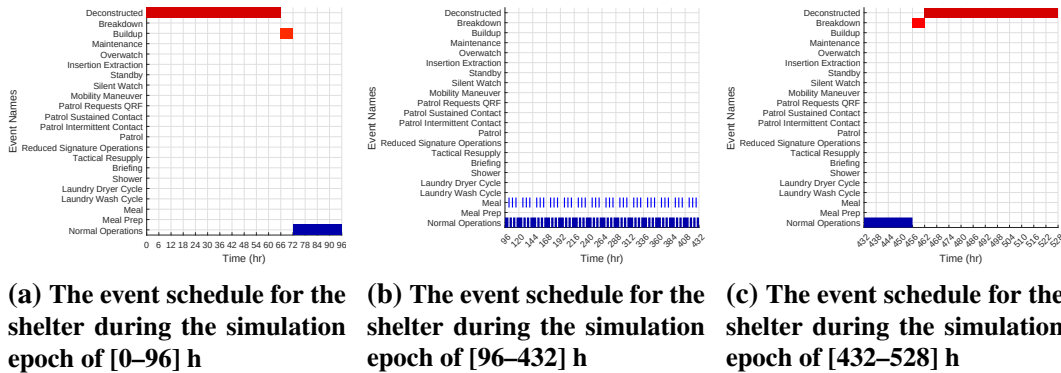


Fig. C-310 The event schedule for the shelter labeled as Mess B

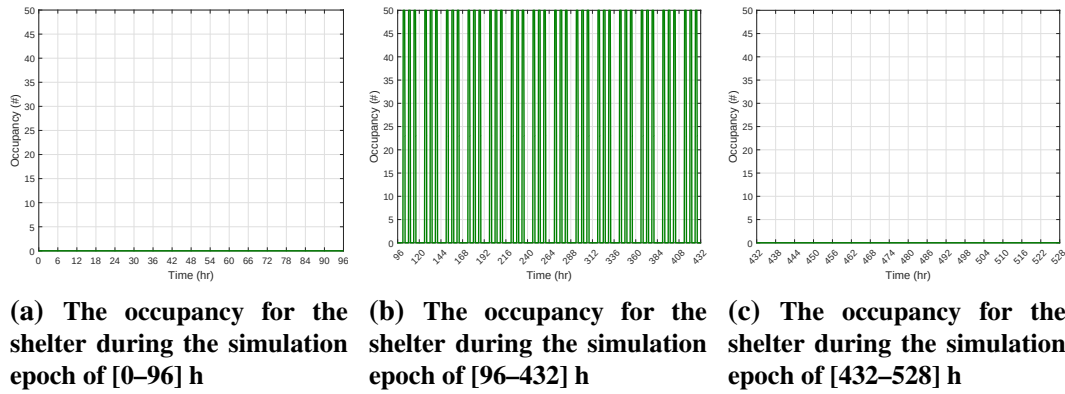


Fig. C-311 The occupancy for the shelter labeled as Mess B

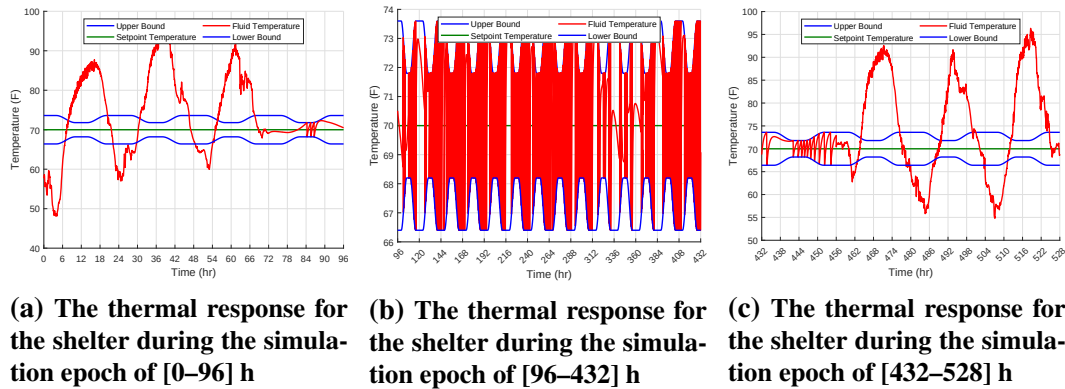


Fig. C-312 The thermal response for the shelter labeled as Mess B

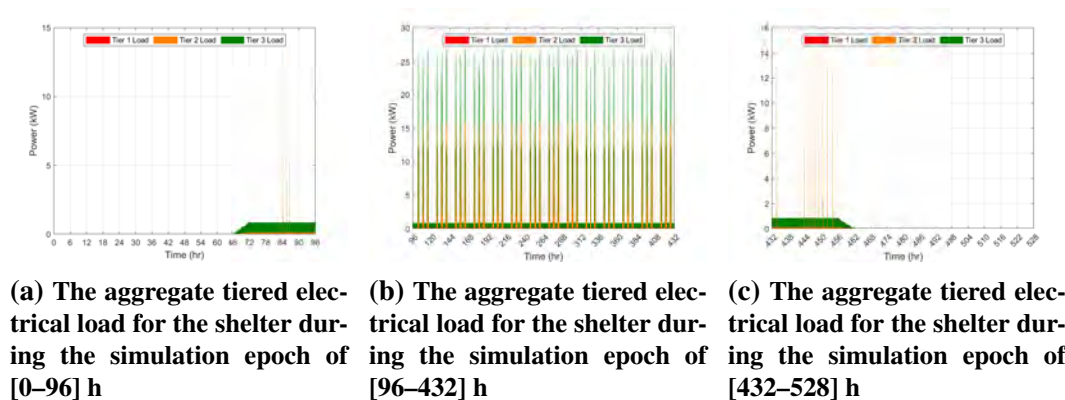
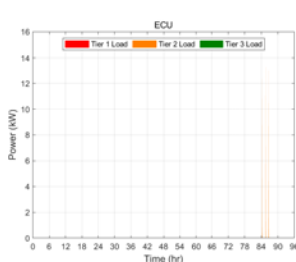
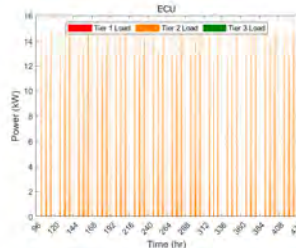


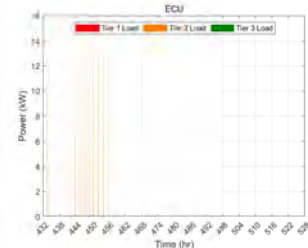
Fig. C-313 The aggregate tiered electrical load for the shelter labeled as Mess B



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

