Errata

1. There are 4 workers
2. There are between 5 and 15 victims but the number of victims is not known at the start of the game. Each room will have 0,1, or 2 victims.
3. There are no more than 3 hazards per room
4. In a room the hazards will be unique (i.e. there will never be a room with 2 Fires)
5. Design should focus on UI/UX, interaction, communication, and decision support
6. Exposure is a measure of incurred risk and will count against the final score. The quantitative score will take the form of
   $s = a_1 \cdot (\#\ victims\ rescued) - a_2 \sum_{v \in victims} E(v) - a_3 \sum_{w \in Workers} E(w) + f(T, \hat{T})$
   Where $a_i \in \mathbb{R}$ are coefficients for the relative importance of the task, $E(x)$ is the amount of exposure received by individual x, and $f(p, q)$ is a function that takes into consideration how closely the triaged victim list q corresponds to the optimal list p
7. Exposure is cumulative for all hazards in a room. For example if a room has a Class I Fire and a Class II Smoke then anyone in that room will receive 3 Exposure per minute.

8. The DC will probably will not be able to interact with a touch screen without taking off their gloved. If your solution is “have them take off their gloves”, that is a solution. If you have a solution that doesn’t involve them taking off their gloves each time they interact with a touchscreen then we would like you to demonstrate that.
9. The ERep is an NFC reader. When a worker enters a room they scan their phone to tell the system they are in the room and then scan an action card to tell the system that they are performing that action. All of that is taken care of behind the scenes. Just some NFC tags.
10. The Icehouse code on the phone will run in the background. It is just there to provide a way for you to make API calls.
11. When a worker enters a room a message will be sent through the system with an ID for the room. This ID is unique, but will not be provided before hand.
12. The map will be printed on a sheet of paper.
13. All of the game state is tracked externally. You will have access to all of the message traffic generated by the system. This includes the messages generated when a worker scans into a room, when they start fighting a hazard and when a hazard is cleared.
14. The system will be set up to allow you to exchange messages over a Rabbit MQ backbone. If that is not sufficient then bring what you think you need.
15. You will have wireless access to the internet.
16. Workers cannot exchange items with their teammates

17. Heart rate information for the team should be available (at a minimum) to the medic.
18. Players do not regenerate. You need to decide what level of risk you are willing to take with a severely exposed worker.

Rules of the World of Icehouse

a Challenge Problem for the Body Sensor Networks Conference 2016

Introduction

The World of Icehouse

Icehouse is a live action role playing (or LARP) game that takes place in a world not too different from our own. In this world, however, you'll have to constantly be on your toes because danger waits around every corner.

The reason for Icehouse having such similarity to our world is because it once was part of it. However, due to an experiment gone awry a rift was created that sealed off the tiny part known as Icehouse. From that point on the two worlds had timelines that slowly diverged. The dangers that were trapped in Icehouse fed back on themselves becoming progressively more malignant. Trapped in this perilous alternate world were a couple of everyday humans. These valiant individuals fought against the evils of Icehouse, resulting in all of them becoming injured and incapacitated.

So far no method has been devised for rescuers to save the victims of Icehouse without becoming victims themselves.

That is where we are today. The people of this world have decided that a rescue effort must be undertaken. A select number of individuals specially trained in handling the hazards of Icehouse are being sent across the rift along with some tools that will help them. These tools have been designed to give our heroes the best chance to rescue the victims of Icehouse.

Consisting of just a handful of rooms, a simple shack serves as the beginning and the end of Icehouse. Because of how treacherous Icehouse has become the rift was sealed in such a manner that the danger could not escape. This means that a lot of effort has to go in to getting material things in and out. Electromagnetic waves, however, have no issue crossing the rift. This allows people in Icehouse to use this world's cellphone infrastructure and download apps.

For this rescue mission to work the people of this world will have to devise powerful methods to overcome the evil of Icehouse. The workers being sent across the rift will need to be equipped with the best sensing, communication and support technology to carry out the plan and retrieve the victims of Icehouse.

