Community Development Committee Meeting

April 7, 2026
4:30 PM

AGENDA

http://www.bonneylake.gov/

Location: Bonney Lake Justice & Municipal Center, 9002 Main Street East, Bonney Lake, Washington.

The public is invited to attend Community Development Committee Meetings. Options for attending are provided below.

In-Person: Bonney Lake Justice & Municipal Center at 9002 Main Street East in Bonney Lake
By phone:1-323-792-6234 (Meeting ID: 576 517 451#)
By internet: Chrome- TEAMS Meeting Link (Meeting ID: 272 334 403 013 80)

All public online cameras and microphones will be disabled except during citizen comments. Only staff and presenters will be visible and unmuted during the entire meeting.

I. Call to Order

II. Community Development Committee Roll Call

Councilmember Fullerton, Councilmember McClimans, and Councilmember Rock.

III. Approval of Minutes

A. **Approval of Minutes:** March 03,2026 Community Development Committee Minutes

IV. Department Reports/Presentations

V. Items for Discussion/Action

A. Battery Energy Storage Systems

B. An Ordinance Of The City Council Of The City Of Bonney Lake, Pierce County, Washington, Relating To Automatic Fire Extinguishing Systems, Repealing Chapter 15.16 Of The Bonney Lake Municipal Code (BLMC); Amending Subsections 14.120.030.A And .B To Remove References To Chapter 15.16 BLMC; Amending Subsection 15.04.084 To Reflect Current Procedure For Annual Fire Safety Inspections; Amending Subsection 15.36.040 To Reflect Current Procedure For Processing Permits For Underground Infrastructure For Automatic Fire Extinguishing Systems; Providing For Severability And Corrections; And Establishing An Effective Date

VI. Open Committee Discussion

A. Geological Hazards Discussion

VII. Public Comments

Public comments can be made in-person, by phone or virtually during this portion of the meeting. Comments are limited to 5 minutes. All who comment will be asked to state their name for the meeting record.

VIII. Adjournment

Anything submitted at the Meeting will be added to the end of the packet the next day.

The City of Bonney Lake does not discriminate on the basis of disability, race, color, or national origin in its programs, services, or activities. If you need language assistance, translation, or an auxiliary aid, service, or policy modification to fully participate, please email the City Clerk's Office or call at 253-862-8062 (TTY 711) at least 5 business days before the event; later requests will be honored when feasible.

Community Development Committee Meeting

March 3, 2026
4:30 PM

Minutes

http://www.bonneylake.gov/

I. Call to Order

Chair Fullerton, called the meeting to order at 4:31 p.m.

II. Community Development Committee Roll Call

Elected officials attending were: Councilmember Gwendolyn Fullerton (Chair), and Councilmember Brittany Rock. Councilmember Kelly McClimans was virtual.

Staff in attendance at the physical location were: Public Services Director Jason Sullivan, Development Services Director Lauren Balisky, and Administrative Specialist II Debbie McDonald.

III. Approval of Minutes

A. **Approval of Minutes:** February 17, 2026 Community Development Committee Meeting

The Community Development Committee draft minutes were approved with a minor correction.

IV. Department Reports/Presentations

None.

V. Items for Discussion/Action

None.

VI. Open Committee Discussion

A. 2025 Permit Summary

Introduced by Development Services Manager Balisky who gave an overview of the 2025 Permit Summary Report.

The Committee discussed and shared their concerns, including:

- Shared mailbox.

• Who scanned
• Age of files scanned.
• Who chose the permitting software?
• Implementation of permitting software.

Councilmember McClimans:
Community Garden. Councilmember McClimans asked if there was an update on the running of the Community Garden.

Public Services Director Sullivan responded GoodRoots Northwest will take over the running of the Community Garden.
The fee for the plots is split 20% for GoodRoots and 80% for the City.

The Committee discussed and shared their concerns, including:
• Contract go through the Finance Committee
• Parcel has to stay a Community Garden.
• Copy of the Contract.

VII. Public Comments

None.

VIII. Adjournment

At 5:07p.m. the Meeting was adjourned by Councilmember Gwendolyn Fullerton with the common consent of the Committee.

Debbie McDonald, Administrative Specialist II	Councilmember Gwendolyn Fullerton, Chair

City of Bonney Lake, Washington

Community Development Committee Agenda Bill (AB)

Agenda Bill Number:	
Agenda Item Type:	None
Presenter:	Jason Sullivan, Public Services Director, Lauren Balisky, Development Services Manager
City Strategic Goal Category:	None
Department/Division Submitting:	Public Services Staff
Impacted Departments That Received Notification:	None

Full Title/Motion: Battery Energy Storage Systems

Short Background Summary:

PURPOSE
In Fall 2025 Puget Sound Energy (PSE) issued a Request for Proposals (RFP) for energy storage sites, including for Battery Energy Storage Systems (BESS). Staff have been receiving inquiries about installation of these systems, including a pre-application meeting request for the property immediately north of the Public Safety building. The purpose of this item is for CDC to direct staff on whether to:

1. Take no action (leave existing requirements as is);
2. Prepare an ordinance containing interim regulations; or
3. Prepare an ordinance placing a temporary moratorium on BESS applications.

ABOUT BATTERY ENERGY STORAGE SYSTEMS (BESS)
Battery Energy Storage Systems (BESS) are systems of rechargeable large-format batteries that help electric utilities moderate demand for electricity during short-term peak usage and extreme weather events. In extreme cases, BESS can help protect sensitive equipment such as transformers, transmission lines, switches, and other infrastructure from overload, preventing blackouts or long-term service outages.

PSE's RFP seeks 5-megawatt lithium-ion systems placed along segments of its system capable of handling the storage systems without major off-site system upgrades. In Bonney Lake, this is generally located along:

- Myers Rd E
- Bonney Lake Blvd E

- Locust Ave
- Veterans Memorial Dr E between Locust Ave E and 192nd Ave E
- Angeline Rd E between Rhodes Lake Rd E and the 9900 block of Angeline Rd E
- Small segments adjacent to Bonney Lake High School and Mountain View Middle School

The PSE Request for Proposals can be viewed online at: https://www.pse.com/en/pages/energy-supply/acquiring-energy/2025-Distributed-Solar-and-Storage-RFP

PROS AND CONS OF BESS
At a high level, the pros and cons of a utility-scale BESS system include:

- PROS
    - Electric grid stabilization during periods of high use or short-term outages
    - Quick response to fluctuations in the electrical grid
    - Reduces the inefficiency of renewable energy sources
- CONS
    - High upfront and replacement capital costs
    - Short use period (4 hours per 24-hour period) and relatively short lifespan (~10-13 years)
    - Significant fire safety risks that require specialized equipment and training. For Bonney Lake, this also includes the impacts of runoff to the City's groundwater supply.

For more information, see the attachments.

CURRENT CITY REGULATORY REQUIREMENTS
Under the Bonney Lake Municipal Code (BLMC), "public utility facilities" are permitted outright in all zoning districts (BLMC 18.08.020). A "public utility" is "*an entity whose principal purpose is to provide electricity, water, sewer, storm drainage, gas, radio, television, telephone and/or other forms of communication utilizing electromagnetic spectrum to the general public*" (Ordinance 1745, page 15). The City requires that the property associated with a public utility facility is owned, under a contract for purchase, or leased by the public utility and not by a private entity to be permitted as a public utility facility.

In the City's residential zones (R-1, R-3, and RC-5), public utility facilities must be for the distribution of services and cannot be an office, warehouse, storage or service yard, or similar use. Landscaping is required.

In all other zones, construction of above-ground public utility facilities are required to comply with all critical area, construction code, and engineering standards. Installations exceeding 2000 square feet of gross floor area are also required to comply with applicable design review standards.

For a map showing the City's zoning districts, visit the Public GIS map at: https://qrco.de/CBLGIS

OPTION 1: TAKE NO ACTION
Under this option, staff would process any BESS application under existing regulations.

OPTION 2: DIRECT STAFF TO PREPARE INTERIM REGULATIONS
Revised Code of Washington (RCW) 36.70A.390 allows cities to adopt interim regulations without a public hearing, so long at the public hearing is held within 60 days. Final regulations must be adopted within 6 months of adoption of the interim ordinance. This includes environmental review, review by state agencies, Planning Commission review and public hearing, and City Council public hearing and decision.

OPTION 3: DIRECT STAFF TO PREPARE A MORATORIUM
Under RCW 36.70A.390, cities can also adopt a moratorium. If CDC chooses this option, staff would prepare an ordinance that prohibits BESS applications for up to 6 months. City Council must hold a hearing on the ordinance within 60 days.

Under both Options 2 and 3, the City may extend the time periods with additional public hearings and a work plan.

Budget Explanation:

N/A

Committee, Board, Commission, & Hearing Examiner Review

Name Of Committee/Commission/Examiner Meeting:

Date of Committee/Commission/Examiner Meeting:

Date of Committee/Commission Public Hearing:

Committee/Commission/Examiner Meeting Decision:

Council Action

Date of Council Workshop	Date of Council Meeting	Date of Council Public Hearing

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Battery Energy Storage Systems:

Main Considerations for Safe Installation and Incident Response

Battery Energy Storage Systems Overview

Battery energy storage systems (BESS) stabilize the electrical grid, ensuring a steady flow of power to homes and businesses regardless of fluctuations from varied energy sources or other disruptions. However, fires at some BESS installations have caused concern in communities considering BESS as a method to support their grids. BESS fires pose challenges to first responders due to the:

- Difficulty in putting out lithium-ion battery fires.
- Potential health impacts from emissions.
- Need to clean up and properly dispose of burned or impacted batteries.

Communities should consult BESS safety experts when considering and designing installations. Communities should also note that despite some high-profile incidents, improvements in BESS quality and design have led to a decrease in the number of failure incidents per gigawatt hour deployed (Figure 1).

This document includes information from first responder and industry guidance as well as:

- Background information on BESS, including challenges and recent fires
- BESS installation considerations
- BESS incident response considerations
- Resources for fire planning and response
- Standards and links to additional resources

In recent years, first responder and industry associations have developed guidance to help communities identify focus areas when planning a BESS, including how to work with local responders to improve incident preparedness. This document is a non-comprehensive collection of existing research and guidance.

Facts about Recent Fires

Since 2020, BESS failure incidents have decreased, but some recent fires have gained attention in the media. On May 15, 2024, Gateway Energy Storage Facility in San Diego, California, experienced a BESS fire with continued flare-ups for seven days following the fire. The facility held about 15,000 nickel manganese cobalt lithium-ion batteries. Following the incident, EPA has required the Gateway facility to conduct extensive environmental monitoring during battery handling and disposal operations and submit detailed work plans and progress reports.[1]

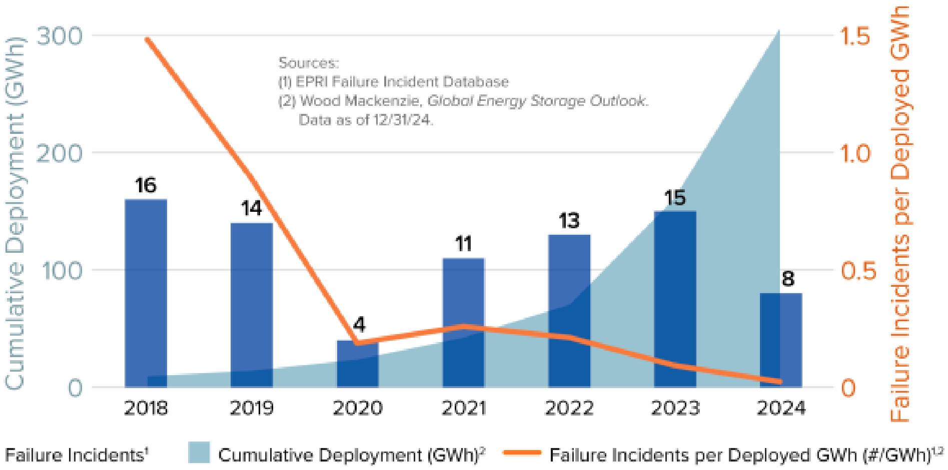

Figure 1. Global grid-scale storage deployment and failure statistics. Source: Electric Power Research Institute (EPRI), 2024.

[1] U.S. Environmental Protection Agency. (n.d.). *Site profile: Gateway Energy Camino lithium-ion battery fire*. https://response.epa.gov/site/site_profile.aspx?site_id=16485.

On January 16, 2025, a BESS fire broke out at the Moss Landing site in Monterey County, California, resulting in a 24-hour evacuation of about 1,200 residents. A joint effort among company personnel and the North County Fire Department kept the fire contained to one building, though with one notable flare-up. Air quality monitoring and sampling occurred during and after the fire and found no risks to public health. Following the incident, EPA continues to work with other regulators to ensure the safe storage, handling, and transportation of undamaged batteries remaining at the Moss Landing site.[2]

Clear and comprehensive incident response plans are critical when managing BESS sites to ensure preparedness in the event of a battery fire.

Installation Considerations

Proactive safety measures can be included in a BESS site design to minimize the risk of a BESS fire. Consider the following before installing a BESS:

- Comply with state and local siting, zoning, marking, and permitting requirements to ensure site suitability.
- Consider the design of BESS units (battery chemistry, manufacturing quality assurance/quality checks, unit design, battery management system analytic capabilities, and system integration) and consult the most recent industry safety standards.
- Include remote sensors and monitoring (e.g., infrared, thermal, fire detection).
- Communicate with local first responders to develop emergency response plans for incidents.

Incident Response Considerations

Consider the following when developing an incident response plan for BESS:

- Ensure use of Personal Protective Equipment (PPE) including self-contained breathing apparatuses to protect against hazardous air emissions.
- Set an isolation zone for large commercial BESS that is at least 330 feet, depending on the site.
- Position responders upwind and uphill.
- Evaluate the need for community shelter-in-place or evacuation, depending on the incident and site.
- Current guidance is to focus the response on preventing the spread of fire.
    - Direct fire crews to let the fire burn itself out and to use water to prevent the spread of fire to neighboring batteries or other structures.[3]
- Assess hazardous air emissions:
    - Use modeling to guide on-site decision making and initially monitor for hydrogen, carbon monoxide, hydrogen fluoride, hydrogen cyanide, and hydrogen chloride.
    - As an incident extends, sample air for metals and other combustion byproducts of burning plastics.
- Minimize, contain, and/or redirect runoff from water application, to the extent possible.
- Package contents safely for transport and disposal after the event, considering Department of Transportation and EPA requirements.

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[2] Vistra. (n.d.). *Moss Landing response*. Moss Landing Response. https://www.mosslandingresponse.com.

[3] Research is ongoing into the most effective method of water application to prevent spread.

Resources for Fire Planning and Response at BESS Installations

In addition to adhering to existing standards, communities and operators of BESS sites should reference existing resources to enhance fire preparedness and response plans. Table 1 includes a list of trainings, standard operating procedure (SOP) guides, toolkits, emergency response plans, and research for BESS sites.

Relevant BESS Standards

National Fire Protection Association (NFPA) Standard 855: Standards detailing the requirements for mitigating the hazards associated with energy storage systems (ESS). First edition 2020; current edition 2023; next update 2026.

Underwriters Laboratory (UL) 9540 and 9540A: Standards for energy storage systems and equipment: charging and discharging procedures, fire protection, and test methods for BESS. First edition 2016, current edition revised 2025.

Table 1. Additional resources for BESS sites

Resource (Linked)	Description
EPA On-Scene Coordinator Lithium-Ion Battery Outreach Page	• **Outreach**: The EPA On-Scene Coordinators are available to provide training to city and county fire fighters, Local Emergency Planning Committees (LEPCs), and conference audiences. Contact information is available on the Outreach page. • **Resources:** Resources for pre-planning with local responders, sample standard operating procedures, presentations, and worksheets. • **Web-based**: Remote training that covers battery basics, hazards, transport and disposal concerns, and air monitoring (coming soon).
NFPA ESS Safety Fact Sheet	• Fact sheet outlining ESS advantages, hazards, and safety measures.
San Diego Fire Department Toolkit	• Collection of resources on lithium-ion battery fire response, incident reports, research, and public safety education.
Tennessee Emergency Management Agency (TEMA) Toolkit	• Collection of fact sheets and presentations on BESS fire hazards and prevention.
International Association of Fire Chief (IAFC) Fact Sheet	• Fact sheet covering recommended fire department ESS pre-planning and incident response.
Electric Power Research Institute (EPRI) Research Hub	• Collection of energy storage research, including information about EPRI’s database of BESS failures and root cause categorizations.
Fire Protection Research Foundation Website	• Information about an ongoing research project examining hazards and mitigation for BESS units.
New York Battery and Energy Storage Technology Consortium Library	• Library of systems safety and best practices resources from various associations and fire codes.

