Industry Material Specifications

Jeb Robbins
Molly Stone, DER

MTech Document No: MTE-70002
Revision: A
Release Date: October 29, 2025

MTECH ENGINEERING SERVICES, LLC

Contents

1.0 Introduction

1.1 Early Use of Structural Composites in Aerospace

Early applications of advanced composite materials such as glass fiber reinforced polymer (GFRP) and carbon fiber reinforced polymer (CFRP) in aerospace were novel and thus limited to risk-tolerant applications such as radomes in military aircraft and secondary structural control surfaces like spoilers, flaps and ailerons, failure of which would not be catastrophic to continued safe flight. Associated materials and processes were highly customized and proprietary. From early adoption of GFRPs in the 1960's and CFRPs in the 1970's and 1980's, military applications were the primary means to demonstrate composites technology. The first successful certifications of primary structure in a commercial aircraft were empennage structures (vertical and horizontal stabilizers) such as the Airbus A320 empennage in the late 1980's and the Boeing 777 empennage in the early 1990's. These tail structures presented a reduced risk for early application in transport category aircraft due to their lower damage threat from ground vehicles and debris, in a time when knowledge and technology of damage tolerant composite materials was still evolving.

1.2 Standardization Initiatives

By the mid 1990's, a growing confidence in aerospace composite materials coupled with a NASA sponsored consortium designed to reinvigorate aviation – known as the Advanced General Aviation Transport Experiments (AGATE) project[1] – provided an ideal environment to incubate standardization of composite materials and processes. Born from this consortium were:

1) A set of technical guidance reports published by the FAA
2) Material specifications published by SAE International
3) Databases for select materials published by MIL-HDBK-17 (later CMH-17 Volume 2[2])

While not perfect, this early effort laid the groundwork for standardization and acceptance of common composite materials and processes in multiple platforms and certification programs. AGATE was successful in reinvigorating the general aviation Industry by breaking down barriers to entry and streamlining processes.

Following the eight-year AGATE project, the Industry and FAA recognized the importance of continued standardization. The FAA took composite material lessons learned from AGATE and provided funding in the mid 2000's to support establishment of the National Center for Advanced Materials Performance (NCAMP)[3]. The structure and oversight of NCAMP was created so that materials, processes, and their specifications and databases could be generated independent of a project application to FAA or EASA, while still meeting the relevant regulations. Both FAA and EASA further acknowledged this with formal policy memos, effectively establishing NCAMP as the first standalone FAA certification pathway for a material outside of the Type Certificate (TC) or Technical Standard Order Authorization (TSOA) pathways.

Figure 1 below illustrates historical applications of composites in aerospace, with standardization initiatives highlighted in dark blue.

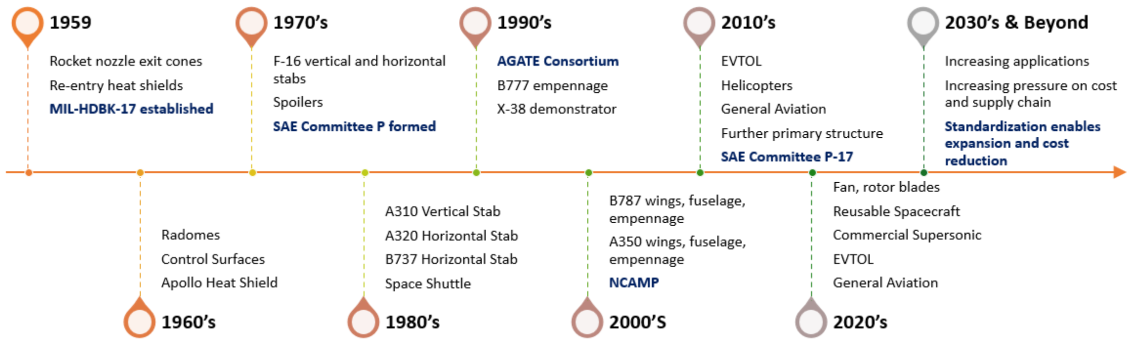

Figure 1: Historical applications of composites in aerospace, standardization shown in **dark blue**

1.3 Three Types of Material Specifications

Best practices for composite materials standardization were documented in SAE specifications, CMH-17 Volumes 1[4] and 3[5], and DOT/FAA technical reports. DOT/FAA/AR-07/3 (published 2007)[6] remains an excellent and widely used resource for developing material specifications and provides clear guidance by distinguishing between three types of material specifications: "Supplier," "Industry" and "End-User". **Table 1** elaborates on the characteristics of these three specification types, all of which are commonly used in aerospace composite material programs.

