Department of
Electrical and Computer Engineering

Undergraduate Teaching Labs

Safety Manual*

(2022-2023)
Version 2.2 - January 2023

* *Energy Systems Group, Microwave and Photonics labs either follow their own policy document or complement this document with specific guidelines for their activities.*

Table of Contents

Emergency & Other Contacts

AMBULANCE, FIRE DEPARTMENT, POLICE	911
U OF T CAMPUS SAFETY (*Formerly Campus Police*)	416-978-2222
ENVIRONMENTAL HEALTH & SAFETY (*For critical / life-threatening injuries and other health & safety emergencies*)	416-208-5141

Other Contacts

UNDERGRADUATE OFFICE	416-978-0488
GRADUATE OFFICE	416-978-5804
HEALTH & WELLNESS CENTRE	416-970-8080
DIRECTOR, TEACHING LABS (**Afshin Poraria**)	416-946-8706
FACILITIES COORDINATOR (**Bianca Nagy)**	416-978-7369

Labs Locations, Supervisors, Managers and Contacts

Laboratory	Location	Contact / Manager	Office / Phone / Email
FUNDAMENTALS	GB341	Mihai Zaharia	GB338A 416-946-4070 m.zaharia@utoronto.ca
MICROWAVE	GB347	Tse Chan	GB347B 416-946-5869 tsechan@ece.utoronto.ca
PHOTONICS	SF2112	Tse Chan	GB347B 416-946-5869 tsechan@ece.utoronto.ca
FPGA DROP-IN	BA3135	Mike Mehramiz	BA3129 416-946-3321 mehr.mehramiz@utoronto.ca
DIGITAL & EMBEDDED SYSTEMS	BA3145 / BA3155 / BA3165	Aslan Hepdogru	BA3110 416-976-5273 aslan.hepdogru@utoronto.ca
UG COMPUTER LAB	BA3128	George Owen	BA3129 416-978-2519 george.owen@utoronto.ca
COMMUNICATIONS & ADVANCED ELECTRONICS	SF2201	Iman Makhmal Koohi	BA3104 416-978-3973 iman.makhmalkoohi@utoronto.ca
SYSTEMS CONTROL	BA3114	Mike Mehramiz	BA3129 416-946-3321 mehr.mehramiz@utoronto.ca
ENERGY SYSTEMS	GB040	Mike Colacci	GB042 416-946-5944 mike.colacci@utoronto.ca

General Safety Instructions and Precautions

Every person working in a laboratory is responsible for ensuring that:

- All applicable health and safety training has been completed.
- All applicable safety rules and practices are followed.
- All required protective equipment is used as recommended.
- All unsafe equipment and working conditions are reported to the laboratory supervisor, manager or technician.
- All accidents/incidents must be promptly reported (see ***Reporting an Incident*** below)
- All lab staff (supervisors, managers, technicians) are required to be present and accessible in person at the laboratories during experiments, conditioned on the standard working hours of the University. In the event of multiple rooms hosting experiments, staff must make frequent visits to all occupied rooms. This applies to the standard working hours of the university, or pre-arranged modified working hours approved by the Director of Teaching Labs.

General Lab Rules

- **No food or drink allowed in the lab**.
- Use of lab equipment any use other than the intended application is strictly prohibited.
- Do not work alone, unless specifically authorized to do so.
- Do not use unauthorized equipment.
- Follow all requirements of safety indicated in the lab manual and posters located on or near the door of the lab.
- If you are not certain on any of the guidelines in this document, ask one of the lab managers for clarification.

General Safety

- Be aware of the risks that are present in the particular lab you are working in.
- **Learn the location of emergency exits, fire alarms, fire extinguishers and first-aid kits**.
- All aisles and workspaces must be kept clear of clutter.
- All exits, fire extinguishers and electrical disconnects must remain accessible at all times.
- Know and understand the hazards, safe handling and standard operating procedures of the materials, equipment and methods being used.
- Review equipment manuals, procedures and instructions before attempting to operate any machine or instrument.
- Read labels carefully.
- Any unsafe or dangerous behavior and accidents must be reported to the lab supervisor, manager, technician and TAs.
- Never block access to exits, emergency equipment (e.g., fire extinguishers, fire alarms, electrical panels, first-aid kits).
- Keep your work area clear of all materials except those needed for your work.
- Extra books, bags, coats and other personal items should be kept away from equipment (e.g., place items on the back tables, hang jackets on hooks).
- Equipment must be properly handled. Any damages or technical issues regarding equipment should be reported to the lab supervisor, manager or technician.

- Return all tools to their proper storage places.
- Do not change faulty equipment and instruments without explicit permission of the lab supervisor, manager or technician.

Smoking

Smoking is not permitted inside any University of Toronto building or vehicle or in areas within eight metres of all buildings. This includes any form of e-cigarette or vaping.

Laboratory Security

Keep laboratories locked when unoccupied to avoid unauthorized entry. Individual users are responsible for the security of any space to which they have keys and shall not admit unauthorized or non-registered persons into that space. Safeguarding University of Toronto resources from unauthorized access, misuse or removal is a duty of all faculty, staff, and students. All laboratory users have a responsibility to take reasonable precautions against theft or misuse of materials, particularly those that could cause public harm.

Electrical Safety

At each stage of your experiment, you should be cautious and mindful of safety rules.

- Stay *calm* and *relaxed*; never rush through any experiments.
- Understand the **power up**, and **power down** procedures; so that you can safely energize and shutdown your experimental setup.
- Do not touch live circuits even at low power; circuits with storage elements exhibit much larger voltage and / or current than the supply.
- At any stage of the experiment, never touch another person's setup.
- If in doubt, always ask questions before you take any actions.

Working Alone

No one is permitted to carry out alone any electrical work over 50V peak. Even for voltages less than 50V peak, it is highly recommended to secure the presence of another student or colleague familiar with the safety procedures in the close vicinity of the area where work is being carried out. The provisions to call for help must always be considered as the primary rule of safety. If solo work on setups limited to below 50V is to be performed at any time, the immediate supervisor and the lab manager must be informed.

Do not work alone in a teaching laboratory.

Always work in the lab with another person. This ensures that in the case of an accident someone is there to assist.

Refer to the Appendix D for additional information regarding electrical safety and shocks.

General Instruction and Precautions While Performing Experiments

You MUST familiarize yourself with the physical lab layout, the emergency procedures, AND the operation of all lab equipment.

- **No liquids in the lab.** (Drinks must be either left outside the lab or placed in your bag and kept in one of the designated areas.)
- Make sure you have a proper layout of the power components and instruments on your table. You may need to touch the measurement devices while the circuit is live (e.g., oscilloscope and multimeters). A proper layout of the power components and instruments minimizes the risk of touching the live circuit.
- Select wires with proper length to keep your setup organized and reduce the risk of touching the live nodes. This also makes it easier to troubleshoot your circuit.
- Do not keep any unconnected wires on the experiment table once you have finished wiring up the experiment. This might cause indirect contact. Remove devices and wires that are not connected.
- Make sure all knobs and terminals are fastened firmly.
- Ensure all tools, papers or other personal items are removed from the test table if not required for the experiment.
- **Haste and inattention cause many accidents**. **Work deliberately and carefully**. Plan your activities prior to the experiment, familiarize yourself with equipment prior to actual operation and verify your work as you progress (consult your TA).
- Learn the location of Emergency Exit doors, First Aid Kit, Fire Extinguishers and Fire Alarm. (See Appendix B.)
- **Report potential hazards and suspected faulty equipment to your TA or one of the lab staff immediately.** This includes wires that have poor insulation, set screws that are loose, insecure connections that may come apart, etc.
- If you smell or observe smoke or fire from a circuit or a piece of equipment*, and if you can do so safely,* turn off power to the circuit or the equipment *and inform the lab supervisor, manager, or technician.*
- Do not attempt to perform any diagnosis, maintenance or repairs yourself. Removing or opening the case from any apparatus may expose parts at line voltage.
- **Tampering with or removal of any laboratory equipment is strictly forbidden**.
- **Students should clean and tidy their workstations when they have finished and return all leads before leaving the laboratory.**
- Many drugs, including alcohol and some medications, can impair your thinking (i.e., judgment) and slow your reactions. *Any student displaying such adverse effects, no matter what substance, will be excluded from laboratory classes.* Similarly, *do not work in the laboratory if you are too tired to think clearly*. Speak to your instructor or lab staff to make alternative arrangements.

- You also need to adhere to the following guidelines in laboratories where exposed electrical components (connectors, unprotected printed circuit boards, etc.) and / or moving elements (electrical motors, robotic arms, etc.) are nearby or are used as part of the experiment.
    - Do not wear loose clothing (including straps or strings) near electrical equipment.
    - If you are wearing metal jewellery (e.g., a watch, long earrings, bracelets, or a necklace), you need to take it off during the lab.
    - Long hair must be tied back.

Violation of safety and operation standards will not be tolerated.

Minor infractions may only incur a verbal warning, but continued failure to follow safe practices may result in immediate removal from the laboratory.

Flagrant violation of safety rules will result in immediate removal from the lab.

Violation of these regulations may also result in the suspension of student's ECE / ECF network and computer account until further notice.

FOLLOW PROCEDURES - MINIMIZE HAZARDS - AVOID UNSAFE BEHAVIOR.

THINK FIRST, ACT CAREFULLY!

Emergency Procedures

In the event of any emergency, you must think clearly.

Remain calm.

It is your responsibility to read safety posters and follow instructions during an emergency. ***Know the location of the laboratory fire extinguisher, fire alarm, first-aid kit, room and building fire exits and emergency contact numbers.***

General Emergency

1. **Notify emergency personnel.**
   - **Call emergency (911**) and direct them to the location of the accident/incident:

Fundamentals Lab:

Galbraith Building (GB)

35 St. George Street, 3rd Floor, Room 341

Communications Lab:

Sandford Fleming Building (SF)

10 King's College Rd, 2nd Floor, Room 2201

Microwave Lab:

Galbraith Building (GB)

35 St. George Street, 3rd Floor, Room 347

Photonics Lab:

Sandford Fleming Building (SF)

10 King's College Rd, 2nd Floor, Room 2112

Digital & Embedded Systems Lab (DESL):

Bahen Centre for Information Technology (BA)

40 St. George Street, 3rd Floor,
Rooms BA3135 / BA3145 / BA3155 / BA365

Systems Control Lab:

Bahen Centre for Information Technology (BA)

40 St. George Street, 3rd Floor, Room BA3114

UG Computer Lab:

Bahen Centre for Information Technology (BA)

40 St. George Street, 3rd Floor, Room BA3114

It is critical to **inform the emergency personnel of the nature of the accident** particularly if you are reporting an electrical accident.

- **Call U of T Campus Safety (416-978-2222)** to inform them of the incident for support and resources.
- **Inform Lab Manager and TA of the incident.**

2. Clear a path to the injured person – move furniture, equipment and unlock doors.
3. Bring in the Automated External Defibrillator (AED) device.
4. Send one individual to the main entrance of the building to help direct emergency response to the incident location.

Fire and Evacuation Procedures

Evacuation

Upon hearing the fire alarm or when an evacuation order is received, remain calm and immediately **WALK** to the nearest exit (see Appendix B for corresponding maps). Remain outside until further instructions are received.

Fire Emergency

When calling to report a fire, notify emergency personnel of the exact location (building and room number) of the incident.

1. In the event of a fire in your work area, shout “Fire!" to alert all in the area.
2. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner using a hand-held fire extinguisher. *If safe*, attempt to extinguish the fire with a fire extinguisher:
    - Pull the pin located at the top of the level while you hold the extinguisher in an upright position by the handle.
    - Aim the nozzle of the extinguisher directly at the fire. Try to identify the point of origin, if you can.
    - Squeeze the level of the extinguisher while directing the nozzle at the point of origin.
    - Sweep and cover the area with the extinguishing substance.
3. **If the fire is growing beyond your control**, and you **cannot put the fire out within 30 seconds:**
    - **Pull the fire alarm** (See Appendix B for locations of the nearest alarm).
    - Immediately vacate the building via the safest and closest exit route.
    - **Call 911** and Campus Safety (**416-978-2222**). Be prepared to state the address (see above).
    - **Get out of the building/area immediately, close but do NOT lock the door.** Do NOT use elevators!

Important Reminders:

- Do not attempt to fight a major fire on your own.
- Never throw water on an electrical fire.
- Never enter a room that is smoke-filled or containing a fire.
- *Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm and the nearest fire escape.*

Calling 911

- **Listen carefully, speak clearly and try to remain calm**.
- **State your emergency** (injury due to fire, electrical shock, fall, medical condition, etc.)
- **Stay on the line and follow instructions**. Your 911 call taker will stay on the line with you to make sure your call is answered by the appropriate agency.
- **Remain on the phone with the 911 dispatcher** until they've told you it's safe to hang up.
- **Be prepared to provide the condition of the injured person to the best of your ability.**
- **Be prepared to provide your exact location (building and room number)** when asked. These can be found on the Fire Safety posters near the room entrance (See Appendix B).
  - Location is particularly important if you are calling from a cellphone or an internet/VoIP phone (see below). Cellphones provide only general location information; internet phones provide no location information.
  - Any other information, such as major intersections and street access to your current location, would be helpful indicators for emergency personnel.
- **Try to find the name of the individual(s) involved in the accident**; this will be critical information needed to fill out an incident report.
- **Send one individual to the main entrance of the building to help direct the emergency responders to the incident location.**
- Monitor the individual until the arrival of Fire/Paramedic Service personnel.