NFPA FACT SHEET

ENERGY STORAGE SYSTEMS SAFETY FACT SHEET

Growing concerns about the use of fossil fuels and greater demand for a cleaner, more efficient, and more resilient energy grid has led to the use of energy storage systems (ESS), and that use has increased substantially over the past decade. Renewable sources of energy such as solar and wind power are intermittent, so storage becomes a key factor in supplying reliable energy. ESS also help meet energy demands during peak times and can supply backup power during natural disasters and other emergencies. However, the rise in the number of ESS installations requires the need for a heightened understanding of the hazards involved and more extensive measures to reduce the risks.

What Is an ESS?

An ESS is a device or group of devices assembled together, capable of storing energy in order to supply electrical energy at a later time. Battery ESS are the most common type of new installation and are the focus of this fact sheet.

DID YOU KNOW?

Battery storage capacity in the United States is expected to more than double between 2022 and 2025 from 9.4 GW to 20.8 GW, according to the U.S. Energy Information Administration.

Some ESS Advantages

Supplement Renewables

Renewable energies such as solar panels or wind turbines only produce electricity when the sun is out or the wind is blowing. Supplementing these with ESS allows users to take advantage of the electricity that is generated when the renewable energy technologies are not producing electricity.

Peak Shaving

ESS allows a user to shift where their electricity comes from by drawing power from the batteries during the higher-cost daytime hours then recharging during the lower-cost nighttime hours. This practice is referred to as peak shaving.

Load Leveling

When power generation facilities ramp up and ramp down to keep up with the changing demand for electricity, it puts stress on the system. ESS can help flatten out the demand curve by charging when electrical demand is low and discharging when it is high.

Uninterruptible Power Supply

ESS can provide near instantaneous protection from power interruptions and are often used in hospitals, data centers, and homes.

Some ESS Hazards

Thermal Runaway

Thermal runaway is a term used for the rapid uncontrolled release of heat energy from a battery cell; it is a condition when a battery creates more heat than it can effectively dissipate. Thermal runaway in a single cell can result in a chain reaction that heats up neighboring cells. As this process continues, it can result in a battery fire or explosion. This can often be the ignition source for larger battery fires.

Stranded Energy

As with most electrical equipment there is a shock hazard present, but what is unique about ESS is that often, even after being involved in a fire, there is still energy within the ESS. This is difficult to discharge since the terminals are often damaged and presents a hazard to those performing overhaul after a fire. Stranded energy can also cause reignition of the fire hours, days, or even weeks later.

Toxic and Flammable Gases Generated

Most batteries create toxic and flammable gases when they undergo thermal runaway. If the gases do not ignite before the lower explosive limit is reached, it can lead to the creation of an explosive atmosphere inside of the ESS room or container.

Deep Seated Fires

ESS are usually comprised of batteries that are housed in a protective metal or plastic casing within larger cabinets. These layers of protection help prevent damage to the system but can also block water from accessing the seat of the fire. This means that it takes large amounts of water to effectively dissipate the heat generated from ESS fires since cooling the hottest part of the fire is often difficult.

ENERGY STORAGE SYSTEMS SAFETY FACT SHEET *CONTINUED*

Failure Modes

These are ways the batteries can fail, often leading to thermal runaway and subsequent fires or explosions.

Mechanical Abuse	Thermal Abuse	Electrical Abuse	Environmental Impacts
Can happen when a battery is physically compromised by either being dropped, crushed, or penetrated.	Can occur when a battery is exposed to external heat sources.	Can happen when the battery is overcharged, charged too rapidly or at high voltage, or discharged too rapidly.	Can lead to battery failure include seismic activity, rodent damage to wiring, extreme heat, and floods.

Tips to Help Keep People and Property Safe

For the Designer/Installer

Explosion Protection/Prevention
If there are enough batteries in a room to create an explosive atmosphere, then explosion prevention systems or deflagration venting should be installed per NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, and NFPA 69, *Standard on Explosion Prevention Systems*.

Fire Suppression System
Testing has shown water to be the most effective medium for cooling an ESS fire. A sprinkler system that complies with NFPA 13, *Standard for the Installation of Sprinkler Systems,* should be installed in buildings where an ESS is installed.

Battery Management System (BMS)
A BMS is a critical system that should be used in an ESS to monitor, control, and optimize performance of an individual or multiple battery modules in an ESS. It can also control the disconnection of the module(s) from the system in the event of abnormal conditions.

Spacing
ESS units should be grouped into small segments limited to certain kilo-watt hours (kWh) and spaced from other segments and walls to prevent horizontal propagation. The table below, which summarizes information from a 2019 Fire Protection Research Foundation (FPRF) report, "Sprinkler Protection Guidance for Lithium-Ion Based Energy Storage Systems," demonstrates the recommended spacing for the testing for specific chemistries and arrangements.

Recommended Separation of Lithium-Ion Battery Energy Storage Systems

ESS Type & Capacity	Object Combustibility	Sprinklered ft (m)	Nonsprinklered ft (m)
LFP 31 kWh	Non Combustible	-	< 3 ft (< 0.9 m)
	Combustible	-	4 ft (1.2 m)
LFP 83kWh	Non Combustible	3 ft (0.9 m)	4 ft (1.2 m)
	Combustible	5 ft (1.5 m)	6 ft (1.8 m)
LNO/LMO 47 kWh	Non Combustible	-	4 ft (1.2 m)
	Combustible	-	6 ft (1.8 m)
LNO/LMO 125 kWh	Non Combustible	6 ft (1.8 m)	8 ft (2.4 m)
	Combustible	9 ft (2.7 m)	13 ft (4.0 m)

ENERGY STORAGE SYSTEMS SAFETY FACT SHEET *CONTINUED*

For the AHJ

Permitting Checklist

Permits should be issued by and in accordance with the procedures of all authorities having jurisdiction (AHJ) and should bear the name and signature of each AHJ or their designated representative(s). In addition, the permit should indicate the following:

1. Purpose of the ESS for which the permit is issued
2. Type of ESS, size, weight broken down by subcomponents or subsystems, type, and amount of any hazardous materials, general arrangement of the system, and extent of work to be performed
3. Address where the ESS is to be installed and operated
4. Name and address of the permittee
5. Permit number and date of issuance
6. Period of validity of the permit
7. Inspection requirements

For the Fire Service

Pre-Incident Planning

The fire department should develop a pre-incident plan for responding to fires, explosions, and other emergency conditions associated with the ESS installation, and the pre-incident plan should include the following elements:

1. Understanding the procedures included in the facility operation and emergency response plan described
2. Identifying the types of ESS technologies present, the potential hazards associated with the systems, and methods for responding to fires and incidents associated with the particular ESS
3. Identifying the location of all electrical disconnects in the building and understanding that electrical energy stored in ESS equipment cannot always be removed or isolated
4. Understanding the procedures for shutting down and de-energizing or isolating equipment to reduce the risk of fire, electric shock, and personal injury hazards
5. Understanding the procedures for dealing with damaged ESS equipment in a post-fire incident, including the following:
   - **a.** Recognizing that stranded electrical energy in fire-damaged storage batteries and other ESS has the potential for reignition long after initial extinguishment
   - **b.** Contacting personnel qualified to safely remove damaged ESS equipment from the facility (This contact information is included in the facility operation and emergency response plan.)

Emergency Operations Planning

An emergency operations plan should be created and contain elements such as procedures to safely shut down the system, procedures for the removal of damaged ESS, general emergency procedures, and annual staff training.

CASE STUDY

On April 19, 2019, a thermal runaway event followed by an explosion occurred at the McMicken Battery Energy Storage System in Surprise, Arizona. A fire captain, a fire engineer, and two firefighters sustained serious injuries. The walk-in structure housed a 2.16 MWh lithium-ion battery energy storage system. This event highlighted the hazard of a non-flaming thermal runaway event and the need for deflagration prevention and protection.

FAQs

Q: Which NFPA standard covers the installation of ESS?

A: If you are installing ESS for either new construction or a renovation, you should review the requirements of NFPA 855, *Standard for the Installation of Energy Storage Systems.*

Q: What is the best extinguishing agent for a fire in a battery ESS?

A: Testing has shown that water is the most effective agent for cooling for a battery ESS. For this reason, a sprinkler system designed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems,* is required by NFPA 855, *Standard for the Installation of Energy Storage Systems.*

Learn More

- Visit nfpa.org/ess to access more FAQs and the latest ESS-related training, information, research, and reports.
- To view NFPA 855, visit nfpa.org/855, or to access the standard plus expert commentary, visit nfpa.org/LiNK.

IT'S A BIG WORLD.
LET'S PROTECT IT TOGETHER.®

Safety of Grid Scale Lithium-ion Battery Energy Storage Systems

EurIng Dr Edmund Fordham MA PhD CPhys CEng FInstP
Fellow of the Institute of Physics

Dr Wade Allison MA DPhil
Professor of Physics, Fellow of Keble College, Oxford University

Professor Sir David Melville CBE FInstP
Professor of Physics, former Vice-Chancellor, University of Kent

Sources of wind and solar electrical power need large energy storage, most often provided by Lithium-Ion batteries of unprecedented capacity.

Incidents of serious fire and explosion suggest that the danger of these to the public, and emergency services, should be properly examined.

5 June 2021

Executive Summary

1. Li-ion batteries are dominant in large, grid-scale, Battery Energy Storage Systems (BESS) of several MWh and upwards in capacity. Several proposals for large-scale solar photovoltaic (PV) "energy farms" are current, incorporating very large capacity BESS. These "mega-scale" BESS have capacities many times the Hornsdale Power Reserve in S. Australia (193 MWh), which was the largest BESS in the world at its installation in 2017.
2. Despite storing electrochemical energy of many hundreds of tons of TNT equivalent, and several times the energy released in the August 2020 Beirut explosion, these BESS are regarded as "articles" by the Health and Safety Executive (HSE), in defiance of the Control of Major Accident Hazards Regulations (COMAH) 2015, intended to safeguard public health, property and the environment. The HSE currently makes no representations on BESS to Planning Examinations.
3. Li-ion batteries can fail by "thermal runaway" where overheating in a single faulty cell can propagate to neighbours with energy releases popularly known as "battery fires". These are not strictly "fires" at all, requiring no oxygen to propagate. They are uncontrollable except by extravagant water cooling. They evolve toxic gases such as Hydrogen Fluoride (HF) and highly inflammable gases including Hydrogen (H_2), Methane (CH_4), Ethylene (C_2H_4) and Carbon Monoxide (CO). These in turn may cause further explosions or fires upon ignition. The chemical energy then released can be up to 20 times the stored electrochemical energy. Acute Toxic gases and Inflammable Gases are "dangerous substances" controlled by COMAH 2015. Quantities present "*if control of the process is lost*" determine the applicability of COMAH.
4. We believe that the approach of the HSE is scientifically mistaken and legally incorrect.
5. "Battery fires" in grid scale BESS have occurred in South Korea, Belgium (2017), Arizona (2019) and in urban Liverpool (Sept 2020). The reports into the Arizona explosion [8, 9] are revelatory, and essential reading for accident planning. A report into the Liverpool "fire" though promised for New Year 2021, has not yet been released by Merseyside Fire and Rescue Service or the operator Ørsted; it is vital for public safety that it be published very soon.
6. No existing engineering standards address thermal runaway adequately, or require measures (such as those already used in EV batteries) to pre-empt propagation of runaway events.
7. Lacking oversight by the HSE, the entire responsibility for major accident planning currently lies with local Fire and Rescue Services. Current plans may be inadequate in respect of water supplies, or for protection of the local public against toxic plumes.
8. The scale of Li-ion BESS energy storage envisioned at "mega scale" energy farms is unprecedented and requires urgent review. The explosion potential and the lack of engineering standards to prevent thermal runaway may put control of "battery fires" beyond the knowledge, experience and capabilities of local Fire and Rescue Services. BESS present special hazards to fire-fighters; four sustained life-limiting injuries in the Arizona incident.
9. We identify the well-established hazards of large-scale Li-ion BESS and review authoritative accounts and analyses of BESS incidents. An internet video [10] is essential initial instruction.
10. We review engineering standards relating to Li-ion BESS and concur with other authorities that these are inadequate to prevent the known hazard of "thermal runaway". We conclude that large-scale BESS should be COMAH establishments and regulated appropriately. We respectfully request evidence from the HSE that "mega-scale" BESS are *not* within the scope of COMAH.
11. We seek the considered response of relevant Government Departments as well as senior fire safety professionals to these concerns.

Contents

1. Introduction

Lithium-ion (Li-ion) batteries are currently the battery of choice in the 'electrification' of our transport, energy storage, mobile telephones, mobility scooters etc. Working as designed, their operation is uneventful, but there are growing concerns about the use of Lithium-ion batteries in large scale applications, especially as Battery Energy Storage Systems (BESS) linked to renewable energy projects and grid energy storage. These concerns arise from the simple consideration that large quantities of energy are being stored, which if released uncontrollably in fault situations could cause major damage to health, life, property and the environment.

Table 1. Comparison of some recent "battery fires" since 2014.
Note: this is not a comprehensive list of all Li-ion BESS battery "fires."

Location	Size	"Battery fire" cause	Time to bring under control	Water needed for cooling	Comments
Houston, Texas, April 2021	0.1 MWh	Driverless vehicle crash	4 hours	30,000 (US) gallons	Tesla Model S
South Korea	Various; 21 fires during 2018-19	Not known to Korean Ministry of Trade Industry and Energy	various	Not known	522 out of 1490 ESS facilities in Korea suspended (Korea Times 2 May 2019)
Drogenbos, Belgium. 2017	1 MWh	Not known.	"rapidly extinguished"	Not known	Occurred during commissioning of system by ENGIE
McMicken Facility Arizona, USA. 2019	2 MWh	Thermal runaway in a single rack out of 27 that were in the cabin – hence 74 kWh electrochemical energy released – less than the Tesla Model S crash.	2 hours from first report to "deflagration"		Explosion as H_2 and CO mixed with air and ignited. Critically injured 4 fire-fighters. Extensive forensic report.
Carnegie Rd, Liverpool, UK, 2020	20 MWh	Not known	11 hours		Full report [1] delayed 4 months; still unpublished.

Even battery electric vehicle (BEV) batteries store energy sufficient for "fires" that have taken hours to control. A Tesla Model S crashed In Texas on the weekend of 17-18 April 2021 igniting a BEV battery fire that took 4 hours to control with water quantities variously reported [2] as 23,000 (US) gallons or 30,000 gallons (87 -115 m^3). Yet the energy storage capacity in even the latest Tesla Model S vehicles is only 100 kWh. This is 1/20 the size of the BESS in Arizona [3] which failed in 2019, and 1/200 the size of the BESS in Liverpool [4] which caught fire [5] in September 2020, and 1/7000 the capacity of the Cleve Hill Solar Farm and Battery Store [6] approved in May 2020.

The past decade has seen a number of serious incidents in grid-scale BESS, which are summarised in Table 1. Despite these incidents, and our growing understanding of these, these large scale Li-ion BESS are not currently regarded by HSE as regulated under the COMAH

Regulations 2015. The legal basis for this attitude is unclear – simple calculations summarised in this paper argue that they should be – and the issue may yet be challenged in judicial review.

