UAS Emergency Kit Design

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1. Introduction

Concept UAV with Emergency Kit

In recent years, uncrewed aerial vehicles (UAVs), commonly known as drones, have emerged as a pivotal technology in emergency management. Their ability to swiftly and efficiently deliver aid in the aftermath of disasters has revolutionized our approach to crisis response. Central to this innovation is the development of well-designed emergency kits, specifically tailored for drone delivery. These kits, equipped with essential supplies, are crucial in providing immediate relief to affected areas where traditional methods of aid delivery may be hindered. This report delves into the integration of drone technology in emergency scenarios, emphasizing the design and composition of emergency kits suitable for drone delivery. It aims to explore the capabilities, challenges, and practical considerations of using drones for rapid aid deployment, thereby contributing to more effective and responsive disaster management strategies.

This study was prepared by “Uncrewed Aircraft Systems for Emergency Applications” (GEOG 386) students in the Geography and Geospatial Sciences Department at South Dakota State University.

2. Background

First FAA-approved medical supply aerial delivery, 2016

The use of drones for emergency response has a relatively recent history but has seen rapid development and adoption. Initially, drones were primarily used for military purposes, but their potential for civilian use, especially in emergencies, was quickly recognized. In the early 2010s, drones began to be used for search and rescue operations, providing a bird's-eye view of disaster zones. Their ability to reach inaccessible areas, collect real-time data, and deliver supplies revolutionized emergency management. In recent years, advancements in drone technology have further enhanced their capabilities, making them an indispensable tool in various emergency scenarios, including natural disasters, humanitarian crises, and public health emergencies.

Emergency kits delivered via drones have been recognized for their potential in drastically improving response times in various emergency situations including:

Rapid Response

Drones enable the quick delivery of emergency kits to areas that are difficult to reach by traditional methods, particularly in the aftermath of natural disasters or in remote regions. Their ability to bypass traffic congestion and navigate through challenging terrains enables faster delivery times, potentially saving lives in time-sensitive situations. (Technology Innovators)

2. Background

Supply Chain Efficiency

Implementing drone delivery for emergencies can streamline the supply chain and reduce logistics challenges. Instead of relying solely on ground transportation or manned flights, which may be subject to delays or limitations, drones provide a direct and efficient route from the distribution center to the emergency location. This improves supply chain efficiency and ensures that critical supplies reach the destination without unnecessary delays. (Technology Innovators)

Customizable Kits

The contents of emergency kits can be tailored to specific disaster scenarios, such as floods, earthquakes, or medical emergencies, enhancing their effectiveness.

Technological Advancements

Innovations in drone technology, including improved battery life, payload capacity, and navigation systems, have expanded the feasibility of drone-based delivery systems.

Cost-Effectiveness

Although initial investment in drone technology can be high, the long-term cost savings, due to the speed and efficiency of drone deliveries, are significant.

Challenges and Limitations

Issues such as regulatory restrictions, privacy concerns, and the need for sophisticated control systems are common challenges and limitations. Ensuring safety is paramount when deploying drones for emergency delivery. Compliance with aviation regulations, airspace management, and collision avoidance systems are crucial to mitigate potential risks. Collaboration with regulatory authorities, emergency services, and local communities is essential to establish guidelines and protocols that govern the safe and responsible use of drones in emergency situations. (Technology Innovators)

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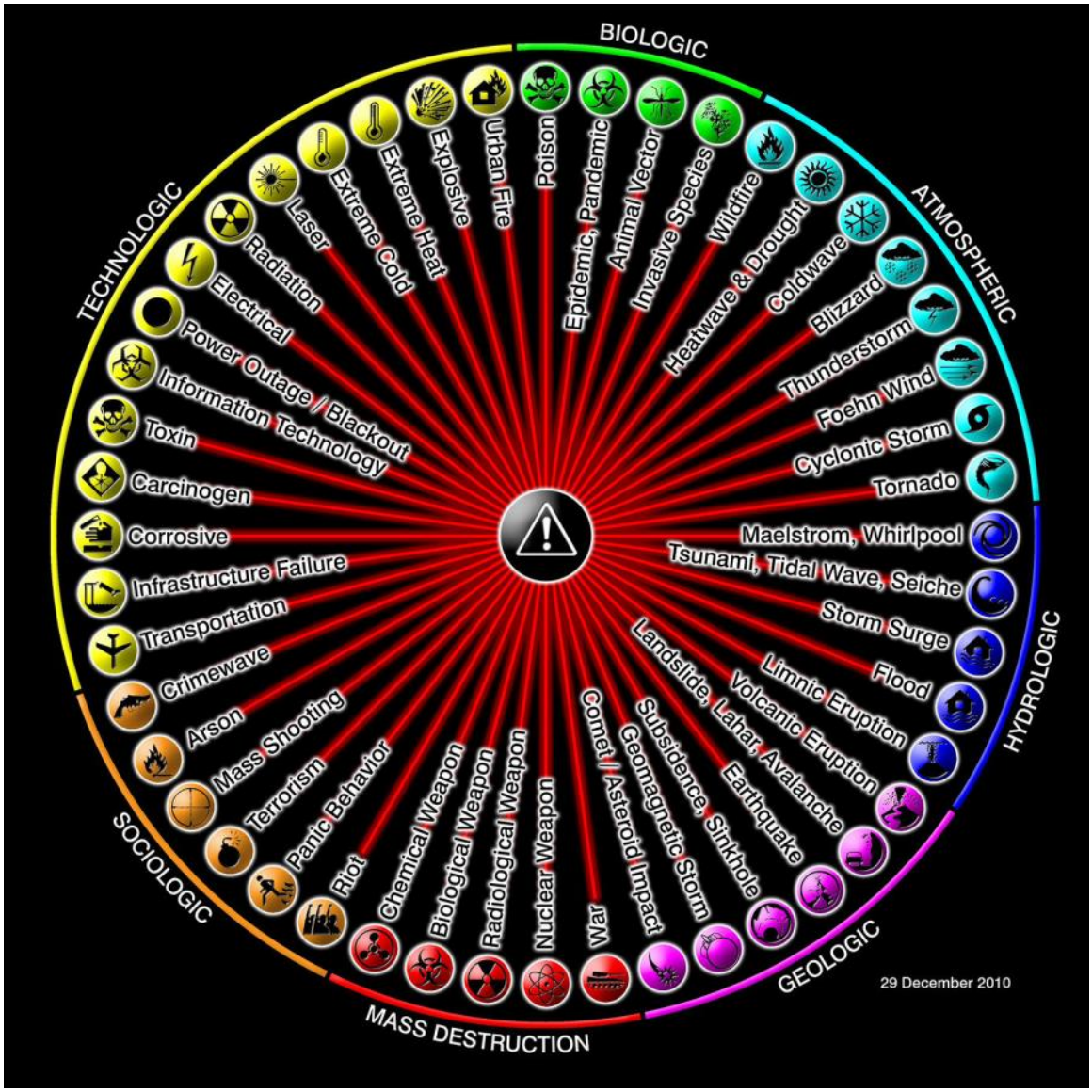
3. Emergency Scenarios



