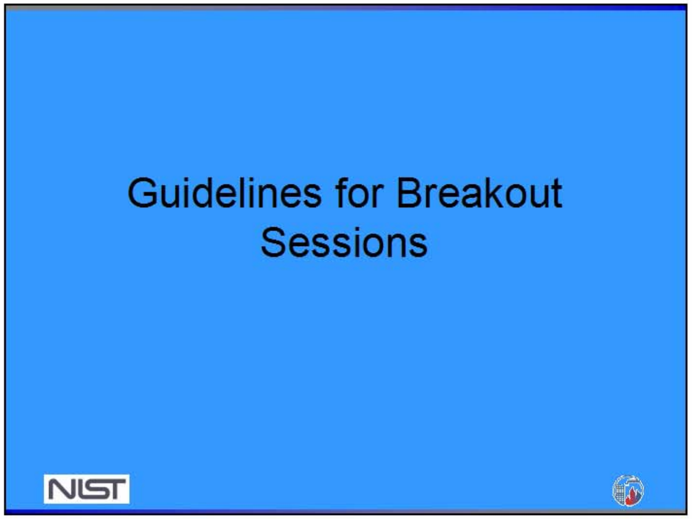
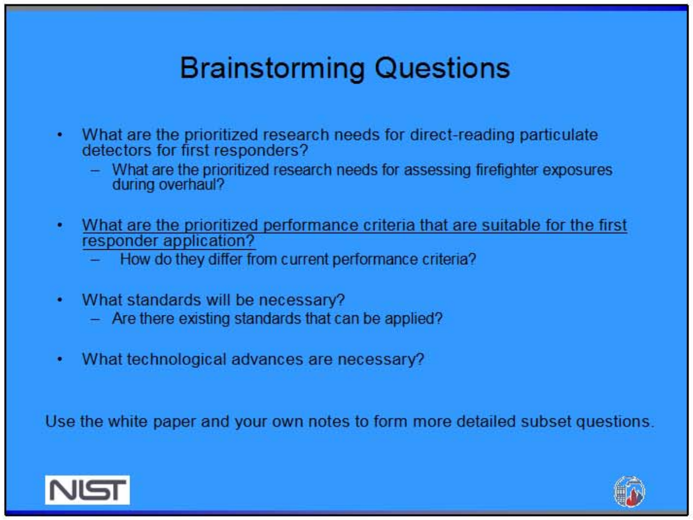
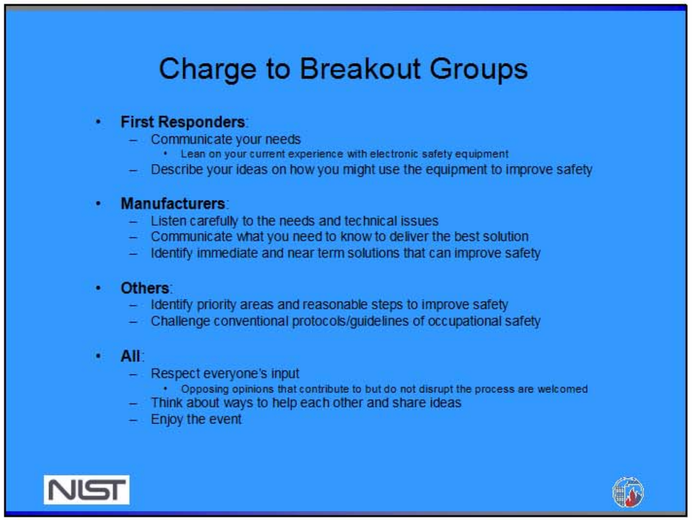
APPENDIX 3.J – Guidelines for Breakout Sessions

Rodney Bryant, Building and Fire Research Laboratory, NIST







APPENDIX 4 –BREAKOUT GROUP DISCUSSIONS

The tables in this appendix present the results from the brainstorming sessions of each breakout group. The groups were asked to respond to the following list of questions:

- What are the prioritized research needs for direct-reading particulate detectors for first responders?
  - What are the prioritized research needs for assessing firefighter exposures during overhaul?
- What are the prioritized performance criteria that are suitable for the first responder application?
  - How do they differ from current performance criteria?
- What standards will be necessary?
- What technological advances are necessary?

These questions are categorized in the tables as Research Needs, Performance Criteria, Standards, and Technological Advances.

