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# **Think A306 Service Manual**

Document #: 06-10001

**Ener1 Lithium Power Systems**

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## Revision Record

<b>Revision Level</b>	<b>Revision Date</b>	<b>Author</b>	<b>Change Description and Section(s) affected by the change</b>
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## **1. Manual Overview**

### **1.1 General Pack Ratings & Specifications**

Reference Document 04-10004

### **1.2 Battery Pack Safety**

Precautions when working around a HV battery pack

### **1.3 Lithium Safety Information**

Hazardous material considerations (Reference Ener1 Material Safety Data Sheet (MSDS) 07-10001)

### **1.4 Service Response Plan**

How customer should respond in the event of a battery pack issue

1. Ener1 Contact
2. Defining and Analyzing a problem. Details of tools available.
3. Ener1 will evaluate and plan
4. Ener1 will implement a solution

## 2. General Pack Ratings & Specifications

### 2.1 Rated Specifications

Description	Specification	Remarks
Cells per pack	384	Pack configuration: 96 cells in series, 4 cells in parallel. Refer to document 04-10004 for individual cell specifications.
Max. Cell Voltage	4.1 V	At 100% SOC (State of Charge)
Min. Cell Voltage	2.5 V	At 0% SOC (State of Charge)
Rated Cell Capacity	17.5 Ah	C/3 rate used to determine capacity. Refer to document 04-10004 for individual cell specification.
Rated Pack Capacity (BOL)	70.0 Ah	C/3 rate used to determine <b>rated</b> capacity. Current taper applied at the end of charge for determination of pack capacity.
Pack Capacity (EOL)	56.0 Ah	<b>80% of rated pack capacity at BOL</b>
Nominal Pack Voltage	345.6 V	Open circuit voltage at 50% SOC (State of Charge). Refer to document 04-10004 for individual cell specification.
Max Pack Voltage	393.6 V	<b>Based on 96 cells in series with max cell voltage of 4.1 V</b>
Min Pack Voltage	240.0 V	<b>Based on 96 cells in series with min cell voltage of 2.5 V</b>
Rated <b>Pack</b> Energy	23.0 kWh	<b>C/3 rate at 25 C to determine rated energy</b>
<b>Average Pack</b> Energy	23.6 kWh	<b>C/3 rate at 25 C to determine average energy</b>

### 2.2 Performance Specifications

Description	Unit	Typical	Remarks
<b>Power</b>			
Max Continuous Discharge Power	kW	49	At 50% SOC (State of Charge)
Max Continuous Charge Power	kW	17.5	50 A at 50% SOC (State of Charge)
<b>Pulse Power</b>			
Max. Pulse Discharge Power	kW	73.5	At 50% SOC (State of Charge) for 30 seconds.
<b>Continuous Current</b>			
Maximum Discharge Current	A	140	Above 20% SOC (State of Charge)
Max Charge Current	A	50	While connected to charge plug.
Maximum Regen. Current	A	150	Below 80% SOC (State of Charge) while in drive mode

### 2.3 System Specifications

Parameter	Units	Value	Condition
Cell Configuration:		96	Series cells
		4	Parallel cells
Internal pack resistance	mΩ	< 200	DC impedance measured via Hybrid Pulse Power Characterization - HPPC (1.5C) at 90% SOC (State of Charge) at 25°C.
Operating Temperature	°C	-25 to 55	Internal cell temperature. Recommended cell operating temperature range is 28 C +/- 3C. Limited performance below -15°C and above 45°C
Storage Temperature	°C	-40 to 60	Recommended storage temperature is 25 C +/- 5 C at 40 to 60 % SOC (State of Charge)
Mass	kg	285	Approximate value. See sec 6.0 Includes tray.
Volume	L	250	Approximate value. See sec 6.0. Includes tray.

### 2.4 A306 Pack (Cover Removed)





## 2.5 A306 installed in Vehicle (Think City)



*Lithium Power Systems*

**ENER1**



Battery Location

Think City in the USA



Ener1 Battery installation

### 3. Battery Pack Safety

#### **WARNING:**

This system is to be operated solely in accordance with the supplied CAN bus user's guide. Failure to do so will result in damage to the Pack System or Vehicle. There are no user serviceable parts inside of pack case.

Pack safety systems are intended to protect the user, and service personnel. Bypassing or forcing these systems to operate in a way other than by design may result in injury or death. Ener1 bears no responsibility for your failure to operate the systems in accordance with this guide and is not liable for any resulting damages whatsoever.

#### **DANGER HIGH VOLTAGE SYSTEM:**

There are no user serviceable parts inside of pack case. Pack safety systems are intended to protect users from injury.

**DO NOT TAMPER WITH PACK CONNECTORS OR REMOVE ANY PANELS OR COVERS FROM THE SYSTEM. DO NOT INSERT FINGERS OR ANY OTHER OBJECTS INTO THE PACK CASE THROUGH ANY OPENINGS, PORTS, OR SEAL INTERFACES. FAILURE TO COMPLY MAY RESULT IN SEVERE INJURY OR DEATH, AND ENER1 IS NOT LIABLE FOR ANY RESULTING INJURIES OR DAMAGES WHATSOEVER AS A RESULT OF A FAILURE TO COMPLY WITH THESE TERMS.**

#### 3.1 Battery Pack Cells

- Major cell components are:
  - Anode
  - Cathode
  - Separator
  - Electrolyte
- Cells are prismatic (flat) and tightly sealed around all sides to prevent leakage
- A damaged cell can leak flammable vapors from the electrolyte
  - These vapors should be contained within the pack unless there is significant damage to the pack case
  - Even low levels of vapor escaping from the pack will give off a distinctive odor
  - Extreme caution should be used to prevent any spark generation in the vicinity of a damaged pack venting electrolyte vapors

#### 3.2 Safety Considerations (only Ener1 certified technicians should be working internally on battery pack)

- Before working on a battery:
  - Disconnect all 12 V connections
  - Disconnect all High Voltage connections (Pack to Vehicle)
  - Check for presence of electrolyte
    - If strong solvent odor, pack is compromised
    - Do not investigate further without guidance from Ener1
  - Visual inspection should be made