Hazard Typology

Global population growth and climate change are creating more frequent and severe natural, sociological, and technological disasters. The Hazard Typology infographic shows a comprehensive spectrum of disasters. This study focuses on the main types of natural disasters.

Natural Disasters

Earthquakes: Occur mainly in the western United States, especially California, but can happen anywhere.
Floods: The most common natural disaster, affecting every region and state.
Heatwaves: Extreme heat events can be particularly dangerous for vulnerable populations.

3. Emergency Scenarios

Hurricanes: These powerful tropical storms can cause widespread devastation along coastlines and several hundred miles inland.
Tornadoes: The U.S. experiences more tornadoes than any other country, especially in the Midwest and Southeast.
Wildfires: Especially prevalent in the western U.S., these can be very destructive.
Winter Storms and Extreme Cold: Can lead to hypothermia, frostbite, and damage to property.
[see Section 6. Emergency Kits]

There are UAS applications to respond to all of these including drone delivery of emergency kits. Drone delivery of emergency kits is beneficial for scenarios with the following characteristics:

Access to Inaccessible Areas: Drones can reach areas that are otherwise inaccessible due to debris, flooding, or damaged infrastructure. This capability is crucial in natural disasters like earthquakes, where traditional rescue vehicles might not be able to navigate.

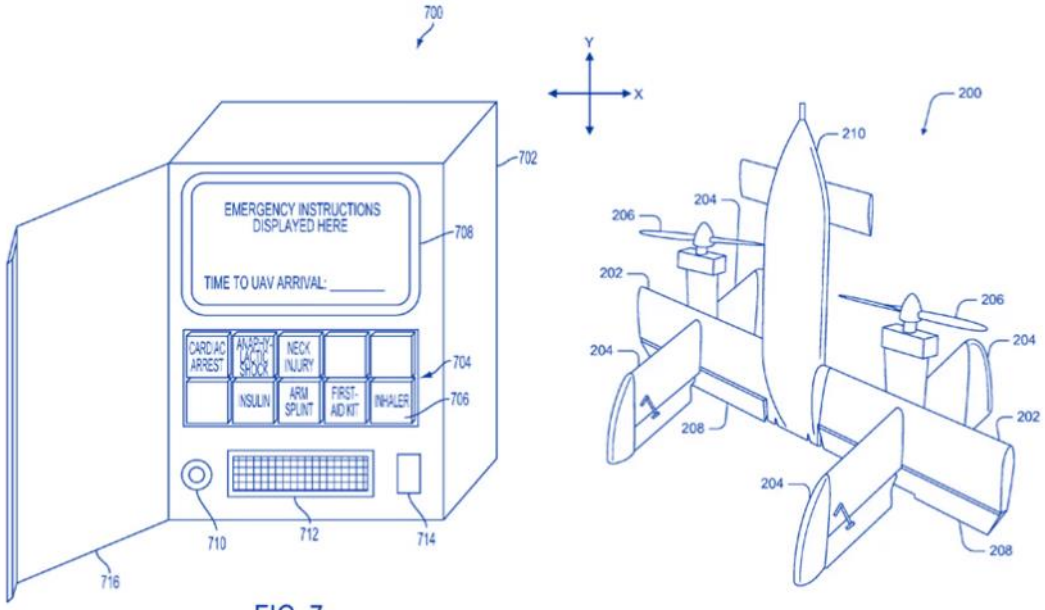


FIG. 7

Speed of Delivery: Drones can quickly deliver emergency kits to disaster-stricken areas, significantly reducing the time it takes to get essential supplies to those in need. This speed can be critical in life-and-death situations. This not only applies to disaster sites, but urban areas with high traffic congestion and remote or inaccessible areas. Google has patented a “drone calling station” for these situations. “The drone-calling station could connect to the drones and a dispatch network using a variety of means, from telephone networks, cellular, wireless, fiber, or other data networks. The system, as patented, sounds like it puts a lot of autonomy in the drone, to fly and find the station, and having fixed, known

3. Emergency Scenarios

locations could help with this. Google's patent includes a few models of drone, from toy airplanes to quadcopters to something that looks a lot like Google's own Project Wing delivery drone design." (Atherton, 2016) This concept has not yet been developed.

Reduced Risk for Rescue Personnel: Delivering supplies via drones minimizes the risk to rescue workers, who might otherwise have to navigate dangerous or unstable conditions. This ensures that more resources can be dedicated to direct rescue efforts rather than logistics.

Efficient Resource Allocation: Drones can carry supplies directly to those who need them most, potentially equipped with cameras and sensors to assess the situation and determine the most critical areas of need.

Cost-Effective: Using drones can be more cost-effective than traditional delivery methods, especially in situations where roads are impassable and helicopters or other aircraft would be the only alternatives.

Flexibility and Scalability: Drones can be deployed in various numbers depending on the scale of the disaster and the needs of the affected area. This scalability allows for tailored responses to different situations.

Real-Time Monitoring and Assessment: Equipped with cameras and sensors, drones can provide real-time information about the disaster area, helping coordinators make informed decisions about rescue operations and resource allocation.

Night-time Operations: Drones can operate at night, providing continuous assistance, which is particularly important in the immediate aftermath of a disaster when every hour counts.

Reduced Contamination Risk: In situations involving hazardous materials or contamination, drones can deliver supplies without risking human exposure.