The next task after brainstorming was for each group to determine and rank their top five priorities in each category. In two groups (2-Blue and 3-Green), each participant was asked to vote on their top five choices. From these votes, further discussion identified and ranked the top five priorities for the group. In one group (1-Red), consensus to identify the top five priorities was achieved through open discussion but rankings were not assigned. During the discussion of the top five priorities, each group discovered commonalities among the responses that allowed multiple responses to be combined. The responses are listed in Tables 6 through 8, with the top five priorities listed first.

Table 6. Group 1 (Red) – Paul Greenberg, facilitator

Research Needs	Performance Criteria
1) More comprehensive data on particle environment associated with real overhaul environments, including particle size distribution (PSD), number density, composition, other moments; statistical sufficiency (local vs global micro-environment); scenarios (wildland vs residential, vehicular, dumpster, vegetative, industrial) 2) Enhanced understanding of dosimetry metrics: distinguish between acute/chronic exposure, toxicity correlations with other environmental factors (are particulates a suitable proxy for toxicity assessment?), human/animal testing, leverage off existing environmental standards 3) Improved characterization of instrument response function: PSD, number density, mixtures (variations/combinations in composition, interference with other gas-phase constituents or nuisance backgrounds e.g. H_2O vapor) 4) Comparative understanding of overhaul environment, procedures, and timeline 5) Instrument sampling efficiency and biases as a function of environmental conditions Conceptual studies for miniaturization and/or enhanced tolerance or performance Materials characteristics (mixtures of materials, scaling and interrelation of various "test" facilities)	1) Form factor - Size, power, weight - Durability (temperature, moisture, shock) - Operability, visibility 2) Measurement performance - Size range (emphasis on ultrafines) - Concentration range - Accuracy 3) Cost of ownership - Calibration requirements - Lifetime - Clogging and clearance - Maintenance protocol 4) Other - Battery type/charging method, schedule - Ancillary collection membrane - Drift, correlation, interference, etc. with chemical or vapor environment - Logging vs instantaneous - Complexity of data display (Go/No Go vs. PSD) 5) Ability to resolve particle size distribution vs. integrated size range measurements Cost / availability Desorption vs composition analysis Local information vs transmitted

Table 6 (cont.). Group 1 (Red) – Paul Greenberg, facilitator

Standards	Technological Advances
1) Need for a standard reflective of combustion/pyrolysis-specific materials 2) Testing standard: materials, protocols, interactions, instrument response (to what quantities or moments) and accuracy 3) Specification of operational environment requirements 4) Instrument configuration and operability 5) Linkage, buy-in, or uniformity with other certifying standards and organizations (e.g. OSHA, NIOSH, EPA, ACGIH, NFPA)	*Near-term perspective: 1-3 year horizon:* 1) Ruggedness, lifetime, environmental tolerance 2) Display visibility and information content/detail 3) Self calibration and internal diagnostics (i.e. self check and validation) 4) Emphasis on detection sensitivity in ultrafine regime 5) Data telemetry *Longer term development – not ranked:* - Ability to resolve particle size distributions, composition - Cost reduction per delivered and maintained unit - Improvements in demands and procedures for maintenance - Integrated functionality (e.g. other sensors such as gaseous species, GPS, volumetric flow measurement) - Immunity to interferences (both species e.g. H_2O vapor, interfering gases; and environmental e.g. RFI – Radio Frequency Interference, acoustic) - “Intelligent” processing (e.g. multiple moment analysis, integrated dosage vs. standard, correlations with other materials or factors) - Reduction in false positives - Reduction in size, power, mass

Table 7. Group 2 (Blue) – Kathryn Butler, facilitator

Research Needs	Performance Criteria
1) Better definition of the hazard - Relative danger of particulates and gases - Is gas riding on particulates? (carbon is a great absorber) - There is an incomplete understanding of exposure risks of firefighters, including risks over a range of activities (wildland vs. structural fires, search & rescue vs. overhaul vs. investigation) and effects of nanoparticle exposure on health - What is the timeline for safe operation? 2) Database for what fires actually generate 3) Confounders – other exposures affecting firefighter health (e.g. contaminated turnout gear, exposure to truck exhaust) 4) Water particles – are they important? How do they affect measurements? Should water be measured as a particle? Does it play a role in health effects? 5) Benefit analysis – is it worth it to do the research? At what point do you tell firefighters that they must wear the SCBA? When is it safe to downgrade PPE? Is there an indicator gas or particulate? Is the respiratory track the only route of entry to consider? (e.g. skin, eyes, ingestion) Product distribution or representative sampling – should every firefighter have a detector? How must a 40-year-old technology be hardened for firefighter use? Should all fires be treated the same? (wildland vs. home vs. big box) All-in-one or specific?	1) What is to be measured? Need to define what hazards to measure in order to build the device. 2) Where should it be measured? Personal vs. area sampler, inside vs. outside, etc. This will dictate the form of the device. 3) Environment - Temperature extremes (both hot and cold) - Vibration-proof, shockproof, waterproof - Credible measurements throughout the range of conditions experienced by the firefighter - Should not create new hazard 4) Go/no-go display – simplicity 5) Data collection and logging, and distribution of information to firefighter and incident commander; redundant system for safety No interference with communications 1-button / heavy glove operation Cost benefit analysis All-in-one meter for gas and particle identification (type of gas, what's in particle) Small Service life > 1 year Minimal training If batteries, make them regular alkaline Size distribution or total mass Measure temperature