While Icehouse draws extensively on real world scenarios and concepts it is also a work of fantasy and should be taken as such. Just because some strategy might work in a real raid does not mean that it necessarily will work the same way in Icehouse. For this reason it is important that players read and understand the rules before embarking on their development process.

People of the World of Icehouse

There are two main roles in Icehouse: Developer and Worker. Developers are responsible for creating technology that assists the workers in doing their job. Workers are the people that interact with the scenario to rescue victims and remove hazards.

To be a successful developer requires that you understand all of the rules of the world of Icehouse. *Should a worker take the Medic skill and a First Aid Kit?* Unless you are familiar with all of the parts of the game you will be sending your work crew into near certain death. It is not expected that you will solve all of the problems that exist here on Icehouse (thousands before you have tried and failed) but rather that you will provide something new that will be passed down to your technological progeny in the quest to one day have a complete solution.

There is actually a third role in Icehouse, but it is totally different from the worker and developer roles: the Kuroko (or Ko for short). To keep up with the evolving environment of Icehouse there are people "behind the scenes" that will manipulate props and handle various effects. This group should be completely transparent to the workers and ignored. There will be several Ko present in any running of Icehouse, but one will be designated as the lead. The lead Ko is ultimately responsible for anything that happens in Icehouse and is the final say on any matter: rules, safety, or otherwise. It is important, however, that whenever any Ko tells a worker to do something the worker follows. This is for the safety of the entire crew: workers and Ko. For the most part, though, the Ko are simply the "spirits of the objects" that inhabit Icehouse.

Actions in Icehouse

Icehouse is a dangerous place!

Don't worry, though, because the danger is only simulated. That's where the role playing comes in. We wouldn't want our intrepid heroes to actually be harmed so all of the hazards have been replaced with physical and electronic representations.

"Wait! Did you say 'electronic representations?'" Ah, yes. That is what sets the world of Icehouse apart from more traditional LARPs. Whereas damage is typically doled out using foam weapons and recorded on a character sheet, in the world of Icehouse the damage is done by industrial hazards and recorded automatically by an app running on your cell phone.

Each room is equipped with a beacon that contains information about the hazards located there. These beacons are interconnected to relay information about the game state. When a player enters a room they will place their phone on the beacon (also called an ERep or

“electronic representation”). This tells the system that they are in the room and in turn will allow them to interact with hazards in the room.

Once a player scans into a room the screen attached to the ERep will display the types of hazards in the room and how far the team has come in combatting them. Each hazard has an associated Action card that is scanned when a player wants to interact with that hazard. Once this occurs the system will update to allow them to start making progress eliminating the danger. (Fighting hazards can be found in “The Game >> Progress” section)

The final component is the physical representation, or “PhysRep”. For example a minor Fire is represented by a tuft of red Mylar. If it grows into a major Fire the PhysRep will evolve into red pom-poms. The various PhysRep will be described later in the Hazards section. If a PhysRep is not present then the worker should not assume that there is no hazard. Some hazards are invisible, just as they would be in real life.

The safety of our players is important. To make Icehouse an enjoyable experience for all the PhysReps are all designed to not put the worker in any danger. They are just a signifier. Some may make the worker’s job harder but they will not harm them or place them in a situation that is likely to cause them harm. Being a good role player is an important part of Icehouse running smoothly.

Materials

This rulebook is the most important part of getting started in the world of Icehouse but it is not the only information that is available. It assumes that players are familiar with live action role playing. Workers need to be familiar with the concepts to allow them to best react to the situations presented and developers need to be aware of how the workers may react to instructions that they are sent though the technology.

Available on the website (in March) are various code snippets that show how to interact with the base technology. These are fully functional, though quite boring, code samples that will help you get started on developing the software and hardware that will save the victims of Icehouse.