Versatility: Drones can be equipped to carry various types of emergency supplies, from medical kits to food and water, and even communication devices.

In summary, drone delivery of emergency kits combines speed, safety, and efficiency, making it an increasingly valuable tool in disaster response and humanitarian aid.

4. UAV Delivery Systems

Delivery Drones

A delivery drone is an uncrewed aerial vehicle (UAV) used to transport packages that include medical supplies, food, or other goods. Due to their potential to save lives, medical supplies are now the most extensively tested application for drone delivery. This technology has been trialed in numerous countries, including Australia, Canada, Botswana, Ghana, Uganda, the United Kingdom, and the United States, among others.

The illustrations above and the following table show some of the most prevalent commercial delivery uncrewed aircraft systems. Commercial delivery operations require FAA Part 135 Air Carrier and Operator Certification. These operators are currently undergoing trials to obtain "beyond visual line-of-sight operations" (BVLOS) approval for expanded commercial service. When BVLOS

4. UAV Delivery Systems

Delivery Drones

Manufacturer	Name	Type	Delivery System	Payload
Wing Aviation[1]	Hummingbird	Multi-rotor fixed wing hybrid	Cable	2.6 lbs 1180 gm
Amazon Prime	MK30	Hexacopter hybrid	Low-altitude airdrop	5 lbs 2270 gm
DJI	Matrice 600 w/ drop box	Hexacopter	Land and release	11 lbs 5000 gm
DroneUp[2]	DJI Inspire 2	Quadcopter	Tether drop mechanism	1.3 lbs 580 gm
Flirtey	3.0	Hexacopter	Cable	10 lbs 4500 gm
UPS Flight Forward	Matternet M2	Quadcopter	Station platform	4.4 lbs 2000 gm
Flytrex	Mule	Hexacopter	Cable	6.5 lbs 2900 gm
Swoop Aero	Kookaburra	Multi-rotor fixed wing hybrid	Land and retrieve	6.6 lbs 3000 gm
Zipline[2]	Platform 2 (P2)	Multi-rotor fixed wing hybrid	Cable “droid” or parachute	8 lbs 3600 gm

1. Alphabet (Google parent company)
2. Partnering with Walmart

operations become standardized, emergency deliveries may be easily integrated into commercial networks and the National Airspace System. Until that time, small UAS visual line-of-sight deliveries may be coordinated by FEMA or expedited via the FAA Special Government Interest (SGI) process depending on the type of emergency. All small UAS operations must follow CFR 14, Part 107 which limits total weight of the UAV and payload to less than 55 lbs [25 kg].

Many commercial UAVs can be easily adapted for payload delivery if their power and airframes can handle additional weight. Primary considerations for selecting emergency delivery drones are payload capacity, weather durability, delivery precision, flight time and distance.

5. Emergency Kits

American Red Cross Emergency Kit

The American Red Cross, Federal Emergency Management Agency, and many other organizations have identified key items for inclusion in emergency, disaster, and survival kits. [see Appendices] The following is a an alphabetized composite list of high-priority items suitable for aerial delivery:

Basic Kit

☐ **Batteries / Portable Power Bank**	**200 gm**
☐ **Cell phone / 2-way radio / satellite messenger**	**200 gm**
☐ **Fire starter kit / waterproof matches**	**50 gm**
☐ **First aid kit & personal medications**	**200 gm**
☐ **Flashlight / headlamp / light sticks**	**100 gm**
☐ **Compass & Local maps**	**80 gm**
☐ **Multi-tool**	**350 gm**
☐ **Mylar blanket**	**100 gm**
☐ **NOAA radio**	**500 gm**
☐ **Whistle**	**20 gm**
Target weight 1800 grams [4 pounds]	**1800 gm**

These items ensure immediate minor medical treatment, weather protection, and emergency communications. If rescue and extraction are delayed, additional

5. Emergency Kits

aerial deliveries can include more items for addressing physical/psychological needs and comfort. There are many UAVs that can deliver a 4-pound payload that will accommodate all of the Basic Kit items. Smaller UAVs must prioritize items and/or make multiple deliveries. The most critical item is a communications device. Smart phones are the most ideal, but may not have reliable coverage in disaster-affected or remote sites. Two-way radios or walkie-talkies are ideal for coordinating with first responders. Satellite messengers are appropriate for very remote sites. These items weigh approximately 200 gm each and can be delivered by most commercial drones with an attached payload device. Emergency kit weights are approximate and derived from actual emergency supplies identified in the online UAS Emergency Kit Design database.

Additional Supplies

- ☐ Automated External Defibrillator (AED)
- ☐ Cord / paracord / nylon rope
- ☐ Dust mask (to help filter contaminated air)
- ☐ Feminine supplies
- ☐ Fire extinguisher
- ☐ Flotation device
- ☐ **Food** (high-calorie food bars / chocolate)
- ☐ Hygiene kit
- ☐ Infant formula, bottles
- ☐ Light sticks
- ☐ Mess kits (cups, plates, paper towels and plastic utensils)
- ☐ Moist towelettes, garbage bags and plastic ties (for personal sanitation)
- ☐ Non-prescription medications (pain relievers, anti-diarrhea medication, antacids or laxatives)
- ☐ Paper and pencil
- ☐ Pet food
- ☐ Plastic sheeting and duct tape (to shelter in place)
- ☐ Prescription eyeglasses
- ☐ Prescription medications
- ☐ Rain poncho
- ☐ Safety goggles
- ☐ Satellite communicator
- ☐ Soap, hand sanitizer and disinfecting wipes
- ☐ Tent
- ☐ **Water** (pouches, filtration devices, purification tablets)
- ☐ Work gloves

Container

The emergency kit container is dependent on the UAS delivery, kit contents, and weather conditions. The types of containers include ABS (durable plastic) hard cases/crates, aluminum cases, buckets, cardboard boxes, light alloy cooking pots,

5. Emergency Kits

material/plastic bags, and zippered soft packs. For low-altitude airdrops and parachute deliveries, padded packaging is necessary to prevent damage to communications equipment, fragile medical items, and flashlights. Pre-packed containers specific to UAV delivery specs save valuable time and energy.