Table 1: Distinction Between Material Specification Types Mentioned in DOT/FAA/AR-07/3

Characteristic	Structural Composite Material Specification Type		
	Supplier	*Industry*	*End-User*
Property Requirements	Reflects a "guarantee" value by the Supplier.	Established by qualification of a specific material.	Driven by End-User design requirements.
Utility	Initial and commodity procurement (not for flight), draft starting point for End-User or Industry specification.	Publicly available to any user.	Available to End-Users and licensees only.
Responsibility	Supplier is solely responsible. No Industry oversight, no possibility of regulatory acceptance.	Test owner is responsible for qualifications and certification. Industry committees are responsible for maintenance and change control.	End-Users are solely responsible for qualification, certification, maintenance and change control.

1.4 Types of Industry Specifications

For this paper, "Industry specifications" refer to composite material specifications published by SAE International as Aerospace Material Specifications (AMS) and those published by NCAMP as NCAMP Material Specifications (NMS). Industry specifications offer advantages to both Users and Suppliers. Materials procured to these publicly available specifications are well vetted, mature, and supported by coupon level allowables recognized by the FAA and EASA, making them advantageous for time-constrained programs. It should be noted that only lower-level building block tests (coupon) are available for such databases. Higher level building block tests (element, sub-component, component) must still be performed by the applicant or design owner as part of the overall certification effort. Adopting Industry material specifications for procurement of composite materials in aerospace provides several benefits. Non-recurring costs related to material qualification and coupon level allowables generation are avoided. Overhead costs related to specification management are avoided or greatly reduced. Design standardization is realized via common material properties and familiarity within the supply chain. However, Users must ensure that all organizational, program-specific and regulatory requirements are met. Common reasons for supplementing or deviating from Industry specifications include Quality Management Systems which may require company-specific documents, procurement protocols, and technical considerations stemming from operational, environmental and regulatory needs.

In addition to these clear benefits, some challenges must be managed to fulfill operational and regulatory requirements when adopting Industry specifications. **Table 2** presents a comparison of the benefits and challenges of each specification type, including the distinction between AMS and NMS Industry specifications.

This white paper defines the role of Industry material specifications in FAA-recognized composite material standardization, further explores the nuances between specification types, examines benefits and challenges of their adoption, and presents strategies – such as Wrapper specification hierarchies – to ensure regulatory and organizational compliance for common use cases.

Table 2. Benefits and Challenges of Material Specification Types

	Structural Composite Material Specification Type			
	Supplier	**Industry (SAE AMS)**	**Industry (NCAMP NMS)**	**End-User**
Specification Management Responsibility	Supplier	SAE P-17 Committee, End-User engagement via SAE P-17 committee membership	NCAMP, End-User engagement via Steering Committee membership	End-User or Design Approval Holder (DAH)
Change Management of Supplier Responsibility	Supplier	PRI P-17 QPG, End-User engagement via QPG membership	NCAMP, End-User engagement via Supplier	End-User or Design Approval Holder (DAH)
Benefits	Easy for initial purchases, development, trade studies, etc.	Established and vetted, already available	Established and vetted, already available, endorsement via FAA/EASA policy statements	Direct End-User control and relationship, customized to End-User needs
Challenges	Little to no End-User control, does not meet aerospace regulations	Limited customization, must join SAE P-17 committee to influence spec, must join PRI P-17 QPG to influence change	Limited customization, must join Steering Committee to influence spec, must engage Supplier to influence change	Niche requirements = higher cost, longer lead times, staffing for maintenance of specs/changes

Definitions

SAE P-17 Committee is a part of SAE International's Aerospace Material Specifications (AMS) division, responsible for developing and maintaining standards related to polymer matrix composites and non-metal additive manufacturing for the aerospace industry.
PRI P-17 QPG is a Qualified Product Group (QPG)[7] within Performance Review Institute (PRI), focused on managing the Qualified Products Listing (QPL) for standards aligned with the SAE P-17 Committee.
NCAMP Steering Committee is a cross-functional industry committee within NCAMP for each material qualification program.
Design Approval Holder (DAH) is the holder of any regulatory design approval such as Type Certificate.

