Energy Storage Systems (ESS)

The purpose of this guide is to provide the fire service a roadmap on how to conduct a safe and informative familiarization of energy storage systems.

This is meant to supplement and not replace training from a recognized source.

Energy Storage Systems (ESS)

Considerations

As you familiarize yourself with DER, take note of the various components, signage and posted safety precautions.

Fire Behavior: Apply lessons learned from BESS thermal runaway incidents to the specific location to illustrate the resources required to respond to a fire.

Energy Isolation: Familiarize firefighters with procedures/tactics that can be used use to isolate energy during an emergency event.

Ventilation and Hazmat Considerations: Discuss procedures/tactics that can be used at the site for ventilation of toxic gases and containment of hazardous substances.

Energy Storage Systems (ESS)

BESS Installation Locations

As you prepare for your familiarization activity, survey the site and answer what type of BESS location is this? Residential, Commercial, or Utility Scale?

BESS Installation Locations

Battery Energy Storage Systems (BESS)

Residential

- Typically located close to electrical panel, in garage, basement or outside
- Similar in appearance to a wall mounted cabinet
- Rarely found in homes without PV systems present

Energy Storage Systems (ESS)

BESS Installation Locations

Identify if Commercial, Residential, or Utility Scale Installation.

BESS Installation Locations

Battery Energy Storage Systems (BESS)

Commercial

- In battery rooms
- Outdoor enclosures
- Separate buildings
- Rooftops
- Barges

Energy Storage Systems (ESS)

BESS Installation Locations

Identify if Commercial, Residential, or Utility Scale Installation.

BESS Installation Locations

Battery Energy Storage Systems (BESS)

Utility Scale

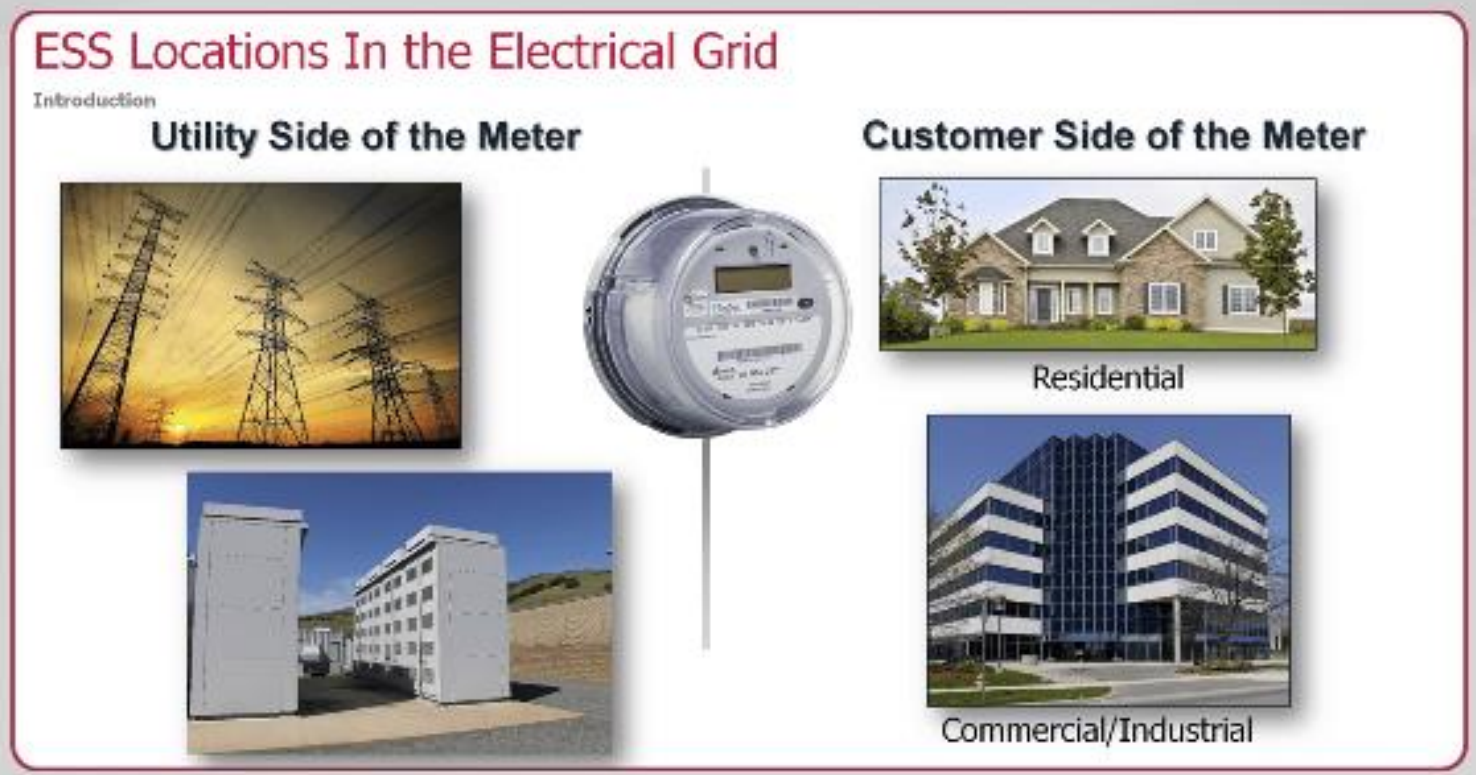
- Small to large substations
- Power generation plants
- Neighborhood micro-grids
- May or may not be owned by utility

Energy Storage Systems (ESS)

BESS Locations In the Grid

And next, where is the BESS located relative to the main electrical distribution network?

Is it a supply source feeding the grid or a consumer location taking from the grid?



Energy Storage Systems (ESS)

BESS Aplications

What is the primary purpose of this BESS?

ESS Applications

Introduction

Backup Power

Off-Grid

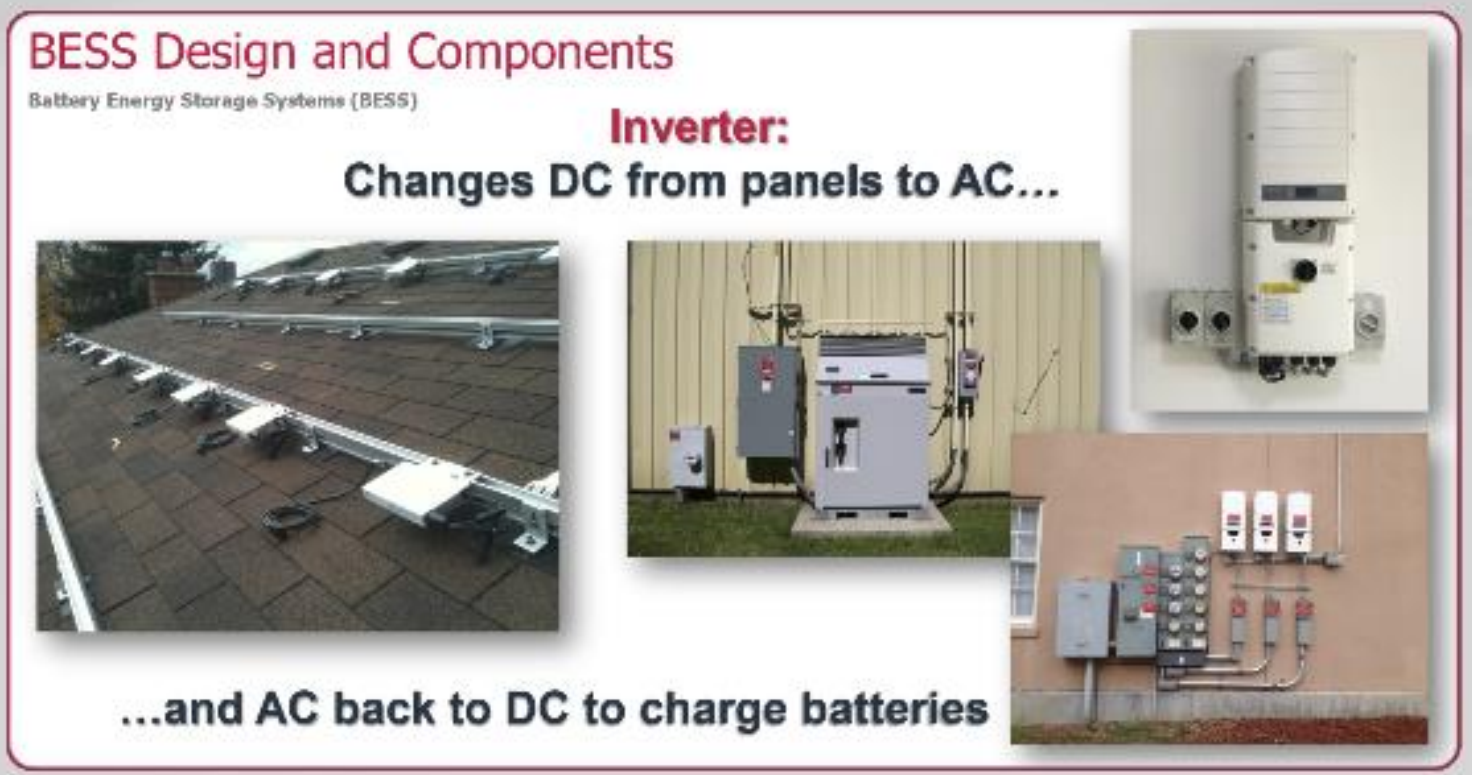
Cost Savings (Peak Shaving)

Renewable Energy Support

Energy Storage Systems (ESS)

