Team Gas Sensor NO_2: Primary Discussion Points

- Assumptions
  - Polyaniline and hydroxylated SHOULD interact with NOx
    - Degree of interaction corresponds to magnitude of resistive changes
  - Vapor functionalization post-processing
  - Device will be conductive
  - Customers
    - Airports, highways, power generation plants, IoT?
    - Bluetooth connectivity, battery operated
    - Mapping NO_2 levels throughout a city

Team Gas Sensor NO_2: Primary Discussion Points

- Factors impacting the reproducibility of the manufacturing method and final product
  - Dynamic range will be limited and needs to be tested
  - A lot of variability with drop-cast tubes
    - Variability in the tubes used in the process
    - Baseline measurement of resistance is required for each sensor
  - To reduce drift, keep the sensor above ambient high temp (also reduces Temp dependency)
- Factors to consider when choosing materials (e.g., cost, purity, source)
  - Quality control on CNTs is terrible
  - May need to remove surfactants, metal impurities, etc.
  - Polyaniline is very toxic
- The plan for testing, including field/test conditions, regulatory requirements, scope, etc.
  - Need to calibrate sensor
  - You can purchase a calibrated gas standard for NO_2, but need to worry about potential interferences (particulates, other chemicals)
  - Very important to do field tests to avoid ants, eagles or any other unexpected visitors

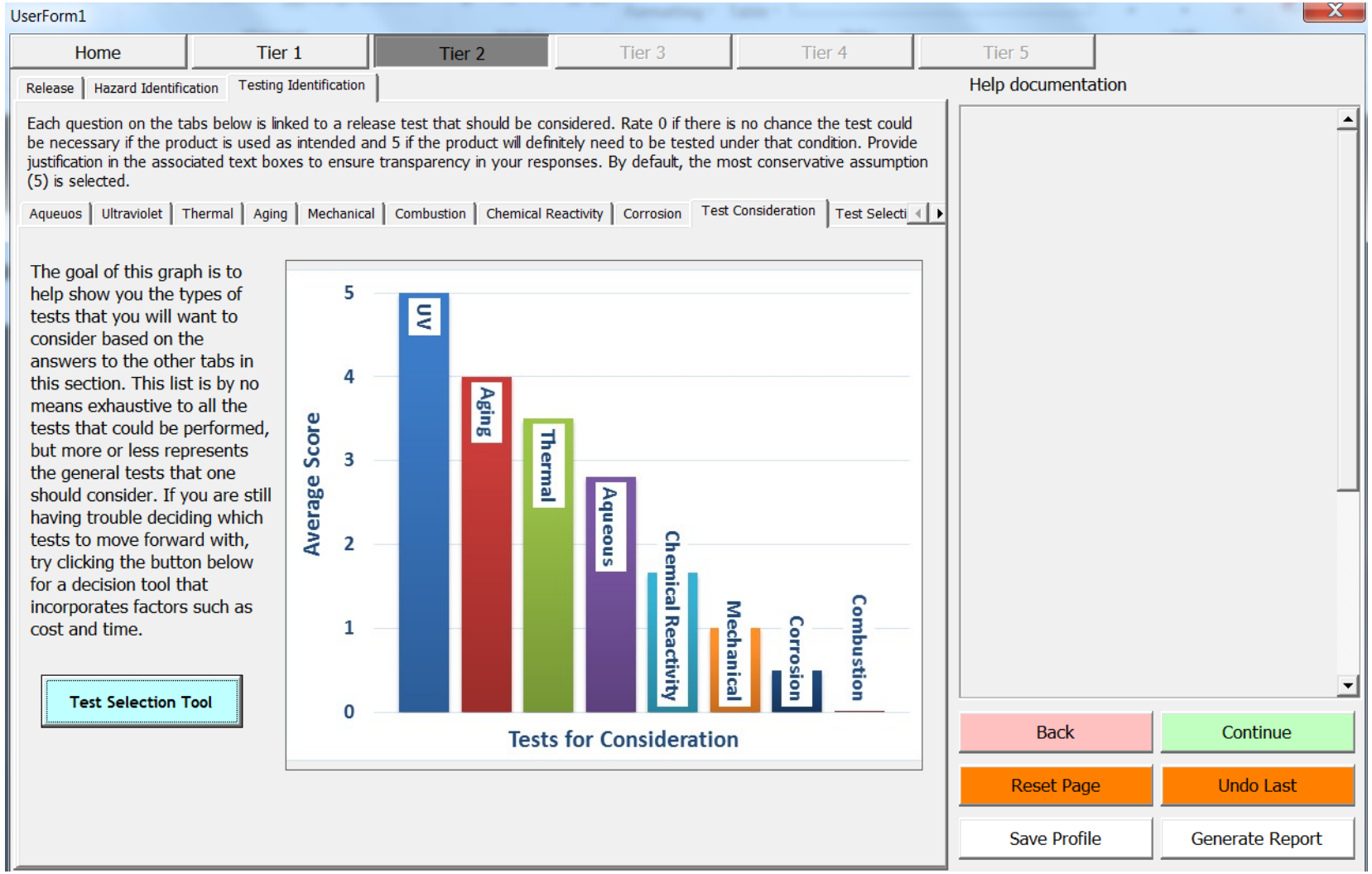
Team Gas Sensor NO2 : Other Considerations (1 of 2)