2.0 Benefits of Adopting Industry Material Specifications

2.1 Starter Database

Industry specifications are often accompanied by public material property databases where previous stakeholders have invested in testing to support coupon level allowables. This includes B-basis and sometimes A-basis data sets for lamina and laminate properties, with a range of statistical data quality and properties depending on the previous investment. While this doesn't fulfill all testing a part manufacturer or End-User must perform, it reduces the up-front coupon testing for a material and provides confidence in the capability of a material during the material selection process. Higher level building block tests (design-specific laminate, element, sub-component, component) must still be performed by the applicant or design owner to accomplish the overall certification effort.

2.2 Improved Lead Times

The use of Industry specifications provides supply chain flexibility and improves material availability. It is easier for a Supplier to justify stocking inventory of a public material (off-the-shelf) as there is a larger pool of potential buyers when compared to a proprietary material specification. Users benefit from harmonized supply chains and reduced lead times. Additionally, increased accessibility to Industry material specifications leads to increased usage, reducing the risk of obsolescence.

2.3 Regulatory Acceptance

Regulatory bodies like the FAA and EASA are familiar with and advocate for Industry specifications and public databases, helping to streamline certification and compliance. In particular, the processes used in this space are explicitly defined and accepted by regulatory bodies. For example, the NCAMP process and development of NMS specifications uses a process accepted by FAA and EASA by policy memos AIR100-2010-120-003[8] and CM-S-004[8], respectively.

2.4 Reduced Costs

All parties benefit from reduction in duplication of efforts like material specification development and material qualification efforts. Adoption of Industry material specifications reduces overhead costs involved with managing a proprietary internal specification. Activities that are reduced or removed include material specification development, specification property development, and specification maintenance and custodianship. Recurring End-User involvement is related to change control, where the user ensures specification changes are acceptable to their programs. Duplicative testing is avoided as well as the cost of additional process control documents (PCDs) at the Supplier, which reduces material cost. Additionally, as the use of Industry material specifications increases, costs decrease due to economies of scale.

2.5 Continuity

Use of common materials simplifies the reuse of existing design data, finite element models, stress analysis, and allowables. It is easier to coordinate with external partners when a common Industry material is used. A well-maintained Industry specification can outlast an End-User specification, providing continuity where an End-User specification may become obsolete due to changes in teams or company restructuring or solvency. Industry specifications are subject to external audits and quality control, often resulting in increased scrutiny from external parties and a more diverse cross-section of committee participants.

3.0 Challenges of Adopting Industry Material Specifications

3.1 Limited Customization

Industry specifications afford less space for customization because they are written to accommodate many users, so they may have requirements than some End-Users cannot tolerate. This could lead to more variability and fewer customizable attributes when compared to a customized End-User specification. An End-User material specification can be tailored in concert with the End-User process specification to reduce scrap, speed up cures, or generally ensure compatibility with internal processes. Furthermore, if Industry specification tolerances require tighter controls in a process than would be required by an End-User, it may increase inspection costs. Such misalignments between Industry specification and end-use requirements may drive the need for some level of End-User specification to receive material if the Industry specification does not meet all requirements for a user.

3.2 Committee Oversight

Industry material specifications depend on standards committees for review and approval. These committees are comprised of industry experts and End-Users who often volunteer their time to review data and documents as a part of a timed polling process. Due to the higher amount of user feedback and polling cycles (usually 14~30 days) required for these committees, Industry specifications often take longer to develop and approve changes. End-Users should be involved in the change control process to influence specification revisions and material changes. Specification and material changes often drive the need for evaluation to ensure the change doesn’t affect the End-User’s part.

3.3 Competitive Edge

An End-User considering adopting an Industry specification should not expect to hold a competitive advantage based on the material alone. Inherently, there is no intellectual protection involved with Industry material specifications, so using them provides no competitive advantage. Performance improvements must come from design or manufacturing and not the material itself.

3.4 Process Flexibility

Unless an End-User is involved in developing the material and process for an Industry material specification and database, there is no inherent tie to an End-User’s existing process specification. When adopting an Industry material specification, the baseline cure process should be adopted to the extent practicable. Deviations to the baseline are subject to equivalency demonstration, and each deviation to the baseline presents a risk to the program. For example, differences in tooling, bagging, cure cycles, or layup techniques can result in non-equivalent properties. When equivalency demonstration fails, development of independent or bridge allowables may be necessary. Users also own the responsibility to scale-up and adapt the process to address their specific parts and fabrication techniques.