BESS Design & Components

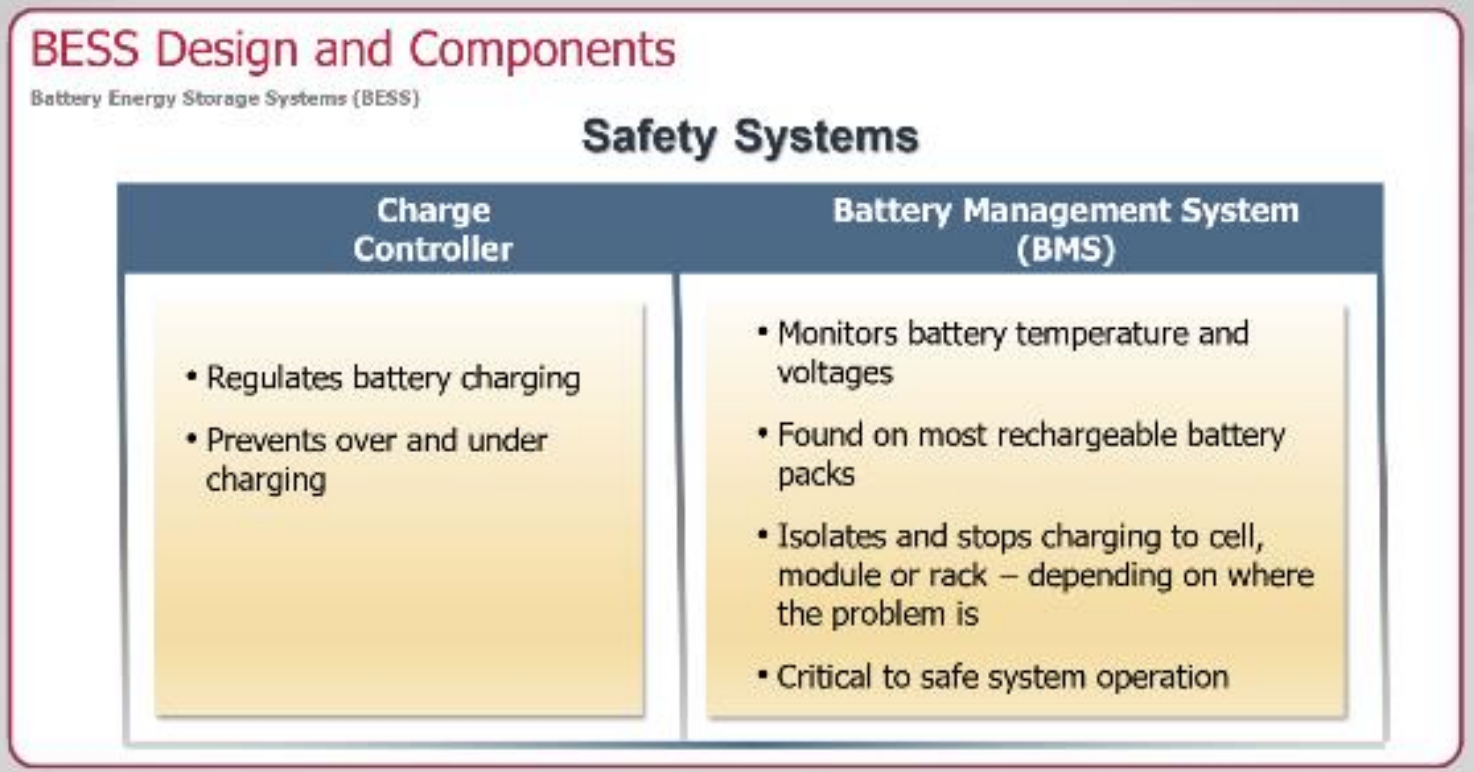
Take a minute to review the critical BESS components you should be looking for.



Energy Storage Systems (ESS)

BESS Design & Components

Knowing how the safety systems for this site function will be useful information when responding to it.



Energy Storage Systems (ESS)

BESS Design & Components

Pay attention to what type of batteries and their chemistries are present.

You may find more than one battery type/chemistry at this BESS site.

Lead Acid Batteries

Battery Energy Storage Systems (BESS)

Wet Cell Lead Acid

- Most common flooded cell type
- Sulfuric acid and water mixture
- Used in Telecom for over 100 years
- Common in off-grid and backup ESS

Dry Cell Lead Acid

- Some lead acid batteries do not have liquid electrolyte
- Similar to deep-cycle maintenance free batteries
- VRLA: Valve Regulated Lead Acid

VRLA batteries are prone to thermal runaway if overheated

Energy Storage Systems (ESS)

BESS Design & Components

Each type has specific hazards.

Batteries may contain different fluids that support safe operation of the battery.

Lithium-Ion Batteries

Battery Energy Storage Systems (BESS)

Electrolyte

- Flammable organic solvent
- Made up lithium salts impregnated in other materials
- Contains very little in a liquid state
- Commonly found in hybrids, EVs, BESS and emobility devices

Does not contain pure lithium which is a reactive metal

Energy Storage Systems (ESS)

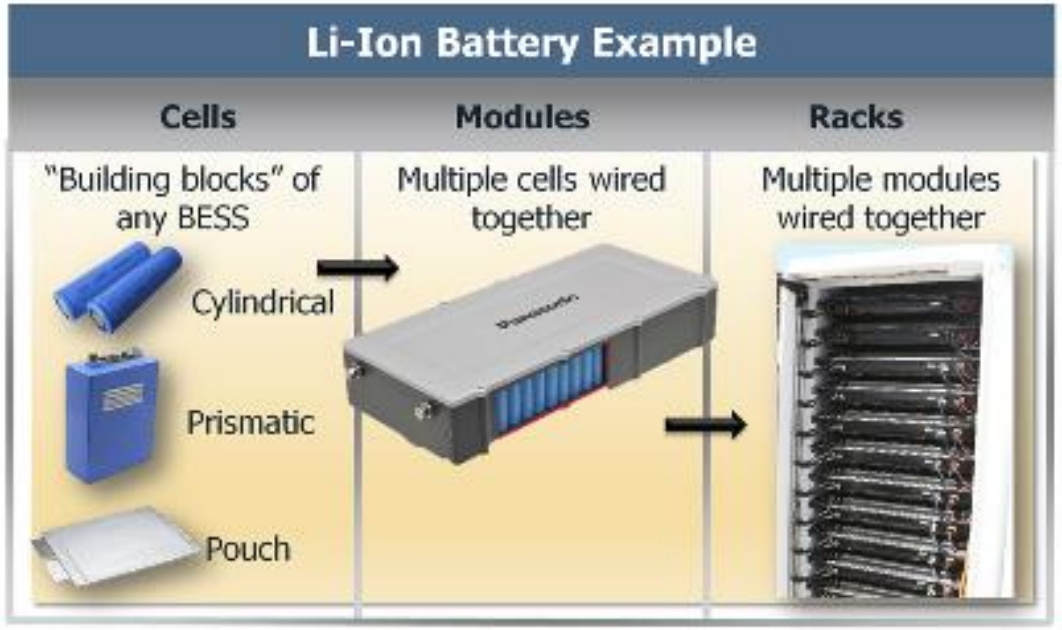
BESS Design & Components

Remember, batteries will be found in different configurations and enclosures.

Often batteries contain assemblies of small cells/pouches that can be connected and placed in racks/enclosures.

BESS Design and Components

Battery Energy Storage Systems (BESS)



Energy Storage Systems (ESS)

Hazards - Thermal Runaway

Thermal runaway is a hazard of Lithium-Ion batteries and can produce fire and flammable gases.

Hazards – Thermal Runaway

Battery Energy Storage Systems (BESS)

Process

- Internal temperature of a cell rises above operating range
- Can propagate from cell to cell
- Can occur without fire

Signs

- Bulging of battery
- Temperature increase
- Visible white smoke or gases
- Heat and flames
- Clicking, hissing, or popping noises

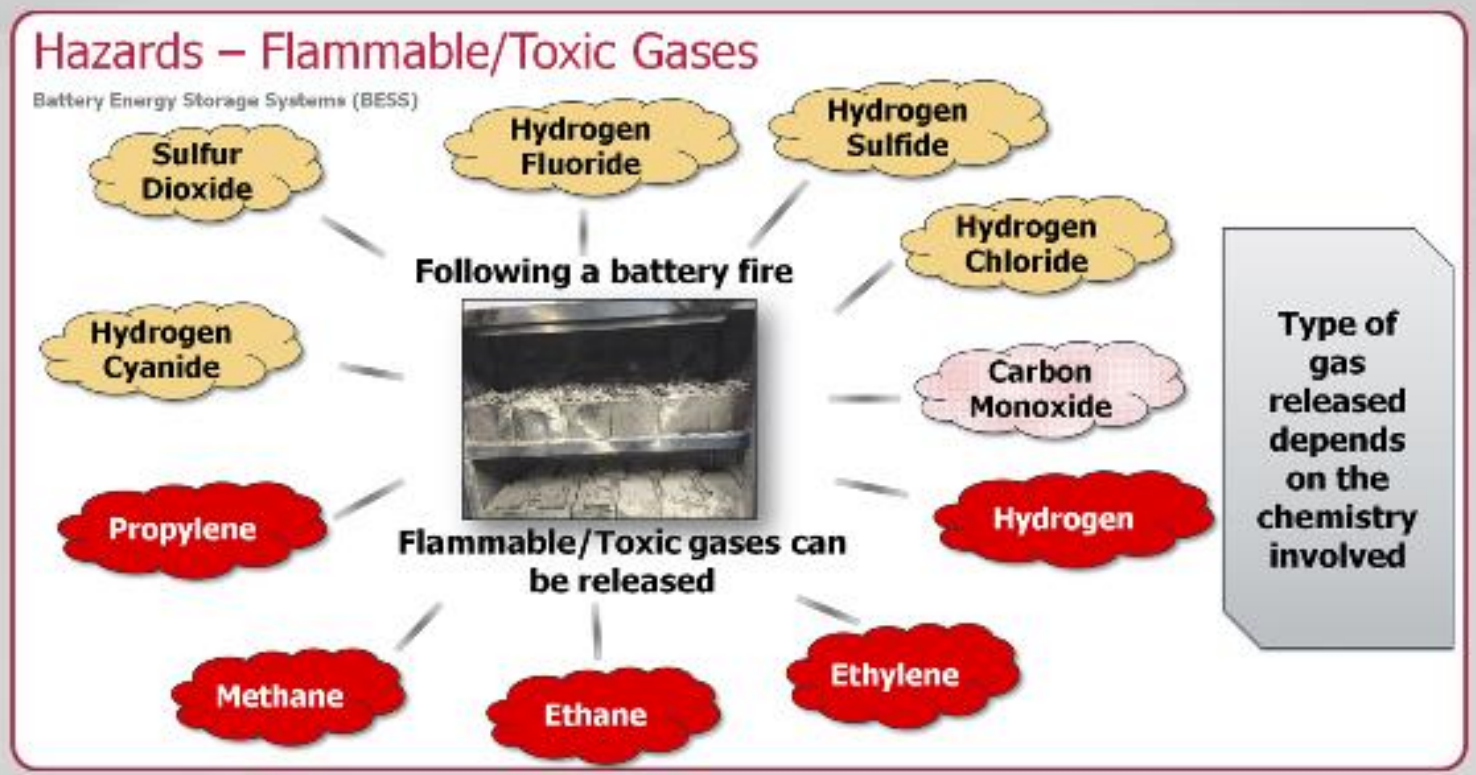
Often results in fire or explosion

Energy Storage Systems (ESS)

Hazards - Flammable/Toxic Gases

These gases contain many chemical by products.