Clothing on Fire

Do not use a fire extinguisher on people.

STOP what you are doing, **DROP** to the floor and cover your face, then **ROLL** back and forth on floor and scream for help until the fire is out.

If you cannot stop, drop and roll...

Wrap with a fire blanket to smother the flame (a coat or other non-flammable fibre may be used if the fire blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Figure 1. Fire Extinguisher

Refer to Appendix B to familiarize yourself with where the fire extinguisher and first aid kits are located in your lab.

First Aid

First-Aid Kits

First-aid kits are located on the wall by the main doors of most teaching labs. If there is no first-aid kit present in the lab, there will be a poster near the main lab door that indicates the location of the nearest first-aid kit.

- Lab ***supervisor, manager or technician*** are responsible for ensuring first-aid kits are within the expiration time-period and restocked with all necessary items prior to the start of every semester.

First-Aid Procedures

Minor injuries may be treated by trained ECE Staff.

Major injuries or illness are best handled by phoning **911**. If you encounter someone who is suffering from a medical condition or injury, take the following action:

- If an ambulance is required, contact **911** and the Campus Safety at ***416-978-2222*** informing them of your location (see Appendix B) and the condition of the individual.
- **Send one individual to the main entrance of the building to help direct the emergency responders to the incident location.**
- If qualified, administer first aid, or seek assistance from someone who is qualified.
- Monitor the individual until the arrival of Fire/Paramedic Service personnel.

Figure 2 First-Aid Kit

Get familiar with items in the first-aid kit. For where kits are located, see Appendix B.

Using an Automated External Defibrillator (AED)

An AED is a small, portable and easy-to-use device that assesses the heart rhythm of a person in cardiac arrest to determine whether it is shockable. If such a rhythm is detected, the provider is instructed to press a button to deliver a shock or series of shocks to the victim's heart, stopping the heart to allow it to return to a normal rhythm. If no shockable rhythm is detected, no shock can be given, and the provider must perform CPR until professional help arrives.

Until recently, only medical and paramedical staff used AEDs. However, the advent of safe and easy-to-use AEDs now makes it possible to extend the use of AEDs to people with little or no medical background.

Do NOT use the AED when a victim:

- **Is conscious, or**
- **Is breathing, or**

- **Has a detectable pulse or other signs of circulation.**

Here at ECE we access to 3 AED units by 2 manufacturers:

- AED Plus / AHA 2010 from ZOLL (1 device)
  - Mounted on a wall next to **Room 132 of Galbraith Building, 1st floor.**

- DDU-100 from Defibtech (2 devices)
  - Mounted on a wall next to **Room 339 of Galbraith Building, 3rd floor**
  - Mounted on a wall inside the **Energy Systems Group Lab, located on the basement of Galbraith Building, Room GB040.**

The locations of the AED devices are shown in Figure 3, 4, and 5.

See Appendix C for instructions on how to use the AED.

Location of AED Devices

The following layouts shows the location of the three (3) AED devices available in the Galbreath building:

1. AED mounted on a wall next to **Room 132 of Galbraith Building, 1st floor**.

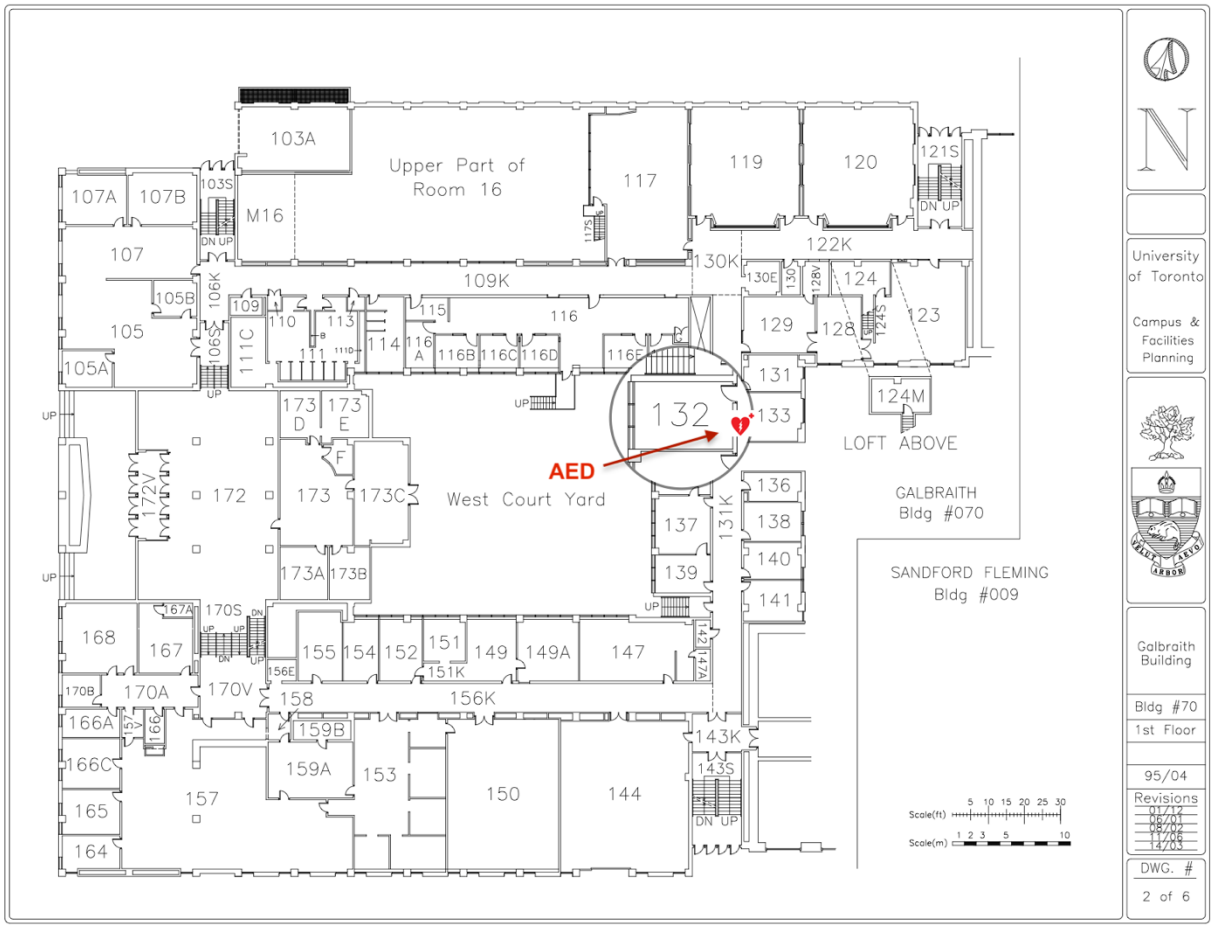


Figure 3 Location of the AED device GB 1st floor (Room # 132)

2. AED mounted on a wall next to **Room 339 of Galbraith Building, 3rd floor**:

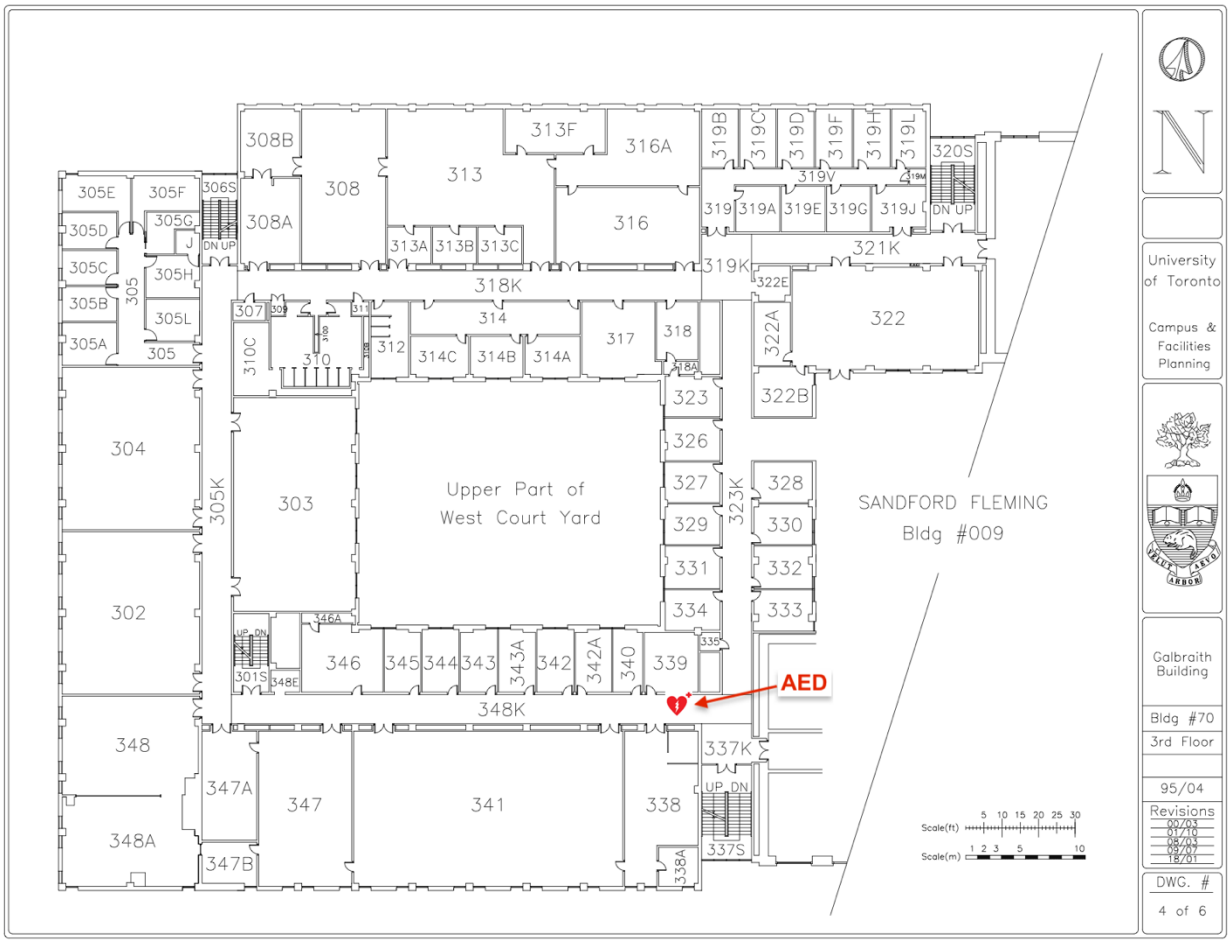


Figure 4. Location of the AED device GB 3rd floor (Room # 339)

3. AED mounted on a wall inside the **Energy Systems Group Lab, located on the basement of Galbraith Building, Room GB040.**

