

# GromEx<sup>®</sup>

## HOLE REINFORCEMENT FOR COMPOSITES



### BENEFITS:

- Protects laminate in areas where bare holes can wear or elongate
- Improves lightning strike performance
- Can be used to facilitate the installation of interference-fit fasteners in load transfer applications
- Enhances electrical conductivity of joints
- Improves joint durability
- Fast, reliable installation
- Sealant and adhesive-free process



Enables the use of interference-fit fasteners in composites and provides better lightning strike performance

**FTI**<sup>®</sup>  
FATIGUE TECHNOLOGY

# GromEX<sup>®</sup>

## WHY USE GROMEX IN COMPOSITES?

FTI's GromEx system is a cost-effective method for reinforcing fastener holes in composite materials using a thin interference-fit metal sleeve or grommet. GromEx is based on FTI's proven cold expansion technology and is designed specifically for use in composites. The amount of radial expansion of the grommet in the hole is carefully tailored to ensure adequate grommet retention and at the same time prevent localized damage to the composite.

**The GromEx system is easier to install, more reliable, and has improved performance over adhesive-bonded grommets.**

**Some of the benefits include:**

### **Initial clearance fit of grommet:**

- Ease of installation
- Prevents installation damage

### **Installation without adhesives or sealants:**

- Significant installation labor savings
- Reliable, better process control
- No messy compounds or cure procedures
- Assured grommet concentricity in hole
- Dry installation enhances conductivity

### **Quality installation:**

- Consistent fit
- Can be used in a wide range of composites

### **Improved damage tolerance:**

- No fastener installation and removal damage
- Enhanced resistance to lightning strike damage

GromEx is versatile. It can be used in a broad range of composite laminates with various NAS or other fastener types. GromEx can be used with any standard fastener head configuration, including 100° or 130° countersink and protruding configurations.

The FTI GromEx system is a total package of integrated technology and tooling backed by FTI's specialized engineering and comprehensive technical support and training programs.

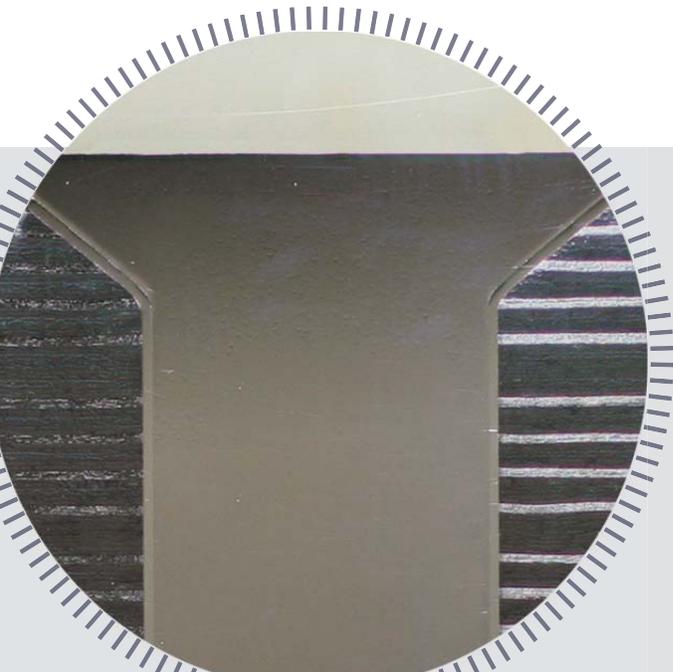


*Materials: Titanium and stainless steel*

## **Interference-Fit Provides High Retention Performance**

GromEx grommets maintain excellent retention in composite holes even after interference-fit fasteners are removed.

This retention performance was tested by pushing the GromEx grommet out of the hole with a close-tolerance step pin and recording the maximum force necessary for removal. It took several hundred pounds of force to remove the grommet. Although the force required to remove the grommet from the composite was less than the force required to remove the fastener from the grommet, the interference of the grommet itself in the hole and the higher coefficient of friction between the grommet and the composite layers ensures retention of the grommet in the hole.