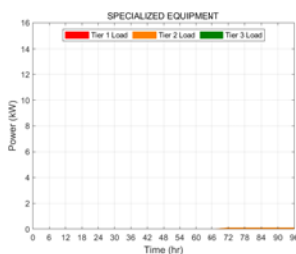


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

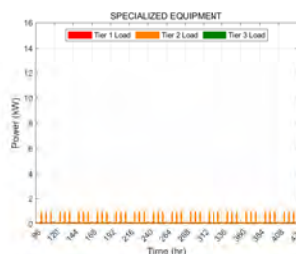


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

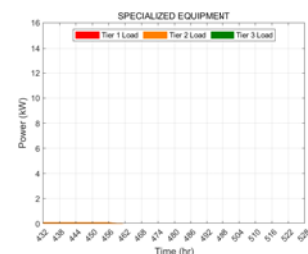
Fig. C-314 The ECU tiered electrical load for the shelter labeled as Mess B



(a) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [0-96] h

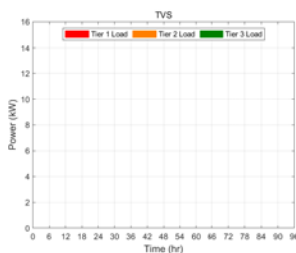


(b) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [96-432] h

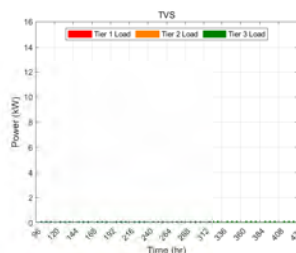


(c) The specialized equipment tiered electrical load for the shelter during the simulation epoch of [432-528] h

