



# ASTM - Structures Developments

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# ASTM – F44 Structures Developments

## Looking to the Future – Entry Level Airplane



1911

2011



Part 23 ARC Kick-Off Meeting  
November 2011



Federal Aviation  
Administration

18

## Small Airplane Revitalization Act of 2013

## Looking to the Future – Entry Level Airplane



1937

2011



Part 23 ARC Kick-Off Meeting  
November 2011



Federal Aviation  
Administration

20



# ASTM – F44 Structures Developments

## What is ASTM

ASTM International

262 members / 9 subcommittees

Multinational effort

FAA, EASA, TCCA, CAAC, ANAC, NZ-CAA, CASA

Textron, Diamond, Flight Design, Embry Riddle,  
Pipistrel, Garmin, GAMA, AOPA, NASA, AEA, etc.

Total of over 29 standards have been published

- None have been officially accepted by EASA/FAA for use as means of compliance with CS-23
- Pending the AMC before end 2017
- FAA Notice of Availability ?





# ASTM – F44 Structures Developments

## STARTING POINT

### CS-VLA Amendment 1 (March 2009)

Single combustion engine

< 2 seats, MTOM < 750 kg

Stall speed < 83 km/h (45 knots)

Day VFR

### CS-23 Amendment 4 (July 2015)

Normal, utility, aerobatic

< 9 PAX, MTOM < 5670 kg (12 500 lb)

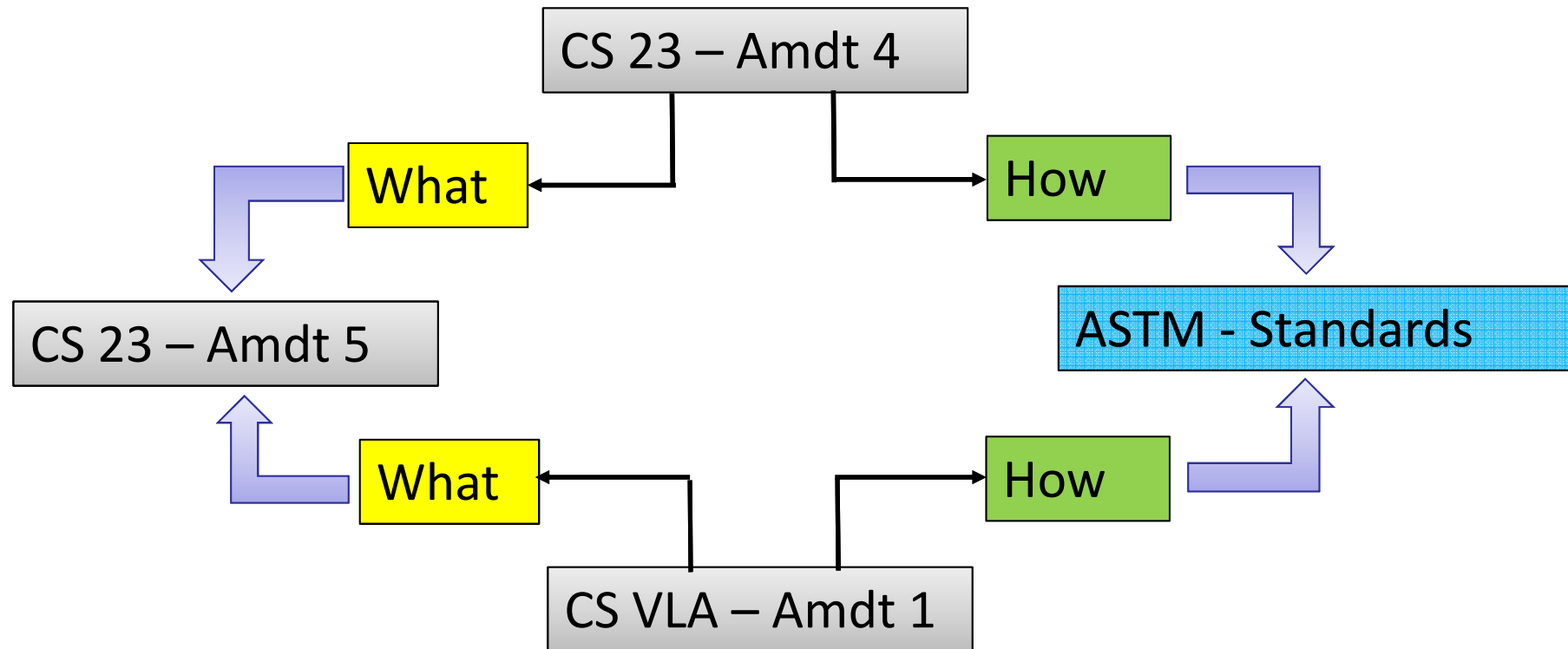
Commuter (Propeller driven, twin engine)