- Paint surface discoloration
- Evidence of potential excessive heat or fire
- Remove all metal jewelry (could cause a short)
  - Hand jewelry
  - Neck chains
  - Be mindful of metal belt buckles
- Do not work on battery if you are the only one around
  - Use the “buddy” system
- High voltage output of the battery is potentially lethal
- Use extreme caution when making electrical connections or having any interaction with the battery
- PPE required
  - Safety glasses
  - Lineman’s gloves (00) with leather overs (check for perforations in gloves)
- Perform Open Circuit Voltage (OCV) check using digital multimeter
  - Pack positive terminal to case
  - Pack negative terminal to case
  - Readings should be zero
- If readings are something other than zero
  - Do not take any further steps without contacting Ener1
  - Indication of internal short

### 3.3 ASTM (American Society for Testing and Materials) Voltage Rating Chart

<b>ASTM Labeling Chart</b>						
Class Color	Proof Test Voltage AC / DC	Max. Use Voltage AC / DC*	Rubber Molded Products Label	Glove Label	Rubber Dipped Sleeve Label	ASTM Specification Reference
00 Beige	2500 / 10,000	500 / 750*				D120 Rubber Insulating Gloves D178 Rubber Insulating Matting
0 Red	5,000 / 20,000	1,000 / 1,500*				D1048 Rubber Insulating Blankets D1049 Rubber Insulating Covers D1050 Rubber Insulating Line Hose D1051 Rubber Insulating Sleeves
1 White	10,000 / 40,000	7,500 / 11,250*				F478 In-Service Care of Line Hose & Covers F479 In-Service Care of Insulating Blankets
2 Yellow	20,000 / 50,000	17,000 / 25,500*				F496 In-Service Care of Gloves & Sleeves F696 Leather Protectors for Insulating Gloves F1236 Inspection Guide for Rubber Products
3 Green	30,000 / 60,000	26,500 / 39,750*				Type I- Designates natural rubber. Type II- Designates SALCOR® UV and ozone resistant rubber.
4 Orange	40,000 / 70,000	36,000 / 54,000*				

\*Maximum use DC voltage is not part of any ASTM specification. Maximum use DC voltages are valid in reference to IEC 903 only.

Gloves and Sleeves must have a color coded label.

"Suitable for live working."  
IEC60903:2002 & IEC60417 fig. 5216

10M303

### 3.4 Fire Extinguishers

- In the event of a fire associated with a battery pack:
  - Carbon Dioxide (CO<sub>2</sub>) extinguishers are preferred
  - Dry Chemical extinguisher may also be used
  - Fire may generate irritating and/or toxic gas

### 3.5 Transporter Safety Information

Packages that are crushed, punctured or torn open should not be transported. These packages should be isolated until the shipper provides instructions and, if appropriate, arranges to have the product inspected and repacked.

In the event that damage to the packaging results in the release of batteries, the spilled contents should be immediately collected and segregated (absorb with earth, sand or other non-combustible material per ERG (Emergency Response Guide) Guide 147). The shipper should be contacted for instructions.

## 4. Service Response Plans

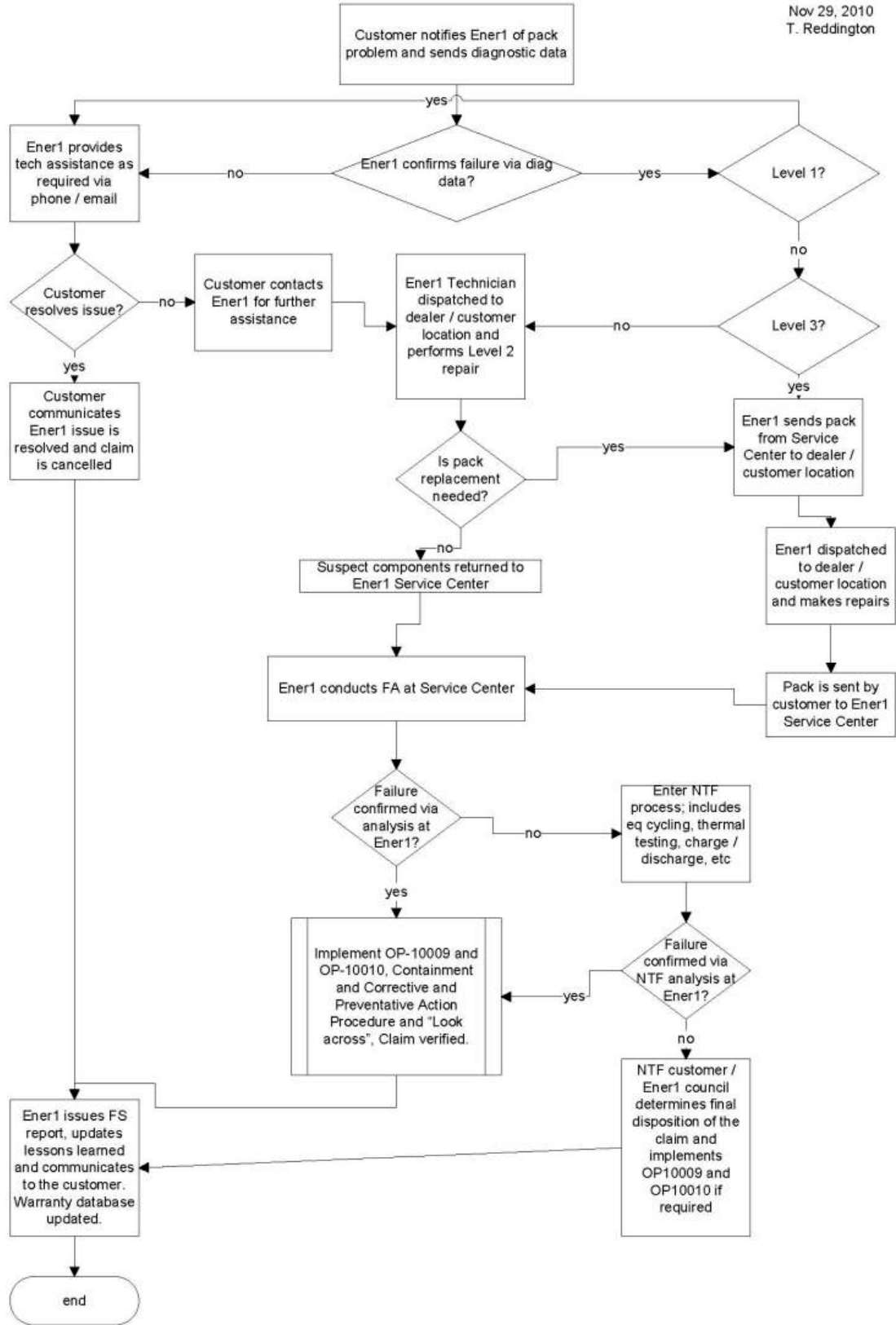
How Customer should respond in the event of a battery pack issue.

