Newer Stationary Engine Starting Options and Changes to Relevant Standards

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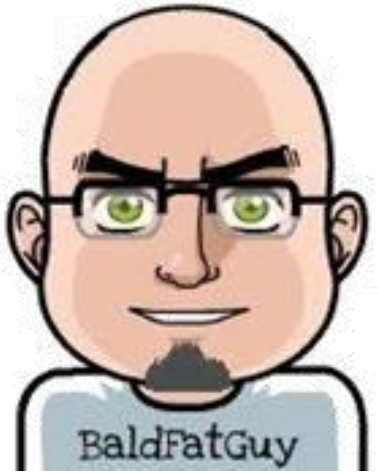
Who is This Bald, Fat Dude?

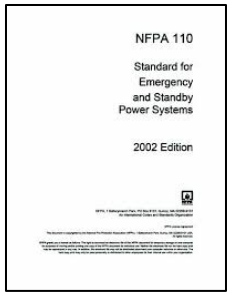


- Trng Dir for Services Subsidiary of a Large Lead-Acid & Li-ion Mfr
  - Started Out of High School with Electric Utility at Generating Plant
  - Then, 26 Years with ITC Company as Power Maintenance Engineer
- Degreed Electrical Engineer and Master/Journeyman Electrician
  - Working on PE
    - Not as Important for Most Electrical Engineers Except Consulting
- Former Chair of IEEE PES ESSB
  - IEEE1635/ASHRAE21 (Battery Ventilation / Thermal Mgmt) co-Chair, IEEE1657 (Batt Tech Trng) Chair, IEEE2962 (Li-ion IO&M) Vice-Chair, etc.
- Principal Member of NFPA 855 (BESS Installation, which Feeds Into Model Fire Codes)
  - Task Group Chair or co-Chair for 4 Task Groups
- Chair of Battcon (Annual Battery User Conference) Tech Cmte
- Former Vice-Chair of ATIS-STEP and Primary First Edition Author of 5 ATIS Standards on Power, Batteries, Grounding, and Electrical Protection

What We Will Cover (Briefly)

- History of Stationary Engine Starting Technologies and Sizing
- Recent Changes to NFPA 110
- Newer Options Beyond Lead-Acid / Ni-Cd / Compressed Air
- Much More Guidance Coming in IEEE P2685

Historical Sizing of Stationary (Emergency and Standby) Engine Start Batteries

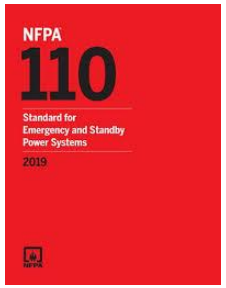


- Batteries Rated in CA/MCA (Sustained Cranking Amps for 30 seconds at 32 °F to an end Voltage of 1.2 V per lead-acid cell or 0.72 V per Ni-Cd/NiZn cell) and/or CCA (Cold Cranking Amps for 30 seconds at 0 °F to the same end Voltages)
  - Defined in SAE J537 (both) and IEC 60095-1 (CCA)

- The Earliest Versions (1985-1993) of NFPA 110 Did Not Contradict This Nor Limit the Type of “Batteries” That Could be Used
  - Later Versions of NFPA 110 Started Matching some European and Japanese Standards in Calling for 3 15 s Cranks Separated by 15 s Rest Periods for Emergency Engines and even up to 6 15 s Crank Cycles in Some Annex Material
    - i.e., 45 or 90 Total Seconds of Cranking Ability

Recent Updates to NFPA 110 And the Reasoning

- 45-75 s or Longer Crank Times Are Now Optional for Both Level 1 (“Emergency”) and Level 2 (“Standby”) Engines Starting with the 2019 Edition
  - Most Stationary Engines (Especially Those That are Level 1 / “Emergency”) Are Frequently Maintained; Have Modern Electronically-Controlled Fuel Injection Systems; Have Good Fuel Stabilizers (and Possibly Heaters) Added to the Tanks; and Most Have Some Type of Jacket Coolant Heater, Block Heater, or Oil Heater
    - All This Leads to a Typical Modern Stationary Standby or Emergency Diesel Engine Starting within ¾ - 3 seconds of Beginning the First Crank Cycle



- The 2025 Edition Opened the Market to Many more Electrochemical/Battery Devices than Lead-Acid and Ni-Cd
  - Excellent (with Much Longer Life than Lead-Acid Batteries) Engine Starting Energy Storage Devices (e.g., super/ultracaps [EDLCs], and HSCs/LiCs [hybrid battery-capacitors]) have been Successfully Used in the Over-the-Road Trucking Industry and Hybrid EVs
    - They Have Less Energy but More Starting Power per Unit Volume and Weight

New? “Definitions” Based on New Engine Starting “Battery” Types and IEEE P2685

- Breakaway Current
  - engine starter 15-700 ms motor inrush (≈2-3x “rolling current” [continuous cranking current])
- HCA (Hot Cranking Amps)
  - 30 seconds at 80 °F to an end Voltage of 1.2 V per lead-acid cell or 0.72 V per Ni-Cd/NiZn cell
- LCA (Lithium Cranking Amps)
  - 15 seconds at 0 °F for a “nominal” 12 V Li-ion battery to 10 V
- LMCA (Lithium Marine Cranking Amps)
  - 8 seconds at 20 °F for a “nominal” 12 V Li-ion battery to 10 V
- PHCA (Pulse Hot Cranking Amps)
  - 5 s at 80 °F for a “nominal” 12 V Li-ion battery to 10 V, or 7.2 V for any other battery/capacitor
- PCA (Pulse Cranking Amps)
  - 3 s at 0 °F for a “nominal” 12 V Li-ion battery to 10 V, or 7.2 V for any other battery/capacitor