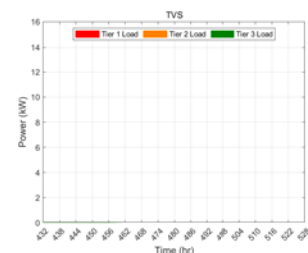
Fig. C-315 The specialized equipment tiered electrical load for the shelter labeled as Mess B



(a) The televisions tiered electrical load for the shelter during the simulation epoch of [0-96] h

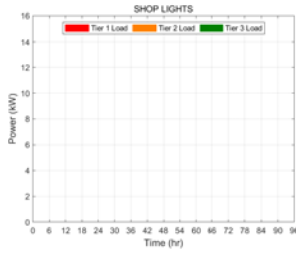


(b) The televisions tiered electrical load for the shelter during the simulation epoch of [96-432] h

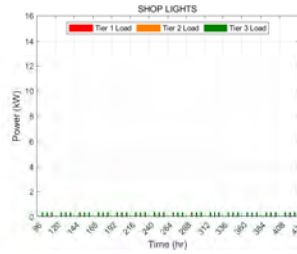


(c) The televisions tiered electrical load for the shelter during the simulation epoch of [432-528] h

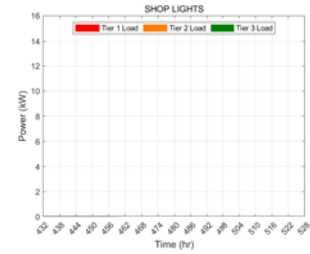
Fig. C-316 The televisions tiered electrical load for the shelter labeled as Mess B



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0-96] h

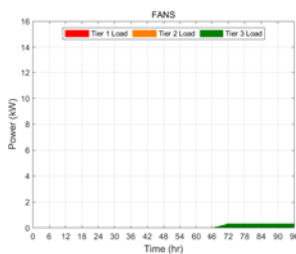


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96-432] h

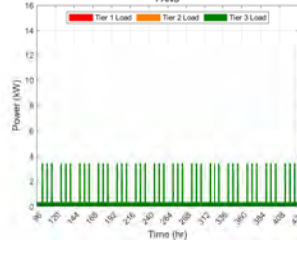


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432-528] h

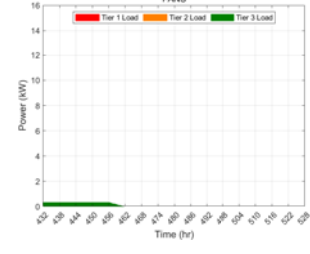
Fig. C-317 The shop lights tiered electrical load for the shelter labeled as Mess B



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h

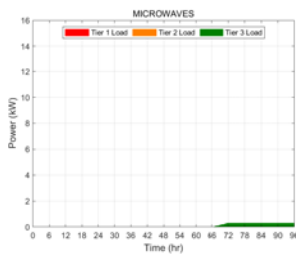


(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h

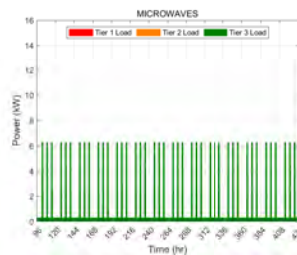


(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

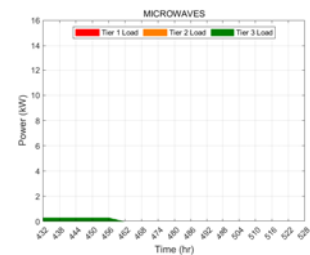
Fig. C-318 The fans tiered electrical load for the shelter labeled as Mess B



(a) The microwaves tiered electrical load for the shelter during the simulation epoch of [0-96] h

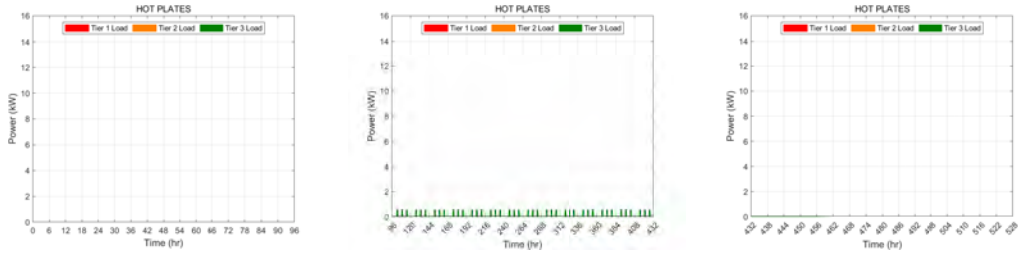


(b) The microwaves tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The microwaves tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-319 The microwaves tiered electrical load for the shelter labeled as Mess B



