Added Details for Option 1 Proposal for SDC as one "Other Consideration" to Minimize Risks Tied to Field Uncertainties and Engineering Assumptions for DTE

Federal Aviation Administration

Notes

- FAA will need more time to gain acceptance from the other NAA
- Option 1 Proposal is not completely documented in this presentation

Presented to: § 25.571 Fatigue & Damage Tolerance ARAC

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Proposed Definition of SDC

- **The attribute of a structure which permits it to retain its required residual strength in the presence of large damage.**
  - A structural attribute that has less dependence on DTE assumptions in avoiding catastrophic failure (similar philosophy as damage categories)
  - Redundant structural design features promote residual strength curves that become relatively independent of the specific size of large damage metrics
  - Definition is the same as proposed in 2003

4 Options Noted in AAWG 6/28/17 Report Out

TAMCSWG Report Out - SDC

Next Step Options

1) ~~Adopt~~ Work with recommended guidance ~~as is~~
   - NAAs draft up elements of rule change and guidance
     - Reassure established OEMs that showing of compliance for ~~thorough threat assessment~~ reliable DTE methodology is already captured by existing practices via guidance
     - Will be a challenge to provide reassurance, yet maintain flexibility in guidance
     - Need reassurance of consistent interpretation from other NAAs not present at this meeting
     - Understand that focus will be on addressing known threats
     - Address ambiguity concerns and SLP in rule change
   - Obtain Industry concurrence
   - Consider raising bar for minimum SDC
2) Conclude there is no practical approach, due to major points of dissention
   - Reject recommended guidance;
   - Elaborate in report on how major points of dissention have proved to be insurmountable
   - Discontinue efforts to incorporate fail-safety back into Part 25
3) Seek a different approach, perhaps re-visit 25.6xx proposal
4) Assume inherent SDC for MLP structure, focus only on how to address Single Load Path structure.

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FAA Views on the Options

- **More details for Option 1 have been included in this presentation**
- **Option 2 diminishes the actual SDC advancements by the current ARAC**
- **Option 3 was previously discussed and didn't get the full industry support**
- **Option 4 is only one part of other options (may be better to make it a hybrid of 2 or more of the other options)**

Proposed Minimal Rule Changes

- Changed corrosion to “environmental deterioration”
- Added: “The evaluation ~~may~~ includes other considerations that ~~mitigate~~ supplement the extent of ~~a threat assessment~~ the damage tolerance evaluation for a given threat.”
- Included SDC under “other considerations”; no specific requirement for SDC
  - *“Other considerations”* will likely also be needed in generalizing a performance based rule to cover both composites and metals
- **When addressing four classes of damage threats —**
  - Fatigue
  - Environmental deterioration
  - Manufacturing defects
  - Accidental damage

Option 1 outlined In red

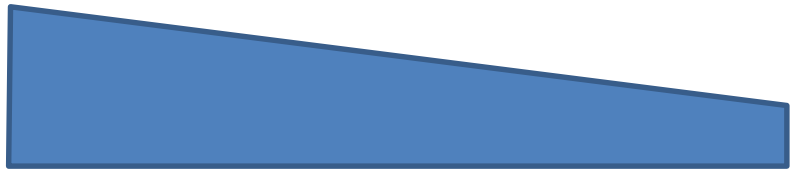
engineering damage tolerance evaluations gain benefits from other considerations (see AC updates)

Examples of SDC as one "Other Consideration" (List is not thought to be complete)

- **Metals**
  - Used to ensure anomalous loads and more serious starter flaws (possibly rare) don't lead to crack growth beyond DTE assumptions
  - Used to ensure inspection challenges or mistakes don't lead to catastrophic failure
  - Used to cover effects of hidden accidental or environmental damage leading to more critical crack growth than DTE
  - Addressing possible interactions between damage threats
- **Composites**
  - Used to address the complexities of accidental impact damage (size vs. detectability, impactor variables) and very rare large impact penetrations
  - Used to ensure anomalous loads and long-term environmental effects don't reduce overall performance
  - Insurance that very rare local weak bonds will not cause catastrophic failure
  - Addressing possible interactions between damage threats
  - Used to minimize more complex testing for structures with low max strains

Pictorial Schematic of the Role of SDC as an Other Consideration Supporting DTE for a Given Threat

Evaluation of Risks noted with DTE Engineering Assumptions and/or Specific Service History