Table 7 (cont.). Group 2 (Blue) – Kathryn Butler, facilitator

Standards	Technological Advances
1) Instrument must maintain performance over the full range of environmental insults (humidity, temperature, shock) 2) Size range of particle measurement 3) Need to quantify against accepted exposure standards (REL – Recommended Exposure Limits, TLV – Threshold Limit Values, PEL – Permissible Exposure Limits) 4) Maintenance and calibration to ensure the unit performs to manufacturer's specifications 5) Training to assure uniformity of use Electrical safety Radio frequency interference Reliability	*Long term development (5-10 years):* 1) Detection of multiple hazards 2) Wider dynamic response to meet challenges due to the wide range of concentrations and maximum concentration level in the fire environment 3) Shrink equipment (including battery and pump) to make a smaller device that would be better accepted by users 4) Knowledge of exposure in real-time (1-5 seconds) in order to make decisions 5) Data logging – event (alarm, low battery, etc.) and data Battery performance and pump efficiency Improved reliability Wireless link to incident commander Calibration – how to do this

Table 8. Group 3 (Green) – Robert Vettori, facilitator

Research Needs	Performance Criteria
1) What is physiological response to different sizes of particles? Prove to me that I need a mask or SCBA. Need to show that it is worthwhile. 2) Multi-metric method – (particle source, exposure) 3) Identify hazard of overhaul – What is the level of hazard in terms of ppm, risk, g/m^3, size 4) Design new cartridge 5) Determine composition of aerosol Location of emissions – find it, identify source – what is it? Use TIC to find hot spots Is APR or SCBA the right mask? Powered APR – is it better? Different cartridges – which cartridge is best? Put cartridges in series What is coming from wood? Combustion particles from overhaul Interest in other than overhaul Skin, dermal absorption All routes of exposure How do detectors respond to smoke/mass concentration? If higher than ambient or background, call it an action level; if measurement exceeds 5 mg/m^3 (current standard), some action is taken What is size distribution of non-flaming smoke aerosol? Equipment calibration for particles Who do we protect – all incidents or 80 % of normal stuff? Baseline of toxicity Correlation between vapor and particle Smart ticket for particles – make turnout gear of this material	1) Want it to data log 2) Hazard or No Hazard – Go or No Go for firefighter 3) Simple and easy to calibrate 4) Transmit to command post 5) What will NFPA criteria be for physical performance (e.g. temperature, humidity)? – this is mainly for manufacturers Where is the hazard? Small for everyone Color or flashing – no more sound Attach to helmet Must mean something Reliable – no false positive Physical performance On/off unless HazMat/Urban Search And Rescue (USAR)/etc.

Table 8 (cont.). Group 3 (Green) – Robert Vettori, facilitator

Standards	Technological Advances
1) Guidelines for what actions you take when the device hits a certain level (mass, number, size distribution). This is a risk management practice since we don't have a standard yet – proactive approach. 2) Standard exposure limit 3) Physical performance standards 4) Standard for calibration – calibration artifact 5) Standard smoke NIOSH guidelines OSHA best practices Need to establish limits for the firefighter workplace, e.g. 5 mg/m^3 for 8 hours for respirable dust, 15 mg/m^3 for total dust – Time Weighted Average (TWA) Standard communication protocol for data logging Standard medical checks for annual physical – HazMat teams do this already	*Near-term perspective: 1-3 year horizon:* 1) End of service life indicators for cartridges 2) Improvements to Air Purifying Respirators (APRs) 3) Real time analysis for Fire Department use. Walk outside of building with a sample and have apparatus on scene to analyze. One instrument vs. lots of instruments, need to know where you got the sample 4) From aerosol arena – What should the wavelength of the source be, what should be the detection angle, how many detectors? 5) The technology is there to do what we want. The equipment needs to be repackaged and we need to know what the specifications are. Money is needed