It should also be noted that the rules are very much in Alpha development. If you feel as though the rules team has missed something or that there is a rule that needs clarified don’t hesitate to email amna@bsn.embs.org and someone will answer right away. In general, though, the spirit of the rules should be apparent and that is what matters. Remember, Icehouse is only a platform for exploring the potential of the technology. A creative development will be

rewarded even if it ultimately functions poorly within the rules as the rules team intended. Relax.

There will also be occasional posts to the website to provide clarification and update the rules if the rules team encounters something that needs fixed.

Technology

Overview

Technology is what the developers will craft to make the job of the workers as easy and efficient as possible. Some technology is directly provided for the developers but that doesn't mean their creativity has to end there. The workers will don the technology and use its prompts and insight to perform their actions.

Cell Phone

Each worker will be equipped with a cellphone. These will all be android phones that meet the minimum specification detailed below. Developers are free to use any of the listed sensors of the cellphone. Any applications that the developers want the workers to have access to will be loaded before the workers enter Icehouse. Once inside the workers will have access to the internet. GPS will likely not work in Icehouse. We cannot guarantee that the WiFi or Bluetooth constellations will be static in location or composition.

- Android Version 4.4.2
- Screen Size 4.7 inches
- Disk Space 16 GB, 1 GB RAM
- MicroSD 128 MB - 32 GB
- Primary Camera resolution 8 MP
- Secondary Camera resolution 1.6 MP
- Baseline Sensors - Accelerometer, proximity (NFC), compass, barometer

Sony SmartEyeglasses

The Sony SmartEyeglasses are a heads up display or *HUD*. Each member of the worker team will be equipped with one pair. These glasses provide a canvas for projecting all sorts of information. They are powered and controlled from an attached *puck* that contains a battery

and touch sensor. Information is exchanged between the SmartEyeglass and the cellphone to control what is being viewed and to offload data from onboard sensors.

They are capable of displaying both pictures and text on their 419h x 138v pixel screen. Because of the way they are designed the image can be placed at any distance into the wearer's field of view. Their display is monochrome green and has 256 levels of intensity.

Not only do the Sony SmartEyeglasses act as a display, they are also a tool for sensing. Next to the lenses is a 3 MP color camera. There is also a speaker and microphone. Finally, the SmartEyeglass is equipped with a 9 axis sensor to provide accelerometer, gyro and magnetic information.

All of these capabilities are open to use by the developers. Your creativity will help to unlock the potential of this new technology.

Sony Smart Band 2

The Sony Smart Band 2 is the latest generation of "life tracker". This device is worn around the wrist and measures heart beats and acceleration. From this data it produces three products: step counter, heart rate, and sleep state.

Additionally the Smart Band has three (3) multi-color LEDs and a vibration motor.

Other

As developer you are free to devise additional hardware and software to allow the workers to do their job. For example, suppose that you have an inventive way of tracking a person's position that relies on additional hardware. The deployment of this technology is allowed so that developers can really show off what they can do. The only restrictions are that it must pass a safety check by the lead Ko and be able to operate safely indoors and on 120V mains power (or battery). Additionally, anything that is being worn by the workers must not encumber or endanger them in a manner deemed excessive by the lead Ko.

These additional pieces MUST be open for investigation by the Ko. This allows us to make sure that they aren't doing anything outside the rules or that may result in harm to anyone.

The Ko and company are also not responsible for any damage that may come to additional hardware. Every effort will be made to keep it safe, but in the unexpected and shifting environment of Icehouse things can get stepped on, dropped, etc. Best to keep all of your devices on the robust side or out of harm's way!

The Game

World Setup

In this instance of Icehouse the world consists of a 40’ x 32’ main section and a small surrounding area. The main section is where all of the action takes place and where the hazards are contained. Outside of the “main door” is some room for staging and the place that the victims are taken to.

Inside the main section are several rooms cordoned off by either pipe-and-drape or office partitions. Each of these rooms can contain some number of hazards and victims. The exact layout will not be known to the workers or developers and will be different every time. Going into the unknown is just another thrilling aspect of Icehouse.