Loading and Performance

As noted, uncrewed aerial vehicles (UAVs) have limited payload capacities and specific delivery systems. Payloads also impact UAV flight performance and duration. It is essential that the kit is configured to balance the load on the UAV and not interfere with the camera gimbal and landing gear. When operating in high density altitude, it is essential that the remote pilot be aware of the aircraft's reduced performance and susceptibility to vortex ring state.

The Basic Kit requires a single 4-pound or two 2-pound payload deliveries. In situations where maximum flight time is required and/or the UAV payload is limited to 1 pound, the kit will need to be modified as required for the most critical needs, e.g. a first aid kit.

Kits can be tailored to specific emergency applications. *The following are some cases that highlight the versatility of kit design and are only for reference.* Detailed information is in the UAS Emergency Kit Design database.

Cold Wave/Blizzard Kit

- ☐ **Container**: ABS hard case. In this situation, a container that is resistant to water is necessary to survive snow, ice, and freezing temperatures. While aluminum is the best at withstanding cold temperatures, becoming stronger as the temperature drops, it is a thermal conductor which makes it very cold to the touch. This would make it difficult for people to open an aluminum case during a cold wave. Because of this, the ideal container for cold waves would be a plastic case. Although it doesn't withstand temperatures as well as aluminum, plastic acts as an insulator.
- ☐ **Basic Kit**
- ☐ **Food and Water**: Food bars and water pouches.
- ☐ **Tools and Safety Equipment**: Foldable shovel. Salt (calcium chloride for melting ice)
- ☐ **Protection and Health**: Blanket.
- ☐ **Delivery Method**: The ideal delivery method for a cold wave/blizzard would be parachutes. The parachute method, while less precise, has a minimized descent rate, helpful with winds, and is ideal for longer range deliveries. (Cornell et al., 2023). Unlike a fire which can sometimes be mitigated, blizzards are unavoidable. Therefore, strategies like landing and stationing would not offer additional benefit in these situations.

The weight of the full cold wave/blizzard kit is under 7 lbs which can be reduced to less than 4 lbs without the salt, foldable shovel, food, and water pouches.

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Earthquake Kit

In post-earthquake conditions, individuals may be trapped in areas inaccessible to rescuers due to debris and other obstacles. The key features of this emergency kit include:

- ☐ **Container**: The kit is housed in a 5-gallon bucket, which can also serve as a makeshift bathroom. Hazard waste bags are included for sanitation.
- ☐ **Basic Kit**
- ☐ **Food and Water**: Food bars, protein powder, and water bags.
- ☐ **Hygiene and Comfort**: Wet wipes are included for cleaning and comfort. Plastic sheeting for shelter or a clean resting surface.
- ☐ **Tools and Safety Equipment**: Hatchet, shaded safety goggles, nylon rope, work gloves, tarp/poncho, and duct tape.
- ☐ **Mobility**: Small duffle bag is included to maintain mobility.
- ☐ **Delivery Method**: The entire kit, weighing less than 20 lbs, is designed to be delivered via parachute from a heavy-lift drone, allowing rescue crews to distribute these kits from a safe distance and potentially save more lives.

This practical and versatile kit provides essential supplies and tools for survival in post-earthquake scenarios, enhancing the chances of being located and surviving until help arrives.

Flood Kit

In flood disasters, individuals may be isolated by flooding of roads and bridge failures. Key emergency kit features include:

- ☐ **Container**: Hard case with padding for fragile items or cardboard box for mass deliveries.
- ☐ **Basic Kit**
- ☐ **Food and Water**: Food/chocolate bars and a water purification device (straw filter or water filtration bags).
- ☐ **Tools and Safety Equipment**: Throw bag with nylon rope.
- ☐ **Delivery Method**: The entire kit, weighing less than 6 lbs, is designed for cable or low altitude drop.

Hurricane Kit

This kit is tailored to hurricane survivors who may be stranded until rescue teams can negotiate flooding, debris, and road damage.

- ☐ **Container**: Hard case or crate with padding for fragile items.
- ☐ **Basic Kit**
- ☐ **Food and Water**: Food bars and a water purification device (straw filter).
- ☐ **Communication and Navigation**: Water-activated strobe light.
- ☐ **Protection and Health**: Compact emergency float device. Waterproof document pouch for personal items.
- ☐ **Delivery Method**: The entire kit, weighing approximately 6 lbs, is designed for cable, low altitude drop, or parachute delivery.

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Survival Kit

This kit provides essential items for individuals such as hikers or climbers who are stranded due to terrain or other hazards.

- ☐ **Container**: The kit is housed in an 8L pot with an attached lid, which doubles as a cooking and water container.
- ☐ **Basic Kit**
- ☐ **Food and Water**: Water pouches and food bars.
- ☐ **Communication and Navigation**: Handheld GPS and local maps for self-extraction.
- ☐ **Tools and Safety Equipment**: Hatchet for chopping wood and protection, plastic sheeting and duct tape for shelter building. Nylon rope. Knife. Mess kit.
- ☐ **Protection and Health**: Bug spray and/or bear spray.
- ☐ **Comfort Items**: Two pairs of socks for mental health and comfort.
- ☐ **Delivery Method**: The entire kit, weighing approximately 12 lbs, is designed for parachute drop, suitable for delivery via a heavy-lift drone equipped to carry large payloads.

This survival kit provides essential tools, sustenance, and protection elements to sustain health, comfort, and safety until rescue in a wilderness survival scenario.

Tornado Kit

This kit includes items specific to post-tornado victim needs.

- ☐ **Container**: The kit is contained in a zippered soft pack.
- ☐ **Basic Kit**
- ☐ **Tools and Safety Equipment**: Compact crowbar. Foldable shovel. Light-weight stretcher.
- ☐ **Delivery Method**: The entire kit, weighing approximately 7 lbs, is designed for any type of delivery system.

This kit provides several items specific to tornado victims for debris removal and survivor extraction.

Wildfire Kit

This kit provides essentials for individuals who are isolated due to existing wildfires and/or wildfire damage to transportation and communications infrastructure.

- ☐ **Container**: Aluminum containers would be unsuitable for fires because despite its fire resistance, it retains heat. Plastic would also be unsuitable as it has the potential to melt. Ideally, this kit would be delivered in a bag made of a fire-resistant fabric such as wool or leather as natural fibers are less flammable than synthetic fibers. (WFCA, 2023) Some additional options would be nylon and polyester due to their high melting points and low thermal conductivity. (Mills, 2021) Alternatively, the fabric could be treated with a flame-retardant coating.