(a) The hot plates tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The hot plates tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The hot plates tiered electrical load for the shelter during the simulation epoch of [432–528] h

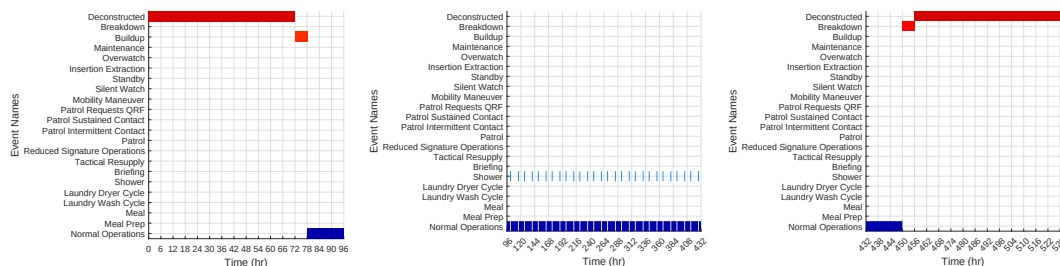
Fig. C-320 The hot plates tiered electrical load for the shelter labeled as Mess B

C.32 Shower A

The shelter labeled as shower A was used as the shower. The maximum capacity of the shelter was estimated to be 16 Soldiers. The shelter’s occupancy was driven by shower-related events. This shelter was configured to house the water heaters and all other related equipment or components required for Soldiers to take a shower.

The event schedule (Fig. C-321), the time-varying occupancy (Fig. C-322), the resulting thermal response (Fig. C-323), aggregate electrical load (Fig. C-324), and the ECU electrical load (Fig. C-325).

The shelter labeled as shower A contains three separate electrical components including 1) shop lights (Fig. C-326), 2) fans (Fig. C-327), and 3) water heaters (Fig. C-328).



(a) The event schedule for the shelter during the simulation epoch of [0–96] h (b) The event schedule for the shelter during the simulation epoch of [96–432] h (c) The event schedule for the shelter during the simulation epoch of [432–528] h