Always utilize full PPE , including SCBA, during all phases of a BESS incident.



Energy Storage Systems (ESS)

Hazards - Fire / Explosion

Developing an awareness of the impact of a fire/explosion at this site needs to be a primary consideration during your familiarization.

Hazards – Fire/Explosion

Battery Energy Storage Systems (BESS)

Fire Concerns

- Thermal runaway
- Rapid cell to cell heat/fire spread (propagation)
- Potential flashover due to built up gases

Explosion Concerns

- Prone to explosion during failure
- Pressure may cause breach of outside containment
- Lead acid batteries release hydrogen

Hazards - Contact with Electrolyte

Consider what event at the site could result in leaking electrolyte.

Refer to site Safety Data Sheets (SDS) for information on electrolytes at this site.

Hazards – Contact with Electrolyte

Failure Modes and Hazards

Possible Results:

- Inhalation hazard/contact exposure
- Skin, eye or irritation burns
- PPE degradation
- Protect the environment from leaking electrolyte or water runoff

Energy Storage Systems (ESS)

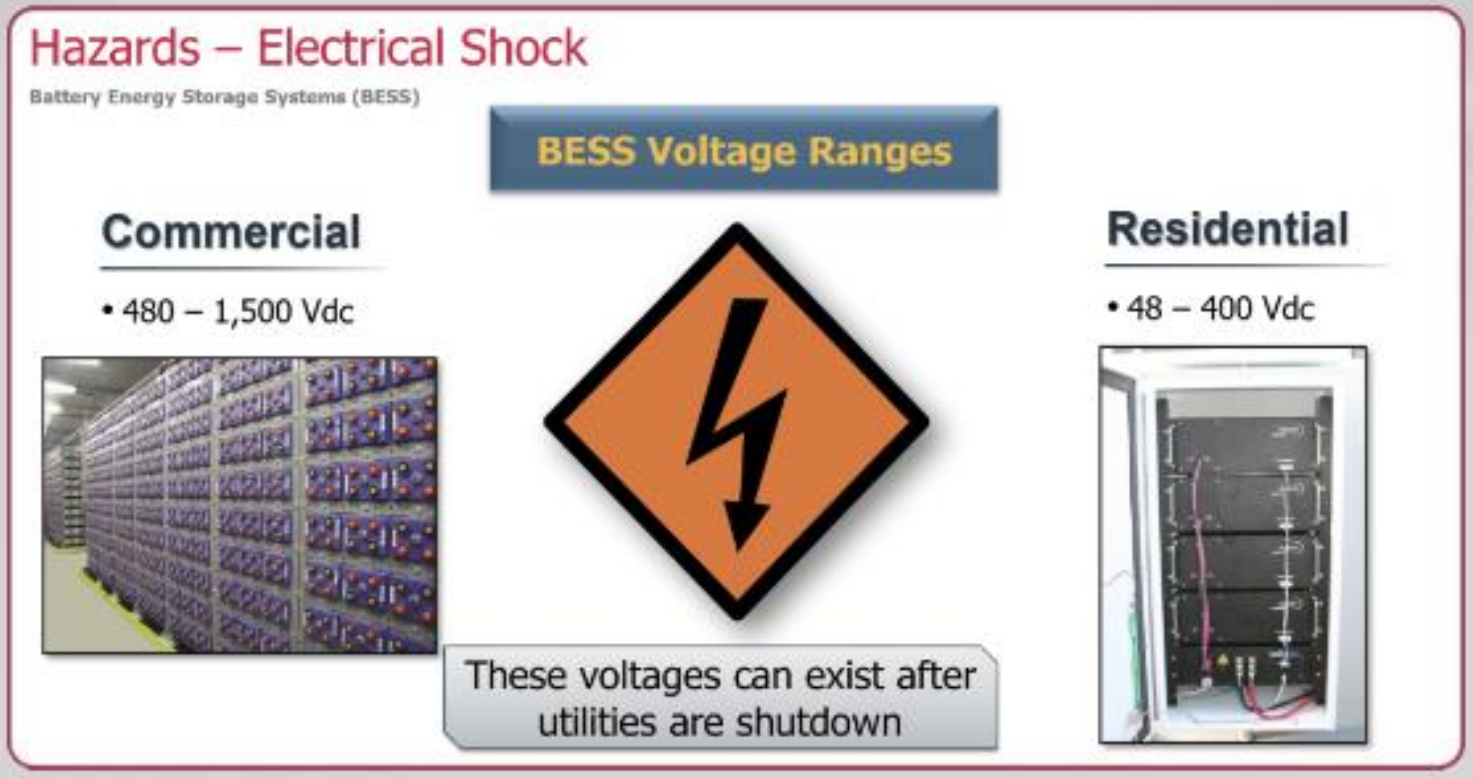
HAZARDS

Electrical shock

BESS energies can be high voltage and posses dangerous amperage levels.

BESS can pose hazards if personnel come in contact with live parts during familiarization activities.

SAFETY: Always follow site safety protocols



Energy Storage Systems (ESS)

Preplanning

Do you have a knowledgeable person guiding you during the familiarization?

Have you reviewed the pre-incident plans for the site?

Preplanning

Pre-Incident Planning

Pre-Incident Planning:
Completed by operational personnel to establish a working knowledge of the installation and procedures

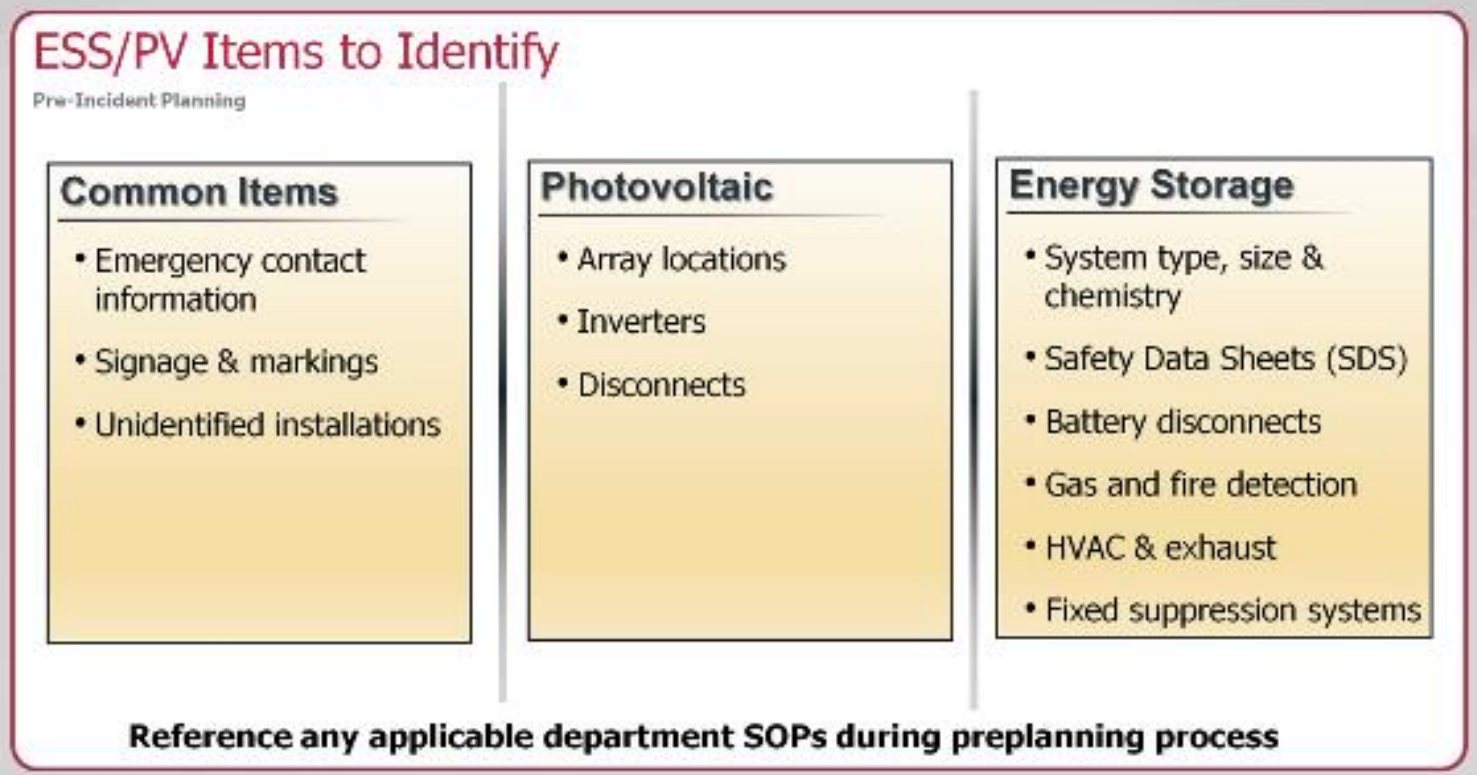
Reach Out
To building officials to see if systems are being installed

Request
Building official notify FD of permits/applications

Energy Storage Systems (ESS)

BESS / PV Items to Identify

Before you begin the familiarization, here are some key areas to focus on.



Energy Storage Systems (ESS)

BESS Installation Type and Hazards

Remember, you want to understand where this site is located and the method the batteries are assembled and their chemistries by the end of the familiarization.

ESS Installation Type and Hazards

Pre-Incident Planning

Determine:

- Locations and size of system
- Interior or exterior install
- Potential life safety hazards
- Assembly – open racks vs. cabinets
- Chemistries utilized and potential hazards
- Application

Identify any additional resources that may be required

Energy Storage Systems (ESS)

Safety Data Sheets

Locate and review any Safety Data Sheets.

Look for information about electrolytes.

Safety Data Sheets

Pre-Incident Planning

Always Review SDS


A123 SYSTEMS

SAFETY DATA SHEET

SDS Provides Key Info

- Battery chemistry
- Health hazards
- Firefighting measures
- Not always available for Li-ion

Any updates should be added to the preplan

Energy Storage Systems (ESS)

Emergency Contact Information

Locate where the emergency contact information is located and ensure all participants know where it is located and what is a qualified person.

Emergency Contact Information

Pre-Incident Planning

NEC 2017 Definition: Qualified Person

One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

- Look for label with system installer contact info
- Contact electrician with experience in PV & ESS

Emergency Contact

- Authorized service personnel
- Building representatives
- Update information on regular basis

Energy Storage Systems (ESS)

PV + BESS Signage and Markings

What signs do you see?

Remember signs will not be visible in reduced visibility conditions.