### 4.1 Flow Chart (following page)

Level	Who	Typical problems	How	Where	Logistic
1	Local Dealer	NTF, Malf codes	Diagnose & S/W update	@ Dealer	Remote support (phone/email)
2	Ener1 Technician	Broken R/MLECs, Fuses, Current Sensors, Contactors, Cables	Replace BMS component	@ Dealer	Ener1 Travel
3	Ener1 lab	Mechanical damage, corrosion, overheating, water ingress	Rework	@ Ener1 lab	Ship battery pack to Ener1

Ener1 Automotive Warranty Flow

Nov 29, 2010  
T. Reddington



## 4.2 Step 1: Contact Ener1

USA

**Ben Wrightsman**  
**Field Service Manager**  
Ener1  
15425 Herriman Blvd.  
Noblesville, IN 46060  
Mobile (317) 383-7089  
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[www.ener1.com](http://www.ener1.com)

## 4.3 Step 2: Defining and Analyzing a problem

### 4.3.1 Detailed look at tools available for analysis

TBD – Comm Tool usage.

**CAUTION!!!**

**DO NOT REMOVE COVER OR ANY PANELS FROM PACK.**

### 4.3.2 Traceability

#### Tracking Requirements

Traceability of the packs through the manufacturing processes is required. Deep traceability is required for each component and component of each subassembly to track back to as early as a particular lot and date code of components and/or software build to provide for serviceability and possible warranty/reliability studies.

All field hardware and software service and installations must track all activity associated with each individual pack. Any changes to a pack's configuration must be recorded and reported so that a pack's configuration matrix can be updated accordingly and in preparation for possible future support as required.



### 4.3.3 Pack Interface Tools

Recommended list of various tools to have kitted and on-hand when supporting battery packs:

BOB (Break-out-Box) /Harness	Safety Glasses
CAN Interface Cable (120 ohm termination)	Rubber Gloves
Serial Cables	Rubber Glove Protectors
Banana Jack Jumpers	Paint Marker (permanent)
CAN interface box	Scope meter / DMM
ELSI interface box	Field Support Kit BOM (Tool List 04282010_0001)

### 4.3.4 Tool Ordering Information

Hand tools are mostly generic; however, specialty and custom/proprietary pack interface hardware and software information is detailed below:

- BOB (Break-out-Box) /Harness (hardware)  
Desc: Break-out-box with male/male 15 ft cable assembly, p/n 1579102  
Mfr: CSI Electronics ([www.csielectronics.com](http://www.csielectronics.com))  
Vendor: CSI Electronics ([www.csielectronics.com](http://www.csielectronics.com))
- CAN Interface Tool (hardware and software)  
Desc: PCAN-USB Adapter with optical isolation, p/n IPEH-002022  
Mfr: PEAK-System ([www.peak-system.com](http://www.peak-system.com))  
Vendor: PHYTEC ([www.phytec.com](http://www.phytec.com))

### 4.3.5 Software Service

**Introduction of software service and installation** (diagnostics and programming)

#### **4.3.5.1 Pack interface tools**

- BOB (Break-out-Box) w/LV pack interface harness  
Custom hardware that can be attached/inserted at the pack LV connector to provide direct access to LV signals during development and debug.
- PCAN Tool w/Viewer and/or Explorer  
Off-the-shelf hardware and software application(s) that provides a method for CAN bus connectivity and communication.
- Comm Tool  
Proprietary hardware and software application that supports Mode 1 communication mode.
  - ✓ ELSI communication is supported for the Comm Tool hardware.
  - ✓ CAN communication is supported for the PCAN Tool hardware.
- Programming Tool  
Proprietary software application that provides a method for application code reprogramming.
  - ✓ ELSI communication is supported for the Comm Tool hardware.
  - ✓ CAN communication is supported for the PCAN Tool hardware.

**4.3.5.2 Pack diagnostics – Software applications**

- PCAN Viewer
- PCAN Explorer (DBC files)
- Comm Tool (LAB “MSF” files)

A CAN Interface Tool (PCAN-USB Adapter with optical isolation) can be connected to CAN-H and CAN-L of the Vehicle CAN Bus at the OBD II connector.

**4.3.5.3 PCAN Viewer**

In Figure 1:

Msg 300, byte 2 is “22” hex – this information indicates MLEC Build “22” Application Software

Msg 610, byte 6 is “13” hex – this information indicates the Contactor Condition Code to be a (19) Service Category Fault (contactors locked out until service fault codes cleared)

Message	Length	Data	Period	Count
263h	6	00 00 2C 78 4F 00	200	42
264h	8	00 00 00 00 00 00 00 00	200	42
300h	8	02 00 22 00 00 00 01 00	1001	8
301h	8	00 00 00 17 00 58 00 DC	200	42
302h	8	00 00 00 00 09 54 00 00	200	42
303h	8	0F 59 00 00 00 00 00 00	200	42
304h	8	00 00 00 00 00 E6 00 D2	200	42
305h	8	00 00 00 40 00 00 00 00	200	42
306h	8	00 00 00 00 00 00 00 00	1000	8
310h	3	00 00 00	200	42
311h	2	00 00	200	42
610h	8	06 72 06 58 17 15 13 00	200	42

Message	Length	Data	Period	Count	Trigger
<Empty>					

Figure 1 PCAN Viewer

**4.3.5.4 Comm Tool**

In Figure 2:

Software\_ID, byte 0 is “XX” hex – this information indicates MLEC Build “XX” Application Software (i.e. “25” hex = Build “25”)

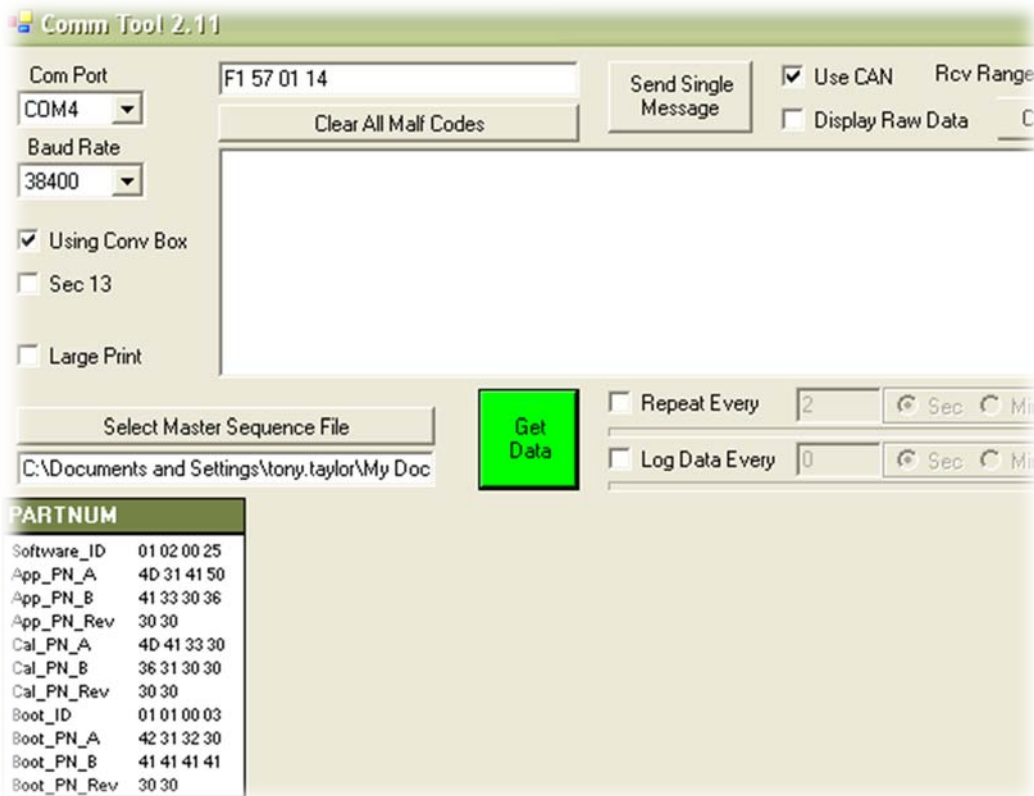


Figure 2 Comm Tool

Note: Contactor Condition Codes and Highest Error Reasons detailed in the *Vehicle CAN Bus Guide* 90-10017 for Msg EDL\_Data00 (CAN msg ID 610) are identified by DECIMAL values. The HEX data determined during pack diagnostics must be converted from HEX to DECIMAL before cross-referencing to the DECIMAL values.

For illustration purposes, a copy of Contactor Condition Codes and Highest Error Reasons from *Vehicle CAN Bus Guide* 90-10017 associated with MLEC Application Software is shown below:

<u>BMS Contactor Conditions Code</u>		(Present Status, Decimal values)
		Designators (S) = Service Category Fault (K) = Key Cycle Category Fault
0	Conditions OK	
1	Loss Of Emergency Power Off Signal	(K)
2	All Internal Slave Data Not Received	
3	Cell Over Voltage	(K)
4	Cell Under Voltage	(K)
5	Pack Over Current	(K)
6	Pack Over Temperature	(K)
7	Pack Under Temperature	(K)
8	Circuit Board Over Temperature	(K)
9	PreCharge Retry Fault	(K)
10	PreCharge Short Circuit Fault	(K)
11	No PCU Data Received (Messages 310 and 311)	(K)
12	Airbag Deployed	(K)
13	Fuel Cutoff (Crash Event Notification)	(K)
14	PCU Fault	
15	Isolation Fault With Contactors On	(K)
16	Isolation Fault With Contactors Off	(K)
17	Low Voltage Pack Recover Mode	
18	Key Cycle Category Fault (Contactors locked out til next key cycle)	
19	Service Category Fault (Contactors locked out til service faults codes cleared)	
20	Circuit Board Under Temperature	(K)
21	Powerup Self Test Fail	(K)
22	No CAN Contactor Request	(Not used for A306)
23	Secondary_ContB_Or_FuseB_Fault	(K)
24	Contactors 1 Stuck On Fault	(S)
25	Contactors 2 Stuck On Fault	(S)
26	Fuel Cell Iso Fault	(Not used for A306)
27	Secondary Contactor Stuck On Fault	(K)
28	Latched Contactor Fault	(Not used for A306)
29	Cont_1_Dropout_Fault	(K)
30	Contactors_Engaged_During_Shutdown	(Not used for A306)
31	Cont_2_Dropout_Fault	(K)
32	Cont_1_Stuck_Open_Fault	(K)
33	Cont_2_Stuck_Open_Fault	(K)
34	Secondary_ContB_Or_FuseB_Fault	(K)
35	Pack_Overcurrent_Regulation_Fault	(K)
36	Aux_Batt_Undervoltage_Fault	
37	Discharge_During_Charge_Fault	(K)

BMS\_Highest\_Err\_Reason

(Most recently detected error, Decimal values)