3.5 Equivalency Demonstration

When adopting any new specification and material for the first time, an equivalency test campaign is required for each new fabricator location to demonstrate equivalency to the baseline allowables dataset. Even with public allowables, materials must be qualified for a specific part. Coupon level allowables are only the start of certifying a composite part, and additional design specific tests are required such as design-specific bearing and pull through tests as well as scaled-up subcomponent tests. This is not exclusive to Industry materials, however, as proprietary End-User materials also require this testing.

4.0 Fulfilling Regulatory Requirements

An organization's choice of material specification management must satisfy regulatory requirements. In the context of material control, the most directly applicable regulation is 14 CFR 2x.603, which requires the suitability and durability of materials used for parts, the failure of which could adversely affect safety, must conform to approved specifications that ensure their having the strength and other properties assumed in the design data, and take into account the effects of environmental conditions expected in service. Compliance with this regulation is guided by advisory circulars AC20-107B[10] Section 6 and AC23-20[11]. Other guidance includes CMH-17 Volume 3 Revision G Section 5.11, DOT/FAA/AR-03/19[9], DOT/FAA/AR-07/3, and DOT/FAA/AR-02/110[12].

The following presents an example of a common approach for means and methods of compliance to this regulation, including relevant guidance, guidelines, and compatible specifications which can be used to show compliance. When following the prescribed guidance, both Industry and End-User specifications can be used to comply with regulations.

4.1 Example Compliance Approach for 14 CFR §25.603 Materials

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must:

(a) be established on the basis of experience or tests;
(b) conform to approved specifications (such as Industry or military specifications, or Technical Standard Orders) that ensure their having the strength and other properties assumed in the design data; and
(c) take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

Means of Compliance:	Test
Method of Compliance:	Material qualification and allowables campaigns, operating envelope testing
Relevant Guidance:	AC20-107B
Relevant Guidelines:	CMH-17 Volumes 1 and 3, DOT/FAA/AR-07/3, DOT/FAA/AR-03/19
Compatible Material Specifications:	Industry, End-User

5.0 Fulfilling Organizational Requirements

As a user develops their overall certification plan and associated means and methods of compliance, organizational factors may drive requirements for additional controls which may not be covered sufficiently by an Industry specification alone. Harmonizing such requirements between organizational systems and the public specification is critical for successful integration of the public specification into a program. Below are some examples of such requirements.

- Quality Management System Requirements
  - Time and Temperature Sensitivity (TATS) – treatment of material after receipt
  - Packaging and labeling – unique company requirements
  - Receiving Inspection (RI) – Instructions to complete receiving
- Procurement Reasons
  - Qualified Product List (QPL) – Control of specific configurations authorized for use
- Technical Reasons
  - Life extension requirements specific to an End-User
  - Direct control of changes
  - RI – Specific tests required to protect design
  - QPL – Control of specific configurations authorized for use

5.1 Wrapper Material Specification

There are multiple options for fulfilling organizational requirements, recommendations for which are summarized in **Table 3**. As part of these recommendations, we introduce a new type of material specification described as "Wrapper". A Wrapper material specification is an End-User specification which directly invokes (requires, calls-out, points to) the Industry specification for procurement purposes and adds additional requirements for organizational and regulatory compliance, effectively "wrapping" all material requirements together into a parent document. **Figure 2** offers a visual depiction of this relationship. The material Supplier may consult an End-User with Wrapper specification content, but the Wrapper specification is not invoked as a direct procurement requirement when issuing a purchase order (PO) for procurement of materials. **In this scenario it is critical to call out the Industry specification on the PO.**

5.2 Options for Fulfilling Organizational Requirements

To address TATS requirements, control is recommended via the process specification or a supporting specification. Packaging and labeling requirements are handled via the PO sent to the material Supplier. Receiving inspection can be dealt with in multiple ways, including a support specification, a Wrapper material specification not invoked by PO, or by accepting the prescribed receiving inspection in the Industry specification. Life extensions are handled similarly by support specification, Wrapper material specification, or by prescribing the life extension protocol in the Industry specification. Specific QPL configurations are controlled by PO or by a Wrapper specification plus PO instruction. Lastly, direct change control can be handled by joining the P-17 QPG or the NCAMP committee or establishing a relationship with the Supplier and auditing.

