Breakout Session Goals

• **Gain agreement on critical safety issues and certification considerations related to M&P Qualification and Control**
  – Discuss proven engineering practices for addressing these issues and considerations

• **Establish needs for M&P Qualification and Control**
  – Additional research
  – ASTM, SAE, MIL-17

• **Other concerns not addressed**
• Select adhesives & substrate materials that are chemically compatible for adhesive bonding and meet application requirements
  – Environmental use limits (e.g., guideline for $T_{gwet}$)

• Establish detailed bonding procedures and process limits suitable for selected manufacturing approach
  – Surface preparation
  – Mix ratios
  – Cure cycle
  – Other factors affecting substrate surface wetting and chemical adhesion
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Session comments

- **Material Selection**
  - *Service environment - Specify range of environments*
  - *What is the criteria to establish Tg for selection? Tg criteria may be restricting design – hot/wet guideline*
  - *Selection tied to design/analysis*
  - *Is it compatible with the manufacturing process (may be primary criteria)*
  - *Carrier of adhesive*
  - *Windows of applications should be considered*
  - *Safety and handling concerns*
  - *Peel test and pre-bond moisture used for screening*
  - *How long is the bond to last?*
  - *Explore material limits (and beyond)*
• **Material compatibility issues**
  – *Look at system (adhesive, adherend, primer, peel ply, carrier, surface, process)*
  – Peel tests used for initial screening for material compatibility
  – Test method and procedures
  – Clear definition of what is the service environment
  – Flammability
  – Compatibility with repair techniques (multiple cure cycles)
  – Scaling factor with respect to cure cycle – heat-up rate
  – Impact on adjacent structures and systems
  – Consideration of desired failure mode
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Qualification Testing

- Qualification tests to demonstrate the suitability and repeatability of selected materials & bonding processes
  - Repetitive testing of key properties – set requirements
    - Distinct batches of material
    - Distinct bonding process runs controlled by the specs
  - Testing details characteristic of the application
    - Chemical and physical tests
    - Mechanical tests (load types, environment)
    - Bond durability tests
    - Bond test specimen details (bondline thickness, overlap length)
  - Analysis & documentation of qualification data
    - Statistical data treatment
    - Apply qualification data to subsequent material & process control
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Session comments

- **Qualification Testing**
  - Number of batches
  - Out time of adhesive
  - Process variables, mix ratios
  - Is the material new to the industry or just new to the company- maturity of material and process specification
  - Interchangeability issues
  - Substrate differences
  - Emphasize durability testing (what is the design philosophy – fail safe vs. damage tolerant)
  - Qualification has a dependency on the design
  - Fabrication of coupon (establish sensitivity)
  - Sub-element testing
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Session comments

- Qualification Testing (cont)
  - Stepped qualification process (adhesive → joint → sub-elements)
  - Qualification process should match production process (key elements should be captured within the qualification)
  - Consideration that adhesives have age and process sensitivity
  - Differences between qualification and what goes into a material specification
  - “Clearing House” for adhesives – shared database methodology for adhesives
• Specifications and instructions to control materials
  – Documented material requirements (acceptance limits)
  – Acceptance testing for adhesives
    ➢ Chemical, physical and mechanical test types
    ➢ Test details (adherend types, environmental effects)
  – Control of ancillary materials (e.g., peel ply)
  – Adhesive & substrate protection, storage and handling
    ➢ Shipping instructions, storage environment and out time
    ➢ Protection from contamination
    ➢ Pre-bond moisture of substrates and adhesives
• Adhesive material changes that require re-assessment
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Session comments

- **Material Control**
  - Environment limits and accessibility for controlling the material
  - Recertification of material (extended life)
  - Requirements and criteria set for material control and change (Has the correct test been identified for material change?)
  - Raw material changes (level of control)
  - Consideration of volatile content
  - Emphasize ancillary materials
  - Control of supplier documentation
  - Emphasize protection from contamination
  - Need for adhesive flow test
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Process Control

- **Specifications & instructions to control bond processes**
  - Bonding process details to be controlled and monitored
    - Substrate surface preparation for bonding
    - Adhesive mixing variables (if applicable)
    - Adhesive application (methods and timing)
    - Bondline thickness
    - Cure pressure and temperature
  - In-process bond testing (witness panels)
  - Inspection of bonded structure
    - Geometric tolerance assessments
    - Use of NDI

- **Substrate material changes that require re-assessment**
- **Changes in bond processes that require re-assessment**
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Session comments

• Process Control
  – Environmental controls (clean room, humidity, etc.)
  – Expendable materials issues (contamination concerns)
  – Vacuum pressure/adhesive compatibility
  – Witness panels are not only mechanical tests (physical and chemical should be included and frequency specified) – what are they being used for?
  – SPC (how does it fit?)
  – Overuse of NDI – false sense of security – use of correct NDI technique – should be quantitative
  – Operator training
  – Emphasize time limits and drying on surface preparation
  – Thermal profile of tooling
  – Repair control versus production control
  – Proof load on actual part
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Session comments

- **Process Control (cont)**
  - Safety in handling
  - Traceability of materials
  - Tool qualification and control
  - Verification of material handling (link between materials and process control)
  - Surface inspection (water break, etc.)