## **LAMINATE INTEGRITY**

The installation of GromEx liners shows no harmful damage to the integrity of the composite laminate.

Post-installation microscopic inspections of the laminate (as shown in the image on the left) have in some instances shown interlamina defects. However, these defects were typically less than the manufacturing allowables for composite hole drilling and machining.

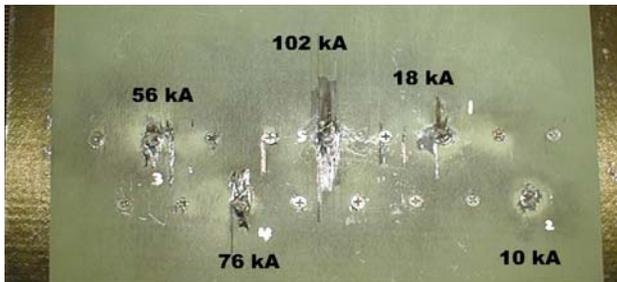
*Cutaway of fastener installed into GromEx grommet in composite.*

# BETTER LIGHTNING STRIKE PERFORMANCE AND ELECTRICAL CONDUCTIVITY

## GromEx lessens lightning strike damage to composite panels compared to glued-in liners

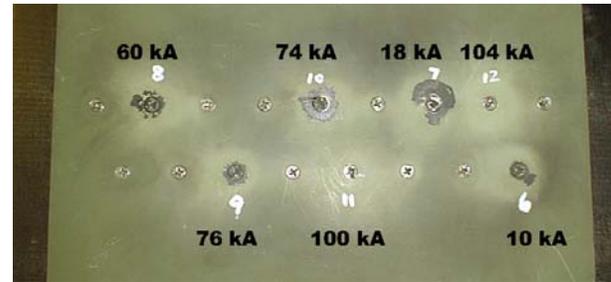
A major concern of manufacturers of composite aircraft structures is lightning strike performance. How lightning will be conducted through the structure, especially around fuel tanks, requires careful consideration. Fasteners usually provide less resistance than the surrounding composite skin panels, resulting in more current passing through the fasteners. This can result in arcing at the fastener, collar, or nut interfaces within the internal structure. It can also result in damage to the composite skins immediately surrounding the fasteners. FTI performed extensive lightning strike tests to evaluate different fastening systems using GromEx grommets.

### Glued-in Liners



IM6/3501-6 carbon/epoxy panel with glued-in or swaged-in liners is damaged by 10kA strike on liner. Extensive damage noted at 102kA.

### GromEx



Same panel material and dimensions as the first photo except GromEx cold expanded grommets were used and the strike was increased 10-fold to 100kA with significantly less damage.

## GromEx improves the electrical conductivity between fasteners and the composite structure

GromEx's electrical conductivity was evaluated prior to performing another set of lightning strike tests. The baseline specimens, which had Hi-Lok fasteners installed had an average resistance of 137 milli-ohms while the GromEx configurations with interference-fit fasteners installed had an average resistance of 3 milli-ohms. This shows that the GromEx installation has better electrical conductivity than the Hi-Lok fasteners.

## Further testing proves GromEx's outstanding lightning strike performance

GromEx was tested again using three fastening configurations (see data below). The test panels were designed to be representative of fastening systems that are used in composite wing integral fuel tanks, with the aluminum sub-structure on the internal surface of the panel.

After completing the tests, the GromEx panels had considerably less laminate damage than the typical clearance-fit Hi-Lok baseline system. The GromEx panels also showed the ability to be struck with a higher electrical current without sparking than the Hi-Lok panels. This improved performance stems from the interference of both the GromEx installation and the fastener in the joint. Moreover, interference-fit fasteners combined with GromEx eliminate gaps that could cause sparking during the lightning strike.

