How can a user hurt themselves? How can a user hurt the tool?

A qualified user should be able to:
- Identify personal safety hazards associated with the tool and what precautions are taken to prevent an accident from occurring.
- Identify hazards to the tool and what precautions are taken to prevent an accident from occurring.
- Operate the tool safely and proficiently.
- Recover from simple errors.
- Demonstrate knowledge of the processes performed with the tool.

### BRUCE FURNACE

#### Personal Safety Hazards
- **High temperatures** – Temperatures of up to 1100 °C are used in the Bruce furnace tubes. Potential exists for severe burns if a user comes in contact with hot equipment. No part of the tube should be touched when above room temperature. When loading and unloading wafers in a hot tube, use a boat fork to place wafers on the cantilever. Allow hot wafers to cool before use.
- **Compressed gases** – The Bruce furnace uses several compressed gases: oxygen, hydrogen, nitrogen, argon, and forming gas (H₂N₂). Do not attempt to defeat protective interlock systems. If a malfunction of any sort is suspected, a SMFL staff member should be contacted immediately. Users should have read and be familiar with material safety data sheets for all gases.
  - Hydrogen is an immediate explosion hazard (lower explosive limit = 4%; autoignition temp = 565 °C; hydrogen burns with an invisible flame) and an acute health hazard (inhalation can lead to asphyxiation without warning).

#### Hazards to the Tool
- **Cross Contamination** – It is imperative that the Bruce tubes not become cross-contaminated by wafers or by boats. Failure to do so may ruin wafers and the tubes. Each tube is dedicated for specific processes:
  - Tube 1 – Wet Oxides
  - Tube 2 – P-type dopants
  - Tube 3 – N-type dopants
  - Tube 4 – Gate/Dry oxides
  Each tube also has a dedicated 4” boat and a dedicated 6” boat.
- No resist or metals are allowed in any tube in the Bruce Furnace.
• **Operating Tool**
  o Users should be able to:
    ▪ Load and unload wafers safely.
    ▪ Load, end and abort a recipe.
    ▪ Execute a furnace run.
    ▪ Acknowledge inhibits.
    ▪ Use the Graphical Analyzer to follow process parameters
    ▪ FILL OUT LOG SHEETS CORRECTLY!
    ▪ Store boats correctly.
  o Reservations – If not present at stated start time, tool is reserved for 15 minutes and is then considered open for general use.

• **Simple Errors**
  o Inhibits
  o Failure to turn on gases
  o **Profile Temp Incoherent** – Follow directions in back of operation manual to clear the thermocouple table

• **Processes**
  o A qualified user should be familiar with:
    ▪ Warm-up recipe and typical recipe steps.
    ▪ Typical gas flows, times, temperatures associated with recipes.
    ▪ Which process is dedicated to which tube

• **Appropriate Uses of the Tool**
  o Each tube is labeled to show its appropriate use. Make sure that you have the correct process in the correct tube.
  o Never process metals or photoresist in the Bruce Furnaces.