< 19 PAX, MTOM < 8618 kg ( 19 000 lb)





# ASTM – F44 Structures Developments





# CS-23 Amdt 5 vs ASTM. Examples

**Pre Amdt 5 CS23.307 Proof of structure**

**CS 23 Amdt 5**

**None**

**ASTM 3114-15**

**4.4 Proof of Structure:**



# CS-23 Amdt 5 vs ASTM. Examples

**Pre Amdt 5 CS23.333, 335, 341...**

**CS 23.2215** Critical flight loads are established for symmetrical and symmetrical loading from all combinations of airspeeds and load factors at and within the boundaries of the manoeuvre and **gust envelope...**

## **ASTM 3116-15**

4.4 Flight Envelope:

4.4.3 Gust Envelope:

4.6 Gust Load Factors:





# CS-23 Amdt 5 vs ASTM Examples

**Pre Amdt 5 CS 23. 561, 562, 787...**

## **CS 23.2270 Emergency conditions**

- (a) The aeroplane, even when damaged in an emergency landing, must protect each occupant against injury that would preclude egress when
  - (a) .....

## **ASTM 3116-15**

Standard Specification for Emergency Conditions, Occupant Safety and Accommodations<sup>1</sup>



# ASTM – F44 Structures Developments

- The old delimiters/criteria of **Weight**, and **Pax** have changed.
- Acceptable safety levels (Risks) defined:
  - No of people on-board (0 to 19)
  - Speed (250kts)
  - In certain Instance Weight and stall speed (Only in Standards)
- Certain Categories are removed
  - Commuter
  - Utility
  - Aerobatics (redefined)
- The design specific criteria in the new concept are moved to AMC
- **certification levels** are defined to capture the risk level associated with the number of people



# ASTM – F44 Structures Developments

## CS 23.2005 Certification of normal-category aeroplanes

(a) Certification in the normal category applies to aeroplanes with a passenger seating configuration of 19 or less and a maximum certified take-off mass of 8 618 kg (19 000 pounds) or less.

(b) Aeroplane certification levels are:

- (1) Level 1 — for aeroplanes with a max seat config of 0 to 1 pax;
- (2) Level 2 — for aeroplanes with a max seat config of 2 to 6 pax;
- (3) Level 3 — for aeroplanes with a max seat config of 7 to 9 pax; and
- (4) Level 4 — for aeroplanes with a max seat config of 10 to 19 pas

(c) Aeroplane performance levels are:

- (1) Low speed — for aeroplanes with a VNO or VMO  $\leq$  250 knots (KCAS) or a MMO  $\leq$  0.6; and
- (2) High speed — for aeroplanes with a VNO or VMO  $>$  250 KCAS or an MMO  $>$  0.6.

(d) Aeroplanes not certified for aerobatics may be used to perform any manoeuvre incident to normal flying, including:

- (1) stalls (except whip stalls); and
- (2) lazy eights, chandelles, and steep turns, in which the angle of bank is not more than 60 degrees.

(e) Aeroplanes certified for aerobatics may be used to perform manoeuvres without limitations, other than those limitations established under Subpart G.