The reason the COMAH regulations should apply is the scale of evolution of toxic or inflammable gases that will arise in BESS “fires”. In the Drogenbos incident (2017, Table 1), the inhabitants of Drogenbos and surrounding towns were asked to keep all windows and doors shut; 50 emergency calls were made from people with irritation of the throat and airways[1]. A chemical cloud which “initially had been enormous”, was charted by helicopter. The Belgian Fire Services could not control what was described as “the chemical reaction” and filled the cabin with water. Fears of an explosion with 20 metre flames kept people confined for an hour. Although the initial visible flames were controlled quickly, cooling continued over the next 36 hours.

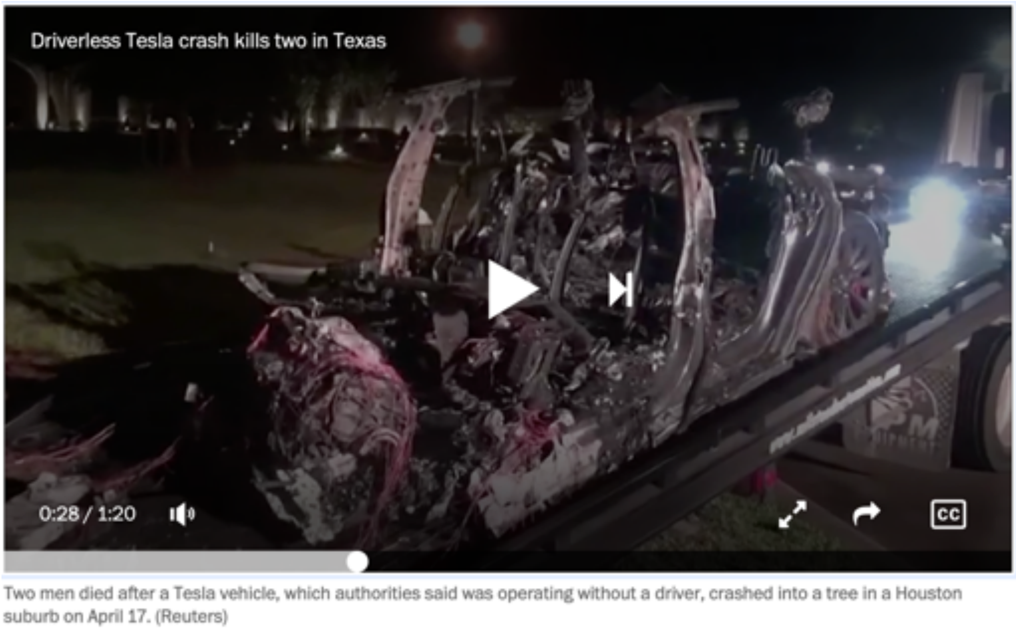

Figure 1: Remains of the Tesla Model S crash and fire, 17 Apr 2021, after 4 hours and 30,000 gallons. Battery capacity 100 kWh.

Figure 2: Remains of a Korean BESS destroyed by a “battery fire”. An energy storage system was destroyed at the Asia Cement plant in Jecheon, North Chungcheong Province, on Dec. 17. Courtesy of North Chungcheong Province Fire Service Headquarters (Korea Times 2 May 2019)

[1] Tom Vierendeels (2017) “Explosiegevaar by brand in Drogenbos geweken : 50-tal oproepen van mensen die zich onwel voelen door rook.” *Het Laatste Nieuws,* 11 November 2017

Figure 3: "Battery Fire" at Drogenbos, Belgium 11 Nov 2017. Taken at the start of the incident and 15 minutes later (eye-witness footage). 1 MWh facility; fire occurred during commissioning.

Figure 4: The 2 MWh McMicken (Arizona) BESS after the explosion on 19 April 2019

Figure 5: The 20 MWh BESS at Carnegie Rd, Liverpool. Courtesy Ørsted.

Figure 6: The fire at Carnegie Road, 15 Sep 2020. Liverpool Echo report, which took 11 hours to control.

The incidents recorded in Table 1 are all in relatively small BESS or a single BEV. Yet "mega-scale" BESS are now planned on a very large scale in many current proposals in the UK, listed in Table 2 and illustrated in the subsequent Figures.

And no engineering standards are currently applied to pre-empt future accidents in grid-scale BESS, the most critical of which would be design features aimed at preventing the phenomenon of "thermal runaway", the process whereby failure in single cell causes over-heating and then propagates to neighbouring cells so long as a temperature (which can be as low as 150 °C) is maintained.

BEV batteries do now include thermal barriers or liquid cooling channels between all cells to safeguard against this phenomenon, but no such engineering standards exist for grid-scale BESS. A large BESS can pass all existing engineering design and fire safety test codes and still fail in thermal runaway – by now a well-known failure mode. This must be urgently addressed.

The consequences of major BESS accidents could be significant and emergency services need adequate plans in place to handle any such incident.

Table 2. "Mega" scale solar plant and/or Li-ion BESS in Australia and the UK*

Project	Location	Status	Solar PV Scheme Size	Battery Stores	Battery type	Battery capacity
Hornsdale Power Reserve	S. Australia	Operational	Not directly associated	Single site	Li-ion	193 MWh
Cleve Hill Solar + Battery Store	Kent	Permission granted (2020)	350 MW; land coverage 890 acres	Single site	Li-ion	700 MWh
Sunnica Solar + Battery Store(2)	Cambridgeshire/ Suffolk	Pending submission	500 MW; land coverage approx. 2792 acres	31.5 ha of land over 3 compounds [7] of 5.2, 10.7 and 15.6 ha	Li-ion	Undeclared. Estimate 1500 – 3000 MWh
Longfield Solar + Battery Store	Essex	Pending statutory consultation	500 MW; land coverage approx. 1400 acres	Stated as 3.7 acres: number of sites TBD	Li-ion	Undeclared. Estimate: 150 MWh

* Li-ion technology has been assumed in all these proposals as Li-ion battery electrochemistry is dominant in grid-scale BESS applications (deployment at this scale is unlikely to involve technologies with lesser experience). Estimated values for Battery Capacity for the Sunnica are calculated based on the McMicken facility in Arizona (Appendix 1) and the Cleve Hill DCO. For the Longfield site it is estimated from Energy Institute guidance on energy density [25] at about 100 MWh ha^{-1}. The exact specification for the battery units has not been disclosed by the developers at this present time.

Figure 7: The Hornsdale Power Reserve (South Australia) in the process of expansion from 100 MW/129 MWh to 150 MW/193.5 MWh, as of November 2017.

Plate 3-10. Typical battery storage compound configuration (*image reproduced courtesy of Fluence Energy*).

Figure 8: a “typical” BESS compound (abstracted from Sunnica PEIR, Ch 3)

Figure 9: Artists impression of Tesla 250 MWh “Megapack”.
Sunnica may have 3 ×this capacity in just one of its three BESS compounds.

2. Leading Concerns

The main concerns regarding large scale Li-ion BESS are:

1) The potential for failure in a single cell (out of many thousands) to propagate to neighbouring cells by the process known as "thermal runaway". Believed to be initiated by lithium metal dendrites growing internally to the cell, a cell may simply discharge internally releasing its stored energy as heat. Even sound Li-ion cells will spontaneously discharge internally if heated to temperatures which can be as low as 150 °C, releasing their stored electrical energy, thus overheating neighbouring cells and so on. Temperatures sufficient to melt aluminium (660 °C) at least have been inferred from analyses of such thermal runaway accidents. Eye-witness reports consistently speak of repeated "re-ignition" which is inevitable, even in the complete absence of oxygen, so long as the temperature anywhere exceeds the thermal runaway initiation threshold.
2) The emission of highly toxic gases – principally Hydrogen Fluoride – for prolonged periods, in the event of thermal runaway or other battery fires. At a minimum, respirators and complete skin protection would be required by any fire-fighters. Measures to protect the public from toxic plumes would also be necessary.
3) The emission of large quantities of highly inflammable gases such as Hydrogen, Methane, Ethylene and Carbon Monoxide even if a fire suppression system is deployed. These gases will be evolved from a thermal runaway accident regardless of such measures, with explosion potential as soon as they are mixed with air and in contact with hot surfaces. Such an explosion was the cause of the "deflagration event" at McMicken, Arizona in 2019 in a 2 MWh BESS, which critically injured four fire-fighters and was triggered simply by opening the cabin door.
4) The absence of any adequate engineering and regulatory standards to prevent or mitigate the consequences of "thermal runaway" accidents in Li-ion BESS.
5) The potential for thermal runaway in one cabin propagating to a neighbouring cabin. In Arizona [3] there were reports of *"fires with 10-15 feet flame lengths that grew into 50 - 75 feet flame lengths appearing to be fed by flammable liquids coming from the cabinets*".
6) The significant volumes of water required to thoroughly cool the system in the event of a "fire", and how this water will be contained and disposed of (since this will be contaminated with highly corrosive hydrofluoric acid and, therefore, must not be allowed to drain into the surrounding environment).

Such incidents are routinely and repeatedly described in the Press as "battery fires" though they are not "fires" at all in the usual sense of the word; oxygen is completely uninvolved. They represent an electrochemical discharge between chemical components that are self-reactive. They do not require air or oxygen at all to proceed.

Hence the traditional "fire triangle" of "Heat, Oxygen, Fuel" simply does not apply, and conventional fire-fighting strategies are likely to fail (Figure 10, over).

Thermal runaway events are uncontrollable except by *cooling* all parts of the structure affected – even the deepest internal parts – below 150 °C. This basically requires water, in large volumes.

Figure 11 The fire triangle and its relationship to thermal runaway

Figure 10: The traditional “fire triangle” does not apply to “thermal runaway”.

3. Thermal Runaway (Battery “fires”)

Li-ion batteries are sensitive to mechanical damage and electrical surges, both in over-charging and discharging. Most of this can however be safeguarded by an appropriate Battery Management System (BMS) and mechanical damage (unless deliberate and malicious) should not be a hazard. Internal cell failures can arise from manufacturing defects or natural changes in electrodes over time; these must be regarded as unavoidable in principle. Subsequent escalation into major incidents can propagate from such apparently trivial initiation.

In July 2020 a thorough failure analysis by Dr Davion Hill of DNV GL [8] was prepared for the Arizona Public Service (APS), following the April 2019 thermal runaway and explosion incident in the 2 MWh Li-ion BESS facility at McMicken, Arizona. This report is revelatory and more detailed than any other failure analysis known to us. It is essential reading for any professional involved in fire safety planning for major BESS. (Figures 11 to 13).

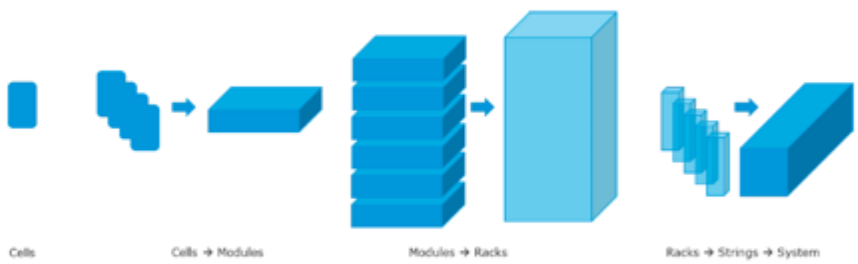

Figure 11: Cells stack into Modules; Modules into Racks; Racks into Strings; Strings into Systems.

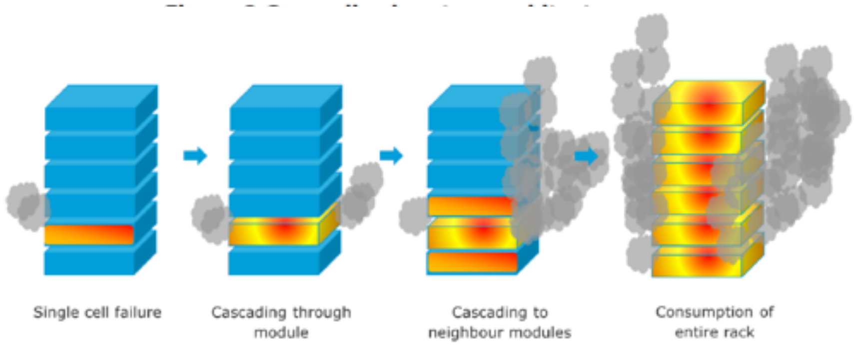

Figure 25 A single cell failure propagated through Module 2, then consumed the whole rack, releasing a large plume of explosive gases. This process could have occurred without visible flame, which would explain why the gases were not burned as they were emitted.

Figure12: Propagation of single Cell failure through Module; cascade to entire Rack.

A report by Underwriters Laboratories (UL) on the same incident [9] is less technical on the physics and engineering of the underlying causes and failure modes, but more comprehensive in terms of practical situations and consequences found, and suffered, by the “first-responders”. Two fire-fighters suffered life-limiting brain injuries, one suffered spinal damage and fourth facial lacerations. This report is similarly essential reading for any fire and emergency response planning.

Figure 13: Destruction of Rack at McMicken.

Detail: molten aluminium pools (exceeded 660 °C)

Figure A.1: Photograph taken during decommissioning of the ESS shows a pool of solidified aluminum on the floor in front of Rack 15 [11].

Forensic analysis [8] of the 2019 Arizona “fire” identified a failure mode different from mechanical abuse or electrical mis-management. The initiating failure was localised to a single cell at a known position in the rack. Although the cell itself was of course destroyed during the incident, the failure mode is believed to have been lithium metal deposition and abnormal growth of lithium metal dendrites. These phenomena were also found in randomly selected *undamaged* cells from the same BESS and also from a different BESS of the same manufacture elsewhere. These phenomena must be regarded as common, and inherent to the cells themselves.

The lithium metal deposits will react with air moisture, causing overheating and smoke. Battery swelling, electrolyte degradation, and internal short circuits are all possible modes of failure with internal discharge and generation of locally intense heat.

Because of the known thermal breakdown of even non-faulty cells, above a threshold temperature (which can be as low as 150 °C), the loss of even a single individual cell can rapidly cascade to surrounding cells, resulting in a larger scale “fire.” This is “thermal runaway” in which failures propagate from cell to cell within “modules” and from module to module within a “rack”.

This is what happened at McMicken [8], with temperatures sufficient to melt Aluminium (660 °C) being reached. Such “fires” can be extremely dangerous to fire fighters and other first responders because, in addition to the immediate fire and explosion risks, they would have to deal with toxic gases (principally hydrogen fluoride HF, also hydrogen cyanide HCN and other fluorine compounds such as phosphoryl fluoride POF_3) and exposure to other hazardous materials.

Rack to rack propagation fortunately did not happen at McMicken, though an explosion did [8]. A local conventional fire involving the plastics materials or gases evolved from them could have initiated rack-to-rack propagation; the only essential factor would have been sufficient heat to trigger thermal breakdown in just one cell in a neighbouring rack. Li-ion cells have been observed to eject molten metal during thermal runaway, another possible mode of propagation over distance. Propagation through a subsequent rack would then occur by exactly the same thermal runaway mechanisms, and potentially beyond between neighbouring cabins in large-scale BESS.

Thermal runaway is illustrated in dramatic fashion with tiny commercial Li-ion cells in a useful internet video [10] (Figure 14). The commercial cells involved in this demonstration have tiny capacities: a mere 2.6 Ah or about 10 Wh for typical terminal voltages.

A Tesla Model S would have the capacity of about ***10,000*** such cells.
A 20 MWh BESS has the capacity of about ***2 million*** such cells.

In the video, the cell is deliberately over-heated on a small electric stove. The fully charged cell goes into thermal breakdown, eventually rupturing the can. The cell flies off as a rocket and seconds later is discharged but red hot and will burn anything combustible. Although not illustrated, it is evidently hot enough to produce the same thermal breakdown in an adjacent cell within a battery.

This illustrates the damage done to a non-faulty cell, simply by overheating externally.

Figure 14: (a) A charged 2.6 Ah cell being deliberately overheated. (b) at the point of rupture (c) the cell takes off as a rocket (d) seconds later the discharge is complete, and the cell is red hot.

4. Toxic and flammable gas emissions

During a Li-ion "battery fire," multiple toxic gases including Hydrogen Fluoride (HF) [11], Hydrogen Cyanide (HCN) [13] and Phosphoryl Fluoride (POF_3) [11] may be evolved. The most important is Hydrogen Fluoride (HF), which may be evolved in quantities [11] up to 200 mg per Wh of energy storage capacity.