PV + ESS Signage and Markings

Pre-Incident Planning

Look for labels and signs

Determine
the location and type of BESS and PV system

It's Possible
that no markings are present on older installations

Energy Storage Systems (ESS)

BESS Signage and Markings

Electrical shock hazard is present throughout the site. Treat all components as energized, even during the familiarization.

ESS Signage and Markings

Pre-Incident Planning

If Not Present or Clear
bring to owner's attention

Energy Storage Systems (ESS)

BESS Battery Disconnects

Note the location and operation of battery disconnects.

Can they be safely operated by fire service personnel?

ESS Battery Disconnects

Pre-Incident Planning

- Important: locate emergency power disconnects
- Should be in sight of electrical panel, or location noted at panel
- Must be included in preplan document

Energy Storage Systems (ESS)

Detection / Suppression System

Identify remote monitoring and how to contact

Identify external alarm/warning devices for unit level fire suppression system discharge

Identify suppression agent product and hazards

Identify smoke/heat/fire detection system at unit level

Locate manual fire suppression system discharge points

Have a supervised tour of units

Energy Storage Systems (ESS)

BESS Detection Systems

Locate any gas and smoke/fire detection systems.

Where do they transmit a signal to, where is the control panel?

ESS Detection Systems

Pre-Incident Planning

Gas Detection	Smoke/Fire Detection
	
• Note air monitoring systems • Determine what they are designed to detect	• Method of monitoring • Detector types

Energy Storage Systems (ESS)

BESS HVAC and Exhaust

Understand how and when the HVAC and Exhaust systems will operate.

Identify where exhaust systems discharge and survey that area for possible exposure to civilians in discharge path.

ESS HVAC and Exhaust

Pre-Incident Planning

HVAC	Exhaust
• Does it need to be controlled? • Specific to battery room? • Determine how system is powered	• Note exit location • Determine how system is powered?

Energy Storage Systems (ESS)

Fixed Fire Suppression Systems

Locate all fire suppression systems.

How they are activated

What agent is being used

Fixed Fire Suppression Systems

Pre-Incident Planning

- Manage fires and prevent spread – limited in effectiveness.
- Lithium ion and lead acid may be exempt in fire code
- AHJ may have requirement

Energy Storage Systems (ESS)

Fire Suppression Systems - Inert Gas

Inert gas systems displace oxygen and must be ventilated before entering.

Fixed Suppression Systems – Inert Gas

Pre-Incident Planning

Inert Gas/Clean Agent

- Carbon dioxide
- Halon
- FM 200
- Argon
- Nitrogen
- NOVEC 1230

- Displaces oxygen, limiting visible combustion
- Limited effect on thermal runaway
- Lithium-ion cells may produce their own oxygen
- Exhaust inert gas prior to entry

Energy Storage Systems (ESS)

Fixed Suppression Systems - Water

Where is your water supply to support water-based fire suppression systems.

Fixed Suppression Systems – Water

Pre-Incident Planning

- Determine system type
- Note if must be supported by the FD (water based)
- FDCs and nearest adequate water supply

- Sprinklers or deluge systems
- Cabinets can prevent water from reaching batteries
- Li-ion is not addressed by NFPA 13 (2016 edition)

Energy Storage Systems (ESS)

WATER SUPPLY

Identify water supplies and available flow

FIRE SUPPRESION

Identify if fire suppression system is present and what areas are covered

Identify if/how fire department can support fire suppression system

FIRE ALARM SYSTEM

Identify if fire alarm system is present, and note, location of fire alarm control unit (FACU) and remote annunciator panels

Energy Storage Systems (ESS)

Codes & Standarts - NFPA 855 (2019)

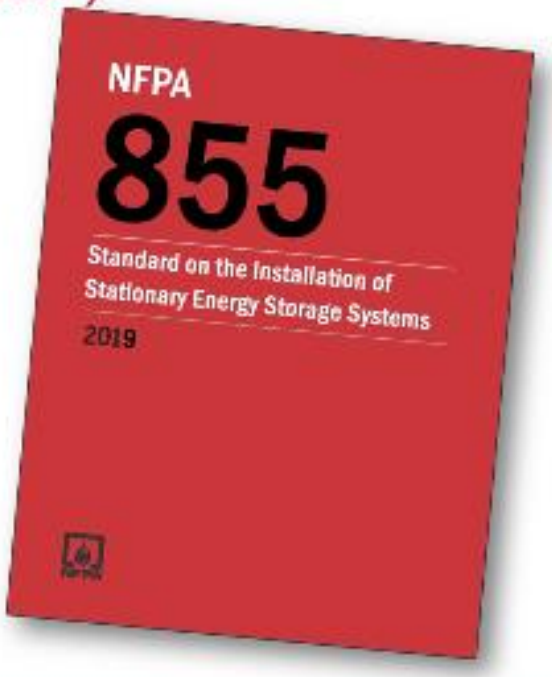
NFPA 855 is a useful resource for information about BESS design, safety recommendations, and steps to protect fire service personnel.

Codes & Standards - NFPA 855 (2019)

Pre-Incident Planning

Requires:

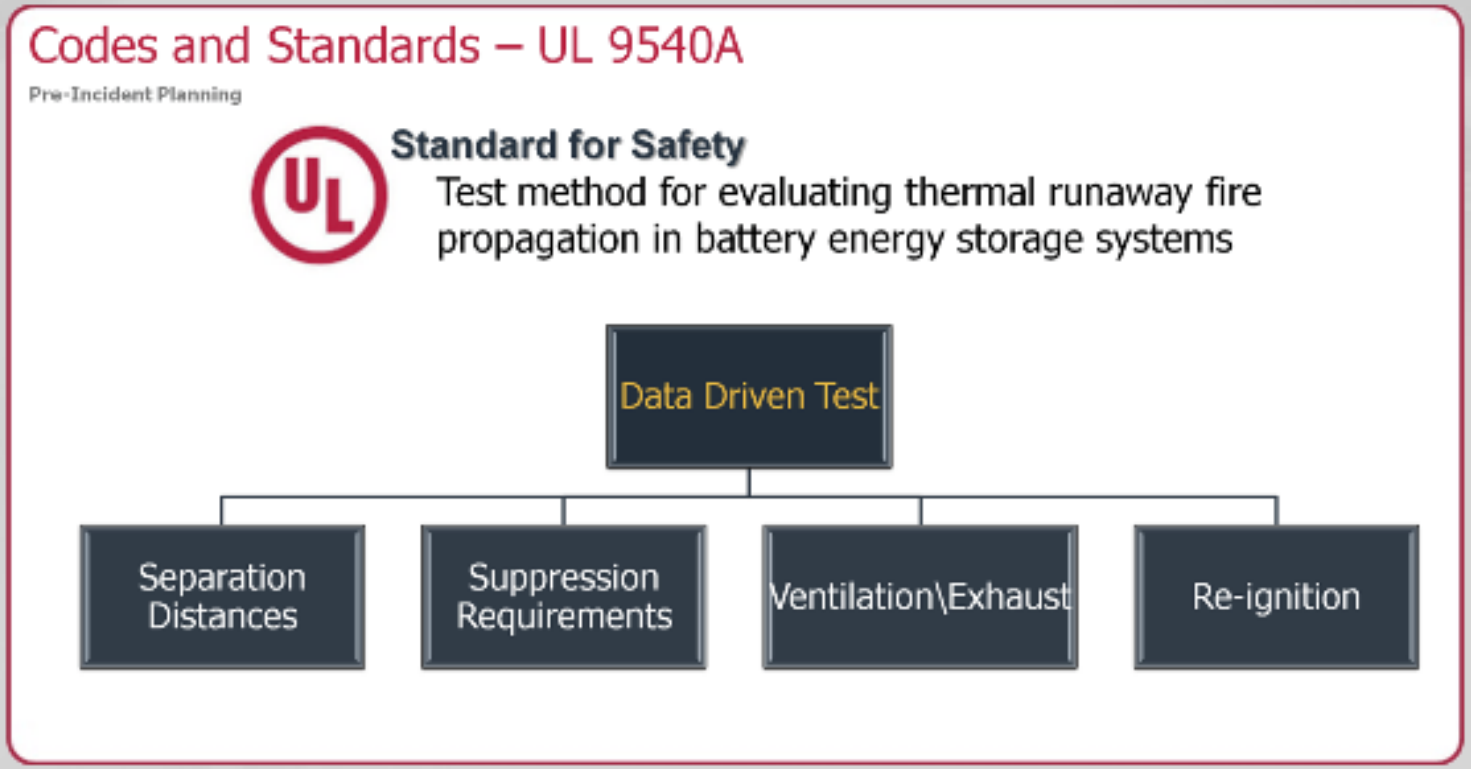
- Emergency Response Plan on site
- Decommissioning plan
- Marking of special hazards



Energy Storage Systems (ESS)

Codes & Standarts - UL 9540A

Verify if the design and systems if this site have been tested in accordance with UL 9540A, which is another useful resource of information.



Energy Storage Systems (ESS)

After completing familiarization can you ...

Identify battery type

Identify if purge system is available for BESS and how it operates

Identify if deflagration panels are available in BESS and how they operate

Identify if staging area safe distance from site

Identify contact info for site access/SME's

Have emergency shutdown procedures explained and demonstrated

Lithium-Ion Batteries

Battery Energy Storage Systems (BESS)

Electrolyte

- Flammable organic solvent
- Made up lithium salts impregnated in other materials
- Contains very little in a liquid state
- Commonly found in hybrids, EVs, BESS and emobility devices