- Factors impacting the scalability of the manufacturing method
  - Drop-cast method should be highly scalable, roll to roll could be used
  - Needs to be modified to speed up manufacturing process – mass produced
- Limitations in terms of raw materials and processing technologies
  - NOx does not selectively interact with many CNTs
- Manufacturing cost drivers for this technology
  - Seems to be pretty reasonable
- Remaining technical issues hindering commercialization of this technology
  - Need to include a front-end filter to keep particles out of the sensor
  - Design includes a fan and heater, paper says it could be removed
  - No heater means it is a one-time measurement
    - But heater would also remove organics (eventually NO2!) and humidity
  - Sampling height?

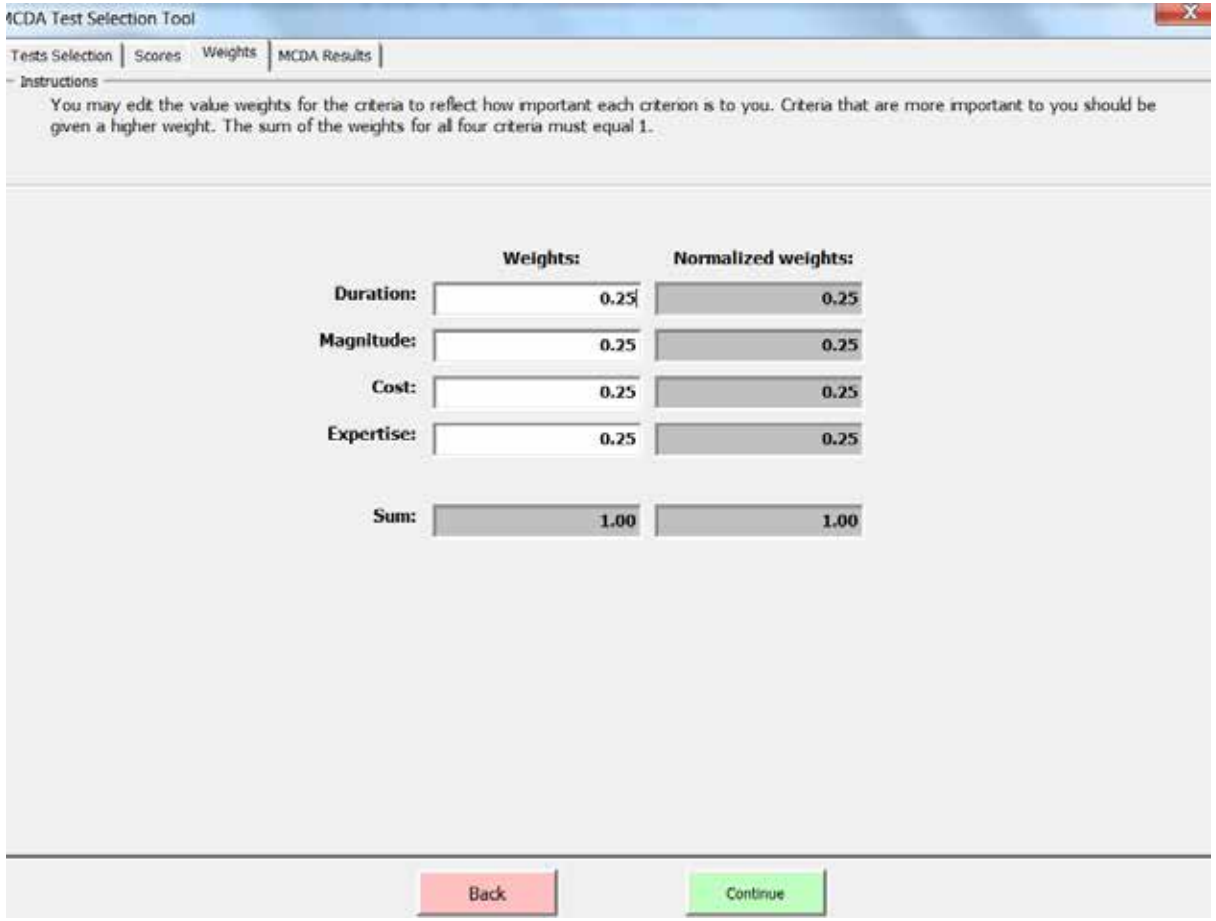
Team Gas Sensor NO2 : Other Considerations (1 of 2)