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- ☐ **Basic Kit**
- ☐ **Tools and Safety Equipment**: Miniature fire extinguisher. Fire blanket. Smoke resistant goggles. Respirator with replaceable filters. Flame resistant gloves.
- ☐ **Protection and Health**: Burn treatment manual and burn dressing cooling gel. Water purifier bag.
- ☐ **Delivery Method**: The entire kit is designed for any type of delivery system. The ideal delivery method during a fire would be a station. Fires would require extreme precision to ensure the drone does not come in contact with the flames. Therefore, landing at a docking station would be the safest option. (Cornell et al., 2023)

This emergency kit includes items specific to wildfire victims who will receive emergency treatment and evacuation within a relatively short period of time. Therefore this kit does not include food in order to conserve delivery weight and accommodate a miniature fire extinguisher and personal protective equipment (PPE). The weight for the total Wildfire Kit is under 7 lbs.

Telemedicine Kits and Ambulance Drones

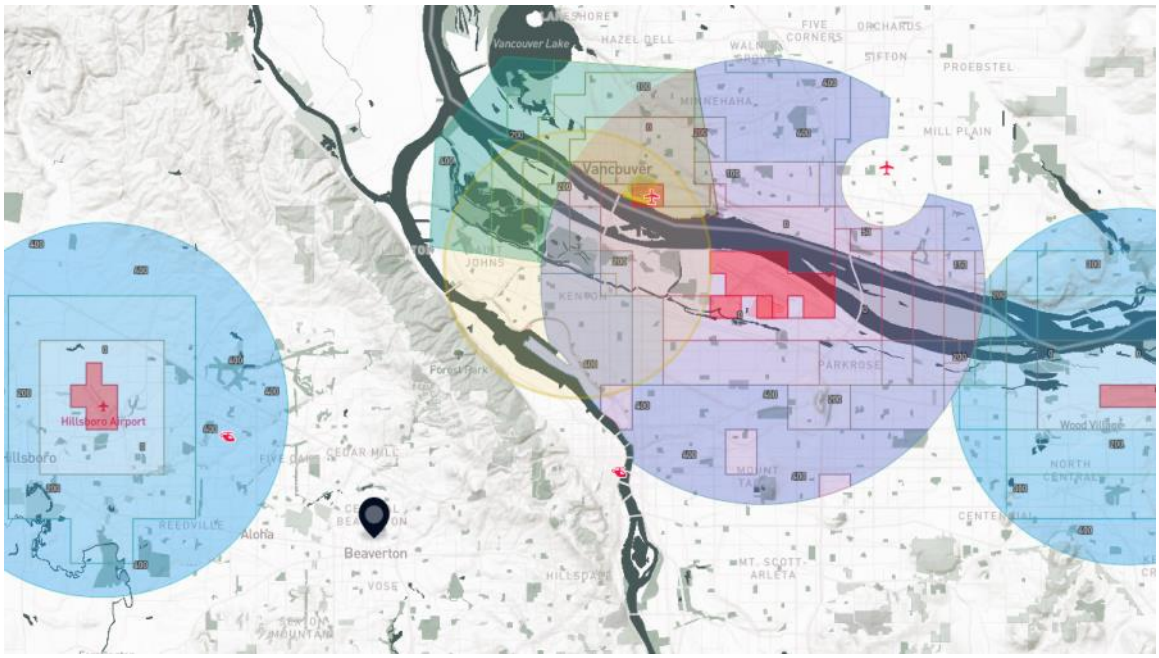
Advances in augmented reality glasses (e.g. Ray-Ban Meta Smart Glasses), artificial intelligence, and communications have enabled the development of telemedicine applications for UAS. A leader in UAS telemedicine is the William Carey University HiRO which stands for Healthcare Integrated Rescue Operations. This “ambulance drone” is capable of flying into disasters, delivering customized medical kits, and enabling doctors to direct emergency treatment through a live communication interface. Several organizations are developing UAS specifically designed as automated external defibrillators (AEDs). The TU Delft Ambulance Drone has a built-in AED and incorporates a two-way, video supported, communication channel in the drone between operators and the first responders. Successful AED usage by lay-persons is currently at 20%. With personalized instructions and communication on the Ambulance Drone, this can be increased to 90%. In short, the Ambulance Drone helps to save lives by extending existing emergency infrastructure with a network of fast and compact UAVs capable of bringing emergency supplies and establishing communication, anywhere. (TU Delft)

5. Emergency Kits

Conclusion

These examples illustrate various approaches to emergency kit containers, contents, and drone delivery systems. The kits should have a modular design that allows for customized contents, and be flexible in terms of container design and delivery system. Future kits may become more integrated with emergency operations and medical personnel via augmented reality, telecommunications, and artificial intelligence.

6. Operational Considerations



Air Aloft Map (NW Oregon)

Deploying drones for the delivery of emergency kits involves several strategic considerations to ensure effectiveness, safety, and efficiency. Training plays a critical role in this process. Here's an outline of strategies for deploying drones with emergency kits:

Pre-Deployment Planning

Area Assessment: Before deploying drones, it's crucial to assess the area's geography, climate, and potential hazards. This helps in planning flight paths and identifying suitable drop-off points.

Kit Customization: Customize the emergency kits based on the specific needs of the disaster-affected area. For floods, include water purification tools; for earthquakes, add tools to navigate debris.

Legal Compliance: Ensure compliance with local and national aviation regulations, and coordinate with authorities to avoid airspace conflicts.

Drone Selection and Equipment

Drone Capabilities: Choose drones based on payload capacity, flight range, and durability in various weather conditions.

Kit Attachment and Release Mechanisms: Equip drones with reliable mechanisms for carrying and releasing emergency kits safely and accurately.

Operator Training

Technical Skills: Train operators in drone navigation, payload management, and

6. Operational Considerations

emergency procedures. Emphasize hands-on experience with the specific drone models used.
Scenario-Based Training: Conduct simulations of different disaster scenarios to prepare operators for real-world challenges.
Safety Protocols: Train operators in safety protocols to minimize risks to themselves, the public, and the equipment.