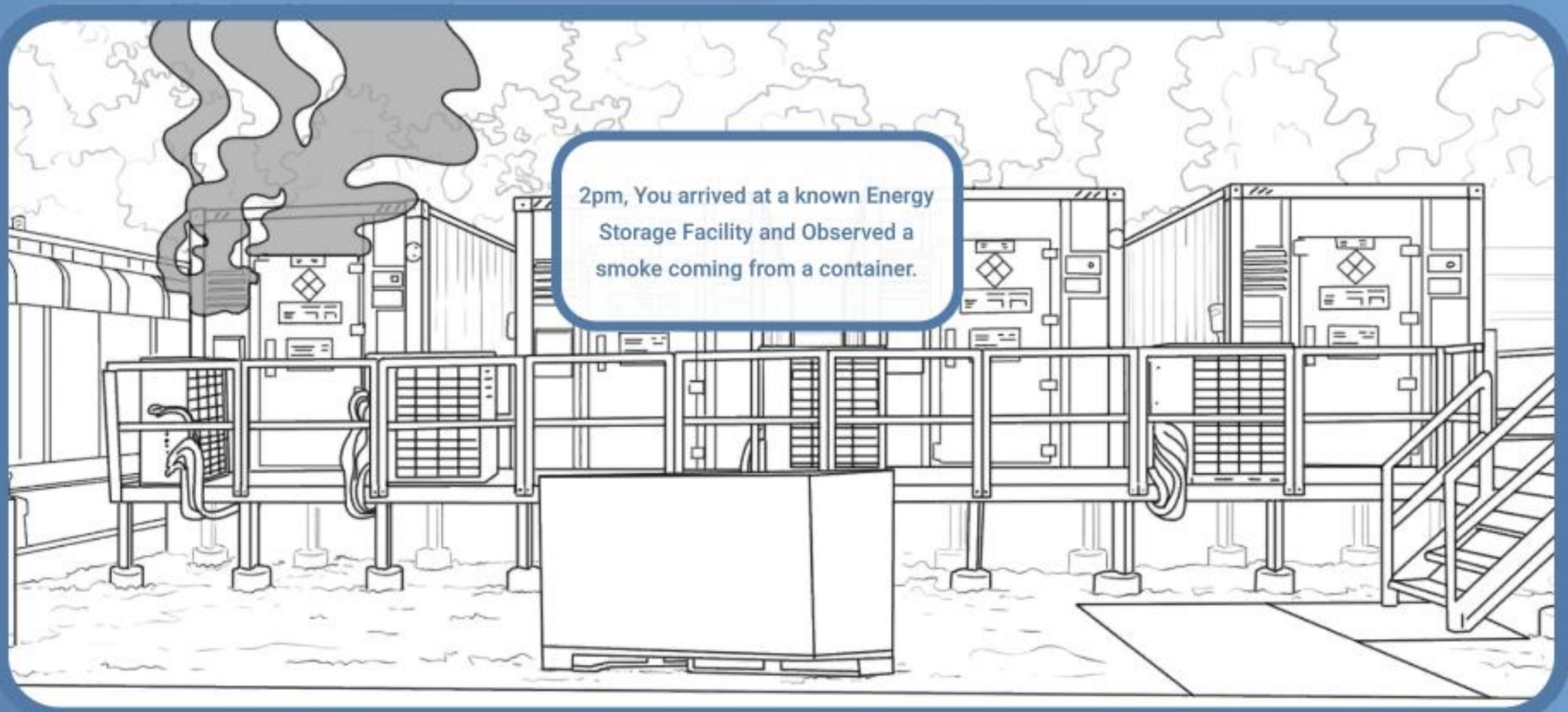
Does not contain pure lithium which is a reactive metal

Congratulations!

You have completed the ESS module. Let's explore an incident scenario.

CONTINUE

Let's explore an incident scenario.



Following the Identify-Shutdown-Watchout process found in the NFPA BESS Curriculum, use the questions in the subsequent pop up boxes to guide a discussion on how to assess this problem.

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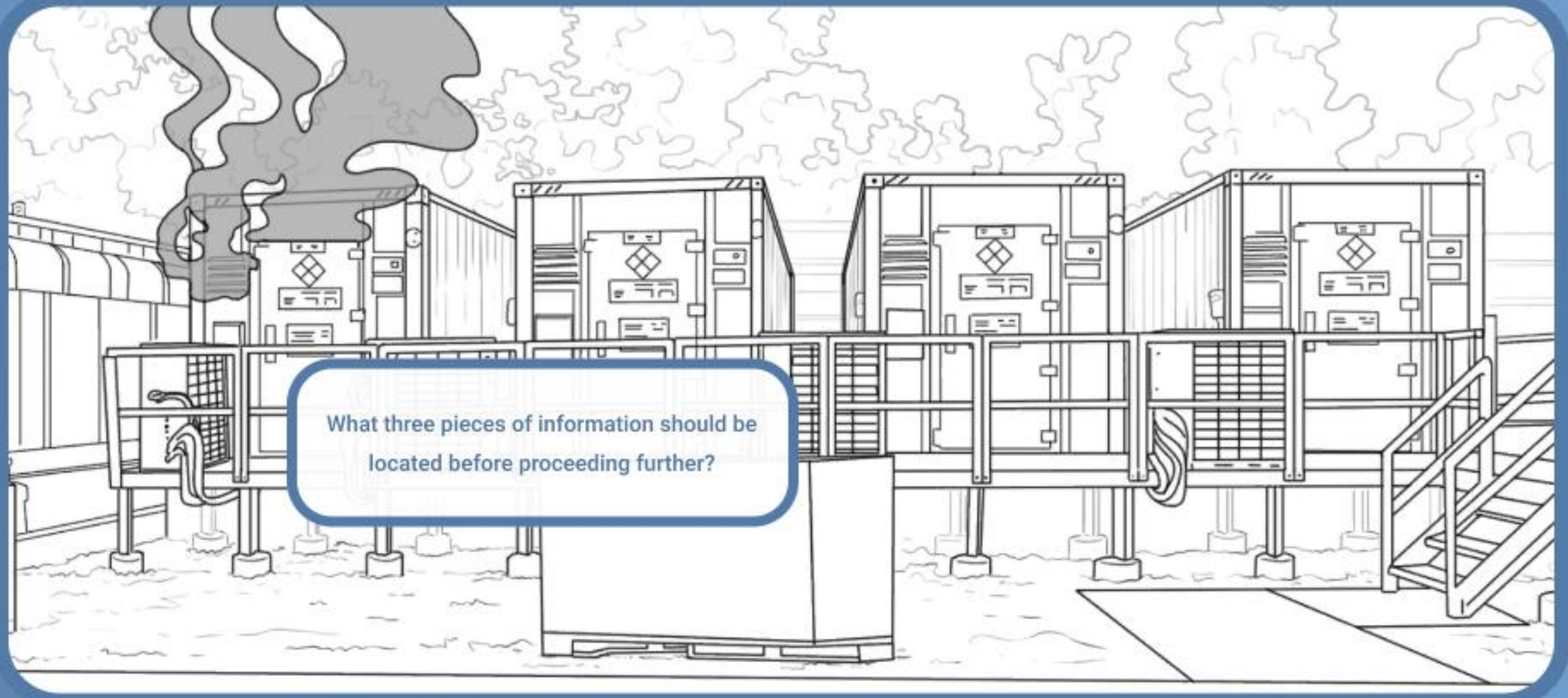

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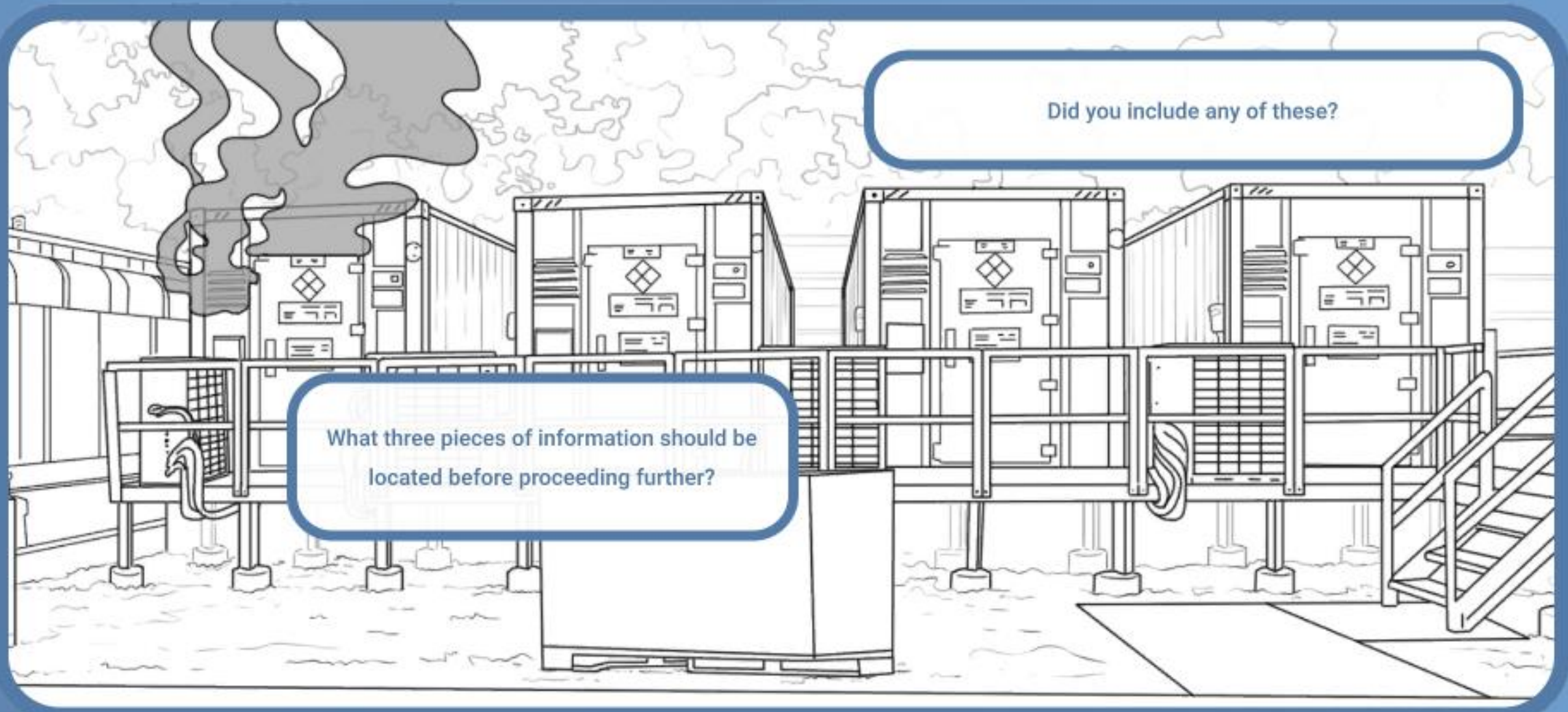