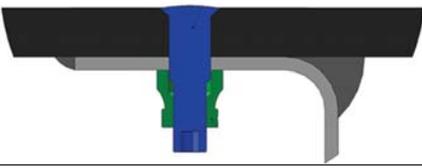
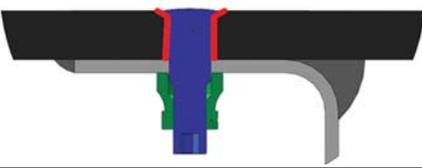
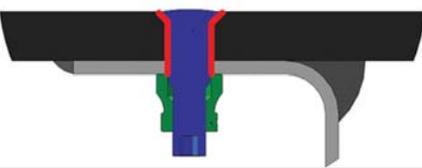


Test #2 - Baseline panel sparking during Zone 1A strike (200 kA).

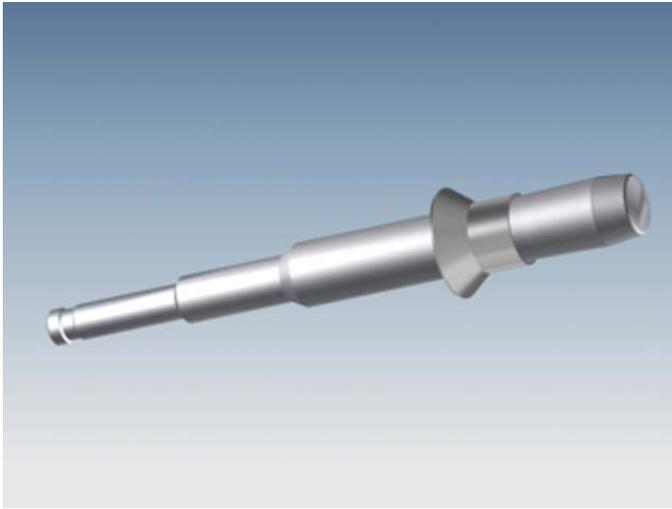


Test #2 - GromEx did not spark until 120% of Zone 1A strike (240 kA).

The baseline specimen (Panel A) consisted of a typical clearance-fit Hi-Lok system with wet-installed fasteners through a composite panel and aluminum sub-structure secured with collars on the backside. The other two specimens (Panel B and Panel C) had GromEx installed dry and cold expanded into the parent material, which provided intimate contact between the metal GromEx grommets and the composite. Panel B's GromEx were installed only in the composite panel while Panel C's GromEx extended through both the composite panel and the aluminum sub-structure. Interference-fit Hi-Lok fasteners were installed in both GromEx panels and secured with Hi-Lok collars. The primary success criterion of the lightning strike testing was no arcing at the fastener interfaces. The baseline Hi-Lok fastener exhibited sparking on the internal surface during a Zone 1A (200 kA) strike. The GromEx panels did not exhibit sparking until they were hit with a 240 kA strike, which is above the required current for a Zone 1A strike. (FTI Report #348962)

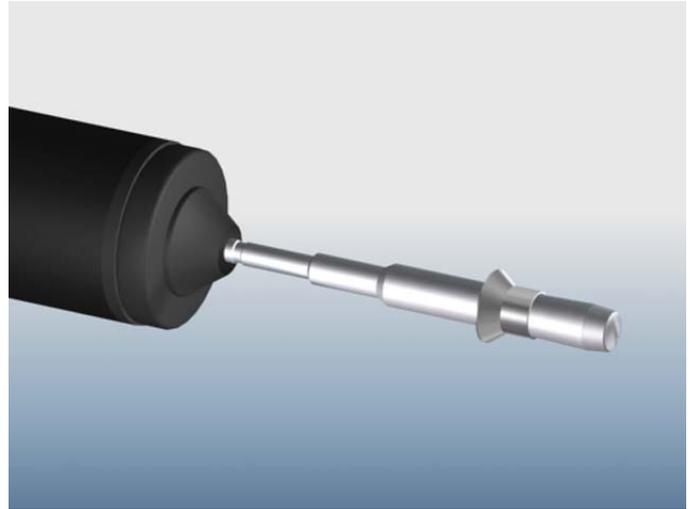
Panel Configuration	Fastener Fit	Zone	Strike Time	Spark	Estimated Damaged Area Near Strike inch <sup>2</sup> (mm <sup>2</sup> )
<b>Panel A:</b> Baseline 	Clearance	2A, 100 kA	1st Strike	No	1.15 (741)
		1A, 200 kA	1st Strike	Yes	6.57 (4240)
		1A, 200 kA	2nd Strike	Yes	1.78 (1152)
<b>Panel B:</b> GromEx through Panel 	Interference	2A, 100 kA	1st Strike	No	0.24 (152)
		1A, 200 kA	1st Strike	No	1.87 (1204)
		1A+, 240 kA	2nd Strike	No	1.97 (1270)
		1A+, 240 kA	2nd Strike	Yes	3.67 (2370)
<b>Panel C:</b> GromEx through Joint 	Interference	2A, 100 kA	1st Strike	No	0.30 (194)
		1A, 200 kA	1st Strike	No	3.31 (2138)
		1A+, 240 kA	2nd Strike	Yes	4.05 (2614)
		1A+, 240 kA	2nd Strike	No	2.95 (1904)