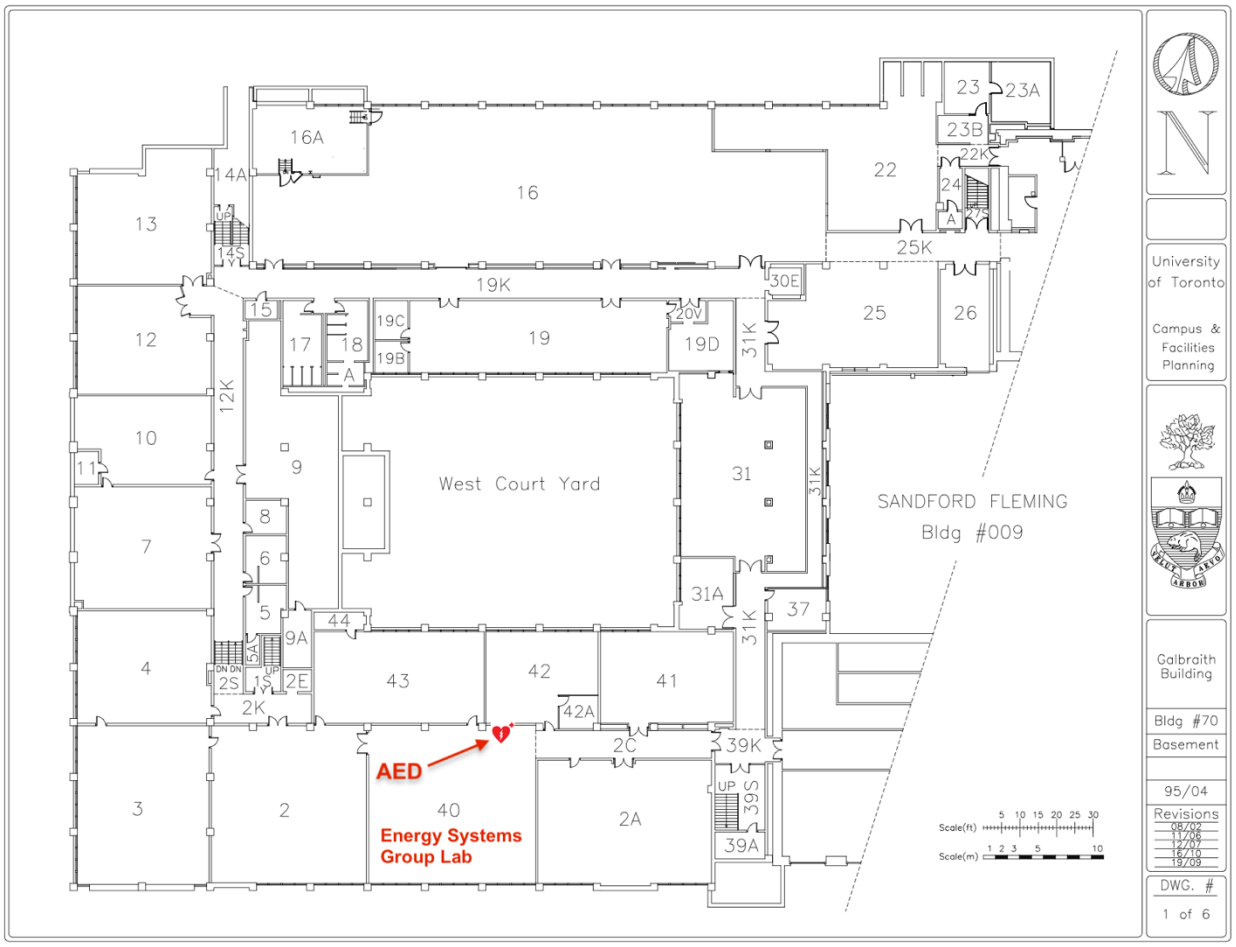


Figure 5. Location of the AED device GB basement (GB040)

Reporting an Incident

Reporting of Accidents, Incidents and Occupational Illnesses

These procedures outline the reporting requirements for accidents, occupational illnesses and incidents which result in or have the potential to result in personal injury or property damage.

Reportable incidents are those which:

- Result in personal injury or lost time from work (including those requiring first aid, and occupational illness).
- Have the potential to result in personal injury or property damage even though no injury or damage was perceived to have occurred.
- Occur to any person on university premises.
- Occur to a university employee(s) during the course of their work either on or off university premises.
- Occur to a student(s) during the course of their classroom, laboratory or field work.
- Occur to a student(s) during the course of a work placement (either paid or unpaid) which forms part of their university curriculum.

The above applies to incidents that occur outside of Ontario. If you will be working outside of Ontario for more than six months, you must contact the Health & Well-being Office at ***416-978-2149*** *to extend your WSIB coverage.*

Filling Out Accident/Incident Reports

1. All employees must report the accident/incident to their supervisor or home department immediately.
2. The employer is responsible for providing and paying for immediate transportation to a hospital, health professional office or the worker's home (as necessary).
3. Within 24 hours, the supervisor must complete and submit the "Online Accident/Incident eForm for Employees" found at: https://ehs.utoronto.ca/report-an-incident/
   This form requires UTORid authentication.
4. Please ensure you have all the required information (details of the incident and personal information of the employee) before starting to fill out the form, as it cannot be saved.
   - When the **supervisor, manager or technician** is unable to fully complete the form within 24 hours, it should still be sent, with the missing information to follow later. Use "not available" for missing information.

If you are having difficulty completing the form after 12 hours of the incident, please contact the EHS office at 416 978-4467 or ehs.office@utoronto.ca.

Once submitted, a copy of this report will be sent to the email addresses that you provided on the form. Please also include:

- The ECE Facilities Co-ordinator, **Bianca Nagy :** bianca.nagy@utoronto.ca
- Director of Teaching Labs, **Afshin Poraria**: afshin.poraria@utoronto.ca

If you do not immediately receive a copy of the report via email, please contact the EHS office (416-978-4467) as your submission may have failed.

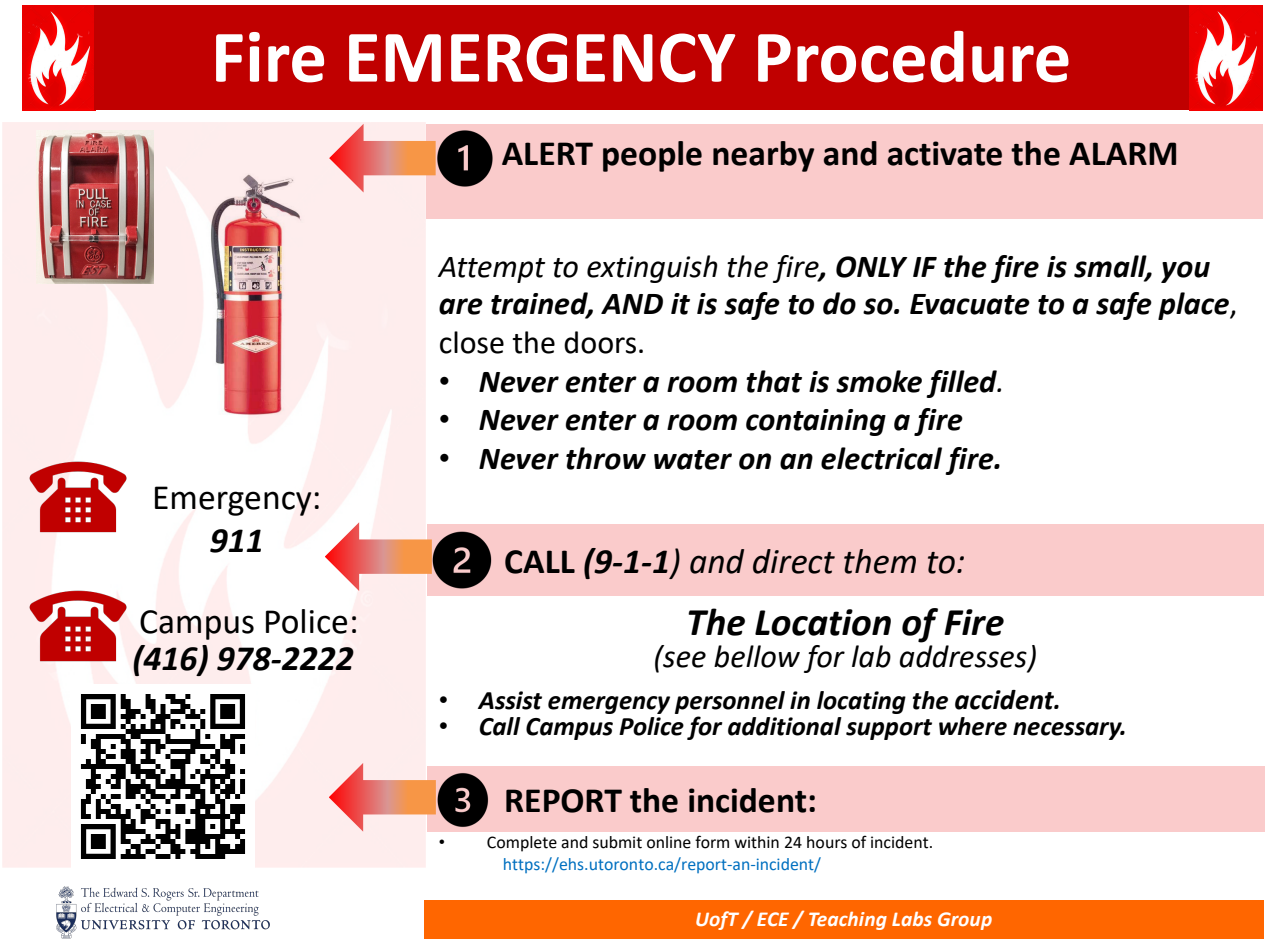
Common Errors/Omissions in Reporting Accidents

- Omission of the name of the injured:
  - Ensure that the name of the person involved in the accident/incident is recorded.
  - If possible, also record the student number of the injured person.
- Incorrect date and time of incident are provided:
  - Ensure the date the time are accurately recorded. (Please note, the form uses a 24-hour drop box.)
- Submission unsuccessful:
  - Ensure all the "Required" fields are filled out.
  - Ensure the green "complete" display appears after submission.
  - Contact the EHS office if your submission is unsuccessful.
- Incorrect classification:
  - Ensure that the accident/incident and the actions taken are appropriately classified.
  - First aid: band-aids and ice packs.
  - Healthcare: family doctor, EMS and Hospital.
- Avoid general statements:
  - Be specific and descriptive when describing the accident/incident and where it occurred.
- Insufficient details of incident:
  - Include in-depth and relevant details surrounding the accident/incident, such as what happened and how it happened.
  - Details of the incident need to be fully understood by outside groups (e.g., WSIB), and they therefore must receive the complete picture.

APPENDIX A

Fire Safety Poster

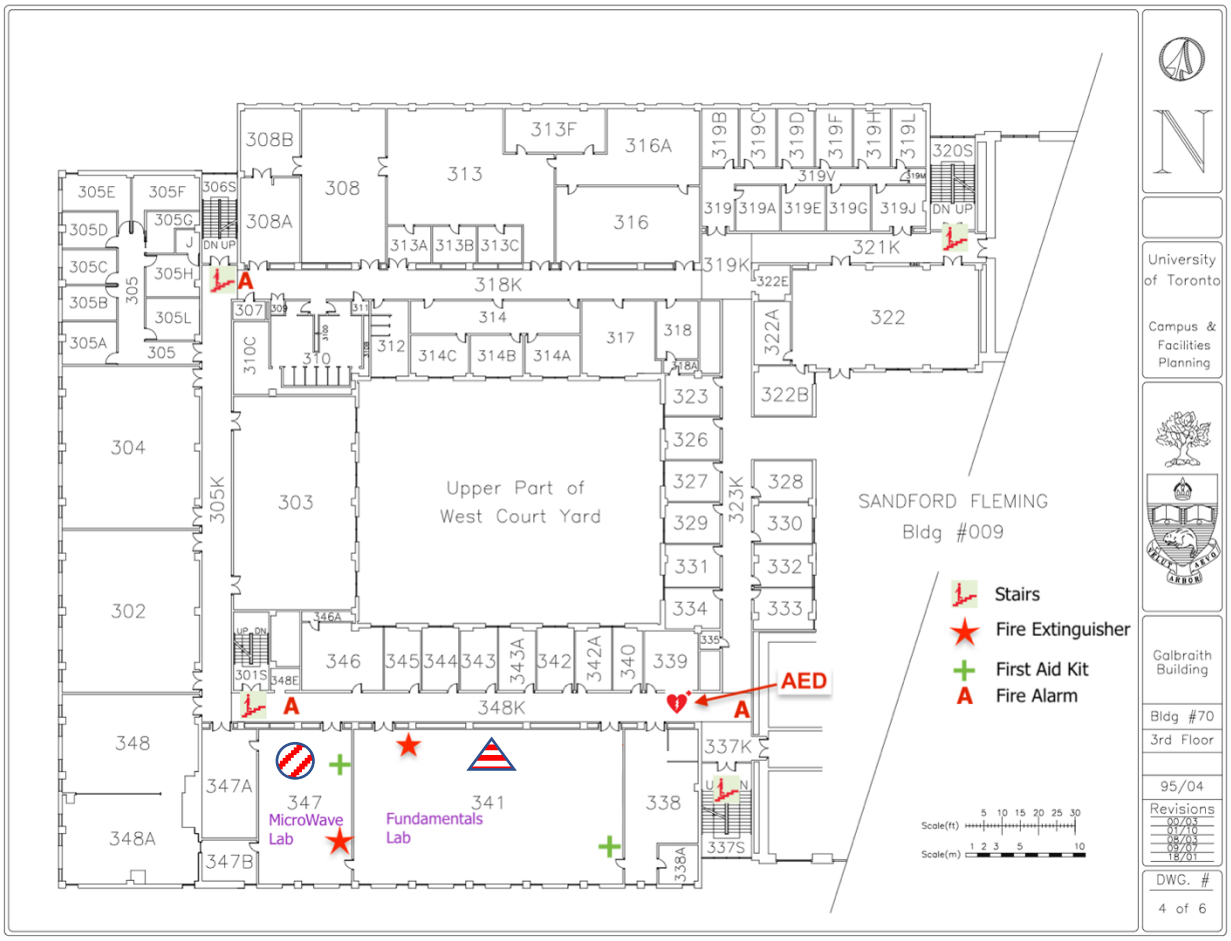
A fire safety poster will be found near the exit(s) of all laboratories. Posters may vary slightly across different laboratories depending on the lab specific safety procedures.