Communication and Coordination

Coordination with Authorities: Establish clear communication channels with local emergency services, law enforcement, and other relevant agencies such as FEMA.
Real-Time Information Sharing: Train operators to share and receive real-time information about changing conditions in the disaster area.

Maintenance and Readiness

Regular Maintenance: Ensure drones and emergency kits are regularly checked and maintained.
Rapid Deployment Readiness: Keep drones in a state of readiness for immediate deployment in emergencies.

Post-Deployment Analysis

Feedback and Debriefing: After each deployment, gather feedback from operators and ground teams to identify areas for improvement.
Data Analysis: Analyze flight data and operational outcomes to refine strategies and training programs.

The successful deployment of drones for emergency kit deliveries hinges on meticulous planning, suitable drone selection, comprehensive operator training, and effective coordination with relevant authorities. Training is the backbone of this process, ensuring that drone operations are safe, efficient, and adaptable to the unique challenges of different disaster scenarios.

7. Recommendations

DJI Matrice 600

DJI Matrice 600 Pro Drone with Emergency Delivery Drop Box

Implementing drone-delivered emergency kits, while innovative and beneficial, comes with several challenges. Addressing these effectively is crucial for the success and reliability of the system. Here are some potential challenges and recommendations for overcoming them:

Regulatory Compliance

Challenge: Navigating complex aviation regulations and securing the necessary permissions for drone operations can be challenging, especially in different jurisdictions. *The most critical regulatory challenge is obtaining beyond visual line-of-sight (BVLOS) authorization*.

The American Security Drone Act Prohibits federal departments and agencies from operating or procuring any covered unmanned aircraft system manufactured or assembled by covered foreign entities, including PRC-based [Chinese] drone manufacturers. The Chinese firm DJI is the largest manufacturer of drones, and proposed legislation would ban these and many others.

Recommendation: Collaborate with legal experts to understand and adhere to local and international aviation laws. Establish partnerships with government agencies to facilitate quicker approvals and compliance.

Small UAS must be operated in accordance with Federal Aviation Administration (FAA) regulations and statutory requirements. Comprehensive sUAS guidance is

7. Recommendations

available on the FAA's website at https://www.faa.gov/uas/. Non-prohibited UAVs and UAVs without prohibited components must be used for federal projects and programs. Alternative aircraft should also be given consideration pending adoption of more comprehensive legislation. The Blue UAS Cleared List has drones vetted by the Defense Innovation Unit.

Technical Limitations

Challenge: Limitations in drone technology, such as limited battery life, payload capacity, and range, can restrict the effectiveness of delivery operations.
Recommendation: Invest in research and development to enhance drone capabilities. Consider partnerships with technology companies specializing in drone innovations. Consider hydrogen-powered UAVs and/or larger platforms for increased flight duration and payload capability.

Weather and Environmental Factors

Challenge: Drones can be susceptible to adverse weather conditions, which may impede their ability to deliver emergency kits reliably.
Recommendation: Use drones equipped to handle a range of weather conditions. Develop predictive models to plan missions around weather patterns and environmental factors.

Operator Training and Skill Levels

Challenge: Operating drones, especially in emergency scenarios, requires skilled personnel with specific training.
Recommendation: Implement comprehensive training programs for operators. Regularly update training modules to include the latest technologies and operational strategies.

Safety and Security Concerns

Challenge: Ensuring the safety of both the drone operations and the people in the disaster areas is critical. There is also a risk of drones being hijacked or tampered with.
Recommendation: Develop and enforce strict safety protocols. Use encrypted communication channels and advanced security features to safeguard drones against unauthorized access.

Coordination with Ground Teams

Challenge: Effective coordination between drone operators and ground rescue teams can be complex, especially in chaotic disaster environments. FEMA is currently reviewing UAS operations for disaster response as part of the Air Operations Branch.

7. Recommendations

Recommendation: Establish robust communication networks and protocols. Use real-time data sharing and GPS tracking to enhance coordination. For federal declared disasters, UAS operations must be coordinated with FEMA.

Public Perception and Privacy Concerns

Challenge: Drones can sometimes be perceived negatively by the public, and there are concerns about privacy invasion.
Recommendation: Conduct public awareness campaigns to educate about the benefits of drone-delivered emergency kits. Ensure compliance with privacy laws and be transparent about drone operations.

Scalability and Resource Allocation

Challenge: Scaling drone operations to match the scope of large-scale disasters can be resource-intensive.
Recommendation: Develop a scalable model that allows for rapid expansion of operations as needed. Secure funding and resources in advance for large-scale deployments.

Reliability and Maintenance

Challenge: Maintaining a fleet of drones in operational condition and ensuring their reliability can be demanding.
Recommendation: Implement a rigorous maintenance schedule. Use predictive maintenance techniques to preemptively address potential issues.

Overcoming these challenges requires a multi-faceted approach, involving technological innovation, strategic planning, regulatory compliance, and continuous improvement. By addressing these issues proactively, the system of drone-delivered emergency kits can become a more effective, reliable, and integral part of disaster response and emergency management.

8. Conclusions

Concept UAV with Emergency Kit

In summary, the use of drones for emergency kit delivery presents a promising avenue in disaster response, offering rapid, safe, and efficient aid to affected areas. However, realizing this potential requires addressing technical, regulatory, and operational challenges through continuous innovation, strategic planning, and stakeholder collaboration. With the right approach, UAS can significantly enhance emergency response capabilities, ultimately saving lives, and improving outcomes in disaster-stricken areas.