HF is toxic in ppm quantities and forms a notoriously corrosive acid (Hydrofluoric Acid) in contact with water. It is toxic or lethal by inhalation, ingestion and by skin contact. The ERPG-2 concentration (1 hour exposure causing irreversible health effects) given by Public Health England is just 20 ppm; the workplace STEL (15 minute Short-Term Exposure Limit) is just 3 ppm [12]. Major emissions of HF would form highly toxic plumes that could easily threaten nearby population centres, workplaces and schools.

Appendix 3 contains calculations of projected toxic gas quantities for 3 grid-scale battery stores that have been approved or are pending review by the Planning Inspectorate (Table 2).

The calculated capacities at the "mega-scale" sites listed in Table 2 are tens, or even hundreds, of times larger than the facilities in Table 1, which experienced significant fires or explosions.

In addition to evolution of toxic gases, even in an inert atmosphere (without Oxygen), multiple flammable gases (such as Hydrogen H_2, Carbon Monoxide CO, Methane CH_4, and Ethylene C_2H_4) would be evolved during thermal runaway. These are "typical of plastics fires" [8] and have been measured in sealed vessel tests [13]. As noted by Hill/DNV [8] and others [13], the proportions of H_2, CO, CH_4 and C_2H_4 do not in fact vary greatly between different cell technologies, simply because the chemical nature of the envelope polymers, separators, electrolyte solvents and electrolytes themselves do not differ greatly. The variations between Li-ion technologies are in the electrode systems, which are typically not polymeric.

Such inflammables can clearly create (ordinary, air-fuel) fires or explosions once mixed with air/oxygen. It is important to note that the Heats of Combustion of the inflammables may be up to 15 – 20 $\times$ the rated electrical energy storage capacity of the BESS. This has been demonstrated by the same tests which determined the quantities of HF evolved [11]. These were fire tests, not sealed vessel tests [13]. The stored electrical energy is therefore by no means a conservative estimate of the total energy release which could be released in a major (air-fuel) fire in a BESS, irrespective of whether the initiating cause was a conventional fire or Li-ion cell thermal runaway.

Appendix 2 estimates the inflammables potentially evolved from the BESS given in Table 2.

5. Total Energy Release Potential

Any large energy storage system has the risk that energy released in malfunction will be uncontrollable in ways that will do major damage. BESS can release electrochemical energy in the form of thermal runaway or "battery fires". In addition they can release chemical energy in the form of explosions or conventional fires of inflammable gases, or of polymer components. Many thermal runaway "fires" have now happened, as has explosion of evolved inflammable gases.

An important indicator of the foreseeable scale of a "worst credible hazard" is provided by the total stored energy in the system. For BESS, this comprises two components:

(i) The stored electrical energy which might be released in the event of thermal runaway incidents, a self-reactive electrochemical energy release not requiring oxygen at all, and

(ii) Stored chemical (fuel) energy which might be released in complete combustion of the inflammable gases which might be released by (i).

Electrochemical energy release is uncontrollable once started, by any measure except cooling – of all cells and cell parts – below about 150°C. Water is the only fire-fighting substance with the necessary heat capacity. Concurrent conventional fire would first heat cells above the thermal runaway temperature, causing more thermal runaway. Chemical energy release from inflammable gases is also uncontrollable once those gases are mixed with air and ignited: explosions result.

What might be the scale of such energy releases? The Sunnica proposal is estimated to have a stored energy between 1.5 – 3.0 GWh in total, spread across 3 separate sites called Sunnica East A, Sunnica East B and Sunnica West A (see calculations in Appendix 1). It is between 2 – 4 times the capacity projected for Cleve Hill (700 MWh). It is 8 – 15 times the capacity (193 MWh) of the "Hornsdale Power Reserve" in Australia, at installation (2017) the world's largest.

Compared to other energy storage technologies, the Dinorwig Pumped Storage Scheme in Snowdonia stores about 9 GWh [14]; the Sunnica BESS corresponds to 17 – 33 % of Dinorwig.

Compared to major explosions, the energy released in the Beirut warehouse explosion of August 2020 has been estimated [15] by Sheffield University at about 0.5 kilotons of TNT (best estimate) with a credible upper limit of 1.12 kilotons. A totally independent estimate [16] (based on seismic propagation instead of eye-witness footage) gives the same range, without specifying a "best" estimate. The popular measure of major explosions in "kilotons of TNT" has an agreed definition[2] of 1.162 GWh of released energy; in this paper we shall take "one Beirut" to be an explosive energy of 0.5 kilotons of TNT or about 580 MWh of released energy.

The projected BESS storage at Sunnica corresponds to 1.4 – 2.7 kilotons of TNT in total, across all three sites. In the "low" case, this would be "0.92 Beiruts" at the Sunnica West A site alone, or "2.7 Beiruts" over the whole scheme. In the "high" case "2.7 Beiruts" could be stored in the Sunnica East B site alone. Note that these are stored electrochemical energy only; the potential for conventional fire or explosion of evolved inflammables could be **up to 20 × larger** [11]. See Table 3, Appendix 1.

This is plainly a quantity of stored energy which, if released uncontrollably, could do major damage. Explosions and fires at individual BESS are matters of record. They can propagate from failure in a single cell out of many thousands. Cell-to-cell and module-to-module propagation occurred at McMicken. Rack-to-rack propagation was avoided, but could readily occur if continuous

[2] See e.g. Wikipedia.

fires start. Cabin-to-cabin propagation of a major BESS "battery fire" would be the critical link that would escalate major but manageable fires into catastrophes.

Yet this propagation route remains unanalysed. Significantly, Commissioner Sandra D Kennedy of the Arizona State Commission [3] reviewed reports on the 2019 McMicken battery fire and also a 2012 battery fire at the APS Eldon substation facility in Flagstaff, AZ. She quotes the Flagstaff fire department report on the latter incident as referencing :

> "*Fires with 10-15 feet flame lengths that grew into 50 - 75 feet flame lengths appearing to be fed by flammable liquids coming from the cabinets*".

Finally, in the context of BESS, "Stranded Energy" will remain a hazard at any affected BESS cabins even assuming an initial incident is controlled. The accident investigation at McMicken required nearly 3 months, simply to discharge "stranded energy" safely [8].

'"Mega-scale" Li-ion BESS should, in all prudence, require the highest level of regulation. The COMAH regulations are designed for this, including establishments where dangerous substances may be generated "if control of the process is lost" [17] in a thermal runaway accident.

6. Applicability of the COMAH (Control of Major Accident Hazard) Regulations 2015

The governing criteria for application of the COMAH Regulations [17] are:

1. The presence of hazardous materials, or their generation, "if control of the process is lost."
2. The quantity of such hazardous materials present or that could be potentially generated.

There is no doubt that hazardous substances such Hydrogen Fluoride (an Acute Toxic controlled by COMAH) would be generated in a BESS accident (i.e., in "battery fires"). Similarly highly Inflammable Gases (also controlled by COMAH) would be evolved even if the atmosphere remained oxygen-free. Depending on the size of the "establishment" these could be produced in sufficient quantities to be in the scope of COMAH. In Appendix 2 we estimate quantities guided by the literature, where fire tests have directly measured evolution of the hazardous gases.

For small capacity BESS installations, under 25 MWh capacity, the quantities ("inventory") of the evolved hazardous substances might be outside COMAH. This paper however addresses the recent trend towards "mega-scale" Li-ion BESS (Table 2) with very large quantities of stored energy, where the inventory should be large enough to bring the installation within scope.

Broadly speaking, the threshold for applicability of COMAH will be dependent on the precise BESS technology chosen, but likely to be for BESS in the region of 20 – 50 MWh. See Appendix 2.

A letter to the HSE regarding applicability of COMAH to large-scale BESS (dated 25 Nov 2020 [18]) received no reply until follow-up letters were sent addressed personally to the Chief Executive on 7 February 2021, with the intervention of Mrs Lucy Frazer MP. The reply from the Chief Executive [19] dated 22 February 2021 stated that "*Li-ion batteries are considered articles and are not in scope of COMAH*".

We believe the current attitude of the HSE – that even large-scale Li-ion BESS are "articles" best regulated by operators – is not consistent with the law.

Unless tested in the Courts however, this throws the entire responsibility for ensuring the safety of major BESS "battery fires" onto the Fire and Rescue Services. Currently the HSE makes no representation to the Planning Inspectorate in respect of BESS hazards.

7. Engineering standards for BESS

As with any hazard, the basic principles of Prevention and Mitigation must be applied to minimise the risk to life, property and the environment. A major contribution of the Hill/DNV report [8] is a review of current engineering and fire protection standards. This did not concern planning, siting and electrical standards, but simply addresses the question: which standards, if any, offer Prevention or Mitigation of the phenomenon of thermal runaway? The answer appears to be none.

"Thermal runaway" is an electrochemical reaction, well-known in Li-ion BESS, that is largely uncontrollable once started. Since failures in single cells (among many thousands) can be sufficient to initiate thermal runaway, the only known Prevention measure is that adopted by the BEV industry, viz. thermal isolation of neighbouring cells, so that if failure occurs in any one cell, insulation or water cooling prevents easy thermal spread to neighbouring cells. Various design strategies have been adopted in BEV Li-ion batteries, usually involving some form of thermal barrier.

However these are not widely used in grid-scale Li-ion BESS. Current practice is the assembly of stacks of cells, typically "pouch" cells which are externally flat polymer bags, that are stacked side by side in low profile modules with no thermal isolation. This is not the construction adopted in current generation BEV batteries; BEV practice *(with* thermal isolation) extended to grid-scale BESS would obviously increase costs and complexity considerably.

The engineering standards reviewed by Hill/DNV [8] included NFPA 855, UL 1973 and UL 9540/9540A. UL 9540A is a US standard that is widely used in grid-scale BESS engineering, is routinely recommended by insurance and risk consultants [20] and was appealed to by the developer of the Cleve Hill solar farm (Table 2). The problem is that UL9540A is fundamentally a test procedure. It mandates no design features. It requires absolutely nothing that would prevent thermal runaway in any BESS design. This means that an operator can say truthfully that a given BESS is "fully compliant" with UL9540A, yet this would provide no assurances at all regarding thermal runaway prevention. It is therefore wholly insufficient as a safeguard to either the operator, the public, or to emergency services.

NFPA 855 [21], uniquely, requires evaluation of thermal runaway in a single module, array or unit and recognises the need for thermal runaway protection. However, it assigns that role, with complete futility, to the Battery Management System (BMS). Thermal runaway is an electrochemical reaction which once started cannot be stopped electrically. It is uncontrollable by electronics or switchgear. A BMS can locate faults, report and trigger alarms, but it cannot stop thermal runaway.

The Hill/DNV report [8] highlights the many shortcomings of existing standards, see Appendix 4. The basic issue is simple:

(1) Thermal Runaway has very few means of Mitigation once started.
(2) It is therefore essential to address Prevention as a priority.
(3) ***No current engineering or industry standards require the Prevention of thermal runaway events by thermal isolation barriers.***

Nothing in existing standards prevents runaway incidents happening again, requiring for initiation only single-cell failures from known common defects in cell manufacture.

8. Fire Safety Planning for BESS "fires"

Taking the recent Sunnica BESS proposal as an example, a joint statutory consultation response has been submitted by the four Local Authorities concerned. The Local Authorities in this case are Cambridgeshire and Suffolk County Councils, and West Suffolk and East Cambridgeshire District Councils. This joint consultation response [22] included a section on Battery Safety (pp 74-75) and states as follows:

Suffolk Fire and Rescue Service (SFRS) *will work and engage with the developer as this project develops to ensure it complies with the statutory responsibilities that we enforce.*

Sunnica should produce a risk reduction strategy as the responsible person for the scheme as stated in the Regulatory Reform (Fire Safety) Order 2005. It is expected that safety measures and risk mitigation is developed in collaboration with services across both counties.

The response also later states: *As with all new and emerging practices within UK industry, the* ***SFRS would like to work with the developers*** *to better understand any risks that may be posed and develop strategies and procedures to mitigate these risks.*

It is clear that local Fire and Rescue Services have been given the lead responsibility for independent emergency planning, in concert with the developers. Because of the attitude of the HSE refusing to exercise regulatory control over BESS safety, local Fire and Rescue Services become the sole independent public body able to influence BESS safety issues at the planning stage.

Many detailed recommendations have been made by the Local Authorities in the case of Sunnica. It is unclear how much opportunity or input Suffolk FRS has had in these. However the recommendations offered betray some serious misunderstandings and a complete lack of awareness of the lessons and recommendations made in publicly available documents such as the Hill/DNV report [8] into the McMicken explosion.

These are taken point by point in Appendix 4 but some general points are made here.

1. Thermal runaway cannot be controlled like a regular (air-fuel) fire. The only way to mitigate "re-ignition" (a regular report of eye-witnesses) is by thorough cooling. Water is the only fire-fighting material with the necessary thermal capacity. Sprinkler systems, though with good records in conventional building fires, are likely to be completely inadequate. The purpose of the water is absorbing a colossal release of energy. The Hill/DNV report [8] called for so-called "dry pipe" systems allowing first responders to connect very large water sources to the interior without having to access the interior.

It is critical to appreciate that all parts of the battery system must be cooled down. Playing water on a battery "fire" may cool the surface, but so long as Li-ion cells deep inside the battery remain above about 150°C, "re-ignition" events will continue. It is not sufficient to estimate water requirements on the basis of calculations assuming water reaches everywhere, uniformly.

For example, in the recent Tesla car fire [2] the BEV battery kept re-igniting, took 4 hours to bring under control and used 30,000 (US) gallons of water (115 m^3). This was for a 100 kWh BEV battery, designed with inter-cell thermal isolation barriers.

In the case of Sunnica, the Local Authorities have suggested that water supplies of 1900 litres per minute for 2 hours (228 m^3) will be needed [22]. But this is grossly inadequate. Using the above Tesla BEV fire experience, this amount of water would suffice for just ***two*** Tesla Model S car fires. Scaling this up to even the smallest 2 MWh BESS (such as that in McMicken [8]), which contains stored energy equivalent to ***twenty*** Tesla Model S cars, it is clear to see that a much greater amount of water would be needed.

The actual amount of water required will depend on the energy storage capacity per cabin which, in the case of Sunnica, is still unstated. Some simple estimates are, however, made below. **The requirements suggested to date by the Local Authorities for the Sunnica installation are completely inadequate and, if not addressed, would leave Suffolk FRS without the means to control a major BESS "fire".**

Taking a storage capacity of 10 MWh in just one of the Sunnica cabins (see Appendix 1), a complete thermal runaway accident in such a BESS would release that stored electrochemical energy, plus an indeterminate quantity of heat from combustion of hydrocarbon polymer materials or inflammable gases evolved from them. Such Total Heat Release may be up to twenty times the amount of the stored electrochemical energy in the BESS [11].

The thermal capacity of water is 4.2 kJ kg^{-1} K^{-1} or in kWh terms, about 1.17 kWh m^{-3} K^{-1}. If heated from 25 °C to boiling point about 87.8 kWh m^{-3} of thermal energy is required.

Hence the water volume required to absorb 10 MWh of released energy without boiling is about 114 m^3 or 30,000 US gallons, the same amount as required in practice to control a fire in a single Tesla Model S car with a mere 100 kWh battery, 100 times smaller than a 10 MWh BESS.

The quantity suggested by the Local Authorities' joint response is 228 m^3 (1900 L min^{-1} for 2 hours), twice the above estimate, which would naively be sufficient for a 20 MWh BESS fire. **However, from the experience of recent BEV fires, it could be insufficient by a factor of 100.**

No such calculations were presented in the Examination of the 700MWh Cleve Hill BESS [6].

2. "Clean agent" fire suppression systems are a common fire suppression system in BESS, but are ***totally ineffective*** to stop "thermal runaway" accidents. The McMicken explosion was an object lesson in this: the installed "clean agent" system operated correctly, as designed, on detection of a hot fault in the cabin [8]. There was no malfunction in the fire suppression system. But it was completely useless because the problem was not a conventional fuel-air fire, it was a thermal runaway event. Only water will serve in thermal runaway.