Designators (S) = Service Category Fault

0	No Error
1	PCU Fault
2	No Charge Current
3	Circuit Board Temperature Warning
4	Current Limit On Low Temperature
5	Current Limit On High Temperature
6	External Isolation Fault
7	Internal Isolation Fault
8	Fuel Cutoff (Crash Event Notification)
9	Airbag Deployed
10	No PCU Data Received (Messages 310 and 311)
11	PreCharge Short Circuit Fault
12	PreCharge Retry Fault
13	Circuit Board Over Temperature Fault
14	Pack Under Temperature Fault
15	Pack Over Temperature Fault
16	Pack Over Current Fault
17	Cell Under Voltage Fault
18	Cell Over Voltage Fault
19	Contactors 2 Stuck On Fault
20	Secondary Contactors Open Fault
21	Loss Of Emergency Power Off Signal
22	Circuit Board Under Temperature Fault
23	Contactors 1 Stuck On Fault
24	Slave Data Not Received Flt
25	Powerup Self Test Flt
26	Secondary Contactors Stuck On Flt
27	Contactors Dropout Flt
28	Fan Current Low Flt
29	Fan Current High Flt
30	Aux_Batt_Under_Volt_Flt
31	Cont1_Stuck_Open_Flt
32	Cont2_Stuck_Open_Flt
33	DChg_During_Chg_Flt
34	Key_Cycle_Category_Flt
35	Service_Category_Flt
36	High_Cont_Coil_Cur_Flt

**4.3.5.5 Comm Tool vs CAN message structure**

- Comm Tool display represents malfunction codes as 4-byte hex values with byte 0 on the right.
- CAN messages are typically shown with byte 0 on the left and display byte values from left to right.

Comm Tool

Malf Code Long Word 1 00 00 00 00<-- byte 0 bit 0  
Malf Code Long Word 2 00 00 00 00<-- byte 4 bit 0

CAN message

Data0 Data1 Data2 Data3 Data4 Data5 Data6 Data7  
00 00 00 00 00 00 00 00  
^ ^  
byte 0 bit 0 byte 4 bit 0

Note: Malfunction Codes (diagnostic flags) are detailed in the *Vehicle CAN Bus Guide* for each of the following specific CAN messages:

- Msg EDL\_Active\_Fault\_Data (CAN msg ID 721)
- Msg EDL\_Latched\_Fault\_Data (CAN msg ID 722)
- Msg EDL\_History\_Fault\_Data (CAN msg ID 723)

For illustration purposes, a copy of Malfunction Codes from *Vehicle CAN Bus Guide* associated with MLEC Application Software is shown below:

EDL\_Active\_Fault\_Data, CAN msg ID: 721

EDL\_Latched\_Fault\_Data, CAN msg ID: 722  
(Same bit definitions as active fault data)

EDL\_History\_Fault\_Data, CAN msg ID: 723  
(Same bit definitions as active fault data)

	Malfunction #	Name	Description
<b>Byte 0</b>			
Bit 0	0	BUS_VOLT_AD_FLT	Bus voltage A/D fault
Bit 1	1	PACK_VOLT_AD_FLT	Pack voltage A/D fault
Bit 2	2	PACK_CUR_B_HI_AD_FLT	Pack current B hi A/D fault
Bit 3	3	PACK_CUR_B_LO_AD_FLT	Pack current B lo A/D fault
Bit 4	4	PACK_CUR_A_HI_AD_FLT	Pack current A hi A/D fault
Bit 5	5	PACK_CUR_A_LO_AD_FLT	Pack current A lo A/D fault
Bit 6	6	BD_UNDER_TEMP_FLT	Circuit board under temperature fault
Bit 7	7	SEC_STUCK_ON_FLT	A secondary contactor is stuck closed
<b>Byte 1</b>			
Bit 0	8	INT_ISO_FLT	Internal isolation fault
Bit 1	9	EXT_ISO_FLT	External (or internal) isolation fault
Bit 2	10	SEC_CONTA_OPEN_FLT	Secondary contactor A or fuse A fault
Bit 3	11	CONT_PCHG_SHORT_FLT	Short circuit detected at precharge
Bit 4	12	CONT1_DROPOUT_2ND_FLT	Contactor 1 dropout second fault
Bit 5	13	CONT1_DROPOUT_1ST_FLT	Contactor 1 dropout first fault
Bit 6	14	CONT_PCHG_RETRY_FLT	Max number of precharge retries exceeded
Bit 7	15	CONT_PCHG_FLT	Contactor precharge timeout fault
<b>Byte 2</b>			
Bit 0	16	CONT2_RETRY_FLT	Max number of contactor 2 retries exceeded
Bit 1	17	CONT2_STUCK_ON_FLT	Contactor 2 detected stuck closed
Bit 2	18	NO_CHARGE_CUR_FLT	No charge current fault
Bit 3	19	BD_OVER_TEMP_FLT	Circuit board over temperature fault
Bit 4	20	UNDER_TEMP_FLT	Pack under (low) temperature fault
Bit 5	21	OVER_TEMP_FLT	Pack over temperature fault
Bit 6	22	FAN_CUR_LO_FLT	Fan current low (open) fault
Bit 7	23	FAN_CUR_HI_FLT	Fan current high fault
<b>Byte 3</b>			
Bit 0	24	CONT1_RETRY_FLT	Max number of contactor 1 retries exceeded
Bit 1	25	CONT1_STUCK_ON_FLT	Contactor 1 detected stuck closed
Bit 2	26	UNDER_VOLT_FLT_B	Cell under voltage fault string B
Bit 3	27	UNDER_VOLT_FLT_A	Cell under voltage fault string A
Bit 4	28	OVER_VOLT_FLT_B	Cell over voltage fault string B
Bit 5	29	OVER_VOLT_FLT_A	Cell over voltage fault string A
Bit 6	30	OVER_CURRENT_FLT	Pack over current fault
Bit 7	31	SPI_FLT	SPI transmit / receive timeout fault
<b>Byte 4</b>			
Bit 0	32	CONT2_DROPOUT_2ND_FLT	Contactor 2 dropout second fault