Fundamentals Lab: Galbraith Building (GB) ***35 St. George Street, 3rd Floor, Room 341***	**Communications Lab:** Sandford Fleming Building (SF) ***10 King's College Rd, 2nd Floor, Room 2201***
Microwave Lab: Galbraith Building (GB) ***35 St. George Street, 3rd Floor, Room 347***	**Photonics Lab:** Sandford Fleming Building (SF) ***10 King's College Rd, 2nd Floor, Room 2112***
Digital & Embedded Systems Lab (DESL): Bahen Centre for Information Technology (BA) ***40 St. George Street, 3rd Floor,*** ***Rooms BA3135 / BA3145 / BA3155 / BA365***	**Systems Control Lab:** Bahen Centre for Information Technology (BA) ***40 St. George Street, 3rd Floor, Room BA3114***
UG Computer Lab: Bahen Centre for Information Technology (BA) ***40 St. George Street, 3rd Floor, Room BA3128***	

APPENDIX B: Maps for Laboratories

1. Galbraith Building, 3rd Floor



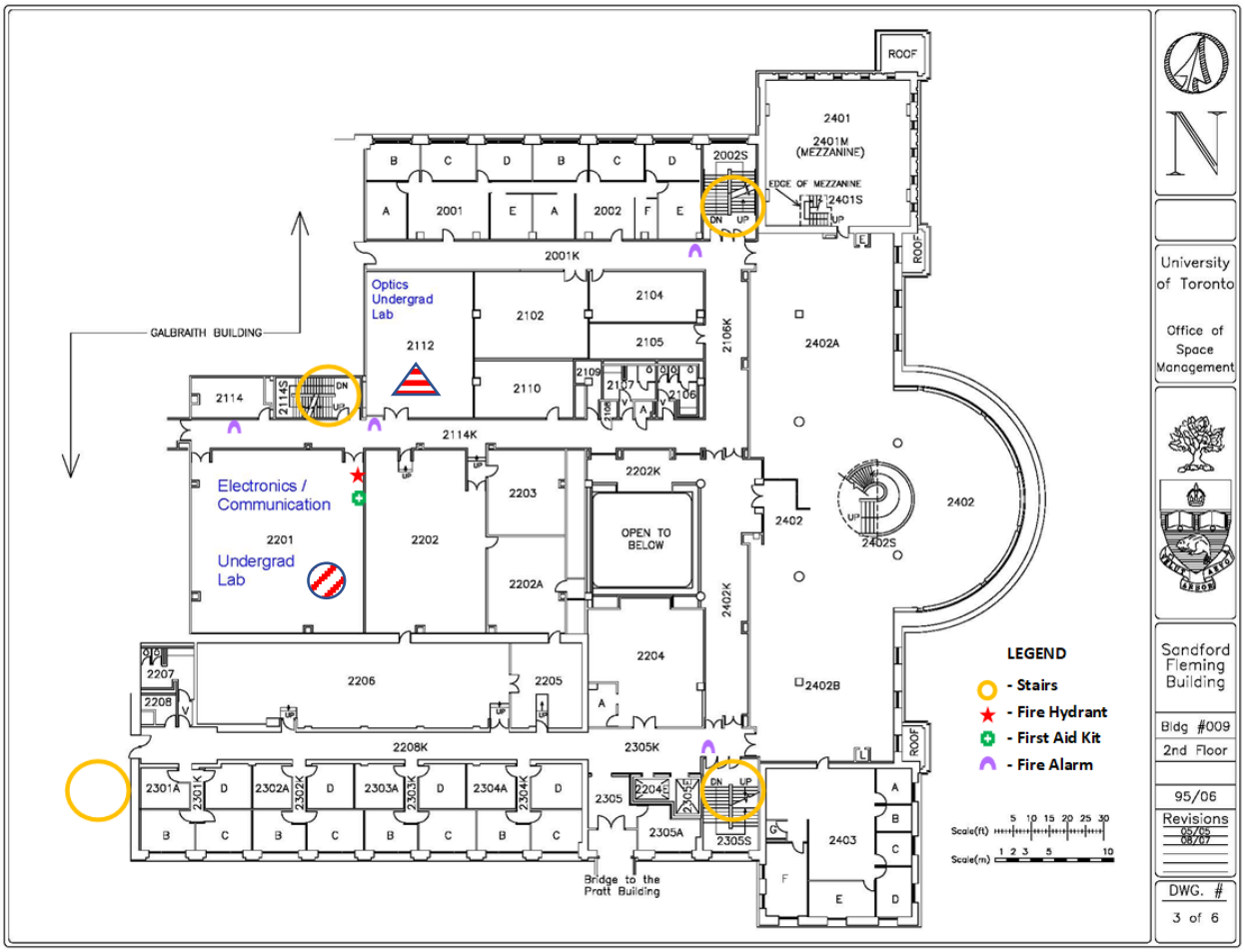
Fundamentals Lab:

35 St. George Street, Galbraith Building 3rd Floor, Room 341

Microwave Lab:

35 St. George Street, Galbraith Building 3rd Floor, Room 347

2. Sanford Fleming Building, 2nd Floor



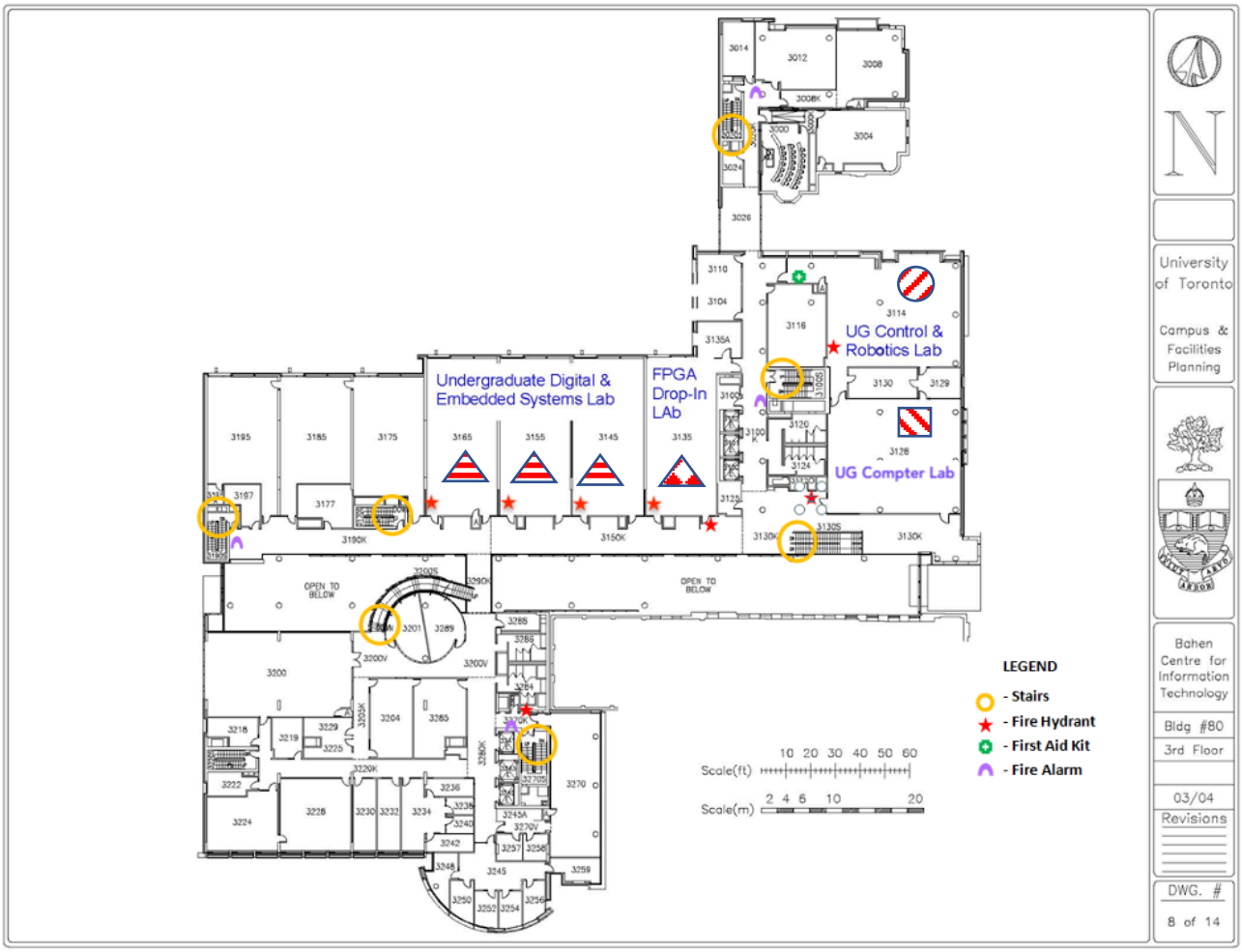
Communications Lab:

10 King's College Rd, Sandford Fleming Building (SF) 2nd Floor, Room 2201

Photonics / Optics Lab:

10 King's College Rd, Sandford Fleming Building (SF) 2nd Floor, Room 2112

3. Bahen Centre for Information Technology (BA), 2nd Floor



Digital & Embedded Systems Lab (DESL):

40 St. George Street, 3rd Floor

Rooms BA3145 / BA3155 / BA3165

FPGA Drop-In Lab

40 St. George Street, 3rd Floor, Room BA3135

Systems Control Lab:

40 St. George Street, 3rd Floor, Room BA3114

UG Computer Lab:

40 St. George Street, 3rd Floor, Room BA3128

APPENDIX C: Defibtech DDU-100 AED Operator's Guide

Defibtech DDU-100
Semi-Automatic
External Defibrillator

Operating Guide

For concise guidance on
set-up, use, maintenance
and technical specifications

ELECTRONIC
DISTRIBUTION

DAC-E561-EN-DF

Notices
Defibtech shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Information in this document is subject to change without notice. Names and data used in any examples are fictitious unless otherwise noted.

For more detailed information regarding the Defibtech DDU-100 AED, please refer to the User Manual at www.defibtech.com.

Limited Warranty
The "Limited Warranty" shipped with Defibtech AED products serves as the sole and exclusive warranty provided by Defibtech, L.L.C. with respect to the products contained herein.

Tracking
U.S.A. federal regulations require Defibtech to maintain records for each AED it distributes (reference 21 CFR 821, Medical Device Tracking). These requirements also apply anytime there is a change in the AED's location, including if you move, sell, donate, give away, export or even throw it away. We depend on AED owners/users to contact us when these things happen to ensure the tracking information remains accurate in the event we need to share important product notices. If your location is outside the U.S.A., we ask you share your information for exactly the same reasons. To keep your information up to date, please visit www.defibtech.com/register.

⚠ **CAUTION: Federal law (USA) restricts this device to sale by or on the order of a physician.**

IMPORTANT: This Operating Guide only applies to DDU-100 AEDs running software version 3.2 or higher that include the marking shown at left on the rear panel AED pad holder label as shown at right.

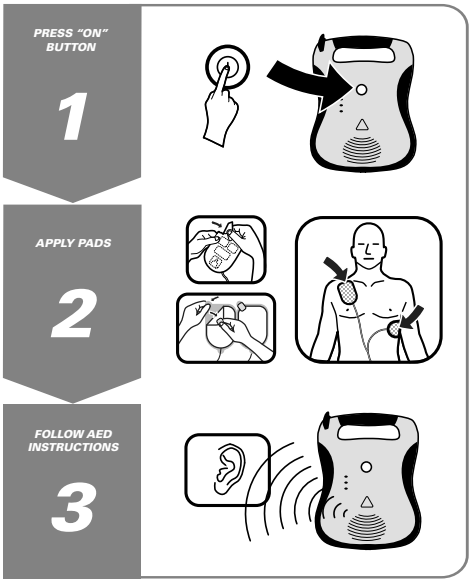
Please refer to **www.defibtech.com/support** for information about DDU-100 AEDs running earlier software versions.

Contents

This Operating Guide is to be used for concise guidance on set-up, use, maintenance and technical specifications on DDU-100 AEDs.

For comprehensive training on set-up, use and maintenance as well as complete technical specifications, refer to the User Manual at www.defibtech.com

QUICK USE INSTRUCTIONS



WHEN TO USE

INDICATIONS

The DDU-100 Automated External Defibrillator (AED) is indicated for use on victims of sudden cardiac arrest (SCA) who are:

- Unconscious and unresponsive
- Not breathing or not breathing normally

For patients under 8 years old, or weighing less than 55 lbs (25 kg), use child/infant defibrillation pads, if available. Do not delay therapy to determine exact age or weight. Apply the pads as shown for a child/infant and use the AED.

Federal Law (USA) restricts this device to sale by or on the order of a physician.

CONTRAINDICATIONS

None.

Refer to User Manual Section 8.1.6 for Summary of Primary Clinical Studies and User Manual Section 8.1.7 for Potential Adverse Effects of the Device on Health.