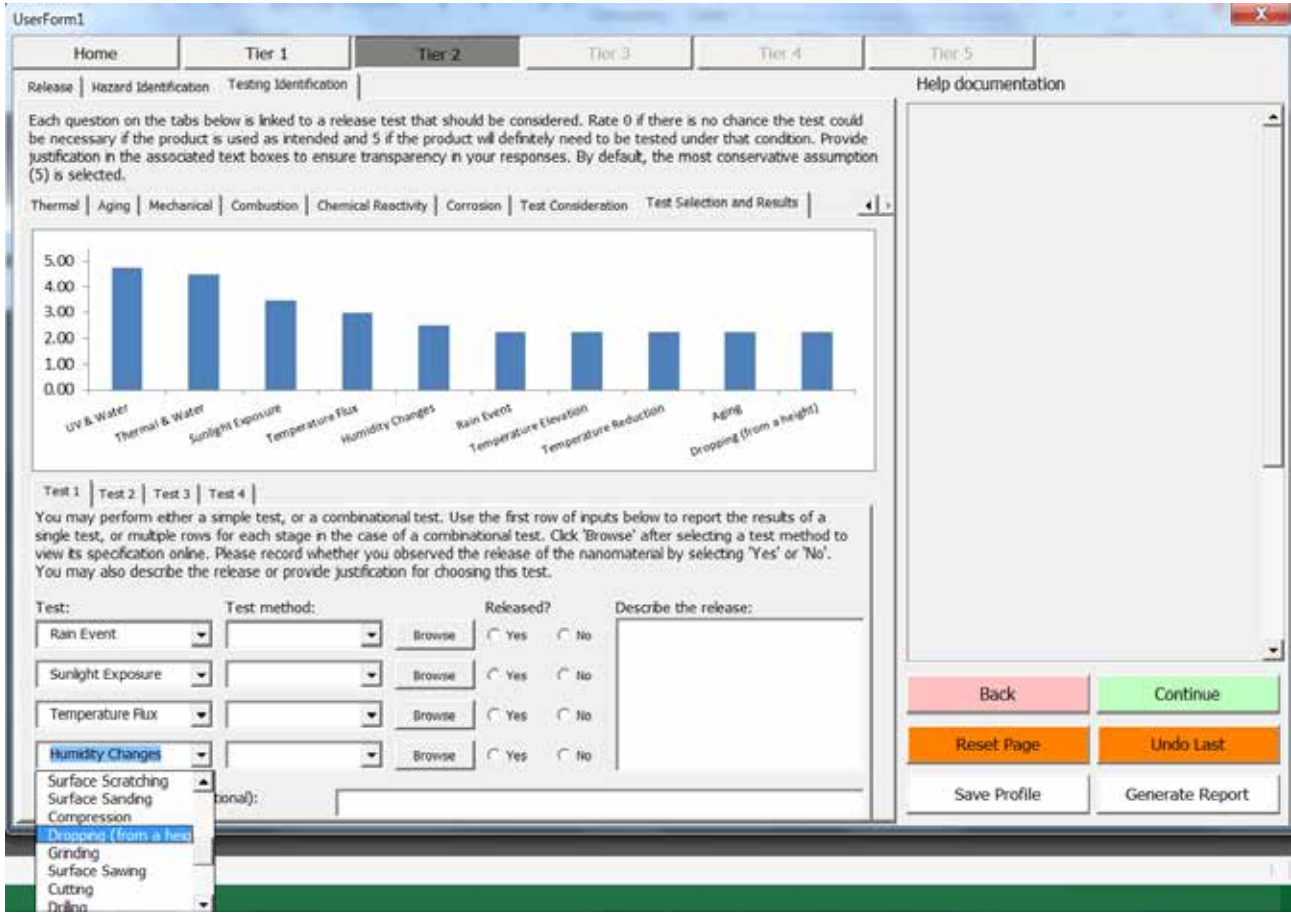
- Factors that will influence the decision to manufacture in-house vs. contracting out
  - In-house manufacture is not sustainable
  - 120 um gap can be screen printed to speed up production, combined with roll to roll
- Life cycle considerations (e.g., device or effluent disposal)
  - Are we assuming the sensor is stable? Even with humidity and other contaminants
- Major safety concerns for manufacturing the sensor
  - CNTs dried during manufacture is a concern
  - Aniline is a concern
  - Durability during rain, acid rain, UV exposure, thermal gradients
- Other (please specify)
  - Wildlife interference?