Fig. C-321 The event schedule for the shelter labeled as shower A

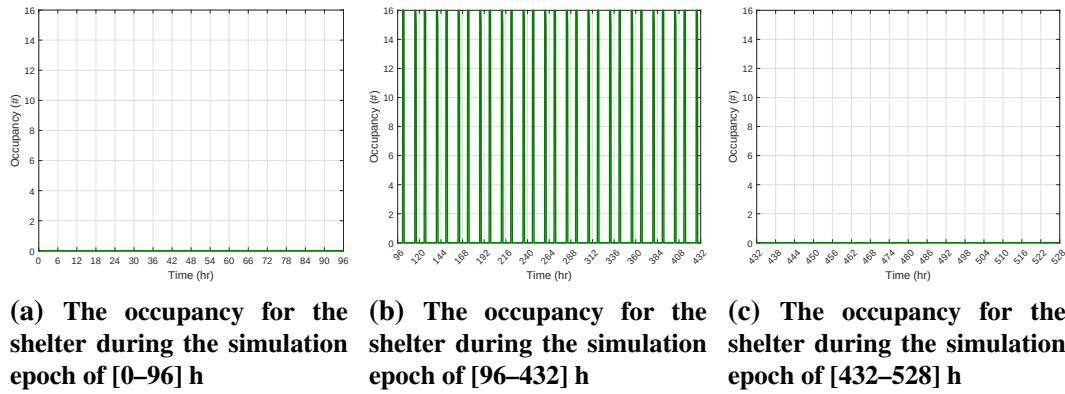


Fig. C-322 The occupancy for the shelter labeled as shower A

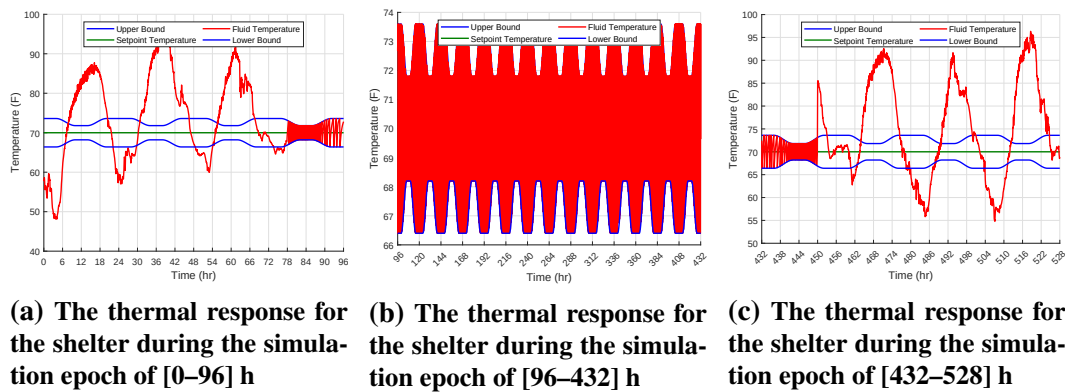


Fig. C-323 The thermal response for the shelter labeled as shower A

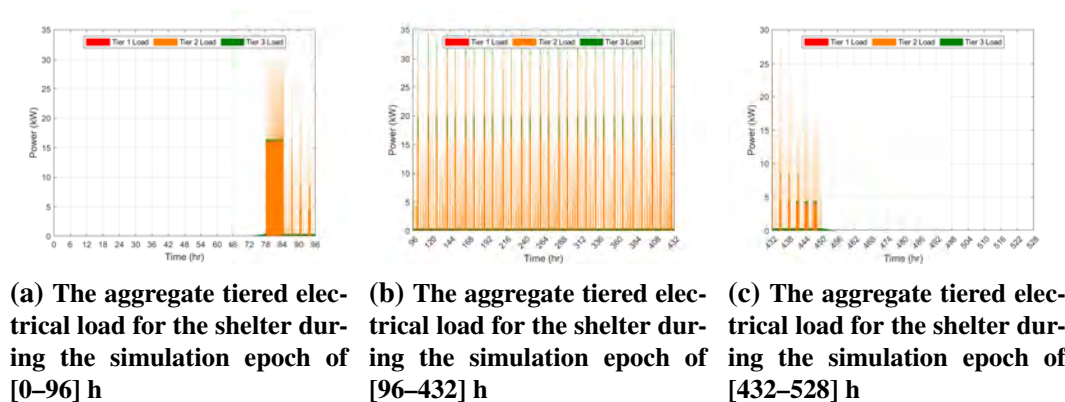
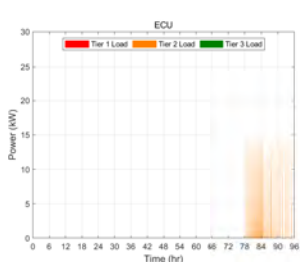
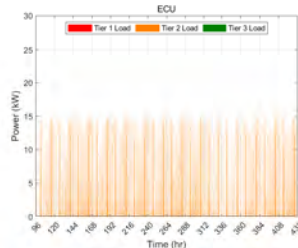


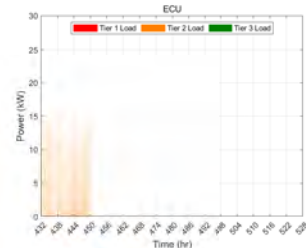
Fig. C-324 The aggregate tiered electrical load for the shelter labeled as shower A



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

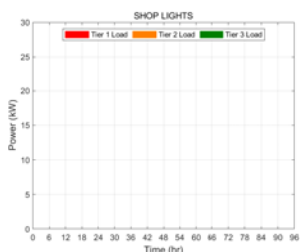


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-325 The ECU tiered electrical load for the shelter labeled as shower A