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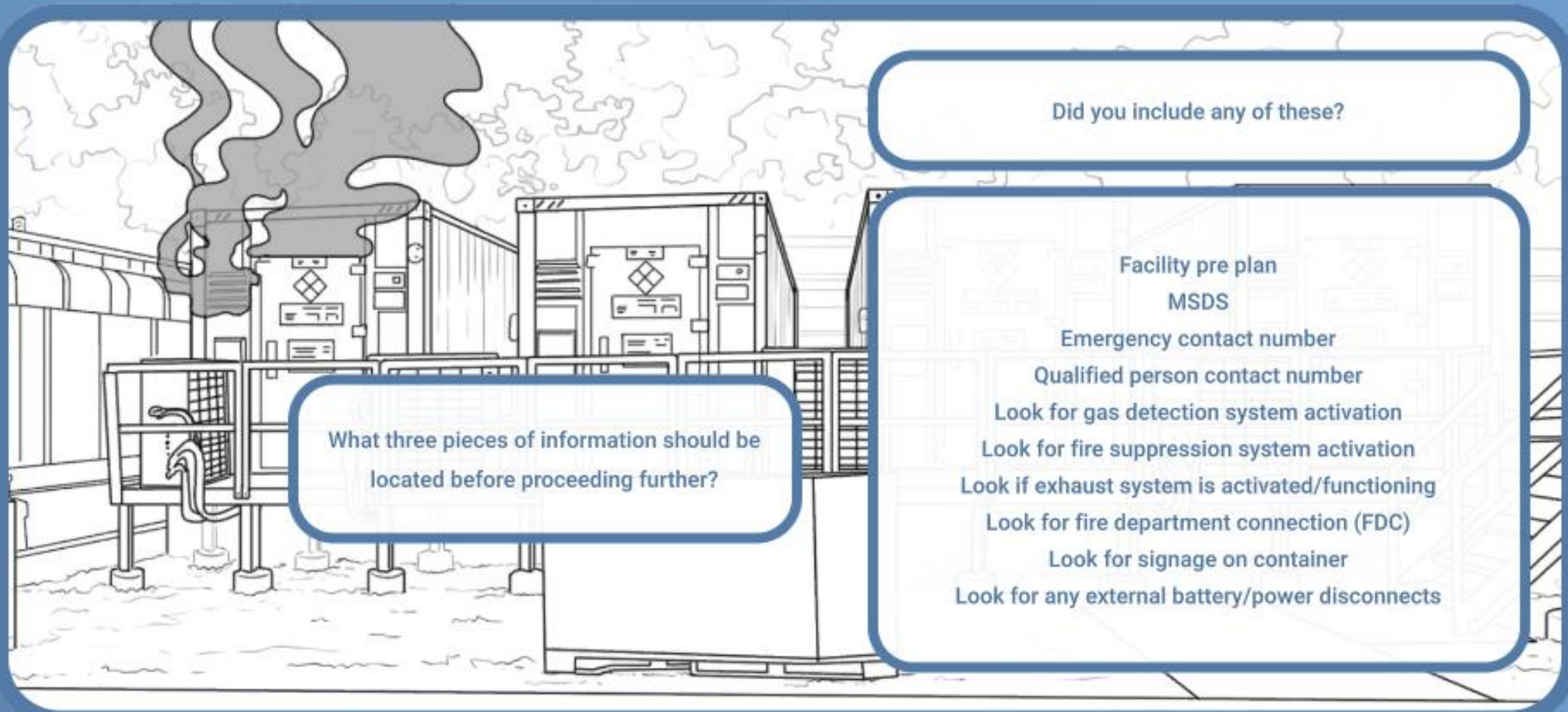

What three pieces of information should be located before proceeding further?

Did you include any of these?

Facility pre plan
MSDS
Emergency contact number
Qualified person contact number
Look for gas detection system activation
Look for fire suppression system activation
Look if exhaust system is activated/functioning
Look for fire department connection (FDC)
Look for signage on container
Look for any external battery/power disconnects

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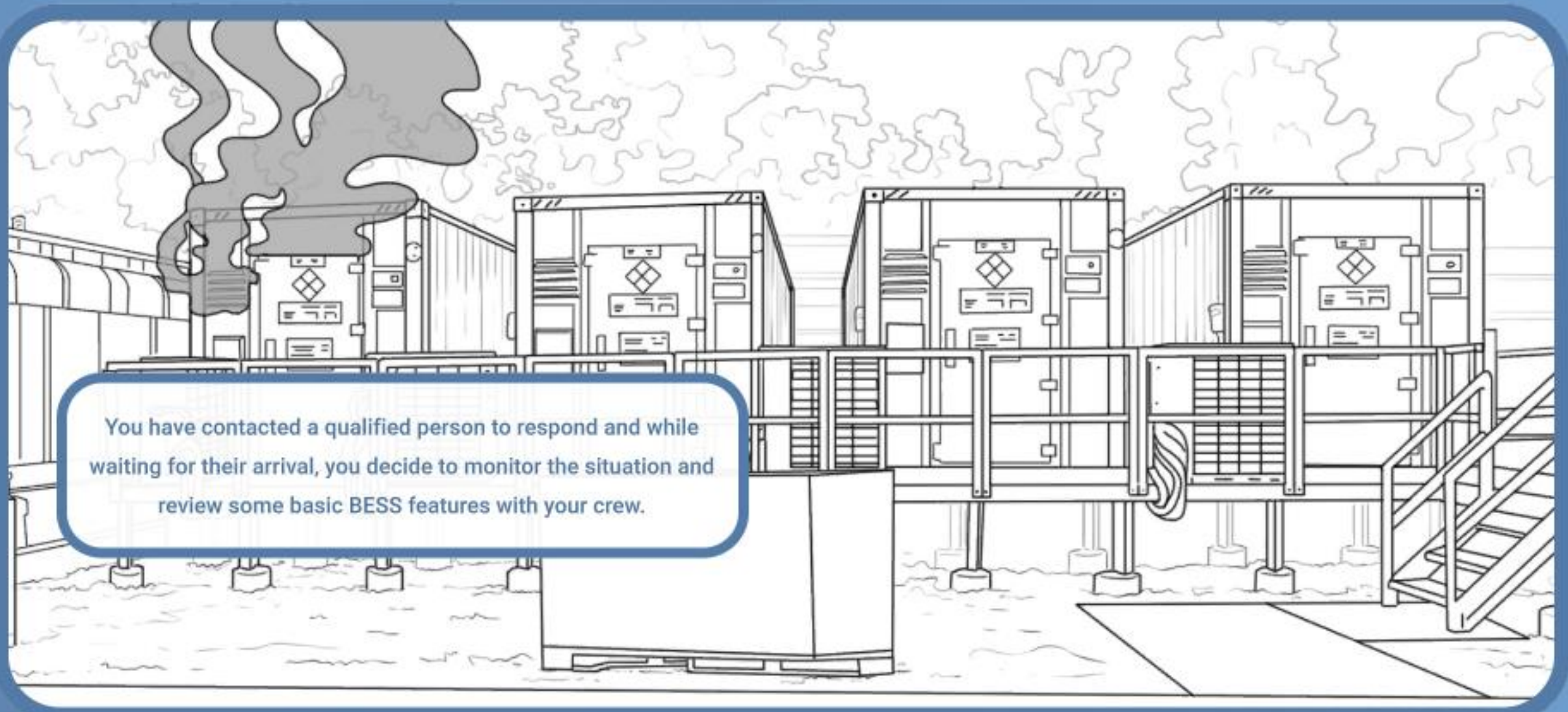

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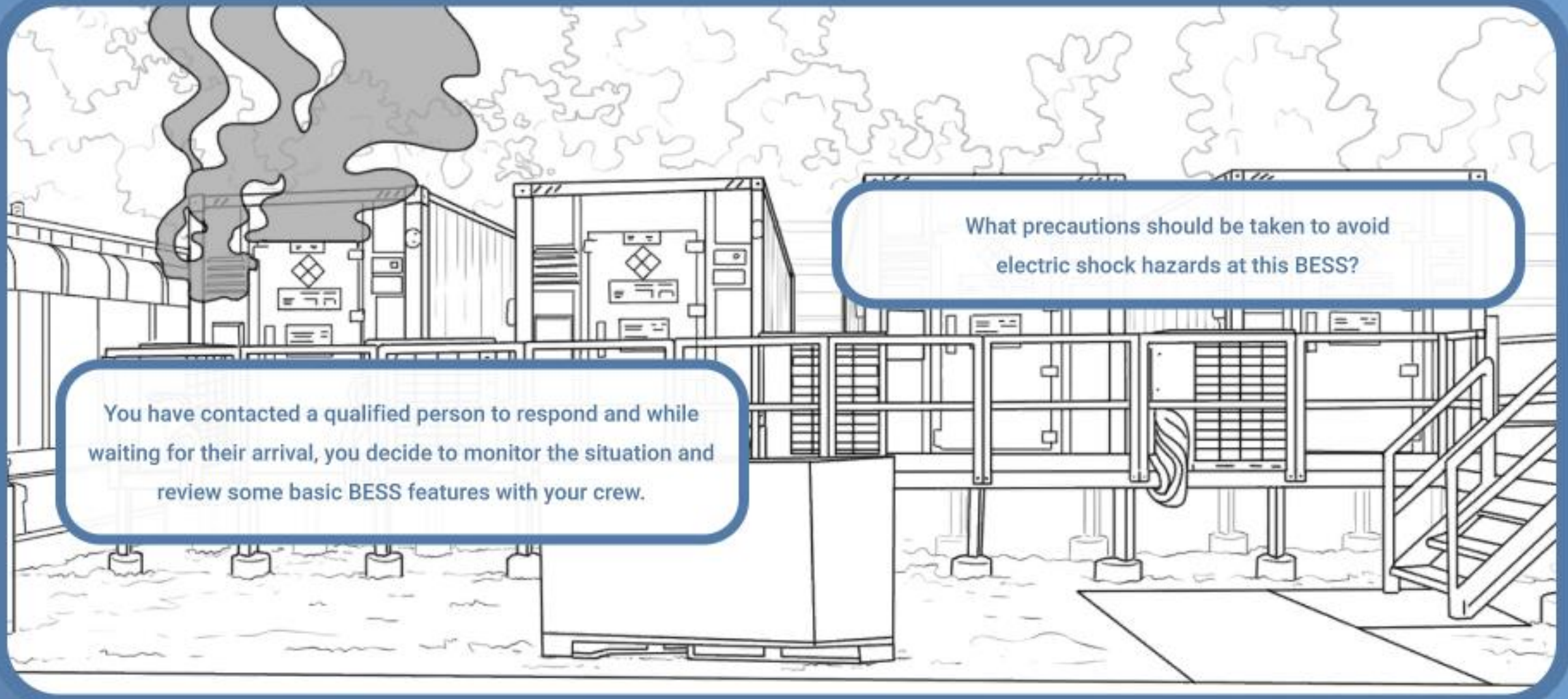