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Appendices

Everdrone Emergency Medical Aerial Delivery (EMADE)

Swoop Aero Kookaburra

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First Aid Kit

American Red Cross
Recommended First Aid Kit for Family of Four

- ☐ 2 absorbent compress dressings (5 x 9 inches)
- ☐ 25 adhesive bandages (assorted sizes)
- ☐ 1 adhesive cloth tape (10 yards x 1 inch)
- ☐ 5 antibiotic ointment packets (approximately 1 gram)
- ☐ 5 antiseptic wipe packets
- ☐ 2 packets of aspirin (81 mg each)
- ☐ 1 emergency blanket
- ☐ 1 breathing barrier (with one-way valve)
- ☐ 1 instant cold compress
- ☐ 2 pair of nonlatex gloves (size: large)
- ☐ 2 hydrocortisone ointment packets (approximately 1 gram each)
- ☐ 1 3 in. gauze roll (roller) bandage
- ☐ 1 roller bandage (4 inches wide)
- ☐ 5 3 in. x 3 in. sterile gauze pads
- ☐ 5 sterile gauze pads (4 x 4 inches)
- ☐ Oral thermometer (non-mercury/nonglass)
- ☐ 2 triangular bandages
- ☐ Tweezers
- ☐ Emergency First Aid instructions

Make a First Aid Kit https://www.redcross.org/get-help/how-to-prepare-for-emergencies/anatomy-of-a-first-aid-kit.html

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Survival Kit

American Red Cross Recommended Survival Kit

- ☐ Water: one gallon per person, per day (3-day supply for evacuation, 2-week for home)
- ☐ Food: non-perishable, easy-to-prepare items (3-day supply for evacuation, 2-week supply for home)
- ☐ Flashlight
- ☐ Battery-powered or hand-crank radio (NOAA Weather Radio, if possible)
- ☐ Extra batteries
- ☐ First aid kit
- ☐ Medications (7-day supply) and medical items
- ☐ Multi-purpose tool
- ☐ Sanitation and personal hygiene items
- ☐ Copies of personal documents (medication list and pertinent medical information, proof of address, deed/lease to home, passports, birth certificates, insurance policies)
- ☐ Cell phone with chargers
- ☐ Family and emergency contact information
- ☐ Extra cash
- ☐ Emergency blanket
- ☐ Map(s) of the area

Consider the needs of all family members and add supplies to your kit:

- ☐ Medical supplies (hearing aids, extra batteries, glasses, contact lenses, syringes, etc)
- ☐ Baby supplies (bottles, formula, baby food, diapers)
- ☐ Games and activities for children
- ☐ Pet supplies (collar, leash, ID, food, carrier, bowl)
- ☐ Two-way radios
- ☐ Extra set of car keys and house keys
- ☐ Manual can opener

Additional supplies to keep at home or in your survival kit based on the types of disasters common to your area:

- ☐ Whistle
- ☐ N95 or surgical masks
- ☐ Matches
- ☐ Rain gear
- ☐ Towels
- ☐ Work gloves
- ☐ Tools/supplies for securing your home
- ☐ Extra clothing, hat and sturdy shoes
- ☐ Plastic sheeting
- ☐ Duct tape
- ☐ Scissors
- ☐ Household liquid bleach
- ☐ Entertainment items
- ☐ Blankets or sleeping bags

Survival Kit Supplies https://www.redcross.org/get-help/how-to-prepare-for-emergencies/survival-kit-supplies.html

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Emergency Kit

FEMA Disaster/Emergency Supplies Kit

Basic Disaster Supplies Kit

A basic emergency supply kit could include the following recommended items:

- ☐ Water (one gallon per person per day for several days, for drinking and sanitation)
- ☐ Food (at least a several-day supply of non-perishable food)
- ☐ Battery-powered or hand-crank radio and a NOAA Weather Radio with tone alert
- ☐ Flashlight
- ☐ First aid kit
- ☐ Extra batteries
- ☐ Whistle (to signal for help)
- ☐ Dust mask (to help filter contaminated air)
- ☐ Plastic sheeting and duct tape (to shelter in place)
- ☐ Moist towelettes, garbage bags and plastic ties (for personal sanitation)
- ☐ Wrench or pliers (to turn off utilities)
- ☐ Manual can opener (for food)
- ☐ Local maps
- ☐ Cell phone with chargers and a backup battery

Additional Emergency Supplies

- ☐ Soap, hand sanitizer and disinfecting wipes to disinfect surfaces
- ☐ Prescriptions medications
- ☐ Non-prescription medications such as pain relievers, anti-diarrhea medication, antacids or laxatives
- ☐ Prescription eyeglasses and contact lens solution
- ☐ Infant formula, bottles, diapers, wipes and diaper rash cream
- ☐ Pet food and extra water for your pet
- ☐ Cash or traveler's checks
- ☐ Important family documents such as copies of insurance policies, identification and bank account records saved electronically or in a waterproof, portable container
- ☐ Sleeping bag or warm blanket for each person
- ☐ Complete change of clothing appropriate for your climate and sturdy shoes
- ☐ Fire extinguisher
- ☐ Matches in a waterproof container
- ☐ Feminine supplies and personal hygiene items
- ☐ Mess kits, paper cups, plates, paper towels and plastic utensils
- ☐ Paper and pencil
- ☐ Books, games, puzzles or other activities for children

Build a Kit https://www.ready.gov/kit

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UNICEF First Aid Kit

UNICEF First Aid Kit Class A

☐	1	S0516110	First Aid bag, UNICEF, blue, 410x280x170mm
☐	1	S0969025	Gloves, exam, nitrile, pwdfree, M, BOX-100
☐	1	S0523050	Compress, paraffin, 10x10cm, ster/BOX-10
☐	1	S0523015	Compress, gauze, 10x10cm, n/ster/PAC-100
☐	1	S0503020	Medical tape, perforated, 10cmx5m,roll
☐	1	S1531510	Chlorhexidine conc. sol. 5%/BOT-100ml
☐	1	S1533010	Ibuprofen 200mg tabs/PAC 10x10
☐	2	S0503015	Medical tape, 2.5cmx5m,roll
☐	2	S0512015	Bandage, elastic, 7.5cmx5m, roll
☐	10	S0512025	Bandage, gauze, 8cmx4m, roll
☐	1	S0572510	Blanket, survival, 220x140cm
☐	1	S0552000	Soap, toilet, bar, approx.100-110g, wrapped
☐	10	S0523055	Compress, gauze, 10x10cm, ster/PAC-5
☐	1	S0721000	Forceps, dressing, standard, 155mm, str
☐	1	S0773500	Scissors, Deaver, 140mm, str, s/b
☐	1	S0539000	Pin, safety, medium size/PAC-12
☐	5	S0746510	Scalpel blade, ster, disp, no.22
☐	1	S0726000	Forceps, artery, Kocher,140mm,str
☐	1	S1551981	Gentamicin 0.3% eye/ear drops/BOT-10ml