# ASTM – F44 Structures Developments

## ➤ ASTM Objectives

- Include all existing MOC CS-23 + VLA into ASTM
- No Additional Burden for any level
- Harmonise with FAA
- Extend some of VLA concepts (level 1&2)
- Generate Simplified MOC



# ASTM – F44 Structures Developments

- F44.10 General
- F44.20 Flight
- **F44.30 Structures**
- F44.40 Powerplant
- F44.50 Systems and Equipment
- F44.90 Executive
- F44.91 Terminology
- F44.92 Regulatory Liaisons
- F44.93 Industry Liaison



# ASTM – F44 Structures Developments

## ➤ Structures Standards

- F3083/F3083M-16 Standard Specification for **Emergency Conditions**, Occupant Safety and Accommodations
- F3093/F3093M-15 Standard Specification for **Aeroelasticity** Requirements
- F3114-15 Standard Specification for Structures
- F3115/F3115M-15 Standard Specification for Structural **Durability** for Small Airplanes
- F3116/F3116M-15 Standard Specification for Design **Loads** and Conditions



# ASTM – F44 Structures Developments

## **F3083/F3083M-16 Emergency Conditions, Occupant Safety and Accommodations**

### ➤ **Additional Items**

- VLA 561(c) Engine mount and supporting structure must withstand 15 g forward for engines installed behind and above the seating compartment. Applicable to all aircraft level
- FAA Harmonised accepting **exemption** to dynamic seat test for Part 23 aircraft if VLA class (ie  $W < 750 \text{ kg}$  (1653 lb) and  $V_{\text{stall}} < 83 \text{ km/h}$  (45 kts).
- Former “***Commuter category***” requirement for doors and emergency exits modified to be consistent with removal of “***Commuter***”



# ASTM – F44 Structures Developments

## **F3083/F3083M-16 Emergency Conditions, Occupant Safety and Accommodations**

### ➤ **Future Developments**

- Simplified methods for Level 1 & 2 aircraft for alternative to dynamic seats
  - Emphasis on mitigating safety features
  - Maintain survival volume
  - Maintaining head flair safe envelope
  - Improvements to restrain system:
    - Single point release
    - Multi point restraint
    - Restrain systems that avoid Submarining
    - Use of Airbags
    - Maybe adopt other standards ( SAE 8043B/ TSO)





# ASTM – F44 Structures Developments

CS 23 & Part23 Amd 62	F3083	Other			
23.561	4.1		23.787(a)	5.3.1	
23.562(a)	4.2.1		23.787(b)	5.3.2	
23.562(b)	4.2.2			5.3.2.1	CS-VLA 787(e)
23.562(c)	4.2.3		23.803	5.4	
23.562(d)	4.2.4		23.805(a)	5.5.1.1	
--	4.2.5	CS-VLA 785	23.805(b)	5.5.1.2	
23.562(e)	4.2.6		23.805(c)	5.5.1.3	
23.785(a)	5.1.1.1		23.787(c)	5.5.1.4	
23.785(b)	5.1.1.2		23.807	5.6	
23.785(c)	5.1.1.3		23.811	5.7	
23.785(d)	5.1.1.4		23.812	5.8	
23.785(e)	5.1.1.5		23.791	5.9	
23.785(f)	5.1.1.6		23.813	5.10	
23.785(g)	5.1.1.7		23.815	5.11	
23.785(h)	5.1.1.8		23.851	6.1	
23.785(i)	5.1.1.9		23.853(a)	6.2.1.1	
23.785(j)	5.1.1.10		23.853(c)	6.2.1.2	
23.785(k)	5.1.1.11		23.853(d)	6.2.1.3	
23.785(l)	5.1.1.12		23.853(f)	6.2.1.4	
23.785(m)	5.1.1.13		23.855(b)	6.3.1	
23.785(n)	5.1.1.14		23.855(c)	6.3.2	Note: This paragraph split with systems
23.783(a)	5.2.1		23.856	6.4	
23.783(b)	5.2.2		23.1411	7.1	
23.783(f)	5.2.3		23.1415	7.2	
23.783(g)	5.2.4		--	Appendix	AMC VLA 785



# ASTM – F44 Structures Developments

## **F3093/F3093M-15 Specification for Aeroelasticity Requirements**

- **No changes**, VLA and CS-23 transposed to new Standard
- **Future Developments**
  - Main objective is to increase safety by taking advantage of latest technology and make it more accessible / min cost.
    - Taking into account Modern/Novel designs (high aspect ratio ( $b^2/S$ ), highly swept, Composite)
  - Discussions and applicability of Reports:
    - “Aeroelastic Flutter Prevention in Gliders and Small Aircraft” by Stender & Kiessling,
    - Report 45 – Simplified Flutter Prevention Criteria (1955)
  - Discussions among International Flutter experts continues...