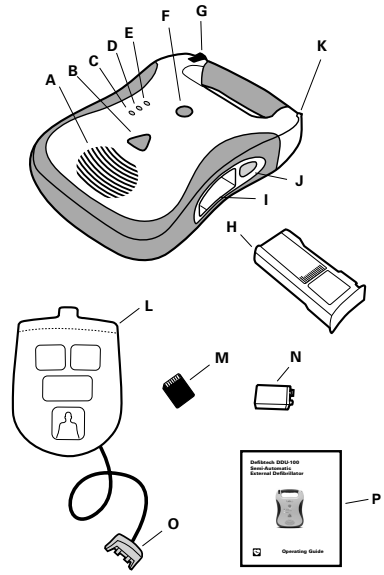
OPERATOR TRAINING REQUIREMENTS

In order to safely and effectively operate the DDU-100 AED, a person shall have met the following requirements:

- Defibtech DDU-100 AED and/or defibrillation training as required by local, state, provincial, or national regulations.
- Any additional training as required by the authorizing physician.
- Thorough knowledge and understanding of the material presented in the User Manual (available for viewing/download at www.defibtech.com).

For more detailed information, refer to the User Manual (at www.defibtech.com).

DIAGRAM OF COMPONENTS



A. *Speaker.* The speaker projects the voice prompts when the AED is on. The speaker also emits a "beep" when the unit is in standby mode and has detected a condition that requires operator attention.

B. *SHOCK button.* This button will flash when a shock is recommended - push this button to deliver the shock to the patient. This button is disabled at all other times.

C. *"analyzing" LED (Light Emitting Diode).* This green LED flashes when the AED is analyzing the patient's ECG rhythm.

D. *"do not touch patient" LED.* This red LED flashes when the AED detects motion or other interference that prevents analysis of the signal or when the user should not be touching or moving the patient.

E. *"check pads" LED.* This red LED flashes when the AED detects that the pad connection to the patient is poor or pads are not applied.

F. *ON/OFF button.* Push button to turn the AED on. Push again to disarm and turn the AED off.

G. *Pads connector port.* Insert Patient Pads Connector (item O) into this port to connect pads to the AED.

H. *Battery pack.* The battery pack provides a replaceable main power source for the AED.

I. *Battery pack opening.* Insert the battery pack firmly into this opening until the latch clicks into place.

J. *Battery pack eject button.* This button releases the battery pack from the AED. To remove the battery pack, push the button until the battery pack is partially ejected from the unit.

K. *Active Status Indicator (ASI).* The ASI indicates the current status of the AED.This indicator flashes green to indicate the unit has passed its last self-test and is ready for use. It flashes red to indicate unit needs attention from the user or needs servicing.

L. *Patient pads.* The defibrillation pads that are placed on the patient. The pads should be stored in the pad storage area on the back of the unit.

M. *Defibtech Data Card (DDC).* This optional plug-in card provides enhanced storage capabilities to the AED.

N. *9V lithium battery.* This 9V lithium battery provides supplemental power to the primary battery pack (item H). It is inserted into a compartment in the battery pack.*

O. *Patient pads connector.* Insert into Pads Connector Port (item G) to connect pads to the AED.

P. *Operating Guide.* Quick reference information for the DDU-100 AED. (The full DDU-100 AED User Manual can be found at www.defibtech.com.)

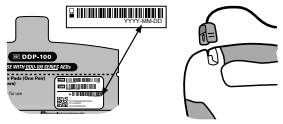
*DDU-100 AEDs will continue to perform standby and ASI functions without the 9V lithium battery installed, but battery pack standby life will be reduced.

For more detailed information, refer to the User Manual (at www.defibtech.com).

SETTING UP THE AED

The DDU-100 AED is designed to be stored in a "ready" state so that few steps are required to begin using the AED.

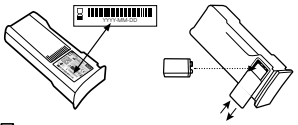
CONNECT THE PADS TO THE AED — 1



Check pads expiration date before connecting to AED as shown. Record pads expiration date for future reference.

For more pads information, refer to page 14.

INSTALL THE 9V LITHIUM BATTERY INTO THE BATTERY PACK* — 2



Check battery pack expiration date as shown. Record battery pack expiration date for future reference.

Ensure that the 9V lithium battery has not expired and install as shown.

For more battery information, refer to page 15.

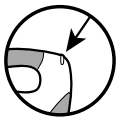
***NOTE:** DDU-100 AEDs will continue to perform standby and ASI functions without the 9V lithium battery installed, but battery pack standby life will be reduced.*

INSTALL THE BATTERY PACK INTO THE AED — 3

When the battery pack is installed, the AED will turn on and run a battery pack self-test. Wait for the test to complete and for the unit to turn off.

For more self-test information, refer to page 17.

CHECK THE STATUS — 4



When the AED is off, the Active Status Indicator (ASI) should flash green. If the ASI flashes red, is solid red, or if there is no flashing light, the unit requires service.

For more ASI information, refer to page 17.

READ THE USER MANUAL *(at www.defibtech.com)* — 5

Comprehensive information about the DDU-100 AED can be found in the User Manual (at www.defibtech.com).

For more detailed information, refer to the User Manual (at www.defibtech.com).

USING THE AED

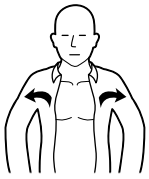
If the patient is unconscious or unresponsive, and is not breathing or not breathing normally, ensure emergency medical assistance has been called and start using the AED.

TURN AED ON
1

Press ON/OFF button to turn AED on.
Follow the voice prompt instructions.

(***NOTE:*** *To power off the AED at any time, press and hold the ON/OFF button for approximately two seconds.)*

PREPARE THE PATIENT
2



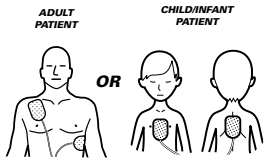
Remove clothing from patient's chest.
If necessary, dry chest and remove excess chest hair.

PREPARE PADS*
3

Tear open pads package. → Peel adhesive pads from blue liner.

NOTE: *If the patient is an infant or child under 8 years or less than 55 pounds (25 kg) and pediatric defibrillation pads are available, disconnect the adult pads connected to the AED and connect the pediatric pads (see step 1 in the "Setting Up the AED" section on page 8 for details). Do not delay therapy to determine exact age or weight. If pediatric pads are not available, apply adult pads in the position as shown in step 4 below for a child/infant and use the AED.*

PLACE PADS
4

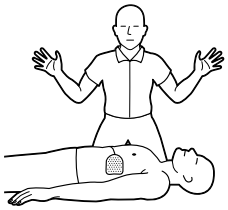


Apply pads to patient's bare chest.
For more information, refer to page 14.

For more detailed information, refer to the User Manual (at www.defibtech.com).

USING THE AED *(continued)*

STAND CLEAR
5

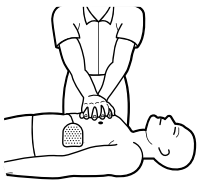


When instructed, do not touch the patient.

IF INSTRUCTED, PRESS SHOCK BUTTON
6

If instructed, press "SHOCK" button.

PERFORM CPR
7



Follow instructions to perform CPR, if needed.

CONTINUE TO FOLLOW INSTRUCTIONS
8

Continue to follow the voice prompt instructions.

For more detailed information, refer to the User Manual (at www.defibtech.com).

THE DEFIBRILLATION PADS

HOW TO CONNECT THE PADS

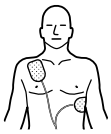
Insert the connector end of the defibrillation pad cable into the pads connector socket on the top-left corner of the DDU-100 AED as shown at left. Insert the pads connector firmly until it is fully seated in the unit. The connector will only fit in one way – if the connector does not fit, rotate the connector before trying again.

The connected pads package should then be stored in the pad storage area on the back of the DDU-100 AED (see diagram at right). After connecting the pads connector to the unit, push the pads package, rounded end first, with the pictures on the package facing out, into the pad storage area. When the pads package is fully inserted, press the pad cable into the groove in the back of the unit to hold the cable in place and tuck any excess cable behind the pads package.

Note: Defibtech recommends that the AED be stored with adult defibrillation pads connected to the unit and that a set of pediatric defibrillation pads be stored in an accessible location near the AED (e.g. in an AED storage case), but not connected to the unit.

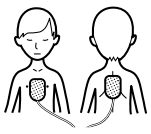
WHICH PADS TO USE

ADULT PADS



For adults and children 8 years or older or over 55 pounds (25 kg), use adult pads

CHILD/INFANT PADS



For infants and children under 8 years or less than 55 pounds (25 kg), use child/infant pads (NOTE: Child/infant pads can be identified by their blue connector and blue pads package)

WHEN TO REPLACE THE PADS

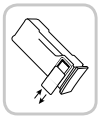
The Defibtech defibrillation pads are intended for one-time use only. The pads must be replaced after each use or if the package has been damaged.

It is important to check the expiration date of the pads. The expiration date is printed on the outside of the sealed package. *Do not use pads past their expiration date.* Discard expired pads. *Use only Defibtech defibrillation pads.*

THE BATTERY PACK

IMPORTANT: DDU-100 AEDs that carry the marking shown at left on the pad holder label on the unit's rear panel (see top of page 3) should use battery packs that also include this marking. Earlier model battery packs without this marking will function during a rescue, but should not be used for standby. If an earlier model battery pack is installed, the AED will prompt the user on shut down that an unknown battery type is present. The battery pack should be replaced with one that includes the marking shown at left.

INSTALLING THE 9V LITHIUM BATTERY



To meet battery pack specifications (see pages 24-25), a 9V lithium battery should be installed into the battery pack. *NOTE: While DDU-100 AEDs will operate rescue and standby functions with a battery pack that does not contain a 9V lithium battery, battery pack standby life will be reduced.*

The 9V lithium battery is installed into the battery pack in the 9V battery compartment. To install, remove the cover covering the 9V battery compartment by pushing on it sideways. The cover will slide and detach from the battery pack. Insert the 9V lithium battery into the 9V battery compartment so that the contacts on the battery touch the contacts in the battery pack. Replace the 9V battery compartment door by placing it in the almost closed position and then sliding it closed. Only a fresh 9V lithium battery should be used as a replacement.

INSTALLING AND REMOVING THE BATTERY PACK

The battery pack provides power to the DDU-100 AED. Before inserting the battery pack into the AED, the 9V lithium battery should be installed in the battery pack itself as described in the previous section. Do not install the battery pack after the expiration date printed on the label. The battery pack is non-rechargeable.

To insert the battery pack into the AED, orient the battery pack so that the label faces up. Make certain that the battery opening in the side of the AED is clean and clear of any foreign objects. Insert the battery pack into the opening in the side of the AED. Slide the battery pack all the way in until the latch clicks. If it does not slide all the way in, it is most likely inserted upside down. Once fully inserted, the battery pack surface should be flush with the side of the AED. To remove the battery pack, push the battery eject button on the side of the AED. After the battery pack is partially ejected, pull the battery pack out.

Within moments of insertion, the AED will turn on and run a battery pack insertion self-test. The AED will announce "Battery OK" after successful completion of the test. The unit will automatically shut off after the test is run. Afterwards, the Active Status Indicator on the top corner of the AED will periodically flash. If the indicator flashes green, the AED and battery pack are functioning properly; if this does not happen, there is a problem. Refer to page 17 for more details on the meaning of the indicator.

For more detailed information, refer to the User Manual (at www.defibtech.com).

THE DEFIBTECH DATA CARD *(optional)*

INSTALLING AND REMOVING THE DEFIBTECH DATA CARD (DDC CARD)

Each time the AED is used, an event file is created on the Defibtech Data Card (if installed). If the unit was used to treat a patient, the DDC in the unit should be removed and provided to the patient's care provider. A new DDC should be installed before the next use.

To remove the DDC, first remove the battery pack by pressing the battery pack eject button on the side of the unit. The DDC card is located in a slot directly above the battery pack opening in the unit. To remove the DDC card, press the DDC in all the way and then release. The DDC will be partially ejected and can be removed by pulling it the rest of the way out. To install a new DDC, insert the DDC, label side up, in the thin slot on the top of the opening for the battery pack. The card should click into place and be flush with the surface of the slot. If the card does not push in all the way, it may have been inserted upside down. In that case, remove the card, flip it over and try inserting it again.

Note: A DDC card is not required for the AED to operate. Even if a DDC card is not installed, relevant event information will still be recorded internally. The AED will still operate properly even after a "replace data card" message.

CAUTION	Using non-Defibtech Data Cards (DDC cards) may damage the unit and will void the warranty.

EVENT DATA

As part of Defibtech's on-going regulatory compliance activities, event data shared with Defibtech may be used by Defibtech to fulfill regulatory obligations. Any identifying personal data or health information received is considered confidential within Defibtech and will not be used for any other purpose. Please contact Defibtech at support@defibtech.com should there be any further questions.

CHECKING AED STATUS

ACTIVE STATUS INDICATOR (ASI)

Once a fully-functional battery pack is installed in the AED, an LED indicator located in the corner of the unit actively indicates unit status. If the unit is fully operational, the Active Status Indicator ("ASI") will blink green and if the unit needs attention, the ASI will blink red. When the ASI blinks red, the unit will also "beep" periodically to call attention to itself.

 **ACTIVE STATUS INDICATOR**	• **Off:** Battery pack not installed or the AED is defective. Install a functional battery pack in the AED. • **Steady-on green:** The AED is ON and operating normally. • **Blinking green:** The AED is OFF and ready to operate normally. • **Blinking red:** The AED is OFF and the AED or battery pack needs attention. Refer to "Troubleshooting" on page 20 or call Defibtech for service.