Progress

The currency of work in Icehouse is Progress. In the real world fighting a fire or removing rubble from a trapped victim takes significant effort. In Icehouse this effort is simulated by monitoring the heart rate of our responders and accumulating the time that they spend with elevated heart rate. One minute of elevated heart rate is equivalent to One (1) Progress. If something takes ‘5 Progress’ then it will require that the combined effort of the responders total to 5 minutes of elevated heart rate. Progress is summed across all of the workers currently engaged in that task.

Various tools will allow workers to do their jobs better. This is simulated by allowing them to accumulate Progress on a task faster. The base rate for Progress is 1 Progress per minute, but if a worker has a +0.5 Progress modifier then they will contribute 1.5 Progress per minute.

Step boxes will be provided in each room to allow workers a convenient way to elevate their heart rate.

Whether the heart rate of the responder is elevated or resting will be determined using on-line naïve Bayesian change point detection as detailed in http://arxiv.org/abs/0710.3742. This allows a rapid assessment of whether the responder is active or not.

Victims

There are several victims inside Icehouse that need to be rescued. Because we don’t want to risk injury by having live victims lying about in Icehouse the victims will have a PhysRep of a sandbag and an Action card that contains important information about them.

Removing a victim from Icehouse is an involved process. Before a victim can be moved they need to be stabilized. Stabilization takes an amount of time based on the severity of the injury that they have sustained. After that the victim can be safely moved. The victim must be moved from their location to the designated drop off site. Two workers are required to transport a victim.

Victims are also subjected to the same hazards as the workers. This will result in their health degrading as they wait for attention. It is up to the developers to direct the workers as they choose which victims to attend to.

Search for Victims

Because of the size of Icehouse there isn't much hiding room. Searching a room requires 3 Progress. The responders must be in the room they are searching. Searching is required before anything can be done with the victims. Not every room is guaranteed to have victims in it so it is important to assess a room before proceeding.

Triaging Victims

As victims are discovered it is important that the workers treat them in the proper order. When a victim is discovered their Action card will produce a number when scanned. The higher the number the more urgently they need care (e.g. a 10 victim should be treated before an 8 victim). Developers will need to provide guidance about whether the workers should search for all the victims first or treat victims as soon as they are discovered. Penalties are assessed when the wrong victims are treated. This penalty has to be weighed against the degradation of victim health as they linger in Icehouse.

Stabilizing Victims

Once victims have been searched for and found the workers can start to stabilize them for transport. This process takes between 3 and 6 Progress depending on the severity of the injuries to the victim. The amount of time required will be displayed on the PhysRep for the victim.

Segments

There are three segments to each game of Icehouse: Loadout, Equip and Engagement. Specific actions need to be taken during each segment. This structure is important to understand because it dictates what information developer should convey to the workers. The information acquired during each stage will alter what needs to be done in the next so the developers need to pay attention to the rules and create tools to work with the conditions found in Icehouse.

Loadout (20 minutes)

Before the workers are sent into Icehouse they are given the opportunity to go over the technology with the developers. During this segment the developers are responsible for explaining any UI/UX features, walking the worker through things they might see, and providing general guidance and insight. This is the ONLY time that the developers and workers will be able to communicate, so make it count! The fate of the victims of Icehouse rests in not just creating useful tools but being able to communicate how to operate them. A well-crafted tool will have an intuitive interface that easily allows navigation even by a novice user.

Workers and developers will also be given a paper map that details the floorplan of Icehouse and the location of some of the threats. Developers should create methods that use information from the map to provide guidance for the workers as they decide what equipment they will take and how they will specialize.

Equip – Ready, Set, … (10 minutes)

After Loadout the workers are sent through the Rift. Developers will not be able to communicate with the workers during this time so the interface will need to have been explained well during Loadout.