	Bit 1	33	CONT2_DROPOUT_1ST_FLT	Contacto 2 dropout first fault
	Bit 2	34	CONT1_STUCK_OPEN_FLT	Contacto 1 detected stuck open
	Bit 3	35	CONT2_STUCK_OPEN_FLT	Contacto 2 detected stuck open
	Bit 4	36	SEC_CONTB_OPEN_FLT	Secondary contacto B or fuse B fault
	Bit 5	37	NO_PCU_DATA_FLT	No PCU data received fault
	Bit 6	38	OVER_CURRENT_REG_FLT	Pack over current regulation fault
	Bit 7	39	IN_12V_UNDER_VOLT_FLT	12V input under voltage fault
Byte 5	Bit 0	40	LO_DCHG_DURING_CHG_FLT	Low level discharge during charge fault
	Bit 1	41	HI_DCHG_DURING_CHG_FLT	High level discharge during charge fault
	Bit 2	42	SLAVE_COMM_FLT	Internal slave data not received fault
	Bit 3	43	STRING_V_MISMATCH_FLT	String voltages have excessive disparity
	Bit 4	44	IN_12V_UV_WARNING	12V input under voltage warning
	Bit 5	45	HI_CONT_COIL_CUR_FLT	High contacto coil current fault
	Bit 6			(Not used)
	Bit 7			(Not used)
Byte 6	Bit 0			(Not used)
	Bit 1			(Not used)
	Bit 2			(Not used)
	Bit 3			(Not used)
	Bit 4			(Not used)
	Bit 5			(Not used)
	Bit 6			(Not used)
	Bit 7			(Not used)
Byte 7	Bit 0			(Not used)
	Bit 1			(Not used)
	Bit 2			(Not used)
	Bit 3			(Not used)
	Bit 4			(Not used)
	Bit 5			(Not used)
	Bit 6			(Not used)
	Bit 7			(Not used)

#### **4.3.5.6 MLEC programming of application code**

- Bootloader and pack end-model compatibility
- Current offset and gain values in EEPROM (unique at pack characterization)
  - ✓ default settings
  - ✓ transfer of CURRENT OFFSET settings
- Malfunction codes (Key Cycle and Service category faults)
  - ✓ Clear codes

#### **4.3.5.7 Battery Pack Application Software Re-Programming**

- Install the re-flash application software known as "Flash Tool".
- Connect the CAN Interface Tool (PCAN-USB Adapter with optical isolation).
- Attach a 2-wire CAN Interface Cable from the PCAN-USB Adapter to Vehicle CAN-H and CAN-L at the vehicle OBD (On-Board Diagnostic) connector.
- Start the re-flash application software by running the Flash Tool executable.
  - ✓ The application will start with preselected default options. The default selections support MLEC programming (CAN Rcv Range is "61E, 61F", CAN Kbaud is "500", and "Auto mode").
  - ✓ Select the "Use CAN" option.

- Click the “Browse” button and select the S19 file for the new MLEC Application Software Build to be programmed into the battery pack. Example: “MLec\_A306\_25.s19”.
  - ✓ Details for Begin, End, and Bytes of the S19 file will be displayed in the Reception: Response window of the Flash Tool.
- Turn Key Run ON to wake up the MLEC in the battery pack.
- Click the “Start” button to begin re-flashing of the new MLEC Application Software Build.
  - ✓ Progress of re-flash will be displayed in the Reception: Response window of the Flash Tool.
  - ✓ If the re-flash is completed successfully, “Flash operation complete” will be displayed in the Reception: Response window of the Flash Tool.
- Turn Key Run OFF.
- Wait for six (6) seconds.
- Turn Key Run ON to wake up the MLEC in the battery pack.
- Using a CAN diagnostic tool (PCAN Viewer, PCAN Explorer, or other), verify the contents of CAN Msg ID 300, Byte 2 received from the battery pack. Example: “02 00 25 00 00 00 01 00” indicates MLEC Build 25 Application Software in the battery pack.
  - ✓ The Ener1 proprietary Comm Tool application software can also be used to verify the new MLEC Application Software Build. The Master Sequence File “PartNum.MSF” will display the MLEC Application Software Build in Software\_ID, Byte 0. Example: “01 02 00 25” indicates MLEC Build 25 Application Software in the battery pack.
- Turn Key Run OFF.
- Disconnect the 2-wire CAN Interface Cable from Vehicle CAN-H and CAN-L at the vehicle OBD (On-Board Diagnostic) connector.
- Re-flash procedure is complete.

**NOTE:** If the battery pack is not installed in a vehicle, Vehicle CAN-H and CAN-L and Key Run may be accessed directly at the LV connector of the battery pack.

#### 4.3.5.8 Flash Tool

In Figure 3:  
MLEC Application Software has been re-flashed successfully

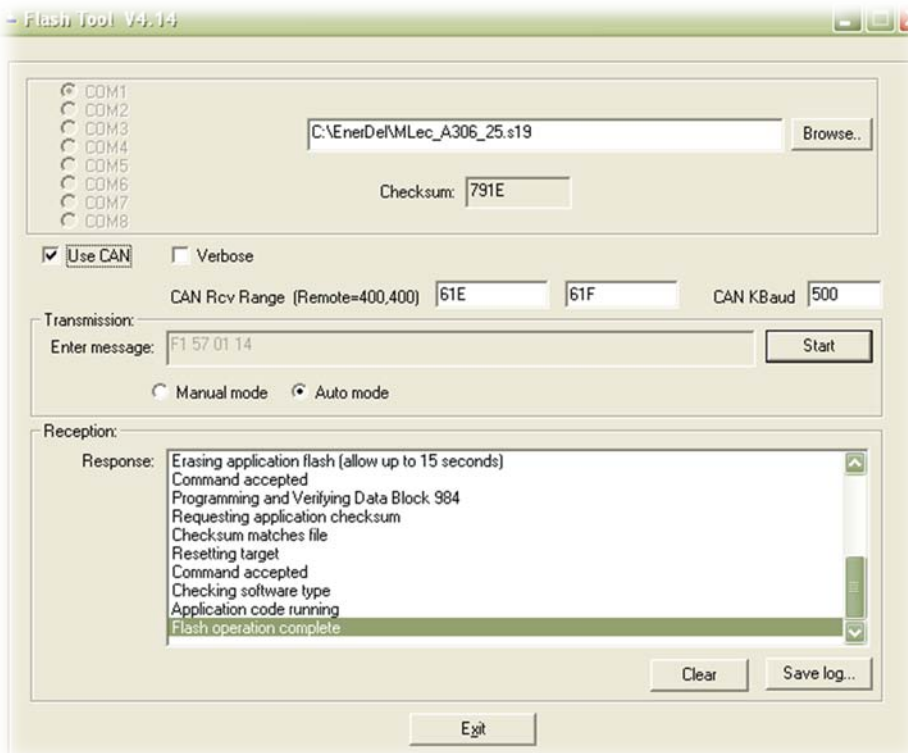


Figure 3 Flash Tool



#### **4.3.5.9 Diagnostics Interface**

Under Development, 2<sup>nd</sup> quarter 2011 implementation planned.