SELF-TESTS

Power-on self-tests are performed every time the unit is turned on to test the basic operation of the unit. The unit also performs daily, weekly, monthly and quarterly self-tests automatically to check the integrity of the unit's hardware and software.

Manually-initiated self-tests may be run at any time by the user to test the AED's systems, including the charging and shocking functions (the shock is internally dissipated and no voltage will be present at the pads).

Note: Every time the manually initiated self-test is run, the unit does an internal shock test. This test reduces the capacity of the battery pack by one shock.

To perform a manual self-test, begin with the unit powered off. Press and hold the ON/OFF button until the unit announces that it is performing a self-test – this should take approximately 5 seconds. Once you hear the announcement, release the ON/OFF button and follow the AED's spoken instructions until the test is complete. The unit will run a series of internal tests, including charge and shock tests. The manually initiated self-test can be aborted by pressing the ON/OFF button again to turn the unit off. When the self-test is complete, the unit will announce its status and power off.

- **If the self-test passes:** The unit will announce: "AED OK" and power off. The unit may then be immediately used by pressing the ON/OFF button again.
- **If the self-test fails:** The unit will announce the symptom. Refer to the "Troubleshooting" section on page 20.

For more detailed information, refer to the User Manual (at www.defibtech.com).

MAINTENANCE

ROUTINE MAINTENANCE

The DDU-100 AED is designed to be very low maintenance. Simple maintenance tasks are recommended to be performed regularly to ensure its readiness (see sample maintenance table below). Different maintenance intervals may be appropriate depending on the environment where the AED is deployed, and ultimately the maintenance program is at the discretion of the emergency response program's medical director.

Daily	Monthly	After Each Use	Action
•	•	•	Check that Active Status Indicator (ASI) is flashing green
	•	•	Check the condition of the unit and accessories
		•	Run manually-initiated self-test
		•	Replace pads
	•		Check pads and battery pack expiration dates
		•	Check the DDC, if one was installed

Note: If the unit has been dropped, mishandled, or abused, a manually-initiated self-test should be performed.

If the unit still requires attention after a manually-initiated self-test has been performed, refer to "Troubleshooting" on page 20 or call Defibtech for service (refer to "Contacts" section on page 30).

CHECKING THE CONDITION OF THE UNIT AND ACCESSORIES

Inspect the unit for cracks or other signs of damage on the case, as well as dirt or contamination, especially in the areas around the connector socket and battery pack opening. If any cracks or other signs of damage are observed, remove the unit from service and contact an authorized service center. If any dirt or contamination is observed, refer to the "Cleaning" section of the full User Manual (available at www.defibtech.com).

It is important that the patient pads and the battery packs not be used past their expiration dates. The expiration date of the pad package is printed on the outside of the sealed package. The expiration date of the battery pack is printed on the label on the pack. The battery pack should be removed and replaced by this date; when the battery pack is used up, the unit will indicate "battery low" or "replace battery now" and the Active Status Indicator will flash red.

Once an accessory is past its expiration date, it should be replaced immediately. Follow the instructions in the "Installing and Removing the Battery Pack" and "How to Connect the Pads" sections of this guide to replace the part with an unexpired part. Patient pads should be discarded. Battery packs should be appropriately recycled.

CLEANING

Periodically clean the AED of any dirt or contaminants on the case and connector socket. The following are important guidelines to be adhered to when cleaning the device:

- The battery pack should be installed when cleaning the AED.
- Do not immerse the AED in fluids or allow fluids to enter the unit. Use a soft cloth to wipe the case clean.
- Do not use abrasive materials or strong solvents such as acetone or acetone-based cleaning agents. The following cleaning agents are recommended for cleaning the AED case and the connector socket:
  - Soapy water
  - Ammonia based cleaners
  - Hydrogen peroxide
  - Isopropyl alcohol (70 percent solution)
  - Chlorine bleach (30 ml/liter water)
- Ensure that the connector socket is completely dry before reinstalling the pads cable. After cleaning the device and before returning it to service, always turn the unit on for a few seconds, which will cause the unit to run a standard power-on self-test.

Please note that none of the items provided with the DDU-100 AED (including the AED itself) are sterile or require sterilization.

⚠ WARNING	Do not sterilize the DDU-100 AED or its accessories.

For more detailed information, refer to the User Manual (at www.defibtech.com).

TROUBLESHOOTING

The following table lists the common causes for problems, the possible cause, and the possible corrective actions. Refer to the User Manual (available at www.defibtech.com) for detailed explanations on how to implement the corrective actions.

To have the unit report what the root cause of the problem is, power the AED on and then power it off by pressing the ON/OFF button for approximately two seconds. While powering off, the unit should issue a voice prompt that details the cause of the problem. Use the chart below to determine the appropriate corrective action based upon what prompt was spoken by the unit.

If the unit continues to be non-functional, call Defibtech for service (refer to the "Contacts" section on page 30).

Symptom	Possible Cause	Corrective Action
Unit will not turn on	Battery pack not inserted	Insert battery pack
	Battery pack depleted or needs servicing	Replace battery pack or call for service
	Unit needs servicing	Call for service
Unit immediately turns off	Battery pack depleted	Replace battery pack
	Unit needs servicing	Call for service
ASI flashes red and/or unit makes periodic "beep" sound	Unit may need servicing	Power unit on and then power off by pressing ON/OFF button for approximately two seconds; note problem indicated by voice prompt and, if necessary, call for service
	Battery pack non-functional	Replace battery pack
	Defibrillation pads are not pre-connected to unit	Connect defibrillation pads to unit
ASI does not flash at all while the unit is in standby (powered off)	Battery pack not inserted	Insert battery pack
	Battery pack is low or needs servicing	Replace battery pack or call for service
	Unit needs servicing	Call for service
"Power on test failed, service code 'xxx'" prompts	Unit needs servicing	Record code number and call for service
"Battery test failed, service code 'xxx'" prompts	Battery pack needs servicing	Record code number and replace with new battery pack
"Service required" prompt	Unit needs servicing	Call for service
"Replace battery now" prompt	Battery pack capacity is critically low	Unit may not deliver a shock, replace battery pack immediately
"Battery low" prompt	Battery pack capacity is getting low	Replace battery pack as soon as possible

Symptom	Possible Cause	Corrective Action
"Unknown battery type" prompt	Battery pack not recommended for use with unit (see top of page 15).	Replace installed battery pack with recommended battery pack
"Pads missing" prompt	Pads not connected	Make sure pads connector is oriented correctly and fully inserted into unit
"Plug in pads connector" prompt	Pads connector not plugged in	Plug in pads connector
	Pads connector broken	Replace pads
	Unit's connector broken	Call for service
"Apply pads to patient's bare chest as shown" prompt	Pads not connected to patient	Place pads on patient
	Pads not making good connection to patient	Check pad connection to patient
	Pads or pad cable damaged	Replace pads
"Poor pad contact to patient", "Press pads firmly", "Replace pads", "Non-rescue pads" or "Warning" prompt	Dry pads	Replace pads
	Partial pad connection	Check that pads are placed securely on patient
	Pads touching	Separate pads and place correctly on patient
	Non-rescue pads (e.g. trainer pads) connected	Replace non-rescue pads with rescue pads
"Check pads" prompt	Pads touching	Separate pads and place correctly on patient
"Stop motion" prompt	Patient motion has been detected	Stop patient motion
"Stop interference" prompt	External interference has been detected	Stop external interference
"Analyzing interrupted" prompt	Motion or interference detected	Stop motion or interference
"Shock cancelled" prompt	Patient's ECG rhythm changed	No action necessary
	Shock button not pushed within 30 seconds	Push shock button within 30 seconds
	Low battery – insufficient to charge	Replace battery pack
	Hardware failure	Run manually initiated Self-Test, return unit for servicing
	Bad pad to patient connection	Check that pads are placed securely on patient
	Dry pads	Replace pads
"Replace data card" prompt	DDC card is full	Replace DDC card with a card that is not full
	DDC has failed	Replace DDC card

For more detailed information, refer to the User Manual (at www.defibtech.com).

WARNINGS AND CAUTIONS

⚠ WARNINGS:

Immediate hazards that will result in serious personal injury or death.

- Hazardous electrical output. This equipment is for use only by qualified personnel.
- Possible fire or explosion. Do not use in the presence of flammable gases or anesthetics. Use care when operating this device close to oxygen sources (such as bag-valve-mask devices or ventilator tubing). Turn off gas source or move source away from patient during defibrillation, if necessary.
- The DDU-100 AED has not been evaluated or approved for use in hazardous locations as defined in the National Electric Code standard. In compliance with IEC classification, the DDU-100 AED is not to be used in the presence of flammable substance/air mixtures.

Conditions, hazards, or unsafe practices that may result in serious personal injury or death.

- Not intended to be used in an environment with high-frequency electrosurgical equipment.
- Improper use can cause injury. Use the DDU-100 AED only as instructed in the User Manual and Operating Guide. The DDU-100 AED delivers electrical energy that can potentially cause death or injury if it is used or discharged improperly.
- Improper maintenance can cause the DDU-100 AED not to function. Maintain the DDU-100 AED only as described in the User Manual and Operating Guide. The AED contains no user-serviceable parts — do not take the unit apart.
- No modification of this equipment is allowed.
- Electrical Shock Hazard. Dangerous high voltages and currents are present. Do not open unit, remove cover (or back), or attempt repair. There are no user serviceable components in the DDU-100 AED. Refer servicing to qualified service personnel.

WARNINGS *(continued)*

- Lithium metal battery packs are not rechargeable. Any attempt to recharge a lithium metal battery pack may result in fire or explosion. Do not attempt to recharge the primary battery pack or lithium 9V battery.
- Do not immerse battery pack in water or other liquids. Immersion in fluids may result in fire or explosion.
- Do not attempt to recharge, short-circuit, puncture, or deform battery. Do not expose battery to temperatures above 50°C (122°F). Remove battery when depleted.
- Do not let fluids get into the DDU-100 AED. Avoid spilling fluids on the AED or its accessories. Spilling fluids into the DDU-100 AED may damage it or cause a fire or shock hazard.
- Do not sterilize the DDU-100 AED or its accessories.
- Use only Defibtech disposable self-adhesive defibrillation pads, battery packs, and other accessories supplied by Defibtech or its authorized distributors. Substitution of non-Defibtech approved accessories may cause the device to perform improperly.
- Do not open sealed pads package until pads are to be used. The packaging should be opened only immediately prior to use, otherwise the pads may dry out and become non-functional.
- Do not touch the patient during defibrillation. Defibrillation current can cause operator or bystander injury.
- Do not allow pads to touch metal objects or equipment in contact with the patient. Do not touch equipment connected to the patient during defibrillation. Disconnect all non-defibrillator proof equipment from the patient before defibrillation to prevent electrical shock hazard and potential damage to that equipment.
- Do not shock with defibrillation pads touching each other. Do not shock with gel surface exposed.

WARNINGS *(continued)*

- Do not allow defibrillation pads to touch each other, or to touch other ECG electrodes, lead wires, dressings, transdermal patches, etc. Such contact can cause electrical arcing and patient skin burns during defibrillation and may divert defibrillating energy away from the heart.
- The defibrillation pads are intended for one-time use only and must be discarded after use. Reuse can lead to potential cross infection, improper performance of the device, inadequate delivery of therapy, and/or injury to the patient or operator.
- Avoid contact between parts of the patient's body and conductive fluids such as water, gel, blood or saline, and metal objects, which may provide unwanted pathways for defibrillating current.
- Aggressive or prolonged CPR to a patient with defibrillation pads attached can cause damage to the pads. Replace the defibrillation pads if they become damaged during use.
- Possible Radio Frequency (RF) interference from RF devices such as cellular phones and two-way radios can cause improper AED operation. Normally using a cell phone near the AED should not cause a problem; however, a distance of 2 meters (6 feet) between RF devices and the DDU-100 AED is recommended.
- CPR during analysis can cause incorrect or delayed diagnosis by the patient analysis system.
- Do not place adult defibrillation pads in the anterior-posterior (front-back) position. A shock or no shock decision may be inappropriately advised. The DDU-100 AED requires that the adult defibrillation pads be placed in the anterior-anterior (front-front) position.
- Some very low amplitude or low frequency VF rhythms may not be interpreted as shockable. Some very low amplitude or low frequency VT rhythms may not be interpreted as shockable.