Sometimes the most important aspect of an emergency response isn't the technology but rather the decision making. The application that the developers have created needs to tell the workers what rooms to go to, which hazards to fight and in what order, etc. At the very least the developers should designate one of the workers as the Captain and have the team rely on that person's judgement. (This isn't a very high scoring strategy, but it's better than no guidance at all.)

Using the instructions provided by the application the workers will each select a Specialty and the team will select 6 pieces of Tech. Workers will not decide on equipment on their own so it is important that some amount of guidance be supplied by the application created by the developers. Once the workers have selected their tools the necessary artifacts will be sent through the Rift.

Not every hazard will be known beforehand. The map should be used to initially guide the workers on a path, but the decision support portion should also allow them to input information about hazards that are discovered along the way and adapt.

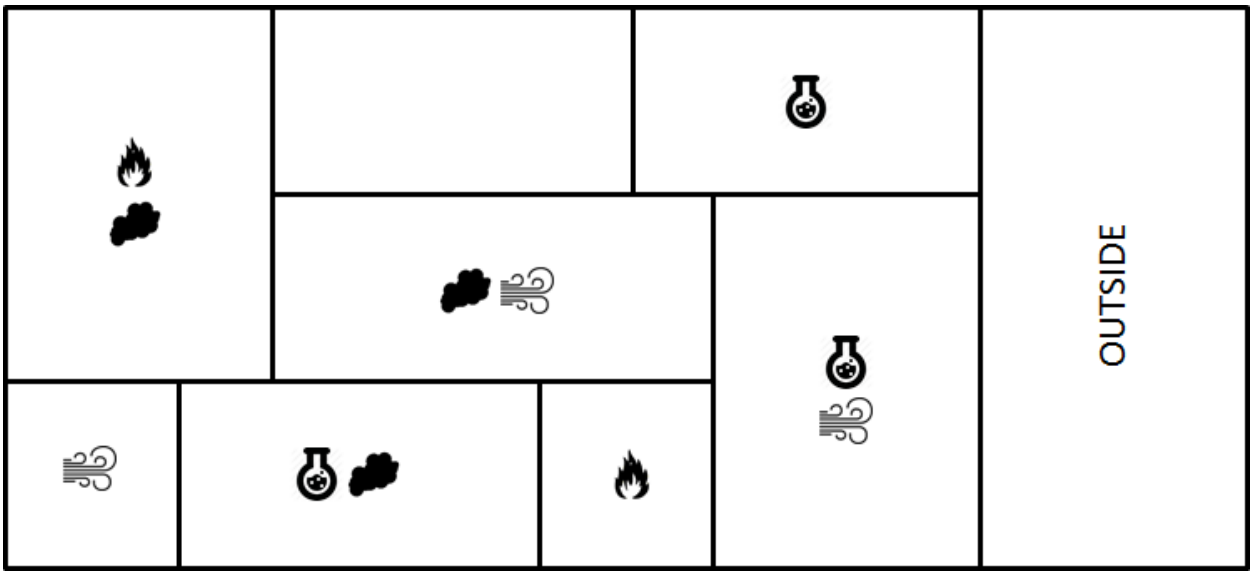

Figure 1 – An example of the map that will be received by workers during Equip

Figure 2 – The types of hazards in Icehouse

Engagement – Into the Maelstrom (20 minutes)

With their equipment in hand the workers can now enter the main part of Icehouse to do their job. At this point the workers will be able to deal with hazards and rescue victims. Hopefully, using the tools provided to them by the developers, the workers will be able to rescue all of the victims and return safely so that Icehouse can be sealed up forever.

After the completion of Engagement the team (developers and workers) will be judged by the Ko. This will involve a survey of workers to measure how well they thought the tools provided by the developers did the job. Developers will also be given the opportunity to explain their thought process and detail why anything went wrong and how they would correct it for the future.