Table 3: Options for Fulfilling Organizational Requirements

End-User Requirement	Option 1	Option 2	Option 3
TATS – Treatment of Material after Receipt	Process Specification	Support Specification	-
Packaging and Labeling – Unique Requirements	PO	-	-
Receiving Inspection	Support Specification referenced by Process Spec	Wrapper Material Spec	Prescribed in Industry Spec
Life Extension	Support Specification	Wrapper Material Spec	Prescribed in Industry Spec
QPL – Specific Configurations	PO (e.g. Supplier specific item code)	Wrapper Material Spec + item specified on PO	-
Direct Control of Changes	Join P-17 QPG or NCAMP committee	Establish relationship with Supplier, audit	End-User spec

Options presented in **Table 3** introduce a new level of complexity beyond a single or simple material specification. It is possible to adopt an Industry material specification while also meeting additional regulatory and organizational requirements. In some cases, this means creating a "Wrapper" specification. Placing the options of **Table 3** into practice involves establishing a clear hierarchy of M&P specifications within an End-User's organization. **Figures 2 - 4** offer depictions of different hierarchy scenarios which can be used to meet requirements. **Figure 2** depicts a scenario in which an Industry specification is invoked by a Wrapper specification. The Wrapper specification also encompasses user-specific receiving inspection criteria and other special internal requirements. The End-User process specification invokes the Wrapper specification and addresses e.g. TATS requirements. **In this scenario it is critical to call out the Industry specification on the PO.**

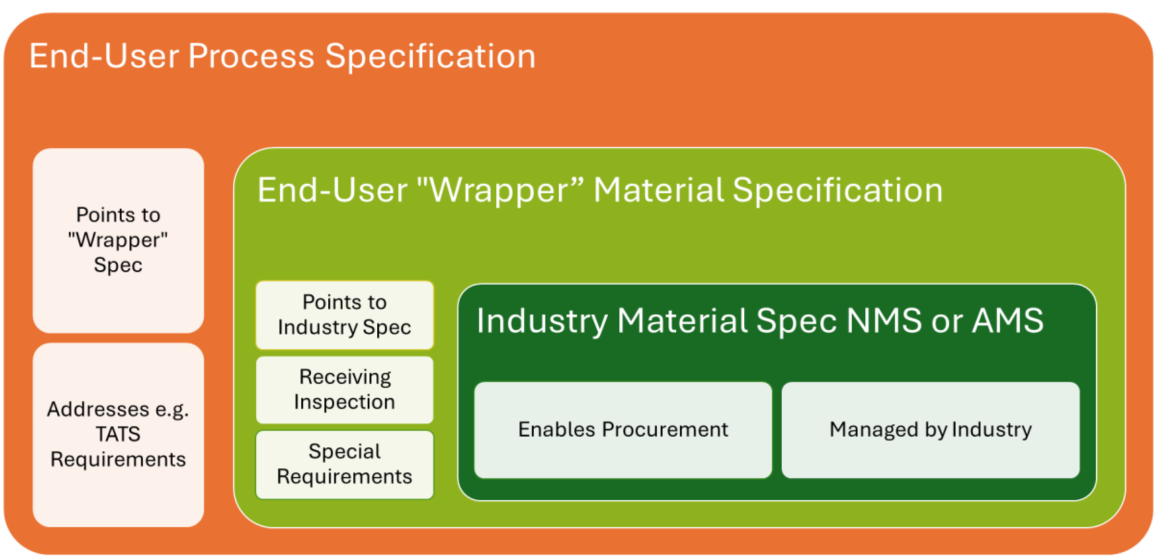

Figure 2: Specification hierarchy when a Wrapper specification invokes an Industry specification

Figure 3 depicts a scenario in which all necessary material and procurement requirements are encompassed satisfied by the Industry specification, and the End-User's process specification directly invokes the Industry specification.