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0-96] h

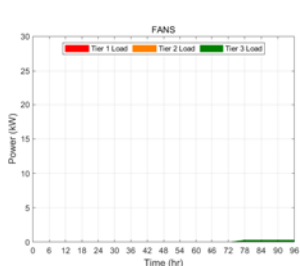


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96-432] h

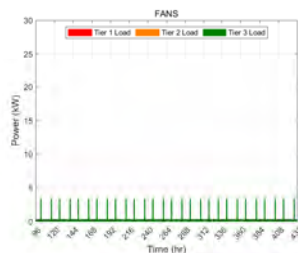


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432-528] h

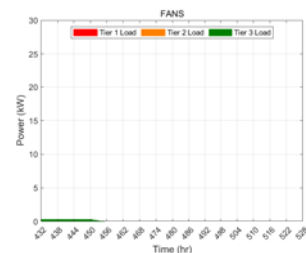
Fig. C-326 The shop lights tiered electrical load for the shelter labeled as shower A



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0-96] h

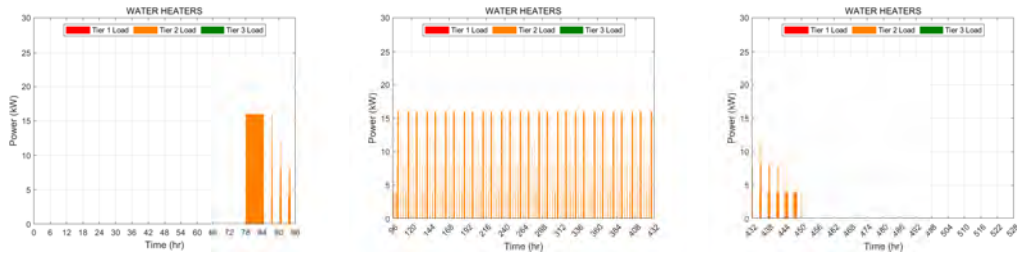


(b) The fans tiered electrical load for the shelter during the simulation epoch of [96-432] h



(c) The fans tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-327 The fans tiered electrical load for the shelter labeled as shower A



(a) The water heaters tiered electrical load for the shelter during the simulation epoch of [0–96] h (b) The water heaters tiered electrical load for the shelter during the simulation epoch of [96–432] h (c) The water heaters tiered electrical load for the shelter during the simulation epoch of [432–528] h

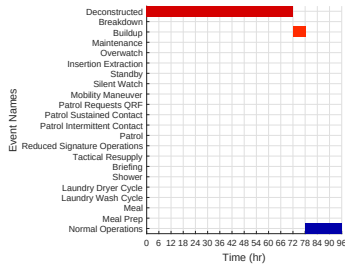
Fig. C-328 The water heaters tiered electrical load for the shelter labeled as shower A

C.33 Shower B

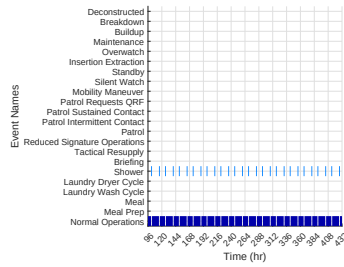
The shelter labeled as shower B was used as the shower. The maximum capacity of the shelter was estimated to be 16 Soldiers. The shelter’s occupancy was driven by shower-related events. This shelter was configured to house the water heaters and all other related equipment or components required for Soldiers to take a shower.

The event schedule (Fig. C-329), the time-varying occupancy (Fig. C-330), the resulting thermal response (Fig. C-331), aggregate electrical load (Fig. C-332), and the ECU electrical load (Fig. C-333).

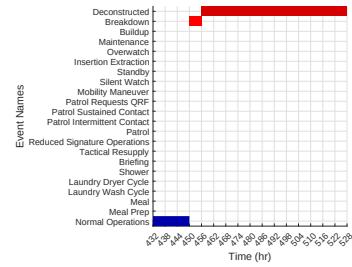
The shelter labeled as shower B contains three separate electrical components including 1) shop lights (Fig. C-334), 2) fans (Fig. C-335), and 3) water heaters (Fig. C-336).