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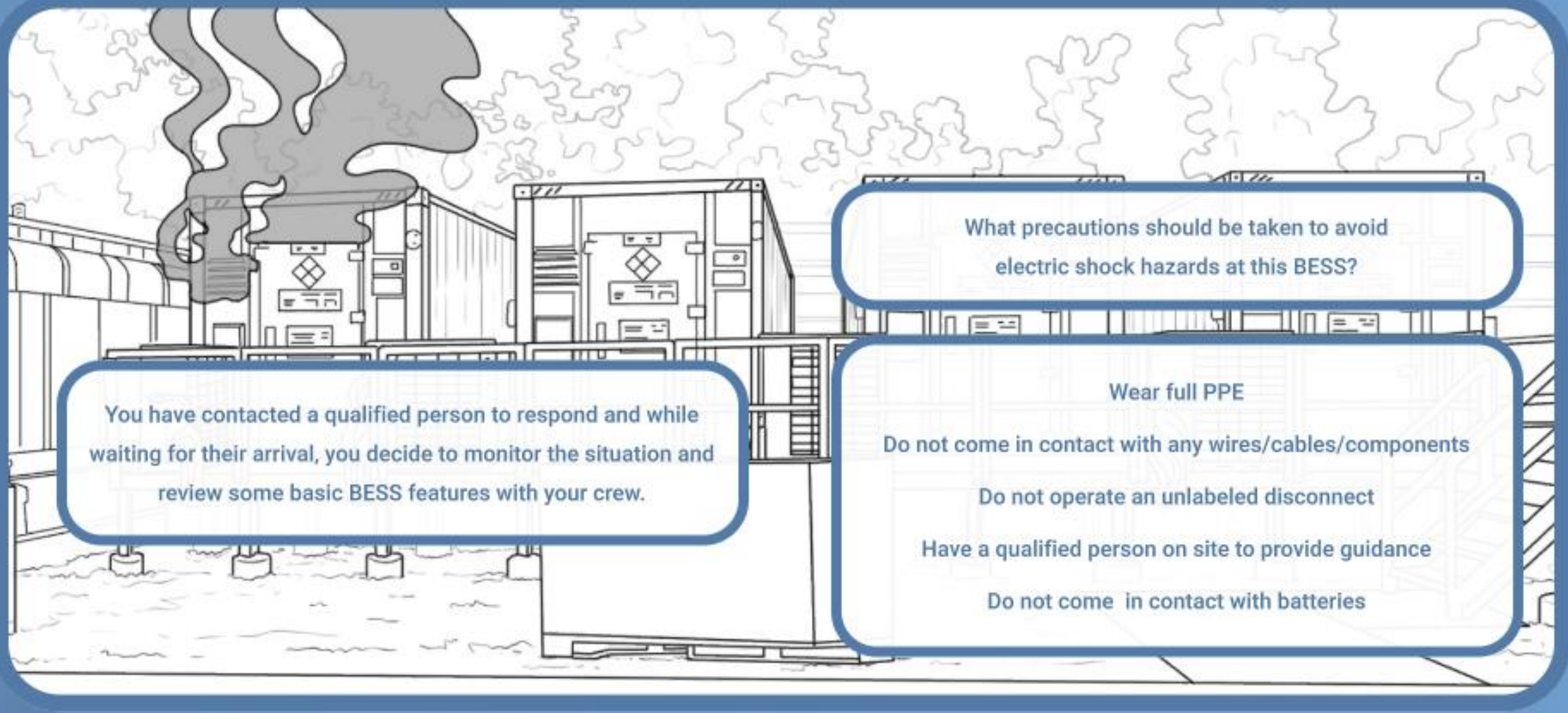

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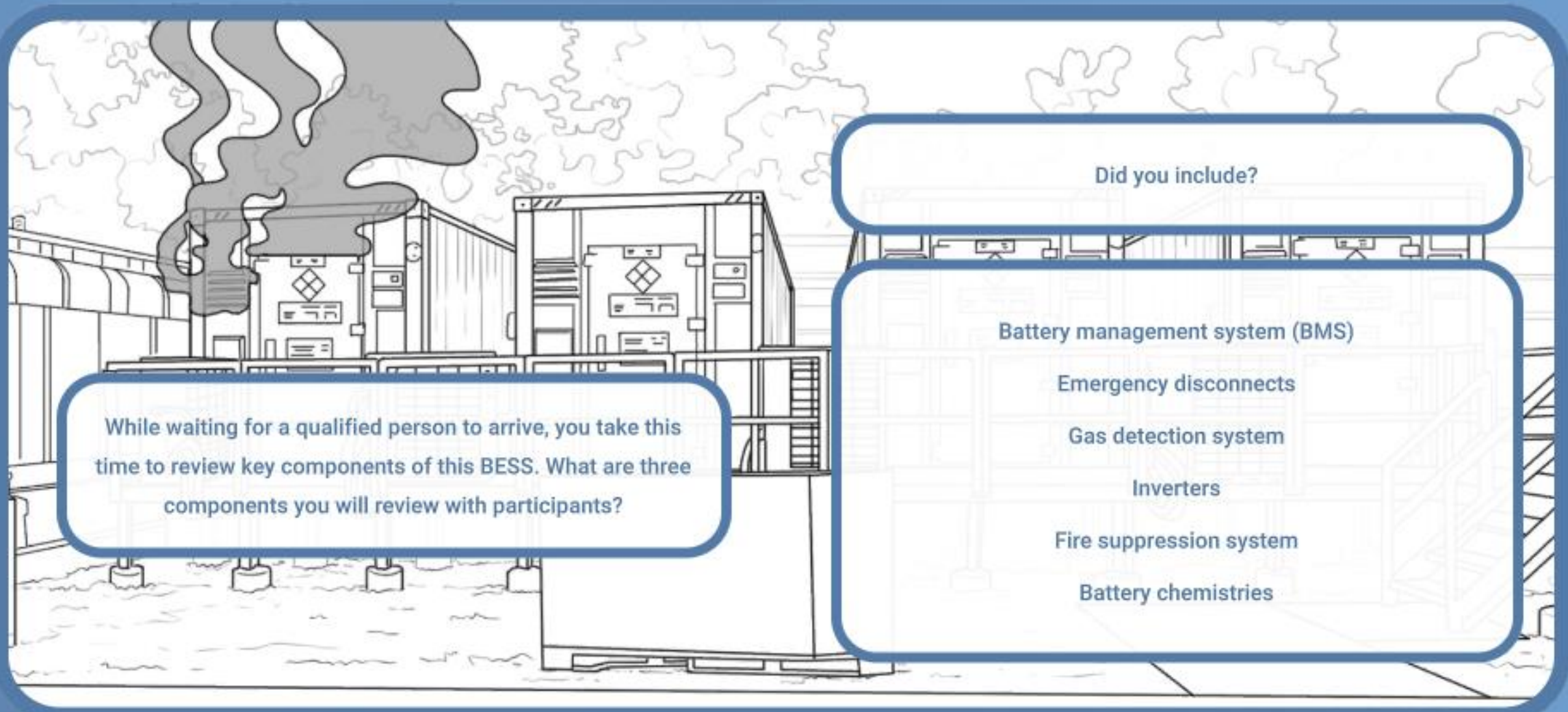

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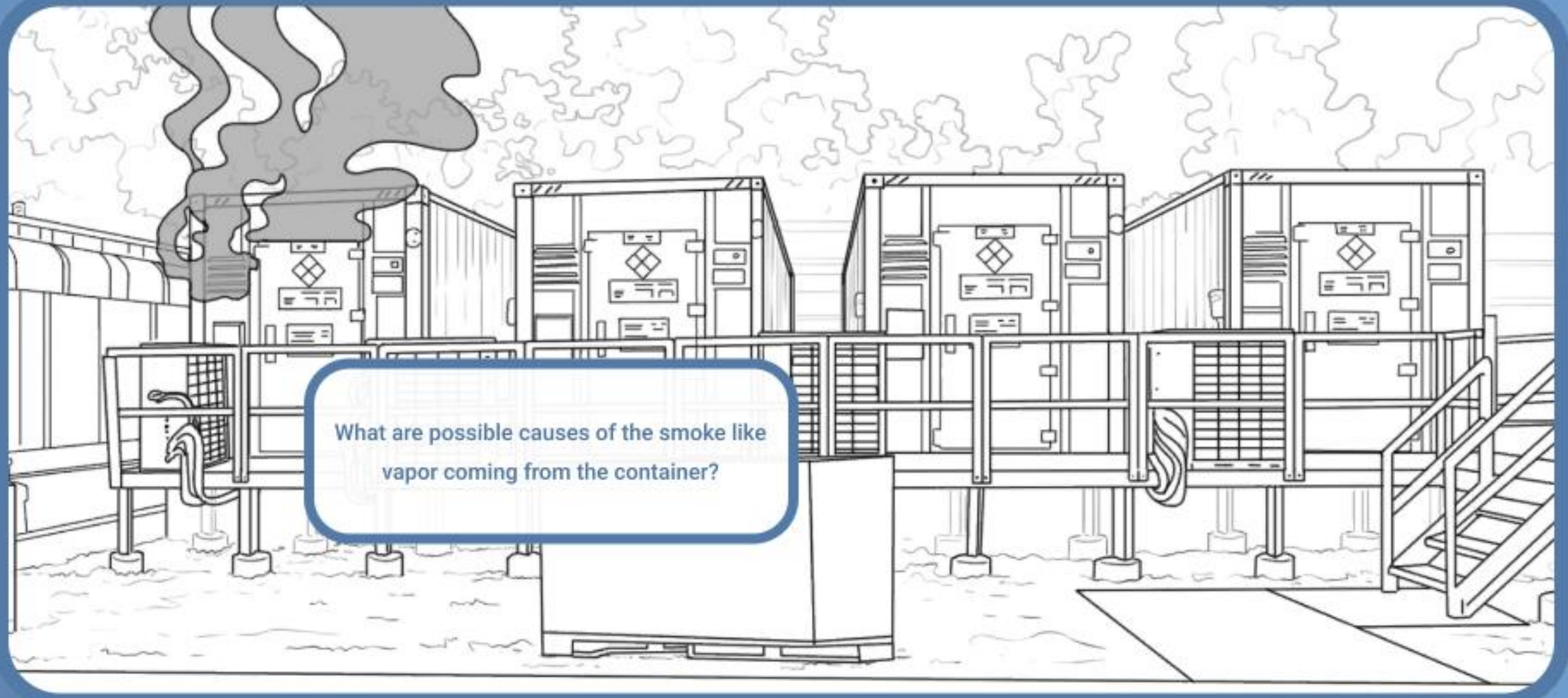