# ASTM – F44 Structures Developments

	F3093		
CS-23 & Part 23 Amd 62	ASTM F44 specs-23	CS-23 & Part 23	ASTM F44 spec
23.629(a)	F3093 4.1	23.629(e)	F3093 4.5
23.629(a)(1)	F3093 4.1.1	23.629(e)(1)	F3093 4.5.1
23.629(a)(2)	F3093 4.1.2	23.629(e)(2)	F3093 4.5.2
23.629(b)	F3093 4.2	23.629(f)	F3093 4.6
23.629(b)(1)	F3093 4.2.1	23.629(f)(1)	F3093 4.6.1
23.629(b)(2)	F3093 4.2.2	23.629(f)(2)	F3093 4.6.2
23.629(b)(3)	F3093 4.2.3	23.629(g)	F3093 4.7
23.629(b)(4)	F3093 4.2.4	23.629(h)	F3093 4.8
23.629(c)	F3093 4.3	23.629(i)	F3093 4.9
23.629(d)	F3093 4.4	n/a	F3093 4.10
23.629(d)(1)	F3093 4.4.1	n/a	F3093 4.10.1
23.629(d)(2)	F3093 4.4.2	n/a	F3093 4.10.2
23.629(d)(3)	F3093 4.4.3	n/a	F3093 4.10.3
23.629(d)(3)(i)	F3093 4.4.3	n/a	F3093 4.10.4
23.629(d)(3)(ii)	F3093 4.4.3		
23.629(d)(3)(iii)	F3093 4.4.3		



# ASTM – F44 Structures Developments

## F3114-15 Specification for Structures

### ➤ No changes

- Included AMC VLA 613 (c) Solar Absorptivity Design Values.
- Appendix F – Burn Standard has been moved to another ASTM Standard

### ➤ Future Developments

- Interaction of Systems and Structures
- Inclusion of AMC Appendix K Factors/Failure rates
- Section 4.9 Testing of “Questionable Design” Old 23.601, under further discussion to Expand *MOC*

*4.9 Testing—The suitability of each questionable design detail and part having an important bearing on safety in operations must be established by tests.*



# ASTM – F44 Structures Developments

CS-23 & Part 23 Amd 62	ASTM F44 Specification for Structures
23.301 (a)	4.1
23.303	4.2
23.305	4.3
23.307	4.4
23.251	4.5
23.302	4.6
23.775	4.7
23.721	4.8
23.601	4.9
23.641	4.9.1.1
23.651(a)	4.9.2.1
23.651(b)	4.9.2.2
23.843(a)	4.9.3
23.23(b)(2)	5.1
23.871	5.2
23.603	6.1
23.605	6.2
23.613	6.3
23.607	7.1
23.609	7.2
23.611	7.3
23.865	7.4
23.619	8.1
23.621	8.2
23.623	8.3
23.625	8.4
AMC VLA 615 and 619	8.5



# ASTM – F44 Structures Developments

## **F3115/F3115M-15 Specification for Structural Durability for Small Airplanes**

### ➤ **Some changes,**

- Low Stress levels VLA not include yet, ... further work
- ANC-18 'Design of wood aircraft structures moved to a practice
- Section 6 defines better “Bonded Structure Residual Strength”

### ➤ **Future Developments**

- Addition of VLA AMC for “Low Stress” certification methodology, some stress levels are changing.
- Low stress level discussion and life limits.
- Addition of an enhanced overload static test that justifies a structure as “low stress”;
  - Different factors for composite and metallic structure