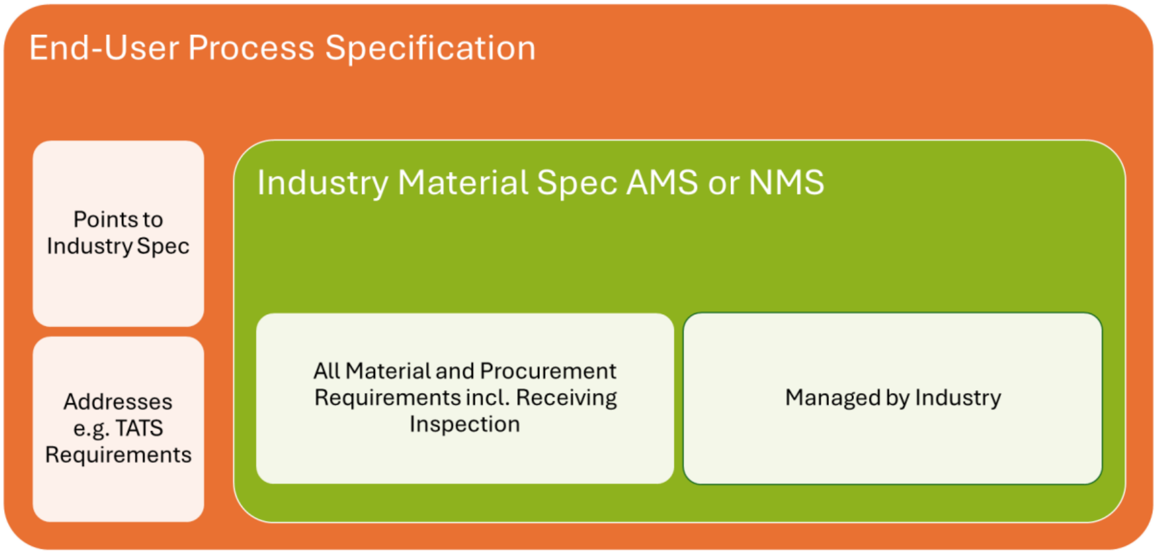

Figure 3: Specification hierarchy when a process specification invokes an Industry specification

Figure 4 depicts a scenario in which an Industry specification is not a good fit for the End-User, and the End-User's process specification directly invokes the End-User material specification.

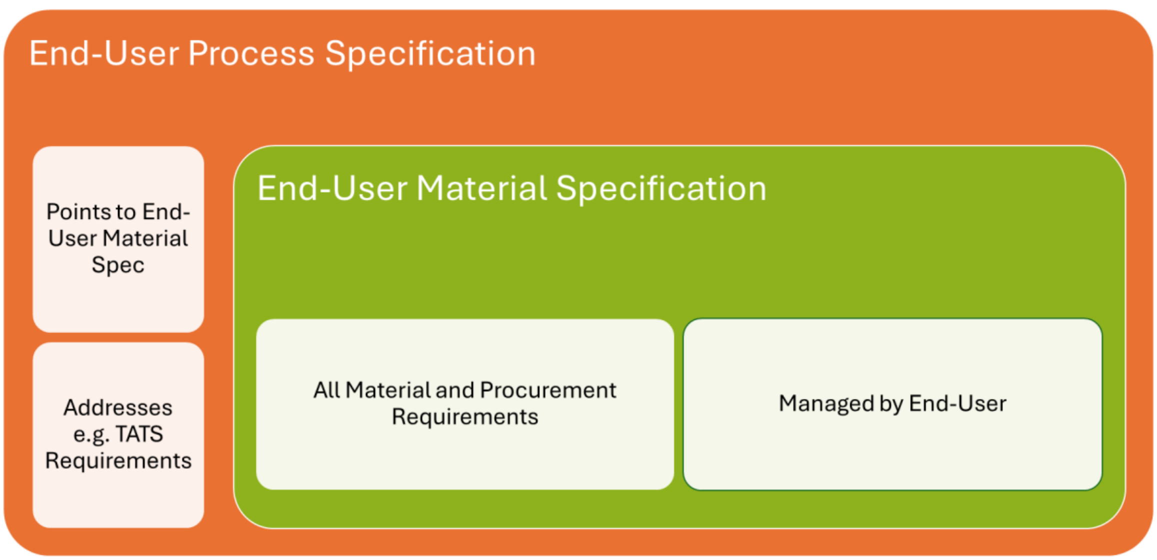

Figure 4: Specification hierarchy when a process specification invokes an End-User specification