- 4.4 Step 3: Using Information provided, Ener1 will evaluate possible solutions and implement a plan.**
  
- 4.5 Step 4: Ener1 will implement the best solution.**

## 5. Appendix A

### 5.1 Acronyms and Terms

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Acronym or Term	Definition
BDM	<i>Background Debug Mode</i>
BMS	<i>Battery Management System</i>
BOB	<i>Break-out Box</i>
BOM	<i>Bill-of-Material</i>
DAC	<i>Data Acquisition Card</i>
EPO	<i>Emergency Power Off</i>
FIS	<i>Factory Information System</i>
FT	<i>Functional Test</i>
FTS	<i>Functional Test Station</i>
GPIB	<i>General Purpose Interface Bus</i>
HPPC	<i>Hybrid Pulse Power Characterization</i>
HV	<i>High Voltage</i>
HW	<i>Hardware</i>
ICT	<i>In-circuit Test</i>
I/O	<i>Inputs and Outputs</i>
LBS	<i>Lithium Battery Systems</i>
LEC	<i>Lithium Energy Controller</i>
LV	<i>Low Voltage</i>
MLEC	<i>Master LEC</i>
MTS	<i>Manufacturing Test Specification</i>
PC	<i>Personal Computer</i>
PCB	<i>Printed Circuit Board</i>
PS	<i>Power Supply</i>
RLEC	<i>Remote LEC</i>
SMT	<i>Surface Mount Technology</i>
SOP	<i>Start of Production</i>
SW	<i>Software</i>
UART	<i>Universal Asynchronous Receiver/Transmitter</i>
USB	<i>Universal Serial Bus</i>
UUT	<i>Unit Under Test</i>
WIP	<i>Work in Process</i>
XFMR	<i>Transformer</i>

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### 6.2.1.1 Contact Info

#### UNITED STATES

1. **CHEMTREC®**, a 24-hour emergency response communication service, can be reached as follows:

CALL **CHEMTREC®** (24 hours)  
**1-800-424-9300**  
(Toll-free in the U.S., Canada, and the U.S. Virgin Islands)  
For calls originating elsewhere:  
**703-527-3887** (Collect calls are accepted)

2. **CHEMTEL, INC.**, a 24-hour emergency response communication service, can be reached as follows:

CALL **CHEMTEL, INC.** (24 hours)  
**1-888-255-3924**  
(Toll-free in the U.S., Canada, Puerto Rico and the U.S. Virgin Islands)  
For calls originating elsewhere:  
**813-248-0585** (Collect calls are accepted)

3. **INFOTRAC**, a 24-hour emergency response communication service, can be reached as follows:

CALL **INFOTRAC** (24 hours)  
**1-800-535-5053**  
(Toll-free in the U.S., Canada, and the U.S. Virgin Islands)  
For calls originating elsewhere:  
**352-323-3500** (Collect calls are accepted)

4. **3E COMPANY**, a 24-hour emergency response communication service, can be reached as follows:

CALL **3E COMPANY** (24 hours)  
**1-800-451-8346**  
(Toll-free in the U.S., Canada, and the U.S. Virgin Islands)  
For calls originating elsewhere:  
**760-602-8703** (Collect calls are accepted)

The emergency response information services shown above have requested to be listed as providers of emergency response information and have agreed to provide emergency response information to all callers. They maintain periodically updated lists of state and Federal radiation authorities who provide information and technical assistance on handling incidents involving radioactive materials.

**5. MILITARY SHIPMENTS**

For assistance at incidents involving materials being shipped by, for, or to the Department of Defense (DOD), call one of the following numbers (24 hours):

**703-697-0218** (call collect) (U.S. Army Operations Center) for incidents involving explosives and ammunition.

**1-800-851-8061** (toll-free in the U.S.) (Defense Logistics Agency) for incidents involving dangerous goods other than explosives and ammunition.

**6. NATIONWIDE POISON CONTROL CENTER (United States Only)**

Emergency and information calls are answered by the nearest Poison Center (24 hours):

**1-800-222-1222** (toll-free in the U.S.).

The above numbers are for **emergencies** only.

**NATIONAL RESPONSE CENTER (NRC)**

The NRC, which is operated by the U.S. Coast Guard, receives reports required when dangerous goods and hazardous substances are spilled. After receiving notification of an incident, the NRC will immediately notify the appropriate Federal On-Scene Coordinator and concerned Federal agencies. Federal law requires that anyone who releases into the environment a reportable quantity of a hazardous substance (including oil when water is, or may be affected) or a material identified as a marine pollutant, must **immediately** notify the NRC. When in doubt as to whether the amount released equals the required reporting levels for these materials, the NRC should be notified.

CALL **NRC** (24 hours)

**1-800-424-8802**

(Toll-free in the U.S., Canada, and the U.S. Virgin Islands)

**202-267-2675** in the District of Columbia

Calling the emergency response telephone number, CHEMTREC®, CHEMTEL, INC., INFOTRAC or 3E COMPANY, does not constitute compliance with regulatory requirements to call the NRC.