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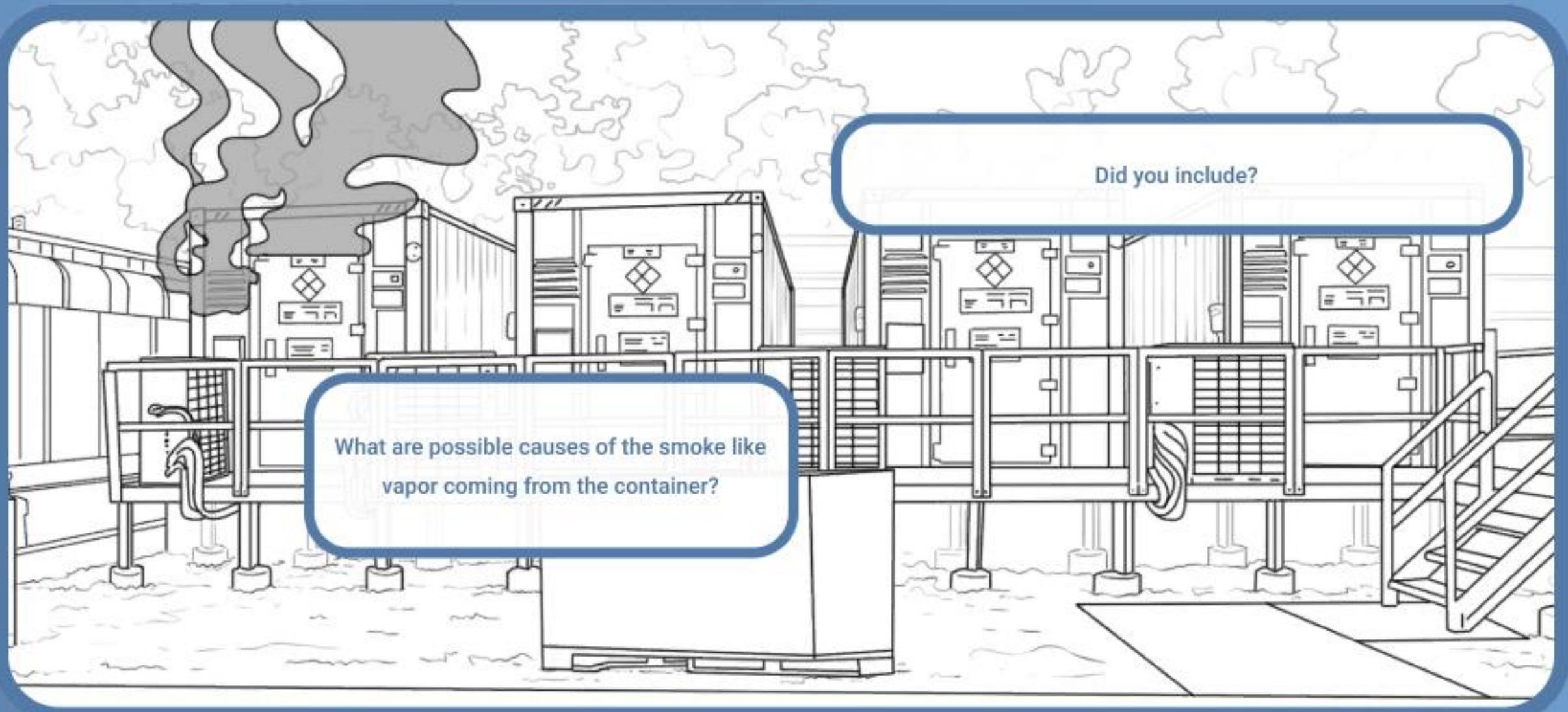

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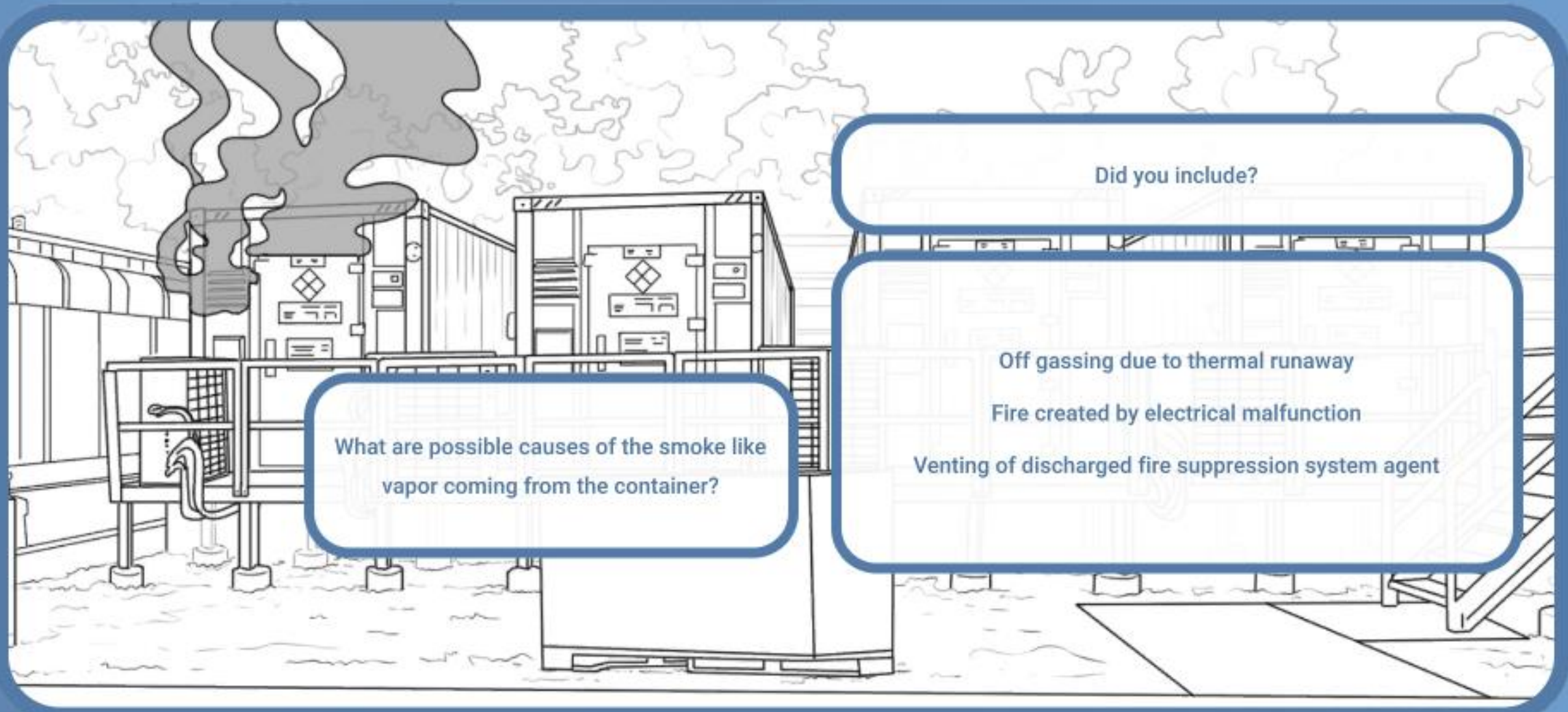

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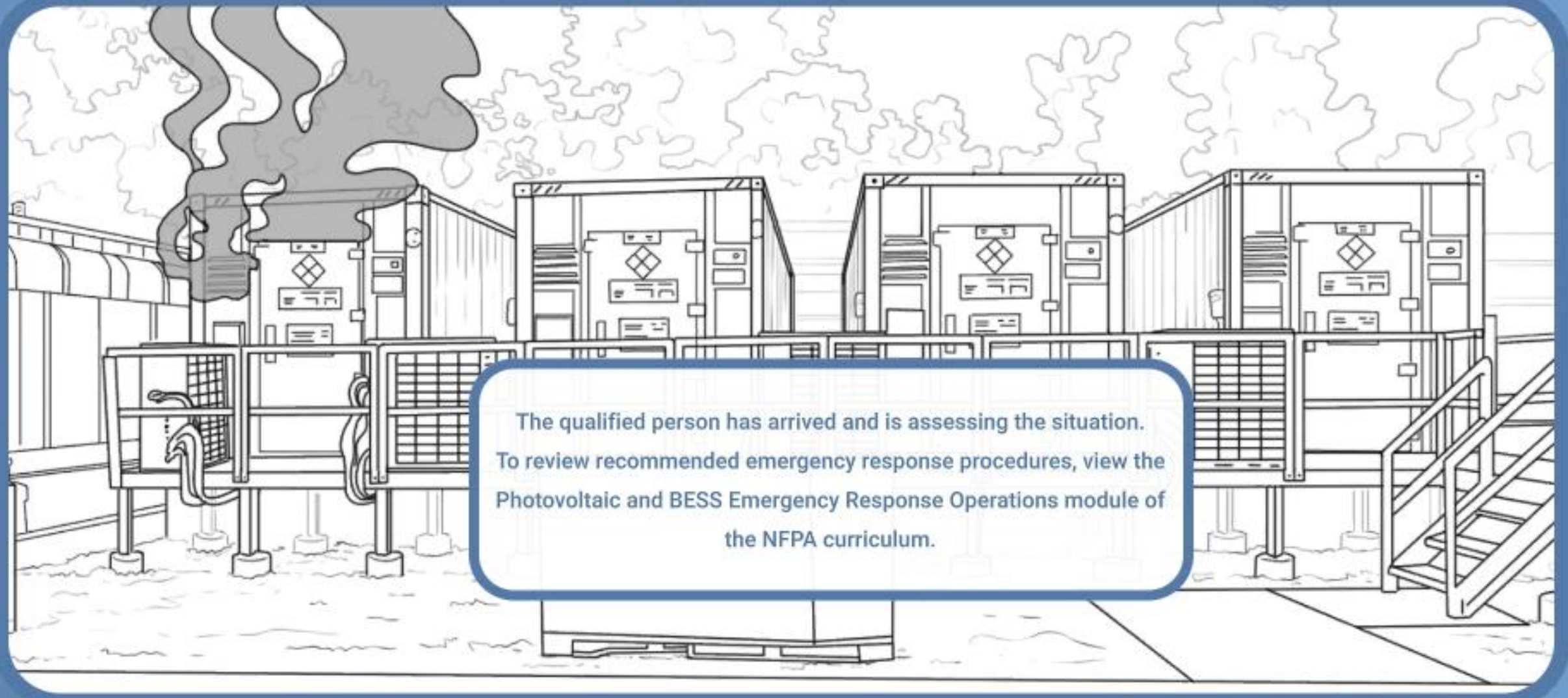
The qualified person has arrived and is assessing the situation.
To review recommended emergency response procedures, view the Photovoltaic and BESS Emergency Response Operations module of the NFPA curriculum.