Indeed in the McMicken explosion the "Novec 1230" clean agent arguably contributed to the explosion by creating a stratified atmosphere with an air/Novec 1230 mixture at the bottom and inflammable gases accumulating at the cabin top.

The most probable cause of the explosion was mixing caused by the opening of the door by first responders. The explosive mixture contacted hot surfaces and ignited [8].

3. A further recommendation of the Hill/DNV report [8] into the McMicken explosion is for a means of ***controlled venting*** of inflammable gases ***before*** first responders attempt access. In the Local Authority response to the Sunnica consultation, ventilation is listed as a BESS requirement [22] but the reason given, bizarrely, is "to control the temperature" – at which ventilation or air-conditioning (also listed) would be totally ineffective, lacking any significant thermal capacity.

The critical reason for controlled ventilation is the removal of inflammable gases ***before*** an explosive mixture forms. Deflagration panels (to decrease the pressure of explosions that do occur) are also recommended.

It should be noted that although controlled venting provisions would mitigate the consequence of inflammable gas evolution, they would also require simultaneous venting of Hydrogen Fluroide that would be evolved concomitantly.

Toxic gas hazard would continue to present a risk to the community and the environment for the duration of the incident. Fire-water will be contaminated with, *inter alia*, highly corrosive Hydrofluoric Acid. Contamination of water supplies and waterways ***must*** be prevented.

It is strongly recommended that Fire Services study the Hill/DNV report [8], and the related Underwriters Labs report [9], act upon their recommendations, and make realistic, physics-based, calculations of the water quantities required to be available at every single BESS cabin. There could be as many as 150 BESS cabins at the Sunnica East B site alone – see Appendix 1; each of these would need a sufficient water supply.

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Appendix 1: Battery Capacity Calculations for the Grid-scale BESS proposed at the "Sunnica" site.

The Sunnica scheme will be taken as an example of a "mega-scale" solar plant with BESS. If approved, it would cover approximately 2800 acres and will include BESS on 3 separate sites.

The proposed BESS capacity in the Sunnica scheme has not been specified. Estimates of storage capacity can be made on the basis of the land areas allocated to the BESS compounds, assuming full use (per meeting with Parish Councillors, 30 October 2020 [23]). Li-ion battery technology has also been assumed because it is the most widely used in the industry today. Li-ion batteries have a high energy density, and the costs of these have fallen significantly over the past few years [24] .

Land areas and cabin size are quoted in the Sunnica Scheme Description as:
Sunnica East A: 5.23 ha
Sunnica East B: 15.6 ha
Sunnica West A: 10.65 ha
Total: 31.48 hectares.

One storage cabin size is 15 m length × 5 m width × 6 m height. This height is *double* that of a so-called "hi-cube" shipping container and has a larger footprint (75 m^2 *vs* 30 m^2 for a standard 40-foot shipping container).

Storage capacity can be estimated based on other BESS and storage cabin volumes:

Single cabin energy storage capacity:

The McMicken, Arizona, Li-ion BESS was a single cabin, footprint of 60 m^2 and 'shipping container' height. The Sunnica BESS cabins are 75 m^2, with 'double shipping container' height (6 m).
Energy storage at McMicken was 2 MWh.

Scaling by footprint and height yields a *single cabin* energy storage capacity estimate of 5 MWh for each of the "Sunnica" BESS cabins.

The Arizona cabin had empty space for expansion racks, so a larger single cabin energy storage capacity, up to say 10 MWh, is entirely conceivable.

Density of BESS cabins on allocated land:

This is unstated by Sunnica. We assume that 7.5% of the allocated land area will be occupied by the BESS cabins themselves (this allows for safety separations, fire access routes, Battery Management Systems (BMS) and other electrical plant, bunding for firewater in the event of incidents). This implies a total of 315 BESS cabins allocated over the three sites.

Total scheme storage capacity:

5 MWh (single cabin capacity) x 315 cabins yields a total energy storage capacity of **1575 MWh** (or 1.574 GWh), distributed over 3 separate battery compounds of unequal size (31.48 ha total). If the single cabin capacity were 10 MWh, the total doubles to **3150 MWh.**

A storage capacity between 1500 – 3000 MWh is therefore credible for the Sunnica proposal, depending on single cabin storage and the density of cabins on the land.

The area density of storage at this cabin density would be 50 MWh ha^{-1} for a single-cabin storage of 5 MWh. This figure of 50 MWh ha^{-1} is independent of the total area allocated; it depends only on the assumed fraction (7.5%) occupied.

For comparison, the corresponding density at Cleve Hill [3] is a very similar 69.2 MWh ha^{-1}.

The Energy Institute [25] gives 100 MWh ha^{-1} as 'typical' for Li-ion BESS planning. This density would be reached in our assumptions if the single cabin capacity were 10 MWh. The latter figure is entirely conceivable because the "base estimate" derives from an incompletely populated cabin. It is also readily achievable if the spacing of cabins is closer than implied by the assumption of 7.5% land occupancy.

The "base case" estimate of 315 cabins and 1574 MWh is an overestimate *only if* the project does *not* fully occupy the allocated land (i.e. BESS cabin density is less than the 7.5% assumed), but this would be contrary to advice from the developer in meetings with local Councillors.

It is also an overestimate if the single cabin storage capacity is less than 5 MWh. This is unlikely because it is estimated from a BESS cabin still incompletely populated.

These estimates are summarised in the following Table.

Table 3. Estimates of electrical stored energy under various assumptions at Sunnica.
Note: "1 kiloton TNT" is equivalent to 1.163 GWh. "One Beirut" is equivalent to 580 MWh.

Compound	**Area**	**No. of cabins at area density of 7.5%**	**Energy storage capacity**		**Comments**
(Single cabin) (per cabin land)	75 m^2 1000 m^2	1	5 MWh	10 MWh	Per cabin assumptions
Sunnica East A	5. 23 ha	52	260 MWh	520 MWh	Per compound estimates of stored energy
Sunnica East B	15.6 ha	156	780 MWh	1560 MWh	
Sunnica West A	10.7 ha	107	535 MWh	1070 MWh	
Whole Scheme	31.5 ha	315	1575 MWh 1.575 GWh 1.36 kilotons 2.72 "Beiruts"	3150 MWh 3.150 MWh 2.71 kilotons 5.44 "Beiruts"	Stored electrochemical energy only. Does not include chemical energy from inflammables.

Appendix 2: Applicability of the COMAH Regulations to large-scale BESS

The COMAH regulations (2015): COMAH regulates establishments with quantities of dangerous substances (categorised as toxic, flammable or environmentally damaging) that are present above defined thresholds. The substances do not need to be present in normal operation. If dangerous substances could be generated "if control of the process is lost", the likely quantity generated thereby must be considered. If the mass of dangerous substances that could be generated in loss of control exceeds the COMAH thresholds, the Regulations apply.

There are two "tiers" to COMAH, the "upper tier" imposing more stringent controls. Thresholds of hazardous substances are listed with thresholds for both tiers.

The regulations specify aggregation rules when more than one substance in a hazard category (e.g. flammables) may be present; even if all such substance are below the COMAH thresholds, others in the same hazard category must be quantified and the proportions of the threshold aggregated. If the total exceeds one, the establishment is subject to COMAH. It is also clear that the inventories of all "installations" – including pipework – must be considered as a whole.

Extracts from COMAH Regulations [26] ***2(1) (definitions):***

"establishment" means the whole location under the control of an operator where a dangerous substance is present in one or more installations, including common or related infrastructures or activities, in a quantity equal to or in excess of the quantity listed in the entry for that substance in column 2 of Part 1 or in column 2 of Part 2 of Schedule 1, where applicable using the rule laid down in note 4 in Part 3 of that Schedule;

"presence of a dangerous substance" means the actual or anticipated presence of a dangerous substance in an establishment, or of a dangerous substance which it is reasonable to foresee may be generated during loss of control of the processes, including storage activities, in any installation within the establishment, in a quantity equal to or in excess of the qualifying quantity listed in the entry for that substance in column 2 of Part 1 or in column 2 of Part 2 of Schedule 1, and "where a dangerous substance is present" is to be construed accordingly;

Application to grid-scale BESS: The Regulations refer to "*a dangerous substance which it is reasonable to foresee may be generated during loss of control of the processes*". Both Flammable Gases (P2) and Acute Toxics (H1 and H2) are certainly "*reasonable to foresee*" in thermal runaway incidents which are now well-documented. The evolution of regulated, named and categorised hazardous substances from Li-ion battery cells in thermal runaway is also well-documented. A "worst credible accident" would have to consider that the entire inventory of Li-ion cells would be destroyed in a single BESS cabin at least. Cabin-to-cabin propagation should also be considered.

The Regulations apply to the entire "establishment", controlled by a single operator. Whilst the individual BESS compounds at Sunnica might be regarded as separate establishments, it is less reasonable that individual BESS cabins should be regarded as separate "establishments". They are separate "installations" but "establishment" means the entire area under control of an "operator".

Only if the most stringent safeguards were in place to ensure that the disastrous consequences of cabin-to-cabin propagation of "battery fires" could not conceivably occur, could it be argued that dangerous substances, exceeding the COMAH thresholds in quantity, were not "*reasonable to foresee* [being] *generated during loss of control of the process*".

We believe the COMAH regulations apply to BESS and that the approach of HSE is wrong in law.

Dangerous substances "reasonable to foresee … generated during loss of control of the processes": The literature and known experience of BESS accidents is clear that dangerous substances in the hazard categories H1 and H2 (Acute Toxic) and P2 (Flammable Gases) are foreseeable in the event of thermal runaway accidents. One of the Flammable Gases is Hydrogen, which is a "Named Dangerous Substance" in Part 2 of Schedule 1 of the COMAH Regulations 2015. Lower thresholds are specified for Hydrogen than for other P2 Inflammable Gases.

It remains therefore to consider the quantities of dangerous substances which could be generated if "control of the process is lost" in a thermal runaway incident. Published literature sources quantify evolution of flammable gases from tests of various Li-ion cells in sealed vessels. Open "fire tests" quantify the evolution of toxic gases particularly Hydrogen Fluoride. Many other test results exist in the records of specialist test laboratories, but here we rely upon two primary published sources.

Golubkov *et al.* (2014) [13] report quantities of evolved inflammables from Li-ion cells of three different electrode chemistries in thermal runaway situations. The proportion of Hydrogen (H_2), Methane (CH_4), Ethylene (C_2H_4) and Carbon Monoxide (CO) does not in fact vary greatly between different types of Li-ion cell, reflecting an underlying inventory of hydro-carbon material (plastics, electrolyte solvents etc) that remain similar in all Li-ion technologies. This is consistent with DNV/GL test data cited in the Hill/DNV report [8]. The quantitative estimates here are taken from results derived from cells with Nickel-Manganese-Cobalt (NMC) electrodes, as used in the McMicken BESS. It was not possible in the apparatus of Golubkov *et al.* to determine the concentrations of HF evolved.

Larsson *et al.* [11] report evolved quantities of Hydrogen Fluoride (HF) from Li-ion cells in open "fire tests", and also the Total Heat Released (THR) from combustion of the inflammables. Again these vary between cell technologies and "form factors", especially whether the cells have an outer metal cannister or are in the "pouch" format. Quantities between 20 – 200 mg / Wh are reported. The worst case figure is used in the following estimates; the lowest evolution reported for "pouch" cells was 43 mg/Wh.

Both sources report evolved gas quantities on a per Wh basis. We scale these to a Li-ion BESS cell size on the basis of stored energy since this will be roughly proportional to the electrolyte solvents and other polymer materials in the cell. Scaling on a per mass basis would be preferable, but this would require further information on the exact composition of the cells in the literature tests, and indeed those for the BESS in question. During the McMicken investigation, the cell manufacturers refused to release such data.

H1 and H2 Acute Toxics. The applicability of COMAH is easiest to determine in respect of Hydrogen Fluoride (HF). This has a dual hazard classification [12] as H1 Acute Toxic (skin exposure) and H2 Acute Toxic (inhalation) and both exposure routes would apply to the general public nearby. The lower tier COMAH threshold for H1 Acute Toxics is 5 tonnes [27]; using the upper estimate of 200 mg/Wh from Larsson, the BESS capacity at which a BESS enters the scope of COMAH (lower tier) is 25 MWh.

This is far below the projected storage capacities given in Table 3 (Appendix 1). With high storage capacity cabins (of e.g. 12.5 MWh), it would require propagation of a fire from just one cabin to a second, to generate HF above the COMAH threshold. It is not necessary to foresee a major conflagration involving multiple cabin-to-cabin propagation to bring the establishment within scope of COMAH; just two cabins would suffice. If 25 MWh were stored in a single large cabin, the question of cabin-to-cabin propagation is irrelevant.

The upper tier for “H1 Acute Toxics” is entered at four times higher capacity (100 MWh), which is well below the estimated capacity of Cleve Hill, and is also below *each* of the three Sunnica BESS compounds individually.

Even on the lowest evolution figure of 43 mg/Wh reported by Larsson *et al.* for “pouch” cells, the lower tier of COMAH is entered at a storage capacity of 120 MWh, again well within the “low case” capacity of each of the Sunnica BESS compounds, and Cleve Hill.

There is little doubt that either the lower or upper tier of COMAH is applicable to Cleve Hill and all three of the Sunnica BESS compounds, on the basis of “H1 Acute Toxics” (HF, skin route) alone.

Carbon Monoxide (CO) is categorised as an H2 Acute Toxic as well as a P2 Inflammable Gas, and will also be evolved, but in application of the aggregation rule its presence does not materially alter these conclusions. It is sufficient to consider HF alone.

P2 Inflammable Gases. Assessing applicability of COMAH on the basis of inflammable gases is more complicated because of the evolution of Hydrogen (H_2), Methane (CH_4), Ethylene (C_2H_4) and Carbon Monoxide (CO) in significant quantities, and because Hydrogen is a “named dangerous substance” for which different COMAH thresholds apply. These must be taken into account when applying the Aggregation Rule. Although proportions are generally similar, quantities do depend on the different electrode chemistries in the different Li-ion cell types.

Taking the largest evolutions reported by Golubkov *et al.* [13] for the LCO/NMC electrode type tested by them these are equivalent to 335 mg/Wh of P2 inflammables. For the NMC cells tested (the McMicken cells were NMC) the evolution was 214 mg/Wh. Taking the higher figure and applying the aggregation rule, grid-scale BESS enter the lower tier of COMAH at about 30 MWh capacity. Taking the lower figure, they enter the lower tier at 45 MWh capacity.

Hence there is little doubt that grid-scale BESS are lower tier COMAH establishments on the basis of “P2 Inflammable Gases” at storage capacities between 30 – 45 MWh.

Because of the variability between cell types, and the difficulty of scaling laboratory tests to actual BESS cells without detailed composition data, there is room for adjustment. However the calculated estimates of the thresholds for applicability of COMAH are so far below the projected capacities that it is inconceivable that the Cleve Hill and Sunnica BESS compounds would *not* be COMAH establishments, in lower tier at the very least, and probably the upper tier also.

Conclusion: Grid-scale Li-ion BESS should be considered COMAH establishments in the lower tier on the basis of “H1 Acute Toxics” (HF) alone, at energy storage capacities in the region of **25 MWh**. Upper tier would apply at about **100 MWh**. They should be lower-tier COMAH establishments on the basis of “P2 inflammable gases” alone, at storage capacities between **30 – 45 MWh**. Again larger establishments could become upper tier COMAH. Laboratory closed vessel and fire tests on actual Li-ion BESS cells proposed to be deployed would be required to refine these estimates definitively.

It is difficult to see how these conclusions could be avoided if tested in litigation.

Appendix 3: Shortcomings of Existing Engineering Standards for Li-ion BESS

The July 2020 report for the Arizona Public Service by Dr D Hill [8] provides a comprehensive discussion of existing engineering standards relating to BESS, and how they are *inadequate* to address the known hazards of "thermal runaway" incidents in Li-ion BESS. This was the failure mode leading to the explosion at McMicken, Arizona.