Scoring

The winning team will be chosen based on several criteria. These are chosen to account for the rapid turnaround in development, the "foreignness" of the environment, and the effort put forward by the team. Obviously a perfect solution would involve universal praise by the workers, cleanly written code that presents a novel solution, and complete rescue of all of the victims. However, since this is unlikely to occur a system has been established to take into account some of these more qualitative aspects. It is also important to remember that the ultimate reason for Icehouse is to evaluate exciting new advancements in body-worn technology and not to create tech that is good for the imaginary world of Icehouse. If developers create code that wins at Icehouse but does not serve a greater purpose then it will not win overall.

- Victims rescued – 15%
- Exposure – 10%
- Hazards eliminated – 5%
- Feedback from workers – 40%
- Code and Tech evaluation – 30%
    - Cleanness and legibility of code
    - Originality of idea
    - Supporting documentation

Hazards

Overview

Hazards are what make Icehouse such a gripping adventure. At any moment one of the workers may have their life taken, leaving the future of the poor victims in doubt. Developers are tasked with evaluating these hazards and matching them to the right set of Specialties and Tech. Team communication is also important as it allows the team to coordinate to get workers with the right skills to the correct hazard.

Most hazards will have an ERep and a PhysRep. For hazards with only an ERep there will be a Ko present to assist the worker in role playing the action associated with encountering that hazard. This helps keep the players safe and ensures that the proper actions are taken by the worker. Such actions include having the worker lay down because they have been struck by a falling object.

The ERep will be constantly monitored using an application running on the workers' phones. This application will also alert the worker to any situation that has arisen because of a limit being exceeded. These limits indicate a dangerous situation such as smoke inhalation or excessive heat. When this alert occurs it is the responsibility of the worker to check the auxiliary app and follow the instructions (likely, "Fall down, you are incapacitated").

Tragedy Strikes!

If a worker is incapacitated they will be instructed to lie down. A Ko will be positioned near the worker to ensure that no one trips over the downed worker. While they are incapacitated the worker cannot do anything.

There are a couple of ways for workers to become incapacitated. Some hazards have the ability to knock workers out immediately. Workers can also be incapacitated by receiving 50 total units of exposure. It doesn't matter what sources this exposure comes from it is all cumulative.

A worker can be revived by being transported out of Icehouse. This is accomplished in much the same way as victim transportation. If two workers come to move the downed worker the attending Ko will hand them a sandbag. Once outside at the drop-off point the downed worker will slowly recover for five minutes at which point they can go back into the Icehouse. All of their exposure will be reset (but the exposure they previously received will be kept in the global database for scoring purposes).

If a worker is downed for three minutes they will move from 'incapacitated' to 'dead'. Once dead a worker cannot be revived and is removed from the game.

Fighting Hazards

To remove a hazard requires workers to spend some amount of time engaging it. The amount of time varies depending on the number of workers and how powerful the hazard is. All hazards have three classes with Class I being the smallest and Class III the largest.

Table 1

Class	To Clear
I	3 Progress
II	6 Progress
III	9 Progress

To engage the hazard the worker will scan their personal tag (or phone) and the associated hazard tag using the ERep. At that point they will proceed to the exercise area to get their heart

rate up. A progress bar on the screen of the ERep will show how close they are to eliminating the hazard.

Hazard Types

The amount of exposure from a hazard depends on the Class of the hazard.

Table 2

Class	Exposure per minute
I	1
II	2
III	4

Gas

Gasses are a general class of invisible hazards. There is no way for a worker to differentiate between the three classes. Developers should take this into consideration when constructing decision support.

Gas hazards have an ERep but no PhysRep due to their invisible nature.

Liquid

Liquids are a general class of visible hazards. There is no way to determine the class of a Liquid hazard. Even though they are visible the PhysRep may not be immediately observable from the doorway.

Liquid hazards have an ERep and PhysRep. Their PhysRep is a piece of paper or plastic film cut into the shape of a puddle.

Fire

Fires have the ability to spread or grow if left unattended. Fires have a 10% chance every minute to spread to an adjacent room. Fire is truly terrifying and should be dealt with as soon as possible.