# ASTM – F44 Structures Developments

## **F3115/F3115M-15 Specification for Structural Durability for Small Airplanes**

### ➤ **Cont ... Future Developments**

- Harmonisation of Scatter Factors (FAA/EASA)
- Aerobatic A/c excluded from Low Stress Compliance
- Non Harmonised Item, Fatigue requirement for
  - Landing Gear and Engine mounts
  - Item under Discussion (EASA/FAA)



# ASTM – F44 Structures Developments

	F3115
CS23 & Part 23 Amd 62	ASTM F44 specification F3115 – 15
23.571(a)	4.2.1, 4.4
23.571(b)	4.2.1, 4.5
23.571(c)	4.2.1, 4.6
23.571(d)	4.2.2
23.572(a)	4.3.1, 4.5, 4.6
23.572(b)	4.3.2
23.573(a)	5
23.573(b)	4.6
23.575	7





# ASTM – F44 Structures Developments

## **F3116/F3116M-15 Specification for Design Loads and Conditions**

### ➤ **Minor changes**

- Included Appendix A – Simplified Design Load Criteria
- Engine Gyroscopic Loads included for VLA type a/c
- Slight difference in VLA type a/c fuel loads.
- As Utility category not exists
  - Min Cruise design speed not  $1.5 V_c$  min for a/c designed for spinning and steep turns (60 – 90 degs)

### ➤ **Future Developments**

- Low level activity, mainly finding inconsistencies (New CS-23/Part 23)
- Loading conditions due to Electric Motors and other propulsion means