Test selection for durability (aqueous due to rain events)



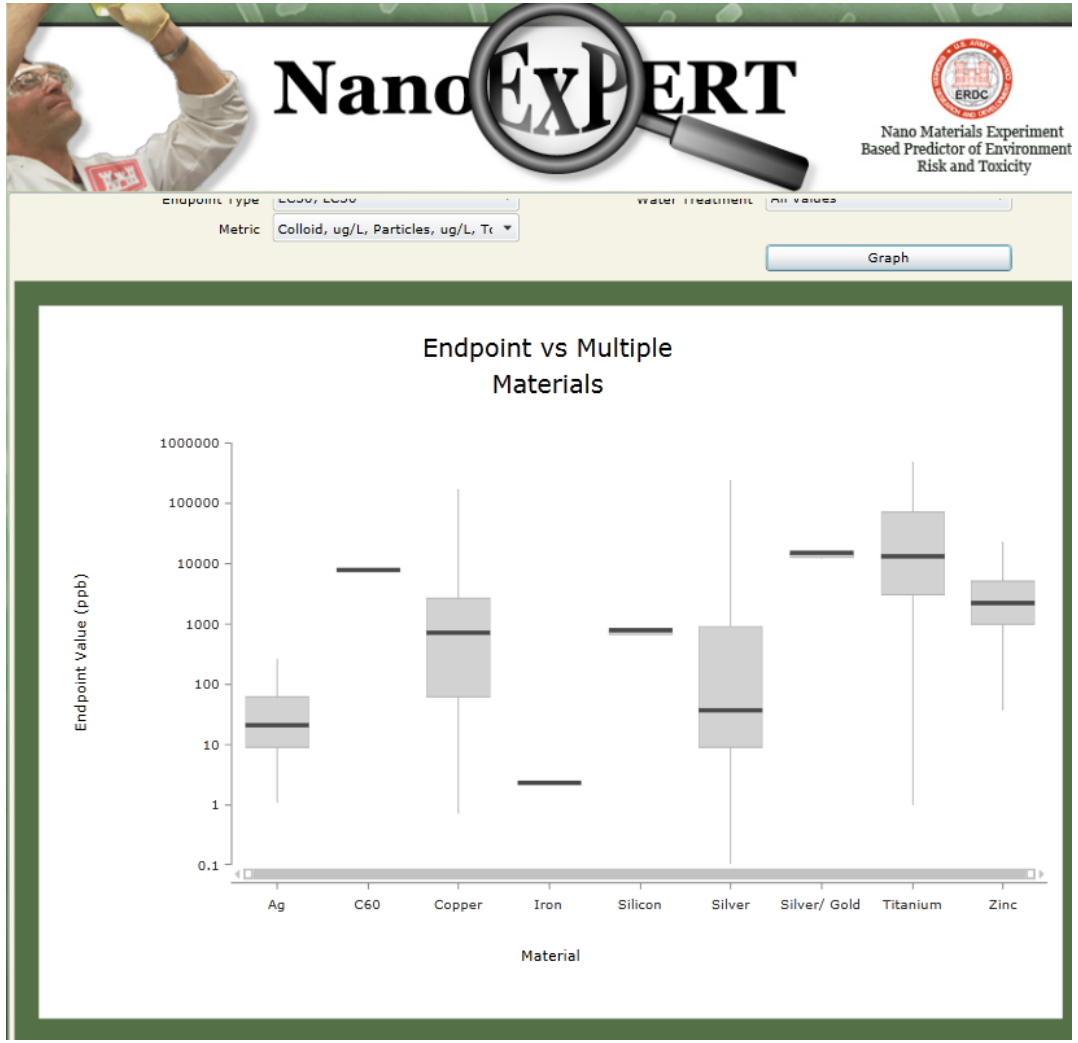
MCDA combinational testing output





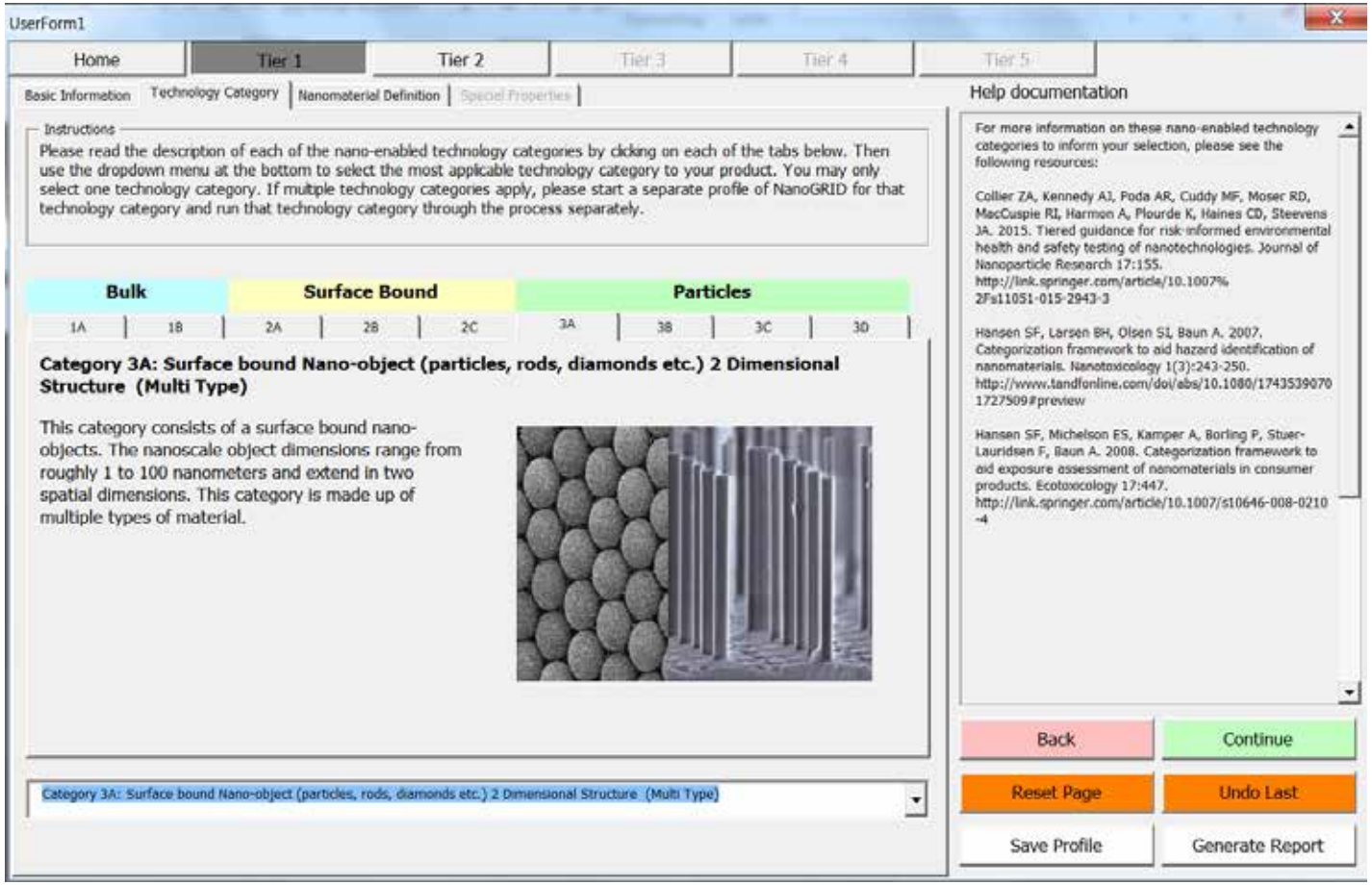
Tiers 2/4: CNTs low environmental hazard; large occupational hazard concern during manufacturing depending on “dustiness” level

aniline is hazardous (non-nano-concern)