The severity of a fire can be determined by examining the PhysRep. A Class I Fire is represented by a small red tuft of Mylar (think wastebasket fire). A Class II Fire is represented by red pom-poms. Finally, Class III Fires will be represented by shaking a large red bath towel.

Smoke

Smoke poses numerous threats to workers. In smoky rooms workers will receive exposure due to smoke inhalation but also lose their ability to see. This means the victims will be hidden from view as well as other hazards.

If smoke is present in a room searching for and stabilizing victims is given -1 Progress (this penalty is applied to the team effort e.g. two workers will make 1 Progress searching a smoke filled room).

Smoke will also obscure Gas hazards so they cannot be identified or fought until the room is clear of smoke.

It has a PhysRep of black pom-poms or black sheets.

Entrapment (Trap)

Structural soundness is not guaranteed in Icehouse. If a worker does not first check the room's integrity then there is a 50% chance every minute of the room collapsing. If a room does collapse, everybody in the room is instantly incapacitated. Because they are covered in rubble special effort has to be made for recovery. This is also true of victims that were in the room at the time of the collapse. The Class of trap determines how catastrophic the collapse is. To free a trapped person requires the Progress from Table 1.

Skills

Overview

Skills are broken down into two areas: specialties and tech. Specialties are what differentiates the strong suits of the workers whereas Tech are tools that can be used by the workers to perform their job. Each worker selects one Specialty. Some Tech requires that it be used by a worker with a specific specialty.

In addition to the abilities provided by their individual Specialties, workers can augment themselves with Tech. The team can select a total of 6 pieces of tech. Selections do not have to be unique.

Tech are things that are available in addition to what is supplied during Loadout. This means that the basic kit and anything that the developers provide does not count as Tech.

Specialties

Medic

Medics are able to assist victims better than other workers. Medics provide +1 Progress when stabilizing victims.

Medics are designated by a white headband.

Hazmat Specialist

Hazmat workers are specially equipped to deal with hazardous materials. This means that they can clean up spills and other types of chemical hazards. A hazmat worker contributes +0.5 Progress to Gas and Liquid hazards.

Hazmat specialists are designated by a purple headband.

Damage Control Specialist

Damage Control Specialists (DC for short) are there to provide special support to firefighting and hazard mitigation efforts. DCs contribute +0.5 Progress to Fire and Trap hazards.

Damage Control specialists are designated by a red headband. DCs also wear heavy leather gloves that impair their manual dexterity.

Tech

Fire Extinguisher

A fire extinguisher is a single use item that contributes 6 Progress to fighting a Fire.

Spill Kit

A spill kit is a single use item that contributes 6 Progress to eliminating a Liquid hazard.

Shoring Kit

A shoring kit is a single use item that contributes 6 Progress to eliminating a Trap hazard.

SCBA

SCBA is short for Self-Contained Breathing Apparatus. This portable air system prevents exposure from gas and smoke sources. Does not affect vision deprivation from Smoke. There are only 5 minutes of air in the SCBA so when it is on must be selected wisely.

Extra Air

Can only be added to a worker's kit if that worker also has an SCBA. It provides an additional 10 minutes of air.

Air Purifier – Hazmat Specialist/DC only

The air purifier gives the user +0.5 Progress when working on Gas or Smoke hazards

Decontamination Unit – Hazmat Specialist

The decontamination unit gives the user +0.5 Progress when working on Gas or Liquid hazards

Firehose – DC only

This DC specialty item gives the ability to extinguish any fire. Use requires that one worker take a cable PhysRep to the Outside area and wait while the DC worker extinguishes the fire. It gives +2 Progress when fighting a Fire.

Tool Box – DC only

A sledgehammer is able to break apart traps and free victims. It reduces the time to do these tasks by giving +1 Progress on Traps.

First Aid Kit – Medic only

The First Aid Kit gives the medic +0.5 Progress when stabilizing victims

IR Camera

Workers equipped with the IR Camera are able to see through smoke and identify hidden victims. This allows victims to be searched for from an adjacent room.