SuperCapacitor / UltraCapacitor (EDLC) Engine Start “Battery” Options

- Not Economical Beyond 10 s
  - Parallel With Lead-Acid for More Cranking Time?
- 2 Terminal vs 3-Terminal (Imbedded DC-DC Converter) Devices
  - Specialized Charger For 2-Terminal Devices Will Lengthen Warranties Out to 10 Yrs
    - Both LaMarche and SENS Make Such Chargers

- Most Common Manufacturers
  - Ioxus (XS Power)
    - Many Standard 12 and 24 V BCI Group Sizes (Including Small PowerSport) with Starting Ratings from 140 PCA to 830 PHCA
  - UCAP (Maxwell)
    - POWERBLoK™ Group U1 860 PHCA
  - Skeleton
    - SkelStart 12/24 V Group 31, 925 PHCA – 310 HCA

LiC / HSC (Hybrid Super Capacitor)

- HSC is the Preferred Term Nowadays Since There Can Be Other Battery Technologies (including Lead-Acid) as the “Battery” Plate(s)
- Manufacturers
  - LaMarche (undisclosed cell supplier)
    - Nominal 12 and 24 V Blocs in Group 24H and 31 Sizes
      - 10 to 31 Ah, 650-1855 W/Bloc (@ 15 min rate), 465-700 PCA
  - Others (Polar Power, Skeleton, Musashi, etc.) Working on Offerings

Li-ion Engine Start Batteries

- BMS Current Path Limits High Starting Rates On Most Li-ion
  - "These" Can Do Starting Though
    - They Can Also do UPS & Long Rates, but are Designed to Start Engines
- Multiple Suppliers, and More Coming
  - Marxon (through Leoch), AntiGravity, Power-Sonic, PowerStart, PowerSync, XS Power, Tusk, EarthX, RELiON, Dakota, Inventus
  - 6, 12, 16 (for use in 32 V starting systems), and 24 V nominal options
  - BCI Groups: B, B01L-LFP, B4L, BT4B, 4D, BTZ4L-BS, BTZ5S-LFP, 6B8L-B, 6N6-3B-1, B7C, BT7, BT7B-LFP, 8D, 12N9, BTX9-BS, BTZ10, BTZ-10S, BT12B, BTX12-BS, B13L-LFPI, BTX14, BTZ14, BT15, BTX15L, BTX15L-BS, B16-B, B18, BT19, BTX20, 22NF, 24H, 26, 27, 31, 34, 35, 47, 48, 49, 51, 65, 75, 91, 94R, E, G, U1, U2
  - Cranking Amps Ranging from 105 PCA to 2400 PHCA
- Most are LFP, with Some LTO
  - LTO Naturally Good at Low Temperatures, but only Some LFP Have Heaters

NiZn for Engine Starting

- ZincFive
  - Group 48/H6/LN3 8-cell Blocs
    - 85 Ah Version; 850 CCA
    - 96 Ah Version; 1075 CCA
  - Higher Float (13.2 V Nominal, 15 V Float) Not Typically a Problem for 12 V Starting Systems, but Could be for Some 24 V Systems?
  - SENS Offers Combined in a Box (12 or 24 V) with Their Charger and 10-yr Warranty
- Aesir
  - Possibly in the Future (all Production Presently for US Government)
    - Group 31, 7 cell bloc (11.55 V nominal, 13.26 V Float)
      - Hybrid (900 CCA)
    - Supposedly Pivoting to 8 Cell Blocs (Float and Nominal Voltage Like ZincFive)

Some of What's Coming in IEEE P2685 That Can be Found Nowhere Else

- Calculation for Breakaway and "Rolling" (Cranking) Amps Based on Engine Cylinder Total Displacement, and Oil Type and Temperature
- Cable Ampacities for 30 second Cranking
- Recommendations on Lead-Acid Types for Constant Float Chargers
- Recommendations on Chargers with Varying "Charging" (and "Rest") Voltages to Lengthen Life (Especially of Lead-Acid)

Comparison of Engine Start “Battery” Technologies

Technology	$/ HCA /12V	$/ PHCA /12V	°F charge range	% cap loss (/-10°F)	% life reduce (10°F)	avg 77°F float life (yrs)	HCA /kg/ 12V	PHCA /kg/ 12V	HCA /L/ 12V	PHCA /L/ 12V
NiCd X-Rate	3.00	2.50	-40 - 150	2	10	25	15	20	25	30
VLA SLI	0.15	0.10	-40 - 150	7	25	4	60	110	100	185
AGM SLI	0.20	0.15	-40 - 150	7	35	6	50	90	85	155
AGM hi-perform	0.30	0.20	-40 - 150	7	35	8	35	65	75	145
gel hi-perform	0.35	0.25	-40 - 150	7	30	7	35	65	75	145
EDLC	3.00	0.50	-40 - 150	0	25	15	35	200	25	135
HSC/LiC	4.00	1.30	-40 - 150	3	25	15	40	125	20	60
Li-ion (LFP)	5.50	0.65	35 - 120	3	30	10	25	270	25	290
Li-ion (LTO)	1.80	0.60	0 - 150	2	20	20	85	250	130	400
NiZn	1.10	0.55	20 - 115	3	15	13	75	150	145	295

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Questions?