Total weight: 3.161 kg
Total volume: 0.034 m3

First Aid Kit Class A https://supply.unicef.org/s9975020.html

Visual Checklist

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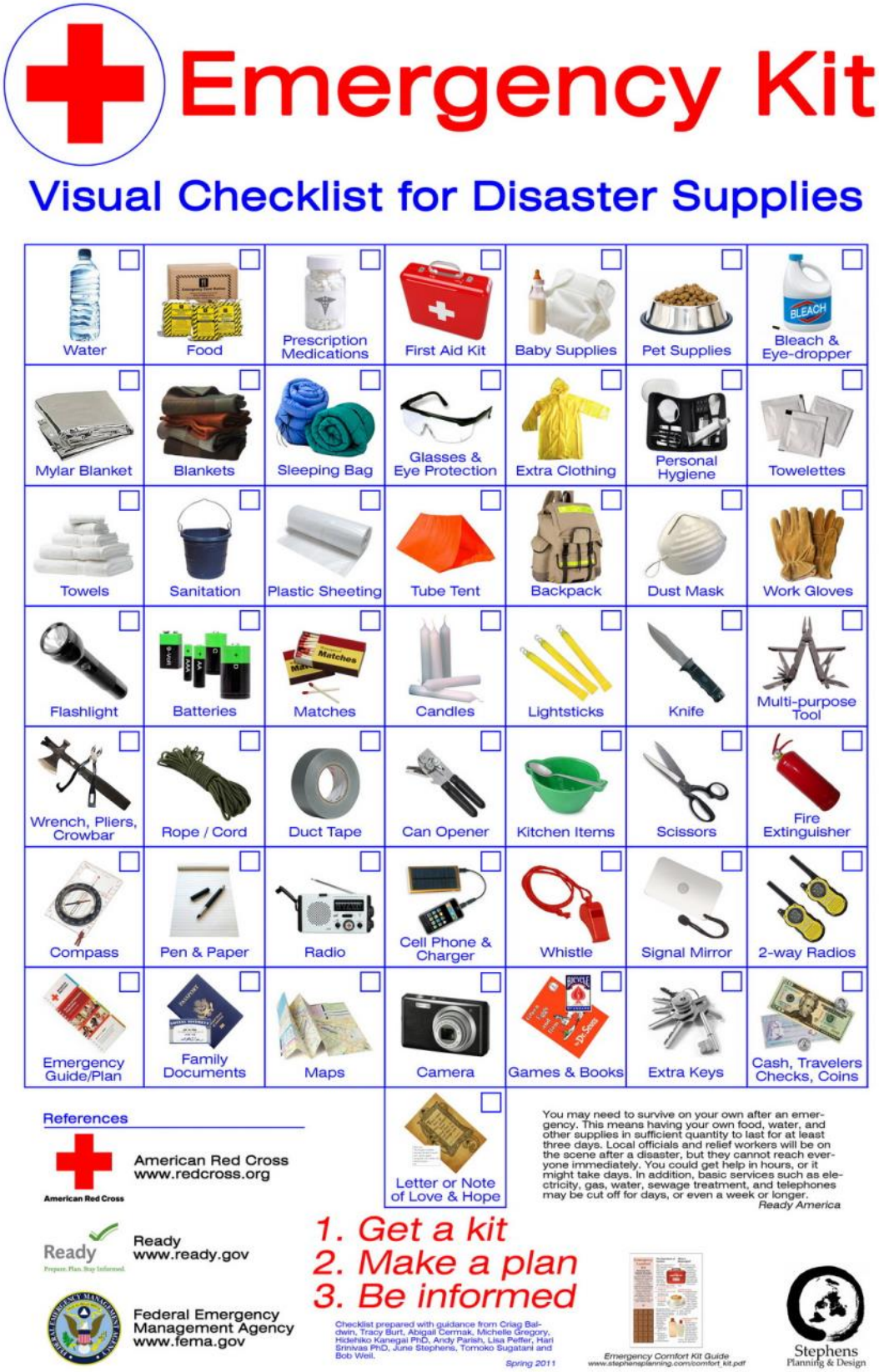

WFCA Fire Emergency Kit

Western Fire Chiefs Association
Fire Emergency Kit Essentials

- ☐ First aid kit
- ☐ Medications
- ☐ Water (in bottles or gallon jugs)
- ☐ Food (non-perishable in cans or pouches)
- ☐ Can opener
- ☐ One or two spare outfits that you can fold or roll to take up less room in your bag
- ☐ Wet wipes and plastic sacks (for keeping clean and sanitizing)
- ☐ Headlamp (for seeing through smoke or darkness)
- ☐ Battery-powered or hand crank radio (to keep track of the location of the fire and to monitor alerts)
- ☐ Backup batteries (for charging cellphones and radios)
- ☐ Foldable plastic sheets and duct tape (to make a temporary shelter)
- ☐ Whistle (to sound for help in case of injury or to help firefighters find your location)
- ☐ Dust mask (to protect your mouth, nose, and throat from dust and particulates from the fire)
- ☐ Local maps

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WHO Emergency Kits

World Health Organization Emergency Health Kits (EHKs)

WHO has developed standardized health kits of medicines and medical supplies to meet different health needs in humanitarian emergencies and disasters.

These kits are developed to provide reliable and affordable medicines and supplies quickly to those in need. The kits are used by United Nations agencies, nongovernmental organizations and national governments.

Based primarily on WHO's Essential Medicines list and guidelines on treatment of specific medical conditions, the contents of the kits are frequently reviewed and updated to adapt to changing needs based on experience in emergency situations.

A certain number of kits are prepositioned in strategic locations to be mobilized quickly in times of need. Long term agreements with suppliers are also in place to ensure rapid shipment wherever needed.

- ☐ Cholera Kit 2020
- ☐ Collection, Testing and Transfusion Kit (CTT) 2021
- ☐ Interagency Emergency Health Kit (IEHK) 2017
- ☐ Major Trauma Backpack 2021
- ☐ Measles Kit 2021
- ☐ Non Communicable Diseases Kit (NCDK) 2022
- ☐ Paediatric Kit (PED/SAM) Sick Children Kit 2020
- ☐ Pneumonia Kit 2020
- ☐ Sample Collection Kit (SCK) 2022
- ☐ Trauma and Emergency Survery Kit (TESK) 2019

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