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M&P Qualification and Control (breakout section)

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*

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M&P Qualification and Control
Material Selection & Process Definition

- *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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- *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)*

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- *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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- *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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- *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*

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Material Control

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- *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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- *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

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- *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*

Likely overlap with Manufacturing Breakout

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- *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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- *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.)*