6.0 Conclusion

Throughout the history of advanced composite material applications in aerospace, Industry efforts associated with CMH-17, AGATE, NCAMP and SAE have evolved to promote standardization. These efforts have helped to move the status of advanced composites from novel application toward mainstream building material. Three material specification types have emerged including "Supplier," "Industry," and "End-User." Supplier specifications have limited oversight and cannot be used for certification, but they are useful for early development and procurement. Industry specifications represent publicly available materials and data, standardized for widespread Industry use. End-User specifications are proprietary in nature and highly customized, often carrying higher costs, but adding organizational benefits. Adopting Industry material specifications offers significant benefits, including a starter database, regulatory acceptance, improved material availability, cost reduction, design standardization and reducing the risk of obsolescence. However, challenges must be managed such as limited customization, sluggish committee oversight, lack of competitive material advantage and the need to demonstrate equivalency.

To successfully integrate Industry material specifications, it is crucial to fulfill both regulatory and organizational requirements. Regulatory requirements, such as those outlined in CFR 25.603, require that materials used must conform to approved specifications ensuring their strength and durability under expected environmental conditions. Organizational requirements may include quality management systems, procurement protocols, and technical specifications that must be harmonized with Industry standards. Navigating the nuances of such requirements may involve implementation of a carefully constructed specification hierarchy to ensure continuity and compliance. A "Wrapper" specification is introduced as a viable vehicle for fulfilling these needs.

When thoughtfully implemented, the advantages of adopting Industry material specifications can outweigh the drawbacks, making it a viable approach for aerospace applications. Some circumstances such as the need for direct control or a niche material may, however, warrant End-User specifications.

7.0 References

1. Grenville, D. and Kleiner, B. M., *AGATE, The Turning Point for General Aviation*, Virginia Polytechnic Institute and State University, April 26 2004, https://appel.nasa.gov/wp-content/uploads/2013/05/agate_casestudy_042604.pdf
2. *Polymer Matrix Composites: Materials Properties,* SAE International, CMH-17-2H, February 2018
3. *National Center for Advanced Materials Performance,* National Institute for Aviation Research, Wichita State University, https://www.wichita.edu/Industry_and_defense/NIAR/Research/ncamp.php
4. *Polymer Matrix Composites: Guidelines for Characterization of Structural Materials,* SAE International, CMH-17-1H, August 2022
5. *Polymer Matrix Composites: Materials Usage, Design, and Analysis,* SAE International, CMH-17-3G, March 2012
6. McCarvill, W., Ward, S., Bogucki, G., Tomblin, J., *GUIDELINES AND RECOMMENDED CRITERIA FOR THE DEVELOPMENT OF A MATERIAL SPECIFICATION FOR CARBON FIBER/EPOXY UNIDIRECTIONAL PREPREGS UPDATE*, National Institute for Aviation Research, Wichita State University, DOT/FAA/AR-07/3, May 2007
7. *Qualified Products Group*, Performance Review Institute, https://www.p-r-i.org/qpl
8. Freisthler, M., *INFORMATION: Acceptance of Composite Specifications and Design Values Developed using the NCAMP Process*, Federal Aviation Administration, September 20 2010, https://www.wichita.edu/Industry_and_defense/NIAR/Documents/FAA-AIR-100-2010-120-003.pdf
9. Waite, S., *Composite Materials – Shared Databases Acceptance of Composite Specifications and Design Values Developed using the NCAMP Process*, European Union Aviation Safety Agency, January 14 2014, https://www.easa.europa.eu/en/document-library/product-certification-consultations/easa-cm-s-004
10. *Composite Aircraft Structure*, Federal Aviation Administration, September 8 2009, AC20-107B, https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC20-107B.pdf
11. Tomblin, J. S., Ng, Y. C., Raju, K. S., *MATERIAL QUALIFICATION AND EQUIVALENCY FOR POLYMER MATRIX COMPOSITE MATERIAL SYSTEMS: UPDATED PROCEDURE,* National Institute for Aviation Research, Wichita State University, DOT/FAA/AR-03/19, September 2003
12. Bogucki, G., McCarvill, W., Ward, S., Tomblin, J., *GUIDELINES FOR THE DEVELOPMENT OF PROCESS SPECIFICATIONS, INSTRUCTIONS, AND CONTROLS FOR THE FABRICATION OF FIBER-REINFORCED POLYMER COMPOSITES,* National Institute for Aviation Research, Wichita State University, DOT/FAA/AR-02/110, March 2003