Unfortunately, when the UK's first "mega-scale" solar plant and battery storage site was granted approval in May 2020, this paper had not been published. The Cleve Hill solar developers cited one standard, UL 9540A [3]. This is also cited by some insurance and risk consultants [20].

It is important to be clear that nothing in UL 9540A addresses thermal runaway, and as a test method standard, it can provide no "safety certification" for Li-ion BESS.

Specific criticisms made in the Hill/DNV report include the following:

1. UL 1973 allows for the complete destruction of a BESS and the creation of an explosive atmosphere so long as no explosion or external flame is observed. An installation can do all these things but still "pass" UL 1973. At McMicken one rack was completely destroyed and an explosive atmosphere created but no flame or explosion occurred until first-responders opened the cabin door.
2. UL 9540A is merely a test method for generating data. It does not define any "pass/fail" criteria for interpreting results. Specifically, it does not address cell-to-cell cascading in thermal runaway, nor the evolution of a potentially explosive atmosphere. It does not even prescribe that the cell-to-cell cascading rate be measured.
   It allows that thermal runaway may proceed to an entire rack (as at McMicken) and offers testing of fire suppression systems (which operated correctly at McMicken but cannot prevent thermal runaway, and did not prevent an explosion).
   Presentation of data generated under UL 9540A to an "AHJ" (Authority Having Jurisdiction) does not translate to a succinct understanding of potential risks.
3. NFPA 855 [21] does require evaluation of thermal runaway in a single module, array or unit and does acknowledge the need for thermal runaway protection. However, it assigns that role to the Battery Management System (BMS). Yet thermal runaway is an electrochemical reaction that once started cannot be stopped electrically. It is uncontrollable by electronics or switchgear, only by water cooling.

The evolution of engineering and safety standards has not yet incorporated the lessons of experience arising from the McMicken explosion [8] **or explosion incidents in the UK like the Liverpool explosion and fire of 15 September 2020** [1]**. Compliance with existing standards does not prevent such incidents happening again.**

Articles in the industry press[3] do now recognise and discuss the problem of thermal runaway but make proposals such as: "*If off-gases can be detected and batteries shut down before thermal runaway can begin, it is possible that fire danger can be averted*".

Such statements betray a dangerous misunderstanding. Batteries cannot be "shut down", except by complete discharge, which cannot be done quickly. Taking cells "out of circuit" is useless; thermal breakdown and runaway will still occur.

[3] https://www.energy-storage.news/blogs/preventing-thermal-runaway-in-lithium-ion-energy-storage-systems

Appendix 4 – Fire Safety Planning requirements in the Local Authorities' Joint Response to the Sunnica statutory consultation

This Appendix deals point by point with the BESS requirements in the Local Authority response (text in blue) pp 74 – 75.

Sunnica should produce a risk reduction strategy as the responsible person for the scheme as stated in the Regulatory Reform (Fire Safety) Order 2005. It is expected that safety measures and risk mitigation is developed in collaboration with services across both counties.

The Local Authorities require that the Fire Services work with Sunnica to prepare fire safety and risk mitigation measures. The Cambridgeshire and Suffolk Fire Services are therefore the only public bodies with independent oversight of BESS safety.

The use of batteries (including lithium-ion) as Energy Storage Systems (ESS) is a relatively new practice in the global renewable energy sector. As with all new and emerging practices within UK industry, the SFRS would like to work with the developers to better understand any risks that may be posed and develop strategies and procedures to mitigate these risks.

This paper is provided as input to this process, which appears to be insufficiently understood.

The promoter must ensure the risk of fire is minimised by:

- Procuring components and using construction techniques which comply with all relevant legislation.

This overlooks the points made in this paper that (i) existing legislation is being ignored by the statutory regulatory body, the HSE (ii) no adequate engineering standards exist to exercise Prevention measures over what is by now a very well-known hazard, viz. thermal runaway. Public Health and Safety cannot be assured whilst either of these situations continues.

- Developing an emergency response plan with both counties fire services to minimise the impact of an incident during construction, operation and decommissioning of the facility.
- Ensuring the BESS is located away from residential areas. Prevailing wind directions should be factored into the location of the BESS to minimise the impact of a fire involving lithium-ion batteries due to the toxic fumes produced.

This is impossible to satisfy. All the BESS compounds in the Sunnica proposal are sufficiently close to residential areas to present a major danger of toxic fumes in the event of an accident. Plume dispersal modelling should be performed to ensure that concentrations of HF cannot exceed dangerous thresholds in the event of the worst credible accident in a BESS compound.

- The emergency response plan should include details of the hazards associated with lithium-ion batteries, isolation of electrical sources to enable firefighting activities, measures to extinguish or cool batteries involved in fire, management of toxic or flammable gases, minimise the environmental impact of an incident, containment of fire water run-off, handling and responsibility for disposal of damaged batteries, establishment of regular onsite training exercises.

This requirement is very broad but insufficiently detailed. Means of cooling would require water volumes many times in excess of those requested. Management of inflammable gases is best addressed by venting, but that exacerbates the hazard of toxic gas plumes. Large water volumes may lead to unrealistic or impossible requirements for the containment, and subsequent disposal, of the contaminated water resulting from the fire-fighting activity. Other sections of this paper address these points.

- The emergency response plan should be maintained and regularly reviewed by Sunnica and any material changes notified to SFRS and CFRS.

- Environmental impact should include the prevention of ground contamination, water course pollution, and the release of toxic gases.

Preventing the release of toxic gases is all but impossible. A thermal runaway event WILL release toxic gases. If inflammables are vented to avoid /mitigate explosion risk, toxic gases WILL be vented. Ground contamination and water course pollution is almost certain to occur if sufficient water to control a major thermal runaway event is deployed. It will pose a significant challenge to contain, and safely dispose of, such large volumes of contaminated fire water.

The BESS facilities should be designed to provide:

- Automatic fire detection and suppression systems. Various types of suppression systems are available, but the Service's preferred system would be a water drenching system as fires involving Lithium-ion batteries have the potential for thermal runaway.

This is a correct precaution, but no specification is made of likely water volume requirements, nor for a "dry pipe" system allowing water to be deployed without cabin entry. We provide some water estimates elsewhere in this paper.

Other systems, such as inert gas, would be less effective in preventing reignition.

This is also a correct insight. The so-called "clean-agent" fire suppression system at McMicken was triggered correctly, but was useless to control thermal runaway. Moreover the stratified atmosphere created allowed the build-up of inflammables to a dangerous level, before the explosion occurred.

- Redundancy in the design to provide multiple layers of protection.
- Design measures to contain and restrict the spread of fire through the use of fire-resistant materials, and adequate separation between elements of the BESS.

This comment only vaguely considers the true essentials. The "elements of the BESS" could be: cells, modules, racks, strings, and the entire system. As discussed in the Hill/DNV report what is required is for the industry as a whole to accept that thermal runaway in an unacceptable hazard, and demand engineering standards that Prevent thermal runaway by design, or if it occurs, Prevent its cascade or escalation to larger system elements. This requires

a. Thermal barriers (i.e. Low thermal conductivity barriers, not merely refractory barriers, ideally with water cooling, between all cells, so that propagation from cell to cell cannot occur. This is precisely the requirement the industry has so far ***NOT*** made in the development of its engineering standards.
b. Separation of modules by similar barriers to Prevent module-to-module cascade.
c. Separation of Racks to prevent rack-to-rack cascade, even with ejection of molten metals.
d. Spacing of BESS cabins such that even with "75 foot flame lengths" cabin to cabin escalation is impossible. This is probably the most critical of all, since cabin-to-cabin escalation could turn a major fire incident into an unprecedented catastrophe, on the scale of the Beirut explosion or a small nuclear weapon.

- Provide adequate thermal barriers between switch gear and batteries,
- Install adequate ventilation or an air conditioning system to control the temperature. Ventilation is important since batteries will continue to generate flammable gas as long as they are hot. Also, carbon monoxide will be generated until the batteries are completely cooled through to their core.

This comment is very strange. There is no possibility whatsoever that air conditioning could be adequate "to control the temperature". The importance of ventilation is however recognised, as is the generation of carbon monoxide (toxic as well as inflammable). However the generation of Hydrogen Fluoride will also continue until the batteries are "completely cooled" and HF (H1 Acute Toxic by skin exposure) is much more toxic than CO (H2 Acute Toxic).

- Install a very early warning fire detection system, such as aspirating smoke detection.

The "very early warning" fire detection system required should be thermocouples to report continuously on the local temperature at every cell in the entire system. A single cell overheating can escalate via thermal runaway. By the time smoke is generated, this will be a "very late", rather than "very early" detection system. Just as thermal runaway events do not necessarily generate flame, neither do they necessarily generate smoke, until nearby combustibles are ignited.

- Install carbon monoxide (CO) detection within the BESS containers.

This is a good straightforward measure, but detectors for other gases expected (HF, H_2, CH_4) could equally well serve and multiple gas detection would provides additional security.

- Install sprinkler protection within BESS containers. The sprinkler system should be designed to adequately contain and extinguish a fire.

The excellent record of sprinkler systems in ordinary building fires shows they would help contain fire in regular combustible parts of the structure. However as discussed earlier in this paper, a mere sprinkler system would be useless to contain thermal runaway. Much larger water quantities would be needed.

- Ensure that sufficient water is available for manual firefighting. An external fire hydrant should be located in close proximity of the BESS containers. The water supply should be able to provide a minimum of 1,900 l/min for at least 2 hours. Further hydrants should be strategically located across the development. These should be tested and regularly serviced by the operator.

As discussed elsewhere, we believe these water requirements to be **under-specified by a factor of 100**, based on real experience with BEV fires. "Strategic location" is inadequate. Every single BESS cabin (potentially up to 150 of these at Sunnica East B alone) should have such a hydrant.

We remark elsewhere on the recommendation made by Hill/DNV for a "dry pipe" system to deploy water drenching inside via external connections, without cabin entry being needed.

- A safe access route for fire appliances to manoeuvre within the site (including turning circles). An alternative access point and approach route should be provided and maintained to enable appliances to approach from an up wind direction. Please note that SFRS requires a minimum carrying capacity for hardstanding for pumping/high reach appliances of 15/26 tonnes, not 12.5 tonnes as detailed in the Building Regulations 2000 Approved Document B, 2006 Edition, due to the specification of our appliances.

The requirement for safe access routes and space for appliances to manoeuvre could usefully be expanded into requirements for safe spacing of BESS cabins and thermal or flame barriers between cabins, to Prevent the "disaster scenario" of cabin-to-cabin propagation.

Final Comment: (over)

Final Comment:

The fundamental failure mode of Li-ion batteries presenting major hazard is thermal runaway. This paper is far from the first to identify the risk which is now well-known.

However the BESS industry as a whole has still not agreed or implemented adequate engineering standards to address basic Prevention measures to pre-empt thermal runaway accidents.

Until it does, Mitigation of major accidents by the Fire Services will remain the sole recourse for public protection and safety.

City of Bonney Lake, Washington

Community Development Committee Agenda Bill (AB)

Agenda Bill Number:	
Agenda Item Type:	Ordinance
Presenter:	Lauren Balisky, Development Services Manager
City Strategic Goal Category:	None
Department/Division Submitting:	Public Services Staff
Impacted Departments That Received Notification:	None

Full Title/Motion: An Ordinance Of The City Council Of The City Of Bonney Lake, Pierce County, Washington, Relating To Automatic Fire Extinguishing Systems, Repealing Chapter 15.16 Of The Bonney Lake Municipal Code (BLMC); Amending Subsections 14.120.030.A And .B To Remove References To Chapter 15.16 BLMC; Amending Subsection 15.04.084 To Reflect Current Procedure For Annual Fire Safety Inspections; Amending Subsection 15.36.040 To Reflect Current Procedure For Processing Permits For Underground Infrastructure For Automatic Fire Extinguishing Systems; Providing For Severability And Corrections; And Establishing An Effective Date

Short Background Summary:

PURPOSE

The purpose of this item is to brief the Community Development Committee on the proposed code amendments related to automatic fire extinguishing systems (fire sprinklers). City staff is requesting initial review and comment on the draft Ordinance (see **Attachment A**).

DISCUSSION

City Council requested staff to bring forward an amendment to Bonney Lake Municipal Code (BLMC) to remove the additional requirements for automatic fire extinguishing systems beyond the minimum requirements in Washington State law. This update:

- **Repeals Existing Chapter 15.16 BLMC** (see **Attachment B**)
- **BLMC 14.120.030:** Removes reference to Chapter 15.16 for appeals to the construction board of appeals.
- **BLMC 15.04.084:** Relocates the language from BLMC 15.16.070 that requires the results of annual fire inspections be provided to the fire department, consistent with the City's Interlocal Agreement with East Pierce Fire & Rescue. No change was made to the language.
- **BLMC 15.36.040:** Relocates language from BLMC 15.16.105 that states what permit type should be used for the installation of underground infrastructure. Typically, these are

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water lines that serve on-site fire hydrants or fire riser rooms. There was no substantive change to the language.

TENTATIVE SCHEDULE

- ~~December 9, 2025 - City Council Adoption of Ordinance 1745, which directed staff to prepare this work item~~
- ~~March 10, 2025 - City Council Motion to Amend 2025-2026 Work Plan~~
- ~~November 18, 2025 - City Council Open Council Discussion~~
- ~~April 1, 2026 - Planning Commission Discussion~~
- April 7, 2026 - CDC Discussion
- May 6, 2026 - Planning Commission Public Hearing
- May 19, 2026 - City Council Decision

Budget Explanation:

N/A

Committee, Board, Commission, & Hearing Examiner Review

Name Of Committee/Commission/Examiner Meeting: Planning Commission

Date of Committee/Commission/Examiner Meeting: 4/1/2026

Date of Committee/Commission Public Hearing: 5/6/2026

Committee/Commission/Examiner Meeting Decision:

Council Action

Date of Council Workshop	Date of Council Meeting	Date of Council Public Hearing
	5/19/2026	

ORDINANCE NO. XXXX

AN ORDINANCE OF THE CITY COUNCIL OF THE CITY OF BONNEY LAKE, PIERCE COUNTY, WASHINGTON, RELATING TO AUTOMATIC FIRE EXTINGUISHING SYSTEMS, REPEALING CHAPTER 15.16 OF THE BONNEY LAKE MUNICIPAL CODE (BLMC); AMENDING SUBSECTIONS 14.120.030.A AND .B TO REMOVE REFERENCES TO CHAPTER 15.16 BLMC; AMENDING SUBSECTION 15.04.084 TO REFLECT CURRENT PROCEDURE FOR ANNUAL FIRE SAFETY INSPECTIONS; AMENDING SUBSECTION 15.36.040 TO REFLECT CURRENT PROCEDURE FOR PROCESSING PERMITS FOR UNDERGROUND INFRASTRUCTURE FOR AUTOMATIC FIRE EXTINGUISHING SYSTEMS; PROVIDING FOR SEVERABILITY AND CORRECTIONS; AND ESTABLISHING AN EFFECTIVE DATE.

WHEREAS, the Washington State Building Code Act (GMA) codified as Chapter 19.27 of the Revised Code of Washington (RCW) requires the City of Bonney Lake adopt state building and fire construction codes; and

WHEREAS, one of the express purposes of Chapter 19.27 RCW is to require minimum performance standards and requirements for construction and construction materials, consistent with accepted standards of engineering, fire and life safety; and

WHEREAS, the City wishes to remove requirements associated with automatic fire extinguishing systems that exceed the minimum performance standards and requirements in the state construction codes; and

WHEREAS, the Public Services Director acting as the State Environmental Policy Act (SEPA) Responsible Official determined that the proposed amendment is categorically exempt from threshold determination pursuant to BLMC 16.08.025.C.4.a; and

WHEREAS, the City provided public notice of the hearing as required by Bonney Lake Municipal Code (BLMC) 14.140.040; and

WHEREAS, the Planning Commission held a public hearing on Month Day, 2026, as required by BLMC 14.140.080 and recommended that the City Council [recommendation], as required by BLMC 14.140.100;

NOW THEREFORE, THE CITY COUNCIL OF THE CITY OF BONNEY LAKE, WASHINGTON, DO ORDAIN AS FOLLOWS:

Section 1. **Findings of Facts and Conclusions.** The findings of fact and conclusions attached as Attachment A are adopted in full by the City Council in support of its decision. The recitals listed above in this Ordinance are further adopted as legislative findings.

