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How Li-ion Battery Fires Caused Changes to the Fire Codes that Could Affect You

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Session 4: *New Powering Solutions*
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Overview

- Li-ion Battery Fires
  - Why They Happen In Larger Systems More than Small Individual Cells
  - Magnitude of the Problem
- What It Has Driven in Model Fire Codes (IFC, NFPA 1, NFPA 855)
- How It Might Affect Your Lead-Acid and Ni-Cd Batteries
- What is Being Done to Improve The Li-ion Fire Problem

Why the Big Deal if We All Carry a Li-ion in our Pocket?

- Internal Short Circuits Causing Overheating of Individual Cells
  - Manufacturing Defects (1 in 10,000,000 cells) Leading to Shorts (Most Common)
  - OverCharging (Failure of the BMS)
  - Mechanical Damage (e.g., car Crash)

- Inherent Flammability Issues
  - High Stored Energy Density
  - Flammable Electrolyte
  - Oxide Positives for Most Chemistries that Release O_2 at High Temperatures

- Cell to Cell Propagation, if Not Controlled Makes a Little Fire Really Big
  - 1 Cell in Phone or 3-Cell Fire in Laptop Pretty Small (Toss Aside & Let Burn), but 13.5 kWh “usable capacity” residential PowerWall has approximately 2000 Cells (1 in 10 million chance now 1 in 5000)

Magnitude of the Stationary Li-ion Battery Fire Problem

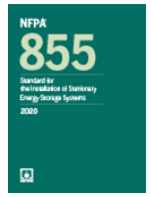
- 3 Large Fires in Very Small AT&T and CenturyLink CdOs
  - Very Limited Quantity Installed in Telecom

- Warehouse Fires
  - Li-ion Can Go Into Thermal Runaway in Storage, Unlike Lead-Acid/Ni-Cd Which Need to be Charging to Go into Thermal Walkaway (Much Less Severe)
- 40+ Well-Documented Large BESS (Energy Storage) Fires Around World
  - AZ APS Incident Severely Injured 4 FireFighters
    - Clean Agent Suppression Didn't Do Enough
  - Even "Safer" Chemistries Like LFP Have Gone Up in Flame
    - Non-Focused Sprinkler System Fire Suppression Has Exacerbated Fires by Shorting Nearby Modules

- FireFighting With Copious H_2O For 1-2 Days and Fire Watch for Re-Ignition for a Week

How Model Fire Codes Responded to the Problem

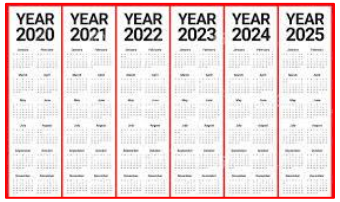
- 2018 IFC (7th Edition –Batt Rqmts 608 --> 1206), 2021 IFC, & 2020 NFPA 855 (1st Edition)
  - Any Li-ion in Industrial Facility over 20 kWh Covered
    - Any Li-ion in Residential over 1 kWh Covered
  - Listing to UL 9540 for the System
    - UL 1973 for the Battery itself
    - UL 9540A Testing to try to Convince AHJ to Get Around Some of the Spacing and other Rules
  - 3' Spacing Rule (Including from walls) for 50 kWh Max "modules"
    - 250 kWh for Lead-Acid/Ni-Cd
    - Doesn't Apply to Outdoor Containers, but They Have Spacing Rules Around Them Too That are 10'+
  - Li-ion Max on Site = 600 kWh
  - No Li-ion Systems in Basements or Higher than 75'

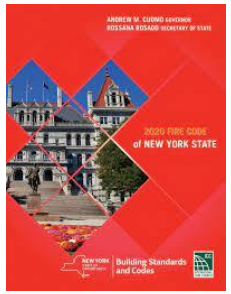


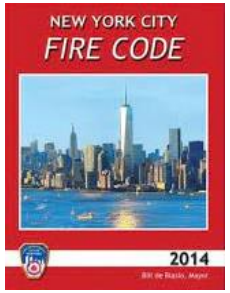
- 2021 Edition of NFPA 1, Chapter 52 Simply Copies and Refers to NFPA 855

Fire Code Local Adoption and Lag

- IFC Serves as the Basis for the Fire Code in About ⅔ of the States/Jurisdictions
  - NFPA 1 is Most of the Rest
  - Adoption by Local Jurisdictions Typically Lags 1-10 Years from Issue Date
    - Both Model Codes Reissued Every 3 Years
  - Local Modifications to the Model Codes Can Remove Some of the Exemptions







How Fire Code Changes Might Affect Your Lead-Acid Batteries

- Existing Model Fire Code Lead-Acid/Ni-Cd Carveouts When Recognized
  - Below 70 kWh (1,400 Ah @ -48 VDC nominal)
    - 20 kWh (400 Ah @ -48 VDC nominal) for Li-ion
  - All Lead-Acid and Ni-Cd Below 60 VDC in Telecom Space
    - Note that 380 VDC and UPS Not Exempted by this specific rule
      - UPS Might Be Exempt if Cabinetized Batteries Listed to UL 1778, or Battery Listed to UL 1973
        - New Appendix H for Lead-Acid/Ni-Cd in UL 1973
          - Previously Only Lead-Acid Plastics UL Recognized (94) and VRLA Valves (1989)
  - 3' Spacing Rule for > 50 kWh (1,000 Ah @ -48 VDC nominal) Relaxed to 250 kWh (5,000 Ah) if Lead-Acid or Ni-Cd Battery UL 1973 Listed
  - Possible Misinterpretation of Fire Code Rules
    - No Batteries over 75' or in Basements

What is Being Done to Improve Li-ion Safety

- Move Towards "Safer" LFP Chemistry
  - 25% Space/Weight Penalty of LFP to be Halved By Coming LFMP
- Getting Rid of the Flammable Electrolyte
  - Long-Term Goal is Solid-State Li-ion
- UL 1973 (2nd Edition, 2018) and IEC 62619 (2017) Now Have Cell-to-Cell Propagation Testing that Drives Better Design
  - Cell Spacing, Intumescents Between Cells, Cooling Between Cells, etc.
- Clean Agent Suppression Not Enough
  - Automatic Sprinkler System or Standpipe Fed
    - Focused Application of Water to Prevent Fire Spread and/or Damage to Nearby Good Batteries

About the Presenter

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Q&A