## 6.2.1.2 Guide 147 Lithium Ion Batteries

ERG Guidelines for safety

<b>GUIDE 147</b>	<b>LITHIUM ION BATTERIES</b>	<b>ERG2008</b>
<b>POTENTIAL HAZARDS</b>		
<b>FIRE OR EXPLOSION</b>		
<ul style="list-style-type: none"><li>• Lithium ion batteries contain flammable liquid electrolyte that may vent, ignite and produce sparks when subjected to high temperatures (&gt; 150 °C (302 °F)), when damaged or abused (e.g., mechanical damage or electrical overcharging).</li><li>• May burn rapidly with flare-burning effect.</li><li>• May ignite other batteries in close proximity.</li></ul>		
<b>HEALTH</b>		
<ul style="list-style-type: none"><li>• Contact with battery electrolyte may be irritating to skin, eyes and mucous membranes.</li><li>• Fire will produce irritating, corrosive and/or toxic gases.</li><li>• Burning batteries may produce toxic hydrogen fluoride gas (see GUIDE 125).</li><li>• Fumes may cause dizziness or suffocation.</li></ul>		
<b>PUBLIC SAFETY</b>		
<ul style="list-style-type: none"><li>• <b>CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.</b></li><li>• As an immediate precautionary measure, isolate spill or leak area for at least 25 meters (75 feet) in all directions.</li><li>• Keep unauthorized personnel away.</li><li>• Stay upwind.</li><li>• Keep out of low areas.</li><li>• Ventilate closed spaces before entering.</li></ul>		
<b>PROTECTIVE CLOTHING</b>		
<ul style="list-style-type: none"><li>• Wear positive pressure self-contained breathing apparatus (SCBA).</li><li>• Structural firefighters' protective clothing will only provide limited protection.</li></ul>		
<b>EVACUATION</b>		
<b>Large Spill</b>		
<ul style="list-style-type: none"><li>• Consider initial downwind evacuation for at least 100 meters (330 feet).</li></ul>		
<b>Fire</b>		
<ul style="list-style-type: none"><li>• If rail car or trailer is involved in a fire, ISOLATE for 500 meters (1/3 mile) in all directions; also initiate evacuation including emergency responders for 500 meters (1/3 mile) in all directions.</li></ul>		

ERG Guidelines for safety

ERG2008

LITHIUM ION BATTERIES **GUIDE**  
**147**

**EMERGENCY RESPONSE**

**FIRE**

**Small Fire**

- Dry chemical, CO<sub>2</sub>, water spray or regular foam.

**Large Fire**

- Water spray, fog or regular foam.
- Move containers from fire area if you can do it without risk.

**SPILL OR LEAK**

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- Do not touch or walk through spilled material.
- Absorb with earth, sand or other non-combustible material.
- Leaking batteries and contaminated absorbent material should be placed in metal containers.

**FIRST AID**

- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.



### 6.2.1.3 Guide 125 Gases – Corrosive

ERG Guidelines for safety

<b>GUIDE 125</b>	<b>GASES - CORROSIVE</b>	<b>ERG2008</b>
<b>POTENTIAL HAZARDS</b>		
<b>HEALTH</b>		
<ul style="list-style-type: none"><li>• <b>TOXIC; may be fatal if inhaled, ingested or absorbed through skin.</b></li><li>• Vapors are extremely irritating and corrosive.</li><li>• Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite.</li><li>• Fire will produce irritating, corrosive and/or toxic gases.</li><li>• Runoff from fire control may cause pollution.</li></ul>		
<b>FIRE OR EXPLOSION</b>		
<ul style="list-style-type: none"><li>• Some may burn but none ignite readily.</li><li>• Vapors from liquefied gas are initially heavier than air and spread along ground.</li><li>• Some of these materials may react violently with water.</li><li>• Cylinders exposed to fire may vent and release toxic and/or corrosive gas through pressure relief devices.</li><li>• Containers may explode when heated.</li><li>• Ruptured cylinders may rocket.</li></ul>		
<b>PUBLIC SAFETY</b>		
<ul style="list-style-type: none"><li>• <b>CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.</b></li><li>• As an immediate precautionary measure, isolate spill or leak area for at least 100 meters (330 feet) in all directions.</li><li>• Keep unauthorized personnel away.</li><li>• Stay upwind.</li><li>• Many gases are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks).</li><li>• Keep out of low areas.</li><li>• Ventilate closed spaces before entering.</li></ul>		
<b>PROTECTIVE CLOTHING</b>		
<ul style="list-style-type: none"><li>• Wear positive pressure self-contained breathing apparatus (SCBA).</li><li>• Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection.</li><li>• Structural firefighters' protective clothing provides limited protection in fire situations <b>ONLY</b>; it is not effective in spill situations where direct contact with the substance is possible.</li></ul>		
<b>EVACUATION</b>		
<b>Spill</b>		
<ul style="list-style-type: none"><li>• See Table 1 - Initial Isolation and Protective Action Distances for highlighted materials. For non-highlighted materials, increase, in the downwind direction, as necessary, the isolation distance shown under "PUBLIC SAFETY".</li></ul>		
<b>Fire</b>		
<ul style="list-style-type: none"><li>• If tank, rail car or tank truck is involved in a fire, ISOLATE for 1600 meters (1 mile) in all directions; also, consider initial evacuation for 1600 meters (1 mile) in all directions.</li></ul>		



ERG Guidelines for safety

ERG2008

GASES - CORROSIVE

GUIDE  
125

EMERGENCY RESPONSE

**FIRE**

**Small Fire**

- Dry chemical or CO<sub>2</sub>.

**Large Fire**

- Water spray, fog or regular foam.
- Move containers from fire area if you can do it without risk.
- Do not get water inside containers.
- Damaged cylinders should be handled only by specialists.

**Fire involving Tanks**

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Do not direct water at source of leak or safety devices; icing may occur.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. • ALWAYS stay away from tanks engulfed in fire.

**SPILL OR LEAK**

- Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- If possible, turn leaking containers so that gas escapes rather than liquid.
- Prevent entry into waterways, sewers, basements or confined areas.
- Do not direct water at spill or source of leak.
- Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. • Isolate area until gas has dispersed.

**FIRST AID**

- Move victim to fresh air. • Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- **Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.**
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with liquefied gas, thaw frosted parts with lukewarm water.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- **In case of contact with Hydrogen fluoride, anhydrous (UN1052),** flush skin and eyes with water for 5 minutes; then, for skin exposures rub on a calcium/jelly combination; for eyes flush with a water/calcium solution for 15 minutes.
- Keep victim warm and quiet. • Keep victim under observation.
- Effects of contact or inhalation may be delayed.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

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