Significant Risks Identified in the Assumptions Used for DTE or Service History

DTE Engineering Assumptions or Service History Evidence that Show Minimum Risks

Level of SDC for certification

Conservative or Necessary Larger SDC

Smaller SDC Justified by more Rigorous Approach to DTE, an area of minimum threat, or other factors approved by administrator

* OEM can perform SDC beyond what is required for certification per internal design rules as today's situation

FAA Thoughts Relating to Previous Graphic

- Allows engineering rigor with assumptions minimizing risks to affect the range of SDC
- Threat assessment may be part of the work that determines a need for "other considerations" (e.g., SDC) but it is not the primary task (see proposal below)
  1. List fatigue, accidental damage, environmental deterioration, and manufacturing defects based on field experience (magnitude, location)
  2. Define the engineering approach for how each threat will be addressed, including assumptions on how to test and analyze each threat versus your companies' experience (i.e., certification plans for DTE)
  3. Define "other considerations" that add with your more formal DTE (conservative damage sizes for expanded DT assessment, SDC, QC advances, environmental protections) to ensure catastrophic failure is avoided
  4. ~~Negotiate DTE and the use of other considerations in seeking approval~~
- ***Guidance materials will be used to show reasons for larger or conservative SDC based on 1) design and location promote robust design (i.e., not DT critical), 2) service history evidence indicates a need or 3) DTE engineering assumptions pose risks***

Guidance Supporting Option 1 Solution

- Provide some freedom for applicants to justify specific details they use for SDC as only one "other consideration" that is supporting their Fatigue and Damage Tolerance Substantiation
  - Use criteria for SDC acceptance to cover it as a rare and difficult to define large damage (e.g., RS with "near Limit load capability" in composite guidance will continue to promote a level of robustness in easily detectable damage)
  - Add criteria for "other considerations" (e.g., Gulfstream larger damage crack growth design criteria) in addition to SDC to be used to supplement DTE (areas that justify using smaller SDC for some structural areas)
    - FAA/NAAs will work with industry (can be recommended as efforts beyond the current ARAC) to ensure internal design criteria are not eliminated and the "other considerations" they currently use in combination are understood
    - Provide guidance or industry guideline (CMH-17?) examples on how SDC and "other considerations" have degrees of freedom that applicants can execute
- "Other considerations" (e.g., stringent bond QC) will be used with SDC to support the DTE for weak bond manufacturing defects
- Give credit for service history with any new product design that is similar to past designs (per specific company experiences)

SDC Guidance Examples

(intending to show the effort is not extensive)

Level of SDC	Location Criticality	Service History	DTE Assumptions (example using test damage simulation)
Large (e.g., 2-bay Crack)	High Loads	Extensive Data High Damage Risk	Conservative
Large (e.g., 2-bay Crack)	High Loads	None	Conservative
Medium (e.g., broken element)	Low Loads	High Damage Risk	Removed Element with starter flaw
Medium (e.g., broken element)	High loads	Low Damage Risk	Removed Element with starter flaw
Small (e.g., partial penetration at Stringer Location)	Low Loads	Mean Damage Risk	Actual Damage Simulation
Small (e.g., partial penetration at Stringer Location)	High Loads	Extensive Data Small Damage Risk	Actual Damage Simulation

Summary of Option 1 Solution

- FAA to consider § 25.571 update that allows applicants to use "other considerations" in damage-tolerance (DT) evaluation
  - Structural damage capability SDC is one "other consideration" (others include quality control, environmental protection) for various damage threats
- **Maintain current SDC definition (consistent with 2003 thoughts)**
  - **SDC is linked to: 1) Compliance ease (robust designs), 2) specific service history for design/location, and 3) DTE assumptions, which in combination support choice**
  - **Single load path (SLP) structure does not have SDC**
  - **Warn against SLP use based on other threats (e.g., bonded SLP)**
- Guidance material to address "other considerations"
  - Continue work with OEMs to provide details on "other considerations"
  - Multiple load path design remain preferred damage-tolerant structure
  - Provide criteria to address single load path structure
  - Link SDC to "other considerations" that mitigate damage threats beyond those identified in specific DTE tests and analyses
  - FAA to consider criteria to address SDC damage size limits without using specific damage sizes (similar to categories of damage in AC 20-107B)
- OEM & regulators will continue to work together in defining guidelines that bound SDC and pursue related educational paths
  - Data collected from industry for the SDC ARAC efforts, provides a start