Commented [LB1]: Findings will be provided as part of the packet materials for the public hearing.

Section 2. **Repeal.** Chapter 15.16 of the Bonney Lake Municipal Code is hereby repealed in its entirety.

Section 3. **Amendment.** Subsection 14.120.030 of the Bonney Lake Municipal Code is hereby amended to read as follows:

14.120.030 Appeals to the construction board of appeals.

Commented [LB2]: Removes references to repealed Chapter 15.16 BLMC.

A. All decisions and interpretations made under the authority of Chapters 15.04~~,~~ and 15.08~~, and 15.16~~ BLMC by the director shall be final and conclusive unless the applicant, a department of the city or county, or other party of record or agency with jurisdiction files a written appeal with the department within 15 days from the date that the decision or interpretation was issued by the city.

B. The construction board of appeals as established in the building codes adopted by Chapter 15.04 BLMC shall hear appeals of, and make final interpretations regarding, Chapters 15.04~~,~~ and 15.08~~, and 15.16~~ BLMC and other appropriate building codes.

….

Section 4. **Amendment.** Subsection 15.04.084 of the Bonney Lake Municipal Code is hereby amended to read as follows:

15.04.084 International Fire Code amended.

Commented [LB3]: Relocates language from BLMC 15.16.070 that requires a copy of annual testing results to be submitted to the fire department, consistent with the City's ILA with East Pierce Fire & Rescue. No change to language.

… Section 505.1 Premises Identification. …

Section 903.5 Testing and maintenance. Sprinkler systems shall be tested and maintained in accordance with Section 901. A copy of the annual inspection report shall be signed by the individual conducting the inspection, and a copy of the report shall be forwarded to the fire department.

Section 907.1.3 Equipment. ….

Section 5. **Amendment.** Subsections 15.36.040.B and .E of the Bonney Lake Municipal Code is hereby amended to read as follows:

15.36.040 Applicable civil improvements.

Commented [LB4]: Relocates language from BLMC 15.16.105 that states what permit type should be used for the installation of underground infrastructure for automatic fire extinguishing systems (water lines to fire hydrants, sprinkler rooms, etc.). No substantive change to language.

The following is a list of the civil construction activities for which a civil improvement permit is required:

…

B. Underground infrastructure for automatic fire extinguishing systems installed as part of a remodel, retrofit, or change of use (Chapter ~~15.16~~ 15.04 BLMC);

…

E. Water system extension within rights-of-way, including any underground infrastructure for automatic fire extinguishing systems which are part of a water system extension (Chapter 13.04 BLMC);

….

Section 6. **Severability.** If any section, sentence, clause, or phrase of this Ordinance should be held to be unconstitutional by a court of competent jurisdiction, such invalidity or unconstitutionality shall not affect the validity or constitutionality of any other section, sentence, clause or phrase of this Ordinance.

Section 7. **Publication.** This Ordinance shall be published by an approved summary consisting of the title.

Section 8. **Corrections.** Upon the approval of the city attorney, the city clerk, and/or the code publisher is authorized to make any necessary technical corrections to this ordinance, including but not limited to the correction of scrivener's/clerical errors, references, ordinance numbering, section/subsection numbers, and any reference thereto. Provided, however, that nothing in this section allows the city attorney, the city clerk, and/or the code publisher to change the intent of this Ordinance.

Section 9. **Effective Date.** This Ordinance shall be effective five days after publication as provided by law.

ADOPTED by the City Council of the City of Bonney Lake and attested by the City Clerk in authentication of such passage on this __ day of ________________, 20__.

APPROVED by the Mayor this __ day of _____________, 20___.

____
Terry Carter, Mayor

AUTHENTICATED:

____
Sadie A. Schaneman, MMC, City Clerk

AB____
Passed:
Valid:
Published:
Effective Date:
This Ordinance totals _____ page(s)

City of Bonney Lake, WA
Tuesday, March 17, 2026

Title 15. Buildings and Construction

Chapter 15.16. AUTOMATIC FIRE EXTINGUISHING SYSTEMS

§ 15.16.010. Where required – Specific occupancies – New construction.

Subsections 903.1, 903.1.1, and 903.2 of the International Fire Code are hereby amended to read as follows:

Section 903.1 General. Automatic sprinkler systems shall comply with this section.

1. For structures with unknown tenants, the sprinkler density of .39 per 5,600 square feet shall be used for design purposes where required by the Fire Chief.

Section 903.1.1 Alternative Protection. Alternative automatic fire-extinguishing systems complying with Section 904 shall be permitted in lieu of automatic sprinkler protection where recognized by the applicable standard and approved by the fire code official.

Section 903.2 Where Required. Approved automatic sprinkler systems in new buildings and structures shall be provided in the locations described in this section.

For provisions on special hazards and hazardous materials, see the fire code.

Gross floor area defined. For purposes of this chapter, gross floor area shall be as defined in Chapter 10, International Building Code.

1. All buildings hereinafter constructed as defined by the International Fire Code shall be equipped with a fully automatic sprinkler system designed, installed, maintained and tested per NFPA 13, 13D, 13R, or 25, the edition currently adopted by the city, where the gross floor area or occupant load exceeds those listed below, or the building is 35 feet in height or three or more stories.

Buildings protected by a fire sprinkler system. Canopies 4 feet or more in width shall be protected by a fire sprinkler system.

For requirements related to additions, alterations and/or remodels to existing buildings see Section **15.16.020**.

(Ord. 699 § 1, 1995; Ord. 1357 § 1, 2010; Ord. 1462 § 11, 2013; Ord. 1484 § 1, 2014)

§ 15.16.011. Group A occupancies.

Subsections 903.2.1, 903.2.1.1, 903.2.1.2, 903.2.1.3, 903.2.1.4, and 903.2.1.5 of the International Fire Code are hereby amended to read as follows:

Section 903.2.1 Group A. An automatic sprinkler system shall be provided throughout buildings and portions thereof used as Group occupancies as provided in this section. For Group A-1, A-2, A-3 and A-4 occupancies, the automatic sprinkler system shall be provided throughout the gross floor area where the Group A-1, A-2, A-3 or A-4 occupancy is located, and in all floors between the Group occupancy and the level of exit discharge. For Group A-5 occupancies, the automatic sprinkler system shall be provided in the spaces indicated in Section 903.2.1.5.

Section 903.2.1.1 Group A-1. An automatic sprinkler system shall be provided for Group A-1 occupancies where one of the following conditions exists:

1. The gross floor area exceeds 5,000 square feet;
2. The gross floor area has an occupant load of 100 or more;
3. The gross floor area is located on a floor other than the level of exit discharge; or
4. The gross floor area contains a multi-theater complex.

Section 903.2.1.2 Group A-2. An automatic sprinkler system shall be provided for Group A-2 occupancies where one of the following conditions exists:

1. The gross floor area exceeds 5,000 square feet;
2. The gross floor area has an occupant load of 100 or more; or
3. The gross floor area is located on a floor other than the level of exit discharge.

Section 903.2.1.3 Group A-3. An automatic sprinkler system shall be provided for Group A-3 occupancies where one of the following conditions exists:

1. The gross floor area exceeds 5,000 square feet;
2. The gross floor area has an occupant load of 100 or more; or
3. The gross floor area is located on a floor other than the level of exit discharge.

Exception: Areas used exclusively as participant sports areas where the main floor area is located at the same level as the level of exit discharge of the main entrance and exit.

Section 903.2.1.4 Group A-4. An automatic sprinkler system shall be provided for Group A-4 occupancies where one of the following conditions exists:

1. The gross floor area exceeds 5,000 square feet;
2. The gross floor area has an occupant load of 100 or more; or
3. The gross floor area is located on a floor other than the level of exit discharge.

Exception: Areas used exclusively as participant sports areas where the main floor area is located at the same level as the level of exit discharge of the main entrance and exit.

Section 903.2.1.5 Group A-5. An automatic sprinkler system shall be provided in concession stands, retail areas, press boxes, and other accessory use areas in excess of 1,000 square feet of gross floor area.

(Ord. 699 § 1, 1995; Ord. 1357 § 2, 2010; Ord. 1462 § 11, 2013)

§ 15.16.012. Group B occupancies.

Group B. Businesses as described in Chapter 2 of the International Fire Code.

An automatic sprinkler system shall be provided throughout all buildings with a Group B occupancy where one of the following conditions exists:

1. Where the gross floor area of a Group B occupancy exceeds 5,000 square feet;
2. Where the gross floor area of a Group B occupancy is located more than three stories above grade; or
3. Where the combined gross floor area of all Group B occupancies on all floors, including any mezzanines, exceeds 5,000 square feet.

(Ord. 699 § 1, 1995; Ord. 1357 § 3, 2010; Ord. 1462 § 11, 2013)

§ 15.16.013. Group E occupancies.

Subsection 903.2.3 of the International Fire Code is hereby amended to read as follows:

Section 903.2.3 Group E. An automatic sprinkler system shall be provided for Group E occupancies as follows:

1. Throughout all Group E occupancies where the gross floor area exceeds 5,000 square feet.

2. Throughout every portion of educational buildings below the level of exit discharge.

Exception: An automatic sprinkler system is not required in any fire area or area below the level of exit discharge where every classroom throughout the building has at least one exterior exit door at ground level.

(Ord. 699 § 1, 1995; Ord. 1357 § 4, 2010; Ord. 1462 § 11, 2013)

§ 15.16.014. Group F occupancies.

Subsections 903.2.4 and 903.2.4.1 of the International Fire Code are hereby amended to read as follows:

Section 903.2.4 Group F-1. An automatic sprinkler system shall be provided throughout all buildings containing a Group F-1 occupancy where one of the following conditions exist:

1. Where the gross floor area of a Group F-1 occupancy exceeds 5,000 square feet;

2. Where the gross floor area of a Group F-1 occupancy is located more than three stories above grade;

3. Where the combined gross floor area of all Group F-1 occupancies on all floors, including any mezzanines, exceeds 5,000 square feet; or

4. Where the gross floor area of a Group F-1 occupancy used for the manufacture of upholstered furniture or mattresses exceed 2,500 square feet.

Section 903.2.4.1 Woodworking Operations. An automatic sprinkler system shall be provided throughout all Group F-1 occupancy fire areas that contain woodworking operations in excess of 2,500 square feet in gross floor area which generate finely divided combustible waste or which use finely divided combustible materials.

(Ord. 699 § 1, 1995; Ord. 1357 § 5, 2010; Ord. 1462 § 7, 2013)

§ 15.16.015. Group H occupancies.

Subsections 903.2.5, 903.2.5.1, 903.2.5.2, and 903.2.5.3 of the International Fire Code are hereby amended to read as follows:

Section 903.2.5 Group H. Automatic sprinkler systems shall be provided in high-hazard occupancies as required in Sections 903.2.5.1 through 903.2.5.3.

Section 903.2.5.1 General. An automatic sprinkler system shall be installed in Group H occupancies.

Section 903.2.5.2 Group H-5 Occupancies. An automatic sprinkler system shall be installed throughout buildings containing Group H-5 occupancies. The design of the sprinkler system shall not be less than that required under the International Building Code for the occupancy hazard classifications in accordance with Table 903.2.5.2.

Where the design area of the sprinkler system consists of a corridor protected by one row of sprinklers, the maximum number of sprinklers required to be calculated is 13.

TABLE 903.2.5.2 GROUP H-5 SPRINKLER DESIGN CRITERIA	
LOCATION	**OCCUPANCY HAZARD CLASSIFICATION**
Fabrication areas	Ordinary Hazard Group 2
Service corridors	Ordinary Hazard Group 2

TABLE 903.2.5.2 GROUP H-5 SPRINKLER DESIGN CRITERIA	
LOCATION	**OCCUPANCY HAZARD CLASSIFICATION**
Storage rooms without dispensing	Ordinary Hazard Group 2
Storage rooms with dispensing	Extra Hazard Group 2
Corridors	Ordinary Hazard Group 2

Section 903.2.5.3 Pyroxylin Plastics. An automatic sprinkler system shall be provided in buildings, or portions thereof, where cellulose nitrate film or pyroxylin plastics are manufactured, stored or handled in quantities exceeding 100 pounds.

(Ord. 699 § 1, 1995; Ord. 1357 § 6, 2010; Ord. 1462 § 11, 2013)

§ 15.16.016. Group I occupancies.

Subsection 903.2.6 of the International Fire Code is hereby amended to read as follows:

Section 903.2.6 Group I. An automatic sprinkler system shall be provided throughout buildings with a Group I fire area.

Exception: An automatic sprinkler system installed in accordance with Section 903.3.1.2 or 903.2.1.3 shall be allowed in Group I-1 facilities.

(Ord. 699 § 1, 1995; Ord. 1357 § 7, 2010; Ord. 1462 § 11, 2013)

§ 15.16.0165. Group M occupancies.

Subsection 903.2.7 and 903.2.7.1 of the International Fire Code are hereby amended to read as follows:

Section 903.2.7 Group M. An automatic sprinkler system shall be provided throughout buildings containing a Group M occupancy where one of the following conditions exists:

1. Where the gross floor area of a Group M occupancy exceeds 5,000 square feet;
2. Where the gross floor area of a Group M occupancy is located more than three stories above grade; or
3. Where the combined gross floor area of all Group M occupancies on all floors, including any mezzanines, exceeds 5,000 square feet.

Section 903.2.7.1 High-Piled Storage. An automatic sprinkler system shall be provided as required in Chapter 23 in all buildings of Group M occupancy where storage of merchandise is in high-piled or rack storage arrays. Permits may be required.

(Ord. 1357 § 8, 2010; Ord. 1462 § 11, 2013)

§ 15.16.017. Group R occupancies.

Subsection 903.2.8 of the International Fire Code is hereby amended to read as follows:

Section 903.2.8 Group R. An automatic sprinkler system installed in accordance with Section 903.3 shall be provided throughout all buildings with a Group R fire area and one and two-family dwellings and townhouses constructed under the Building Codes adopted under Chapter **15.04** BLMC.

903.2.8.1 Group R-3 or R-4 congregate residences. An automatic sprinkler system installed in accordance with Section 903.3.1.3 shall be permitted in Group R-3 or R-4 congregate living facilities with 16 or fewer residents.

903.2.8.2 Care facilities. An automatic sprinkler system installed in accordance with Section 903.3.1.3 shall be permitted in care facilities with 5 or fewer individuals in a single-family dwelling.

(Ord. 699 § 1, 1995; Ord. 1357 § 9, 2010; Ord. 1462 § 8, 2013; Ord. 1484 § 2, 2014; Ord. 1686 § 11, 2023)

§ 15.16.018. Group S occupancies.

Subsections 903.2.9, 903.2.9.1, 903.2.9.2, 903.2.10, and 903.2.10.1 of the International Fire Code are hereby amended to read as follows:

Section 903.2.9 Group S-1. An automatic sprinkler system shall be provided throughout all buildings containing a Group S-1 occupancy where one of the following conditions exists:

1. Where the gross floor area of a Group S-1 occupancy exceeds 5,000 square feet;

2. Where the gross floor area of a Group S-1 occupancy is located more than three stories above grade;

3. Where the combined gross floor area of all Group S-1 occupancies on all floors, including any mezzanines, exceeds 5,000 square feet;

4. Where the gross floor area of a Group S-1 occupancy used for the storage of commercial trucks of buses exceed 5,000 square feet; or

5. Where the gross floor area of a Group F-1 occupancy used for the storage of upholstered furniture or mattresses exceed 2,500 square feet.

Section 903.2.9.1 Repair garages. An automatic sprinkler system shall be provided throughout all buildings used as repair garages in accordance with Section 406.8 of the International Building Code, as shown:

1. Buildings two or more stories in height, including basements, with a gross floor area containing a repair garage exceeding 5,000 square feet.