(a) The event schedule for the shelter during the simulation epoch of [0-96] h

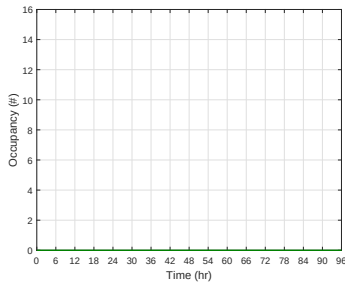


(b) The event schedule for the shelter during the simulation epoch of [96-432] h

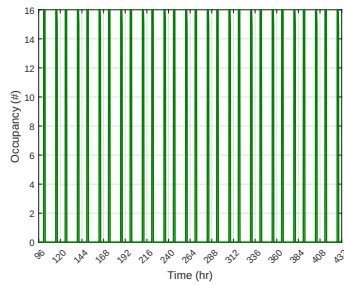


(c) The event schedule for the shelter during the simulation epoch of [432-528] h

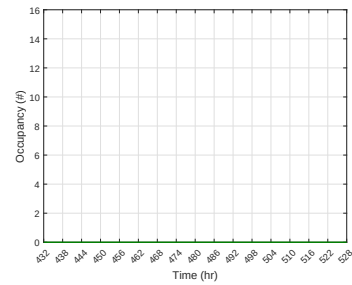
Fig. C-329 The event schedule for the shelter labeled as shower B



(a) The occupancy for the shelter during the simulation epoch of [0-96] h

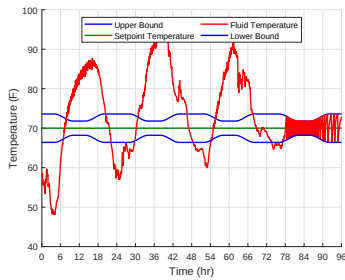


(b) The occupancy for the shelter during the simulation epoch of [96-432] h

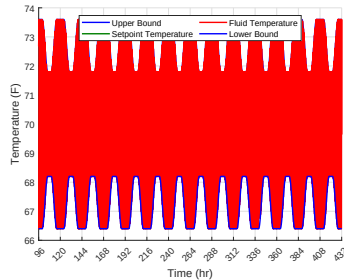


(c) The occupancy for the shelter during the simulation epoch of [432-528] h

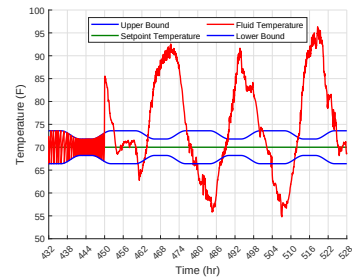
Fig. C-330 The occupancy for the shelter labeled as shower B



(a) The thermal response for the shelter during the simulation epoch of [0-96] h

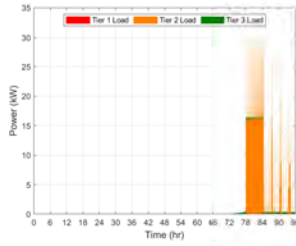


(b) The thermal response for the shelter during the simulation epoch of [96-432] h

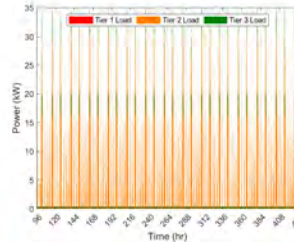


(c) The thermal response for the shelter during the simulation epoch of [432-528] h

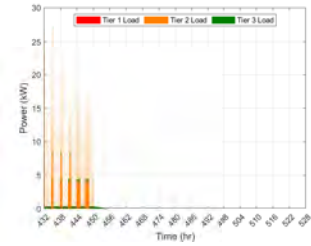
Fig. C-331 The thermal response for the shelter labeled as shower B



(a) The aggregate tiered electrical load for the shelter during the simulation epoch of [0-96] h

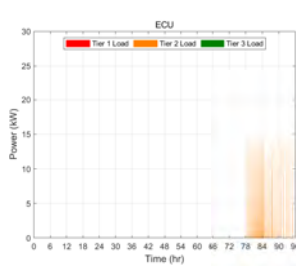


(b) The aggregate tiered electrical load for the shelter during the simulation epoch of [96-432] h

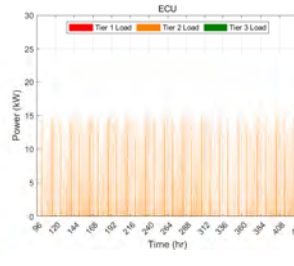


(c) The aggregate tiered electrical load for the shelter during the simulation epoch of [432-528] h

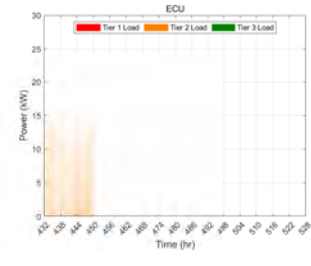
Fig. C-332 The aggregate tiered electrical load for the shelter labeled as shower B