WARNINGS *(continued)*

- Handling or transporting the patient during ECG analysis can cause incorrect or delayed diagnosis, especially if very low amplitude or low frequency rhythms are present. If the patient is being transported, stop vehicle before beginning ECG analysis.
- In patients with cardiac pacemakers, the DDU-100 AED may have reduced sensitivity and not detect all shockable rhythms. If you know the patient has an implanted pacemaker, do not place electrodes directly over an implanted device.
- During defibrillation, air pockets between the skin and defibrillation pads can cause patient skin burns. To help prevent air pockets, make sure self-adhesive defibrillation pads completely adhere to the skin. Do not use dried out or expired defibrillation pads.
- Defibrillation may cause skin burns around the defibrillation pads area.
- User-initiated and automatic self-tests are designed to assess the DDU-100 AED's readiness for use. However, no degree of testing can assure performance or detect abuse, damage, or a defect that occurred after the most recent test is completed.
- Use of damaged equipment or accessories may cause the device to perform improperly and/or result in injury to the patient or operator.
- In the event the voice prompts cannot be heard for any reason (e.g. noisy environment), follow the LEDs on the front of the AED to complete the rescue.
- It may be possible for the AED to not detect a shockable rhythm, not deliver a shock to a shockable rhythm or not deliver the intended energy during defibrillation.

Warnings continue on next page.

WARNINGS AND CAUTIONS *(continued)*

WARNINGS *(continued)*

- It may be possible that the AED recommends a shock for a non-shockable rhythm, and if a shock is delivered, VF or cardiac arrest may occur.
- Even if defibrillation occurs, the sudden cardiac arrest event may not result in survival.
- Defibrillation may cause myocardial damage or post-shock dysfunction.
- Therapy cannot be delivered while an AED software update is in process.
- Do not turn off the AED or remove the battery pack or the update data card until an AED software update process is complete as these actions may render the AED incapable of delivering therapy. If any of these interruptions occur, restart the update procedure from the beginning.
- Use of this equipment adjacent to or stacked with other equipment should be avoided because it could result in improper operation. If such use is necessary, this equipment and the other equipment should be observed to verify that they are operating normally.

⚠ CAUTIONS:

Conditions, hazards, or unsafe practices that may result in minor personal injury, damage to the DDU-100 AED, or loss of data.

- Follow all battery pack labeling instructions. Do not install battery packs after the expiration date.
- Follow all defibrillation pad label instructions. Use defibrillation pads prior to their expiration date.
- The defibrillation pads should not be in continuous contact with the patient's skin for more than 24 hours.
- Allergic dermatitis or a minor skin rash may result in patients that are sensitive to the materials used for the defibrillation pads. Remove the defibrillation pads from the patient as soon as practical.
- Recycle or dispose of lithium battery packs in accordance with local, state, provincial, and/or national regulations. To avoid fire and explosion hazard, do not burn or incinerate the battery pack. Do not crush.
- Use and store the DDU-100 AED only within the range of environmental conditions specified in the technical specifications.
- If possible, disconnect the DDU-100 AED from the patient prior to use of other defibrillators.
- Using non-Defibtech Data Cards (DDC cards) may damage the unit and will void the warranty.
- DefibView software is not intended for clinical use. Information presented by DefibView should not be used for making clinical decisions.
- Although the DDU-100 AED is designed for a wide variety of field use conditions, rough handling beyond specifications may result in damage to the unit.
- Federal Law (USA) restricts this device to sale by or on the order of a physician.

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APPENDIX C: ZOLL AHA 2010 AED Operator's Guide

Warning!

- Use the AED Plus® unit only as described in this manual. Improper use of the device can cause death or injury.
- DO NOT use or place the AED Plus unit in service until you have read the AED Plus Operator's and Administrator's Guides.
- DO NOT use or place the AED Plus unit in service if the unit's status indicator window (located on the left side of the handle) displays a red "X".
- DO NOT use or place the AED Plus unit in service if the unit emits a beeping tone.

- Connect the electrode cable to the AED Plus unit after installing batteries.
- Keep the electrode cable connected to the AED Plus unit at all times.
- This device should only be used by properly trained individuals.
- Only use electrodes labeled "Infant/Child" on children less than 8 years old or weighing less than 55 lbs (25 kg). Use ***CPR-D•padz***® if patient is older than 8 years or weighs more than 55 lbs (25 kg).
- Always stand clear of patient when delivering treatment. Defibrillation energy delivered to the patient may be conducted through the patient's body and cause a lethal shock to those touching the patient.
- DO NOT touch the electrode surfaces, the patient, or any conductive material touching the patient during ECG analysis or defibrillation.
- Move patient away from electrically conductive surfaces prior to use of equipment.
- DO NOT use the unit near or within puddles of water.
- Keep the patient as motionless as possible during ECG analysis.
- DO NOT use the unit near flammable agents, such as gasoline, oxygen-rich atmospheres, or flammable anesthetics.
- Avoid radio frequency interference from high-power sources that might cause the defibrillator to interpret cardiac rhythms incorrectly by turning off cell phones and 2-way radios.
- Disconnect non-defibrillation protected electronic devices or equipment from patient before defibrillation.
- Dry victim's chest, if wet, before attaching electrodes.
- Apply freshly opened and undamaged electrodes, within the electrode expiration date, to clean and dry skin to minimize burning.
- DO NOT place electrodes directly over the patient's implanted pacemaker. Pacemaker stimuli may degrade the accuracy of ECG rhythm analyses or the pacemaker may be damaged by defibrillator discharges.
- Check labeling inside the ZOLL® AED Plus cover before using the cover as a Passive Airway Support System (PASS) device to ensure it is intended for this use.
- DO NOT use the Passive Airway Support System (PASS) if there is a suspected head or neck injury. Place the patient on a firm surface before performing CPR.
- DO NOT recharge, disassemble, or dispose of batteries in fire. Batteries may explode if mistreated.
- DO NOT use or stack the AED Plus unit with other equipment. If the unit is used or stacked with other equipment, verify proper operation prior to use.

Caution!

- DO NOT disassemble the unit. A shock hazard exists. Refer all servicing to qualified personnel.
- Use only commercially available type 123A lithium manganese dioxide batteries. Discard batteries properly after removal from unit. Use only batteries from recommended manufacturers. See the AED Plus Administrator's Guide (P/N 9650-0301-01) for a list of recommended battery manufacturers.
- If the device is stored outside the recommended environmental conditions, the electrode pads and/or batteries may be damaged or their useful life reduced.
- The ***CPR-D•padz*** Electrode can be connected to other ZOLL defibrillators with Multifunction Cables. Defibrillation can be administered when connected to other ZOLL defibrillators.The CPR function does not operate with any device other than the AED Plus defibrillator.

Important!

This symbol indicates that an AED Plus unit is equipped for treating adult and pediatric patients. An AED Plus unit without this symbol is not equipped to treat pediatric patients and will NOT work with ***pedi•padz® II*** pediatric electrodes. To upgrade an AED Plus unit for use with ZOLL ***pedi•padz II*** pediatric electrodes, contact ZOLL Medical Corporation or an authorized ZOLL distributor for information on the ZOLL AED Plus Pediatric Upgrade Kit.

Set-up and Check-out Procedure:

1. Insert 10 new batteries into AED Plus unit.
2. Connect electrode cable to AED Plus unit and pack sealed electrodes inside unit cover. Close cover.
3. Turn unit on and wait for "Unit OK" audio message. Verify that unit issues appropriate "Adult Pads" or "Pediatric Pads" audio message.
4. Turn unit off.
5. Wait 2 minutes. Verify that green check symbol (✔) appears in status indicator window (located on left side of handle) and that unit does not emit a beeping tone.
6. Place AED Plus unit in service.
7. Check AED Plus unit periodically to ensure that green check symbol (✔) appears in status indicator window.

Battery Replacement

For AED Plus units running software version 5.32 or higher, replace batteries every 5 years or if unit prompts. For earlier software versions, replace batteries every 3 years and place a dated AED Plus battery replacement reminder label next to the On/Off button. These labels are available from ZOLL Customer Service. Use only type 123A lithium manganese dioxide batteries from recommended manufacturers.

- Remove all batteries from battery compartment and discard before installing any new batteries.
- Insert 10 new batteries into battery well. Do not use old batteries.
- Press button in battery well only after installation of new batteries.

Cleaning

- Clean and disinfect unit with soft, damp cloth using 90% isopropyl alcohol or soap and water, or chlorine bleach (30 ml/liter water).
- Do not immerse any part of the unit in water.
- Do not use ketones (MEK, acetone, etc.).
- Avoid using abrasives (e.g., paper towels) on the LCD display, if so equipped.
- Do not sterilize the unit.

TROUBLESHOOTING

Problem	Recommended Action
Self-test failed.	Manually test by pressing and holding the ON/OFF button for more than 5 seconds. If unit fails test again, remove from service.
"Change batteries" prompt.	Replace all batteries at the same time.
Red "X" in Status Indicator window OR beeping noise when unit is OFF.	Perform manual test. Check to see if cable is attached properly to unit. Replace batteries. If unit still does not operate correctly, remove from service.
Red "X" in Status Indicator window when unit is ON.	Power cycle the unit. If Red "X" is still present in Status Indicator window, remove unit from service.

Federal (U.S.A.) law restricts this device for sale to or on the order of a physician.

AED Plus®

Automated External Defibrillator

Operator's Guide

AHA 2010

ZOLL®

For Technical support or repair:

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International Service:
Contact your local distributor.

CE 0123

REF 9650-0300-01 Rev. P

The Edward S. Rogers Sr. Department of Electrical & Computer Engineering
UNIVERSITY OF TORONTO

INDICATIONS FOR USE

Use the AED when a suspected cardiac arrest victim has an apparent LACK OF CIRCULATION indicated by:

- Unconsciousness and
- Absence of normal breathing and
- Absence of a pulse or signs of circulation.

When a victim is less than 8 years of age, or weighs less than 55 lbs (25 kg), the ZOLL AED Plus should be used with ZOLL AED Plus Pediatric Electrodes. Therapy should not be delayed to determine the patient's exact age or weight.

CONTRAINDICATIONS FOR USE

Do NOT use when a patient:

- Is conscious; or
- Is breathing; or
- Has a detectable pulse or other signs of circulation.

INTENDED USER

The ZOLL AED Plus external defibrillator is intended to be used by personnel who are qualified by training in the use of the AED Plus device and basic life support, advanced life support, or other physician-authorized emergency medical response to defibrillate victims of cardiac arrest. The CPR monitoring function provides a metronome designed to encourage rescuers to perform chest compressions at the AHA recommended rate of 100 compressions per minute. Voice and visual prompts encourage a minimum compression depth of 2 inches for adult patients. The CPR monitoring function is not intended for use on patients under 8 years of age.

ZOLL®

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APPENDIX D: Understanding Electrical Hazards

Electrical shock is a result of electrical current flowing through the body. In general, there are three contributing factors that determine the severity of the electrical shock:

1. ***The path and the amplitude of the current through the body,***
2. ***The amount of time that current flows through the body, and***
3. ***The frequency of the current that flows through the body.***

1.1 Current path and amplitude

The path that current takes through the subject's body determines the lethality of the electrical shock. It is more dangerous if the current flows through the heart muscle and lungs.

There are two ways that the electrical current can flow through human body:

- Resistive coupling in which the human body acts as a resistor.
- Capacitive coupling where the human body acts as a capacitor.

1.1.1 Resistive Coupling

In the case of resistive coupling, to close the current path a person will have to be in contact with at least two points in the live circuit. The second point of contact, however, could be the ground the subject is standing on, or any conductive element (such as a pole, or panel, etc.) which he or she is touching. *The path that current takes, and the resistance of that path, determines how much current would be generated*. Of course, the current always take the path of least resistance. The amplitude of this current is one of the main factors determining the severity of the electrical shock.

Floating power supplies (batteries or power supplies with an isolating transformer) provide current that does not seek to return current via ground, but some current may flow from stray capacitive coupling. However, the voltage sources in this lab are **not isolated**; therefore, even a single point of contact to any elements fed by these power supplies potentially completes a current path via ground.

It is estimated that a healthy, dry human body with no skin cuts can exhibit around 100,000 Ohms of resistance. This value drops rapidly if the skin is damaged or moist (down to 1,000 Ohms) or the voltage exceeds the skin puncture level of 25-50V. The resistance of the internal organs, however, is much lower at around 300-1000 Ohms. Figure 1, below, depicts the resistance model of the internal organs. As can be seen, the human body can be modelled as a resistive network with different terminals. The total resistance at low voltage is mainly present on the outer layer of the skin: the dead and dry layer of cells covering the body.

The current flowing through the human body follows Ohm's law and can be found as:

$$I = \frac{V}{R}$$

The electric shock hazard depends on the current, not the voltage. It is the amount of charge moved through the body, and the duration of charge displacement, which causes shock. Nevertheless, as Ohm's law suggests, this current is dependent on both the source voltage and the path (resistances) through the body. Therefore, a certain voltage can cause shocks with different levels of severity when applied across different parts of the body because the current that flows through the resistances of each path are different.