# ASTM – F44 Structures Developments

Reg	CS-23 & Part 23 Title	F3116 Section	Reg	CS-23 & Part 23 Title	F3116 Section
<a href="#">Sec. 23.301</a>	Loads.	4.1	<a href="#">Sec. 23.473</a>	Ground load conditions and assumptions.	8.2
<a href="#">Sec. 23.321</a>	General.	4.2	<a href="#">Sec. 23.477</a>	Landing gear arrangement.	8.3
<a href="#">Sec. 23.331</a>	Symmetrical flight conditions.	4.3	<a href="#">Sec. 23.479</a>	Level landing conditions.	8.4
<a href="#">Sec. 23.333</a>	Flight envelope.	4.4	<a href="#">Sec. 23.481</a>	Tail down landing conditions.	8.5
<a href="#">Sec. 23.335</a>	Design airspeeds.	5.1	<a href="#">Sec. 23.483</a>	One-wheel landing conditions.	8.6
<a href="#">Sec. 23.337</a>	Limit maneuvering load factors.	4.5	<a href="#">Sec. 23.485</a>	Side load conditions.	8.7
<a href="#">Sec. 23.341</a>	Gust load factors.	4.6	<a href="#">Sec. 23.493</a>	Braked roll conditions.	8.8
<a href="#">Sec. 23.343</a>	Design fuel loads.	4.7	<a href="#">Sec. 23.497</a>	Supplementary conditions for tail wheels.	8.9
<a href="#">Sec. 23.345</a>	High lift devices.	4.8	<a href="#">Sec. 23.499</a>	Supplementary conditions for nose wheels.	8.10
<a href="#">Sec. 23.347</a>	Unsymmetrical flight conditions.	4.9	<a href="#">Sec. 23.505</a>	Supplementary conditions for skiplanes.	8.11
<a href="#">Sec. 23.349</a>	Rolling conditions.	4.10	<a href="#">Sec. 23.507</a>	Jacking loads.	8.12
<a href="#">Sec. 23.351</a>	Yawing conditions.	4.11	<a href="#">Sec. 23.509</a>	Towing loads.	8.13
<a href="#">Sec. 23.361</a>	Engine torque.	6.1	<a href="#">Sec. 23.511</a>	[Ground load; unsymmetrical loads on multiple-wheel units.]	8.14
<a href="#">Sec. 23.363</a>	Side load on engine mount.	6.2	<a href="#">Sec. 23.521</a>	Water load conditions.	9.1
<a href="#">Sec. 23.365</a>	Pressurized cabin loads.	4.12	<a href="#">Sec. 23.523</a>	Design weights and center of gravity positions.	X7.1
<a href="#">Sec. 23.367</a>	Unsymmetrical loads due to engine failure.	4.13	<a href="#">Sec. 23.525</a>	Application of loads.	X7.2
<a href="#">Sec. 23.369</a>	Rear lift truss.	4.14	<a href="#">Sec. 23.527</a>	Hull and main float load factors.	X7.3
<a href="#">Sec. 23.371</a>	Gyroscopic and aerodynamic loads.	6.3	<a href="#">Sec. 23.529</a>	Hull and main float landing conditions.	X7.4
<a href="#">Sec. 23.373</a>	Speed control devices.	4.15	<a href="#">Sec. 23.531</a>	Hull and main float takeoff condition.	X7.5
<a href="#">Sec. 23.391</a>	Control surface loads.	7.1	<a href="#">Sec. 23.533</a>	Hull and main float bottom pressures.	X7.6
<a href="#">Sec. 23.393</a>	Loads parallel to hinge line.	7.2	<a href="#">Sec. 23.535</a>	Auxiliary float loads.	X7.7
<a href="#">Sec. 23.395</a>	Control system [loads.]	7.3	<a href="#">Sec. 23.537</a>	Seawing loads.	X7.8
<a href="#">Sec. 23.397</a>	Limit control forces and torques.	7.4	<a href="#">Sec. 23.753</a>	Main float design <= Design and Construction Subpart	9.1.3
<a href="#">Sec. 23.399</a>	Dual control system.	7.5	<a href="#">Sec. A23.1</a>	General.	X1.1
<a href="#">Sec. 23.405</a>	Secondary control system.	7.6	<a href="#">Sec. A23.3</a>	Special symbols.	X1.2
<a href="#">Sec. 23.407</a>	Trim tab effects.	7.7	<a href="#">Sec. A23.5</a>		n/a
<a href="#">Sec. 23.409</a>	Tabs.	7.8	<a href="#">Sec. A23.7</a>	Flight loads.	X1.3
<a href="#">Sec. 23.415</a>	Ground gust conditions.	7.9	<a href="#">Sec. A23.9</a>	Flight conditions.	X1.4
<a href="#">Sec. 23.421</a>	Balancing loads.	4.16	<a href="#">Sec. A23.11</a>	Control surface loads.	X2.2
<a href="#">Sec. 23.423</a>	Maneuvering loads.	4.17	<a href="#">Sec. A23.13</a>	Control system loads.	X3.2
<a href="#">Sec. 23.425</a>	Gust loads.	4.18	<a href="#">Sec. B23.1</a>	Added back in from CS-VLA	X4.1
<a href="#">Sec. 23.427</a>	Unsymmetrical loads.	4.19	<a href="#">Sec. B23.11</a>	Added back in from CS-VLA	X4.2
<a href="#">Sec. 23.441</a>	Maneuvering loads.	4.20	<a href="#">Sec. C23.1</a>	Basic landing conditions.	X5.1
<a href="#">Sec. 23.443</a>	Gust loads.	4.21	<a href="#">Sec. D23.1</a>	Wheel spin-up loads.	X6.1
<a href="#">Sec. 23.445</a>	Outboard fins or winglets.	4.22	<a href="#">Sec. I23</a>	[Seaplane loads.]	X7.3.3 X7.6.3



# ASTM – F44 Structures Developments

- **Generic Overview of what was and what is now**
- **Only main differences identified (...*disclaimer*)**
- **Future work Items simply main topics presented**
- **Additional work continues in**
  - **Include Simplified methods for Compliance**
  - **Include Versatility for Future Technologies**
  - **Develop “Practises and Guides”**
    - **Practise eg. Wood/Composites/ Critical parts classification**
    - **Guides eg. Additive manufacture/FE Model Validation**



# ASTM – F44 Structures Developments

## Concerns....

- **Limited EU participation at present**
- **You want to keep in Touch/Contribute/Affect ASTM workings .... Then become a Member and participate!**
  - **Face to Face**
  - **Webex**
  - **Get Voting rights**



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**Thank you for your attention!**



Any questions....?

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