(a) The ECU tiered electrical load for the shelter during the simulation epoch of [0-96] h

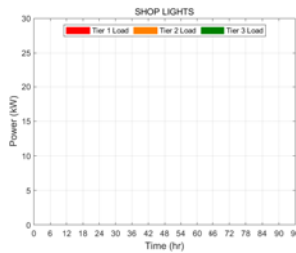


(b) The ECU tiered electrical load for the shelter during the simulation epoch of [96-432] h

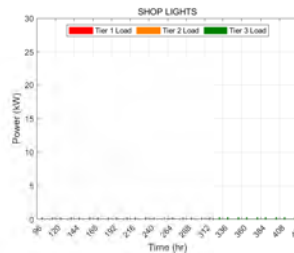


(c) The ECU tiered electrical load for the shelter during the simulation epoch of [432-528] h

Fig. C-333 The ECU tiered electrical load for the shelter labeled as shower B



(a) The shop lights tiered electrical load for the shelter during the simulation epoch of [0-96] h

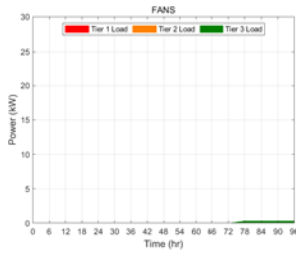


(b) The shop lights tiered electrical load for the shelter during the simulation epoch of [96-432] h

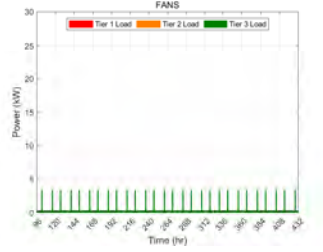


(c) The shop lights tiered electrical load for the shelter during the simulation epoch of [432-528] h

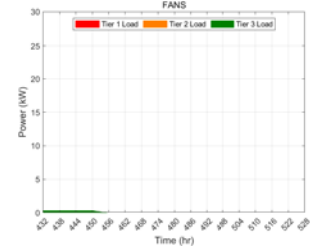
Fig. C-334 The shop lights tiered electrical load for the shelter labeled as shower B



(a) The fans tiered electrical load for the shelter during the simulation epoch of [0–96] h

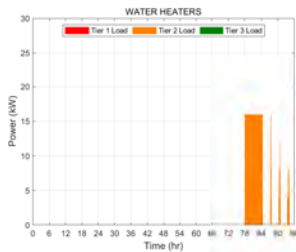


(b) The fans tiered electrical load for the shelter during the simulation epoch of [96–432] h

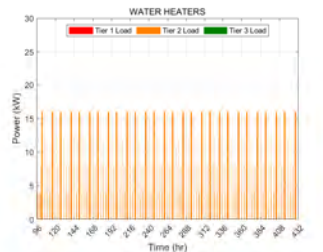


(c) The fans tiered electrical load for the shelter during the simulation epoch of [432–528] h

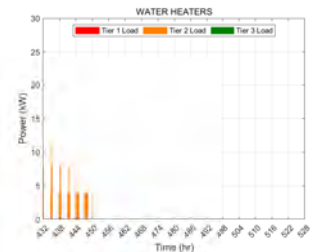
Fig. C-335 The fans tiered electrical load for the shelter labeled as shower B



(a) The water heaters tiered electrical load for the shelter during the simulation epoch of [0–96] h



(b) The water heaters tiered electrical load for the shelter during the simulation epoch of [96–432] h



(c) The water heaters tiered electrical load for the shelter during the simulation epoch of [432–528] h

Fig. C-336 The water heaters tiered electrical load for the shelter labeled as shower B

List of Symbols, Abbreviations, and Acronyms

AI	artificial intelligence
AIHPG	Artificial Intelligence for Hybridized Power Grid
COC	Combat Operations Center
COM	Communications
COP	Combat Outpost
ECU	environmental control unit
E&P	energy and power
FOB	Forward Operating Base
GFE	government-furnished equipment
HVAC	heating ventilation and air conditioning
ML	machine learning
NREL	National Renewable Energy Laboratory
QRF	Quick Response Force
TV	television

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FCDD RLC ED
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G VAUCHER (5 HC)