Body Part	Resistance
Dry Skin (no cuts or scabs)	Over 100,000 Ohms
Wet Skin	1,000 Ohms
Within the Body	500 Ohms
Ear to Ear	100 Ohms

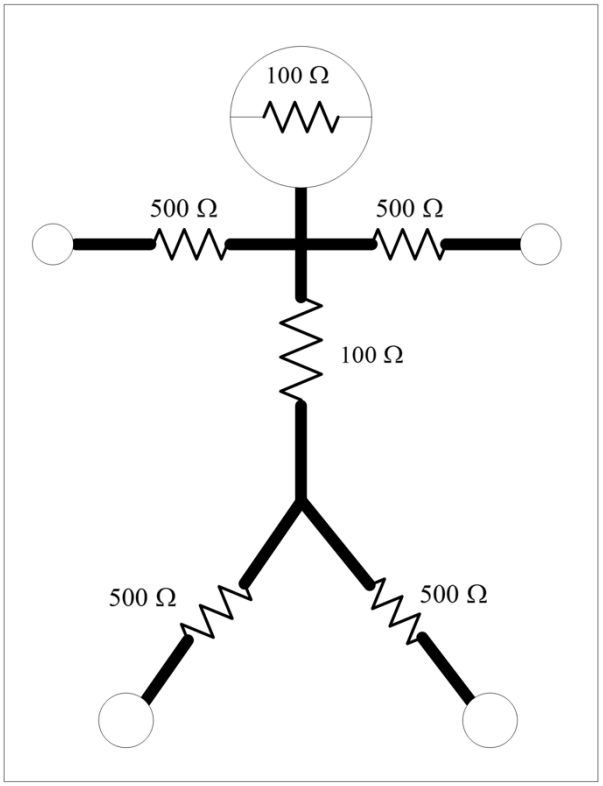

Figure 4. Human Body Resistance Model

Table 1 and Figure 5 show the harmful physiological effects of different amounts of electrical current on a human body for the duration of one second. As can be seen, the effects of electrical shock depend on the current amplitude. A certain amount of current, e.g., 5 mA, can be caused by a wide voltage range, from 5-500 V. This depends on the fact that the skin in the current path is dry and not damaged. **This is one of the reasons why liquids are prohibited to be brought to the lab**.

Humans can perceive currents as low as 1mA. A current of about 3 mA DC flows when testing a fresh 9V battery for a smoke detector across soft tissue, such as a tongue. The maximum harmless current is 5 mA. However, at current levels where a shock does no direct physiological harm, there are still possibilities of inflicting indirect injuries. The shocked individual may react voluntarily or involuntary by muscle contraction. In moving away, possibly very rapidly and by reflex action

without thinking, he or she can fall over backwards, bang against a nearby chair or workbench, or just hurt their hand against the chassis of the item they are working on.

Current levels between 10 and 20 mA (depending on the body mass and gender), determine the "**let-go threshold**" current. Beyond that, the muscles are contracted, and the subject can't release the conductor. Above this limit, involuntary clasping of the conductor is present. This results in longer duration of electrical current flow through the subject's body. The severity of the electrical shock depends on the duration of the current flow. The fact that the subject can't disconnect from the live voltage increases the time that current flows through the body and therefore multiplies the severity of the shock. Moreover, as the grip tightens, resistance reduces and the increased current may burn through the subject's skin, leaving only the internal body resistance with dramatically increased current amplitude.

AC-line frequency currents larger than 30mA can cause ventricular fibrillation if it flows through the subject's upper body. The heart itself produces a dipole current of about 2.5 mA, as shown in Figure 6, and any external current of this magnitude can interfere with the normal heart rhythm. As can be seen from Table 1, ventricular fibrillation caused by a sustained 100 mA AC current can be fatal. For greater currents, besides the effects on the subject's heart and respiratory system, the tissues may burn because of the extensive heating of the tissues.

Table.1 Shock Physiological Effects *(For 1 second contact of AC source 60Hz)*

Electric Current	Physiological Effect	Voltage required to produce the current with assumed body resistance: 100,000 Ohms Dry Skin	1000 Ohms Wet Skin
1 mA	Threshold of feeling, tingling sensation	100 V	1 V
5 mA	Accepted as maximum harmless current	500 V	5 V
10-20 mA	Beginning of sustained muscular contraction ("Can't let go" current)	1,000 V	10 V
100-300 mA	Ventricular fibrillation, fatal if continued. Respiratory function continues	10,000 V	100 V
6 A	Sustained ventricular contraction followed by normal heart rhythm (defibrillation). Temporary respiratory paralysis and possibly burns	600,000 V	6,000 V

Source: Georgia State University website

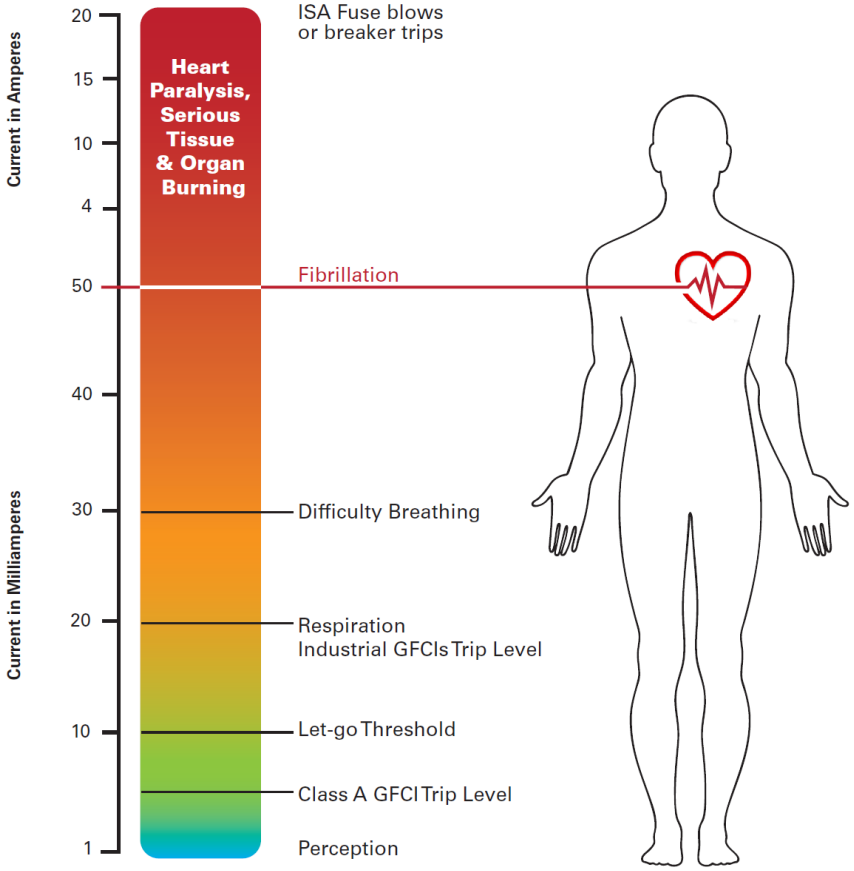

Figure 5. Current Flow Effect in Human Body

1.1.2 Capacitive Coupling

Another interesting point to consider is that beyond acting like a resistor, the epidermis acts like a capacitor. In addition to greater current flow, high voltages (over about 600 volts) may cause dielectric breakdown at the skin, thus lowering skin resistance and allowing further increased current flow. This becomes very important in the case of working with high voltages. It also becomes extremely important to consider the danger from stored energy in filter capacitors. This danger persists even if equipment has been disconnected from the supply and is only mitigated when a ground strap or crowbar has been applied across the capacitor terminals. **All capacitors should be considered charged and potentially deadly if a voltage tester has not been used to prove that no voltage is present.**

The expression for ventricular fibrillation charge is:

$$Q\,(\text{mC}) = 13.38 \times V^{-0.354}$$ *(V is in volts, Q in millicoulombs)*

Using the expression $\boldsymbol{Q = CV}$, we develop a list of capacitors that can be lethal if discharged through the body:

Capacitance (μF)	26	10	6	3	1.2	0.45	0.13
Voltage (V)	100	200	300	500	1,000	2,000	5,000

This means that nearly all energy storage and filter capacitors in the Energy Systems Laboratory should be treated as live, and discharged as a part of the safety process, after isolating apparatus from the supply and before making adjustments.

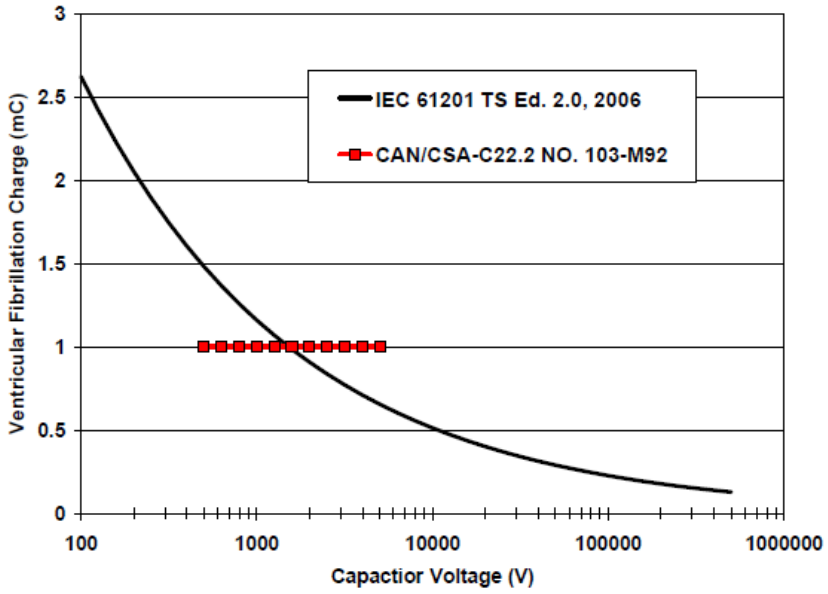

Figure 6. Capacitor Charge that causes Ventricular Fibrillation (IEC 61201) compared to 1 mC standard for Electric Fences in CAN/CSA C22.2

1.2 Time

In order to understand the effect of the time duration on a body that is exposed to an electrical shock, we should revisit the relation between electrical energy, current and voltage:

$$\boldsymbol{E = I^2 . R . t}$$

That is, if a body is exposed for a long time to even a small amount of current, the energy produced can cause burn and blister to the contact area, which results in lower resistance path and higher current, and thereby increased shock level. Duration, then, affects the intensity and severity of electrical shock.

According to IEEE Std. 80, you can determine the maximum safe shock duration for a 50-kg and 70-kg person for an AC system by the following formulas:

For 50 kg weight	***For 70 kg weight***
$t = \left(\frac{0.116}{(V/R)} \right)^2$	$t = \left(\frac{0.157}{(V/R)} \right)^2$

Where "t" is duration in seconds, "V" is the AC voltage in volts, and "R" is resistance of the person. Assume 1,000 Ohms, lowest human body resistance (see Fig. 1), the following table shows the maximum safe time duration for a 50 and 70 kg person.

	For 50 kg weight	***For 70 kg weight***
120 V	$t = 0.934\ sec$	$t = 1.71\ sec$
277 V	$t = 0.175\ sec$	$t = 0.321\ sec$

1.3. Frequency

Currents of the same amplitude with different frequencies have different levels of electrical shock severity. The power supplies in the lab are either DC (0 Hz) or power line frequency AC, i.e., 60 Hz. Both AC and DC currents can cause fibrillation of the heart at high enough levels. This typically takes place at ***30 mA of AC 60 Hz*** or ***300-500 mA of DC***. Though both AC and DC currents and shock are lethal, more DC current is required to have the same effect as AC current. For example, for a person to be electrically shocked, 0.5 to 1.5 milliamps of AC 60 Hz current, and up to 4 mA of DC current is required. For the let-go threshold in AC, a current of 3 to 22 mA is required against 15 to 88mA of DC current.

Table 2 demonstrates the hazard threshold for different electrical sources. Power line frequency 50 Hz/60 Hz and the frequency range of 1-3 kHz are the most harmful frequencies for human body. The switching frequency of the converters in the lab are usually 1 kHz. ***This means the converter output nodes contain voltages at this frequency and therefore they are hazardous to touch.***

Moreover, in the lab setup there is a large capacitor (4,800 μF) on the DC-link usually charged up to 115 V. This capacitor contains around 30 J of energy. This amount of energy is much larger than the hazard threshold for a capacitor (>1 J) according to Table 2.

Table 2. Electrical Hazard Thresholds

Source	**Includes**	**Thresholds**
AC	50-60 Hz nominal	≥ 50 V and ≥ 5 mA
DC	All	≥ 100 V and ≥ 40 mA
Capacitors	All	≥ 100 V and ≥ 1 J, or ≥ 400 V and ≥ 0.25 J
Batteries	All	≥ 100 V
Sub-RF	1 Hz to 3 kHz	≥ 50 V and ≥ 5 mA
RF	3 kHz to 100 MHz	A

Source: Environment, Health and Safety (EH&S) Division of Lawrence Berkeley National Laboratory, http://electricalsafety.lbl.gov/resources/field-program-guides/

Acknowledgement:

This document is designed to address the most critical guidelines and procedures to maintain a safe environment in the undergraduate teaching laboratories of Department of Electrical & Computer Engineering and, therefore, it may change from time to time. It also includes emergency procedures which deal with both electrical and fire accidents, as well as when a call to 911 is required.
Energy Systems Group, Microwave and Photonics labs either follow their own policy document or complement this document with specific guidelines for their activities.

If you have any suggestions or questions, please contact:
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