2. One-story buildings with a gross floor area containing a repair garage exceeding 5,000 square feet.

3. Buildings with a repair garage servicing vehicles parked in the basement.

4. Where the gross floor area of a Group S-1 occupancy used for the repair of commercial trucks of buses exceed 5,000 square feet.

Section 903.2.9.2 Bulk Storage of Tires. Buildings and structures where the area for the storage of tires exceeds 20,000 cubic feet shall be equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

Section 903.2.10 Group S-2. An automatic sprinkler system shall be provided throughout buildings classified as an enclosed parking garage in accordance with the International Building Code or where located beneath other groups.

Exception: Enclosed parking garages located beneath Group R-3 occupancies.

Section 903.2.10.1 Commercial Parking Garages. An automatic sprinkler system shall be provided throughout buildings used for storage of commercial trucks or buses where the gross floor area exceeds 5,000 square feet.

(Ord. 699 § 1, 1995; Ord. 1357 § 10, 2010; Ord. 1462 § 9, 2013)

§ 15.16.019. General requirements.

Subsection 903.3.7 of the International Fire Code is hereby amended to read as follows:

Section 903.3.7 Fire department connections. The location of fire department connections shall be approved by the fire chief. Where possible, fire department connections shall be located not less than 50 feet from the protected building and not more than 50 feet from the fire hydrant.

(Ord. 1462 §§ 10, 11, 2013)

§ 15.16.020. Where required.

Subsection 903.6 of the International Fire Code is hereby amended to read as follows:

Section 903.6 Existing buildings. The provisions of this section are intended to provide a reasonable degree of safety in existing structures by requiring the installation of an automatic sprinkler system in all existing structures where the gross floor area or occupant load exceeds those listed in BLMC Sections **15.16.010** – 019 that are altered, remodeled, or enlarged 50% or more of the existing floor area as defined by the International Building and Fire Code. This provision shall apply to the existing and proposed additional square footage in their entirety.

The project may be exempt from the requirements for automatic sprinkler systems provided:

1. a. There is no increase in occupied space, including existing areas previously vacant; and

b. There is no change in occupancy; and

c. The project complies with all other fire and life safety requirements of adopted construction codes; or

2. The structure is of noncombustible construction with wholly noncombustible contents, provided automatic sprinklers are not required to satisfy other requirements of adopted codes.

Existing basements in other than R occupancies, in excess of 1,500 square feet may be exempt from automatic sprinkler requirements provided the following conditions are met:

1. A one-hour fire-resistive occupancy separation is installed between the basement and the remainder of the building; and

2. The entire building must be provided with a fully automatic fire alarm system; and

3. No residential occupancy is located in the building.

(Ord. 699 § 1, 1995; Ord. 851 § 19, 2000; Ord. 1357 § 12, 2010; Ord. 1462 § 11, 2013; Ord. 1484 § 3, 2014)

§ 15.16.030. Where required – Specific conditions.

A fully automatic extinguishing system shall be required by the building official, with the concurrence of the fire chief of Pierce County Fire Protection District No. 22, for a new building with lesser gross floor area when in his judgment any of the following conditions exist:

A. Hazardous operation or hazardous conditions;

B. Critical exposure problems where buildings are inaccessible on more than two sides;

C. Limited access to the building or property, as defined by the International Fire Code;

D. Where the available fire flow is less than 80 percent of the required fire flow;

E. Other factors which may contribute to an extreme fire hazard.

(Ord. 699 § 1, 1995; Ord. 851 § 20, 2000; Ord. 1357 § 13, 2010)

§ 15.16.040. Permissible sprinkler omissions.

Subsection 903.3.1.1.1 of the International Fire Code is hereby amended to read as follows:

Section 903.3.1.1.1 Exempt locations. Subject to the approval of the Fire Chief, automatic sprinklers may be omitted in the following rooms or areas where such rooms or areas are protected with an approved automatic fire detection system in accordance with Section 907.2 that will respond to visible or invisible particles of combustion. Sprinklers shall not be omitted from any room merely because it is damp, of fire-resistance rated construction or contains electrical equipment.

1. Any room where the application of water, or flame and water, constitutes a serious life or fire hazard.

2. Safe deposit or other vaults of fire-resistive construction, when used for the storage of record files and other documents, when stored in metal cabinets.

3. Any room or space where sprinklers are considered undesirable because of the nature of the contents, when approved by the fire code official.

4. Generator and transformer rooms separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a fire-resistance rating of not less than 2 hours.

5. In rooms or areas that are of non-combustible construction with wholly non-combustible contents.

6. Fire service access elevator machine rooms and machinery spaces.

(Ord. 699 § 1, 1995; Ord. 851 § 21, 2000; Ord. 1357 § 14, 2010; Ord. 1462 § 11, 2013)

§ 15.16.050. Sprinkler system alarms.

Subsection 903.4.2 of the International Fire Code is hereby amended to read as follows:

Section 903.4.2 Alarms. Approved audible devices shall be connected to every automatic sprinkler system. Such sprinkler water-flow alarm devices shall be activated by water flow equivalent to the flow of a single sprinkler of the smallest orifice size installed in the system. Alarm devices shall be installed on the exterior of the building in an approved location. An approved audible sprinkler flow alarm to alert the occupants shall be provided in the interior of the building in a normally occupied location. Where a fire alarm system is installed, actuation of the automatic sprinkler system shall actuate the building fire alarm system.

(Ord. 699 § 1, 1995; Ord. 851 § 22, 2000; Ord. 1357 § 15, 2010; Ord. 1462 § 11, 2013)

§ 15.16.060. Indicating valves.

Subsection 903.4.3 of the International Fire Code is hereby amended to read as follows:

Section 903.4.3 Indicating valves. All automatic sprinkler systems shall be provided with a listed and approved indicating valve. Such valve shall be provided on the exterior of the building in a location to be determined by the Fire Chief. When possible, such valve shall be located not less than 50 feet from the protected structure.

(Ord. 699 § 1, 1995; Ord. 851 § 23, 2000; Ord. 1357 § 16, 2010; Ord. 1462 § 11, 2013)

§ 15.16.070. Testing and maintenance.

Subsection 903.5 of the International Fire Code is hereby amended to read as follows:

Section 903.5 Testing and maintenance. Sprinkler systems shall be tested and maintained in accordance with Section 901. A copy of the annual inspection report shall be signed by the individual conducting the inspection, and a copy of the report shall be forwarded to the fire department.

(Ord. 699 § 1, 1995; Ord. 1357 § 17, 2010; Ord. 1462 § 11, 2013)

§ 15.16.080. Separation walls – Floor area calculations.

Area and occupancy separation walls as defined in the International Building Code shall not be used to separate a building into smaller areas in order to delete the automatic extinguishing system requirement. In buildings with mixed occupancy groups, the floor area shall be calculated with the structure's gross square footage and computed with the highest group in place. For the purposes of this

chapter, when buildings are attached by common walls and each building is located on a separate parcel of land, each building shall be considered as a separate building.
(Ord. 699 § 1, 1995; Ord. 1357 § 18, 2010)

§ 15.16.090. Plans – Professional approval.

Only plans approved by the Washington State Survey and Rating Bureau, NICET level as approved by the Washington State Fire Marshal certification program, or certified and stamped by a fire protection engineer shall be accepted. Four sets of approved automatic sprinkler system plans shall be submitted to the building official or fire code official.
(Ord. 699 § 1, 1995; Ord. 851 § 24, 2000; Ord. 1357 § 19, 2010)

§ 15.16.100. Plans – City approval.

No building shall be occupied prior to installation and approval of required automatic sprinkler and fire alarm systems as set forth in this chapter.
(Ord. 699 § 1, 1995; Ord. 1357 § 20, 2010)

§ 15.16.105. Retrofit city permit and inspection.

Underground automatic fire extinguishing systems which are part of a water system extension will be permitted and inspected as part of the water system extension permit. Underground automatic fire extinguishing systems installed as part of a remodel, retrofit or change of use will be permitted in accordance with Chapter **15.36** BLMC.
(Ord. 1432 § 3, 2012)

§ 15.16.110. Appeals – Filing.

Whenever the fire chief disapproves an application or refuses to grant a permit applied for, or when it is claimed that the provisions of the code do not apply or that the true intent and meaning of the code have been misconstrued or wrongly interpreted, the applicant may appeal the decision of the fire chief to the board of appeals within 20 days from the date of the decision as provided by Chapter **15.04** BLMC.
(Ord. 699 § 1, 1995; Ord. 851 § 25, 2000; Ord. 988 § 2, 2003; Ord. 1357 § 21, 2010)

§ 15.16.120. Conflict with the building code.

In the event there is a conflict between the provisions of this chapter and the provisions of the International Code Council's International Building Code the more restrictive shall apply.
(Ord. 699 § 1, 1995; Ord. 1357 § 22, 2010; Ord. 1462 § 11, 2013)

§ 15.16.130. Enforcement.

Repealed by Ord. 988.
(Ord. 699 § 1, 1995)

City of Bonney Lake, Washington

Community Development Committee Agenda Bill (AB)

Agenda Bill Number:	
Agenda Item Type:	None
Presenter:	Gwendolyn Fullerton, Councilmember
City Strategic Goal Category:	None
Department/Division Submitting:	Public Services Staff
Impacted Departments That Received Notification:	None

Full Title/Motion: Geological Hazards Discussion

Short Background Summary:

Discussion on requirements in local and state law and the review process for properties with geological hazards.

Budget Explanation:

N/A

Committee, Board, Commission, & Hearing Examiner Review

Name Of Committee/Commission/Examiner Meeting:

Date of Committee/Commission/Examiner Meeting:

Date of Committee/Commission Public Hearing:

Committee/Commission/Examiner Meeting Decision:

Council Action

Date of Council Workshop	Date of Council Meeting	Date of Council Public Hearing

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CRITICAL AREAS REPORT REVIEW DECISION

Date of Issuance:	March 18, 2026
Project File Number:	PLN-2025-03122
Project Name:	Hansen Critical Area Report
Applicant:	Ethan Gillming, Elevation Home Designs, LLC.
Project Site Address:	19007 109th Street Ct. E., Bonney Lake, WA 98391
Tax Parcel(s):	7000220240
Description of the Project:	Critical area review of the landslide hazard areas to construct decks at the rear of the primary structure.
Decision	The City of Bonney Lake accepts the findings and recommendations within the Hansen Critical Area Evaluation dated April 25, 2025, and revised on August 1, 2025, and February 11, 2026, prepared by Innovative Geo-Services, LLC, with the below conditions:

Common approval language

1. If any portion of the project is proposed or required to change, please contact the Planning department, prior to changes, at Planning@bonneylake.gov.

City of Bonney Lake Minimum Site plan requirements.

2. An updated site plan is required for the Building Permit resubmittal that delineates the landslide hazard areas.

BLMC 16.64010(A)

3. A separate Tree Removal permit shall be required for the proposed tree removal.

BLMC 16.20.070

4. A separate Critical Area Exemption permit is required for the proposed tree removal since the tree removal is proposed within the critical area.

BLMC 16.28.050(B)(1)

5. No development is allowed within the Class 1 landslide hazard area pursuant to BLMC 16.28.050(B)(1).

BLMC 16.28.050(B)(2) and supported by Geo report.

6. The proposed decks are allowed to encroach into the 50-foot setback at the **top** of the Class 1 landslide hazard area per the geotechnical report.

Required by Geo report.

7. Stormwater runoff from the two proposed decks shall be controlled, captured, and diverted into the existing stormwater system per the geotechnical report.

Required by Geo report.

8. No surface runoff is allowed to be directed towards the Class 1 landslide hazard area per the geotechnical report.

Required by Geo report.

9. Disturbed areas between the proposed decks and the **top** of the Class 1 landslide hazard area shall be replanted with native, deep rooting plants and groundcover pursuant to the geotechnical report.

No reductions supported by Geo report, thus BLMC16.28.050(B)(1)-(B)(3) still apply.

10. This report does not specify the allowances of development within the **toe** of the Class 1 landslide hazard area. Therefore, the substantive requirements outlined in BLMC 16.28.050(B)(1)-(3) shall apply to the toe of the Class 1 landslide hazard areas for the purposes of this application. In the future, the property owner may request a development allowance following the process in BLMC Title 16, Article II.

No reductions supported by Geo report, thus BLMC16.28.050(C)(1)-(C)(3) still apply.

11. This report does not specify the allowance of development within the Class 2 landslide hazard area. Therefore, the substantive requirements outlined in BLMC 16.28.050(C)(1)-(3) shall apply to the property for the purposes of this application. In the future, the property owner may request a development allowance following the process in BLMC Title 16, Article II.

Required by Geo report.

12. The proposed tree removal of five (5) trees within the Class1 and Class 2 landslide hazard areas is allowed pursuant to the geotechnical report and shall follow the following requirements:

    - Trees shall be cut as close to the ground as possible.

    - Stumps shall be left in place.

BLMC 16.60.050(C)

13. Tree removal within Class 1 and Class 2 landslide hazard areas shall not occur between October 1st and April 1st pursuant to BLMC 16.60.050(C).

BLMC 15.20.220

14. Prior to work commencing, a temporary construction fence shall be installed along the top of slope of the Class 1 and Class 2 landslide hazard area. The toe is not required to have a temporary fence since no work is proposed near the toes of slope.

15. A Planning inspection is required to confirm the location of the temporary fencing prior to the commencement of construction.

BLMC 16.20.130(F)

16. To comply with BLMC 16.20.130(F), properties with undevelopable critical areas shall place the critical area and buffer within a conservation easement, known as a Critical Areas Protection Area (CAPA). The CAPA document is enclosed. The CAPA shall be recorded with the Pierce County Auditor's Office prior to the Final Building inspection for the decks or within one (1) year of this decision, whichever is sooner.

BLMC 16.20.130(G)(1)

17. To comply with BLMC 16.20.130(G)(1), the property owner shall file a notice on title for the property with Pierce County Auditor's Office

stating the presence of critical areas. Environmental notice is enclosed. The environmental notices shall be recorded within three (3) months of this decision.

18. To comply with BLMC 16.20.130(G)(2), the applicant shall place a split-rail fence at the top of the slope with landslide signage placed every 50 feet along the fence.

Mis-referenced code should be BLMC 16.20.130(F)(4).

19. A Planning inspection is required to confirm the split rail fence and landscaping have been installed prior to the Final Building inspection for the decks.

BLMC 16.20.150

20. Allowed activities within the critical area that do not require a permit are listed under BLMC 16.20.070(A), otherwise no other activities shall be allowed within the critical area unless approved by the City of Bonney Lake.

Exemptions include, but not limited to:

1. Normal operation, maintenance, or repair of existing structures, utilities, roads, levees, drainage systems, or similar improvements, including vegetation management, if the action does not modify or increase the impact to or encroach upon the critical area or buffer, and if the action accords with best management practices and maintenance, and does not impact an endangered or threatened species;...

...5. Removal with hand labor and light equipment of invasive or noxious plants as designated by the director, including, but not limited to:

a. English ivy (Hedera helix);
b. Himalayan blackberry (Rubus discolor, R. procerus);
c. Evergreen blackberry (Rubus laciniatus); and
d. Weeds listed on the Noxious Weeds Designated for Control or Eradication in Pierce County annual list by the Pierce County noxious weed control board;

6. Minor pruning or thinning of trees may be allowed only if such activity is consistent BLMC 16.20.070(6)(a)-(e).

21. Approval of this report does not signify acceptance or approval of any other development on this site and in not meant to legitimize or approve any unpermitted improvements on the property. The City's approval is limited to the work described in the permit application submitted to the City as part permit no. PLN-2025-03122.

Common approval language

ALED to the City of Bonney Lake Hearing Examiner. Please ppeal procedures. A complete appeal application and fee Services Department prior to the close of business April 2, repared to make specific factual objections.

A copy of this notice was mailed to the applicant, the county assessor, and anyone who, prior to the decision, requested notice of the decision or submitted substantive comments on the application or was otherwise a party of record.

For any questions regarding this project, please contact:
Mettie Brasel, Associate Planner
Phone: (253) 447-4350
Email: BraselM@bonneylake.gov
City of Bonney Lake
21719 96th St. E., Second Floor
Buckley, WA 98321