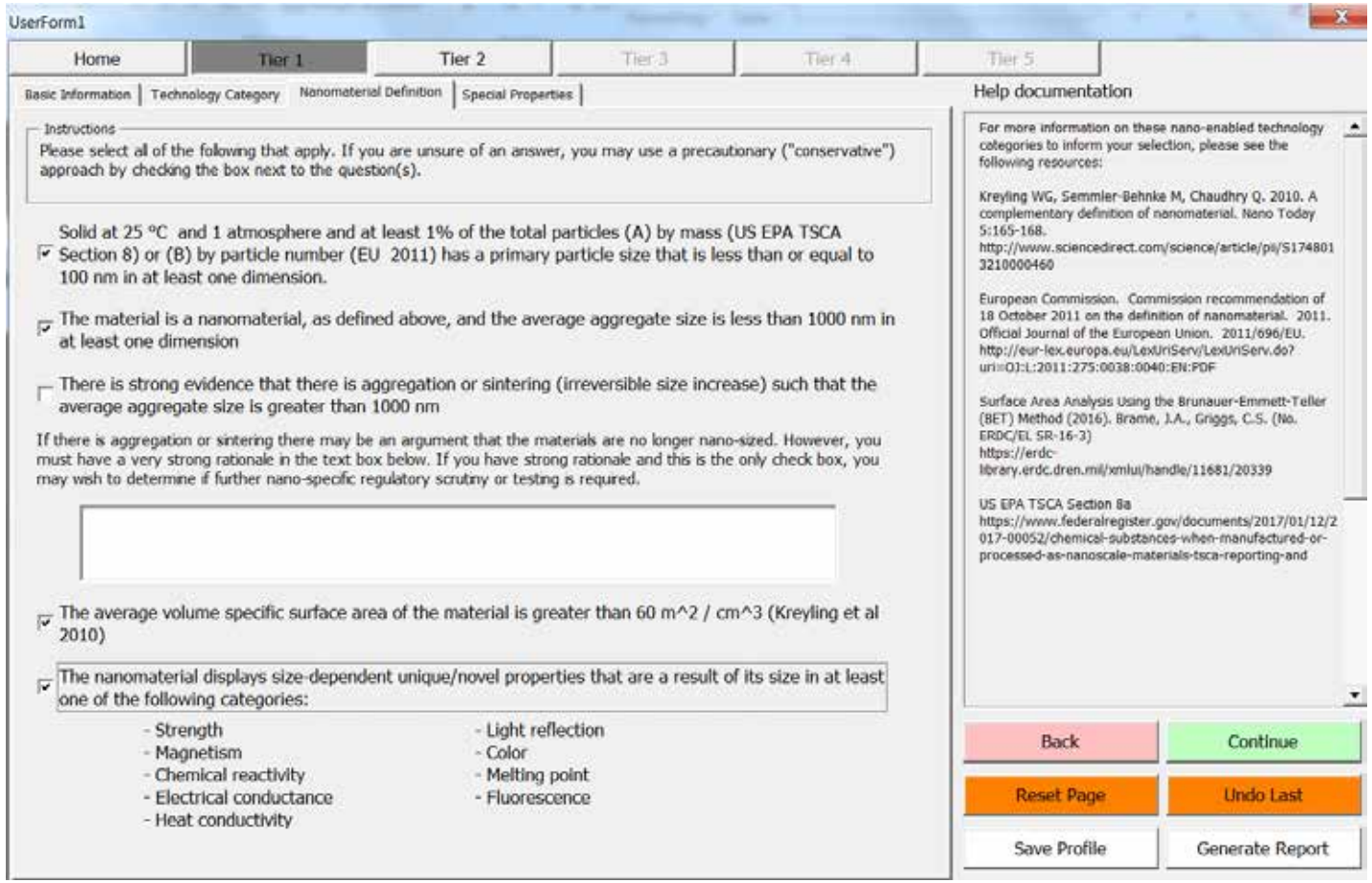


Gas sensor to measure NO_2 in air

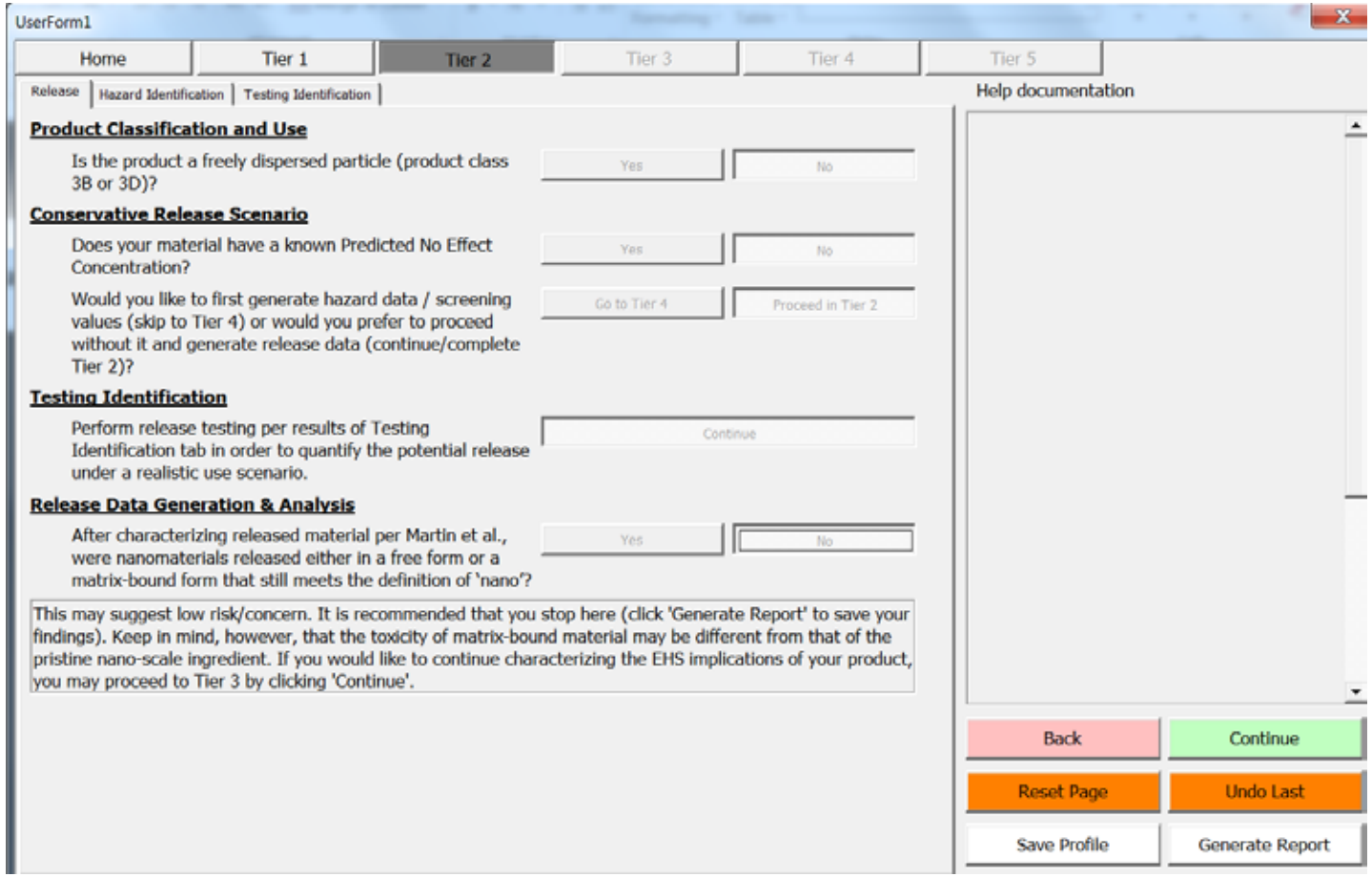
Use of nano-enabled technology structure category cannot be excluded from regulatory testing



Use of nanoparticle cannot be excluded from regulatory testing



Perform tests: Low release potential?



Hazard values entered for demonstration purposes: need to consider CNT dustiness, worker inhalation risk during manufacturing (while material is dry)