# QUICK AND SIMPLE INSTALLATION PROCEDURE



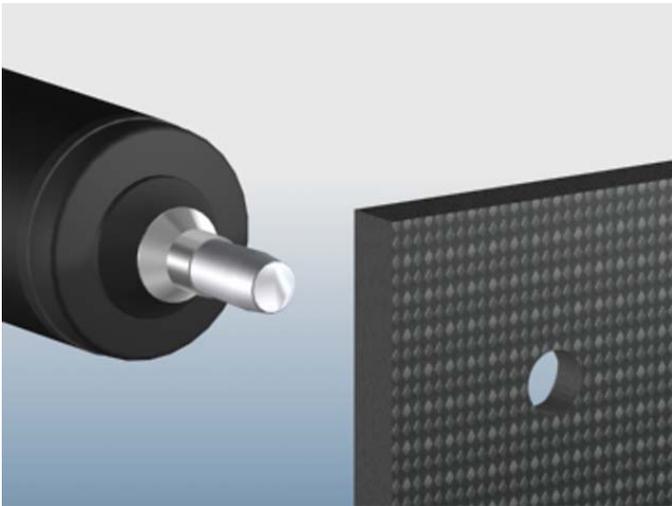
## Step 1.

Slide grommet onto mandrel.



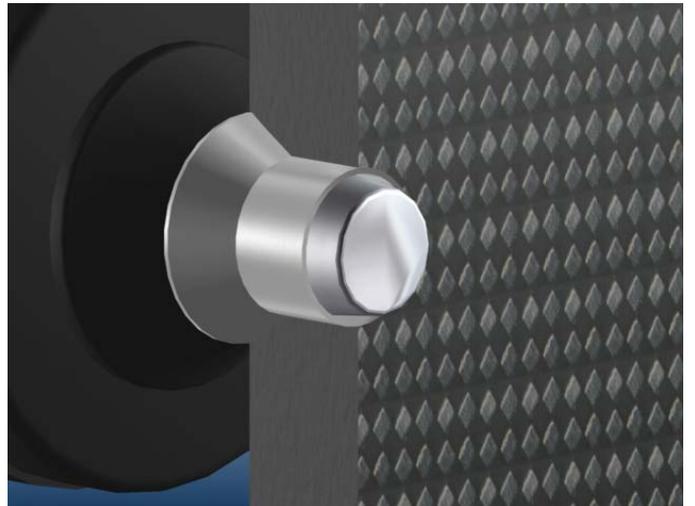
## Step 2.

Insert mandrel into FTI puller unit.



## Step 3.

Insert grommet and mandrel into the open hole.



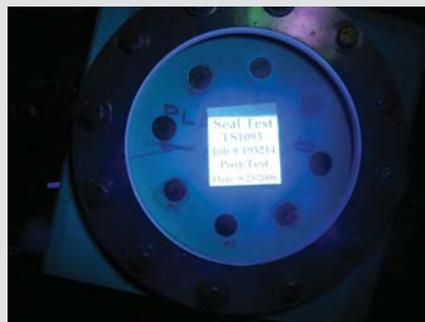
## Step 4.

Activate puller to expand the grommet in the hole.

## NO FUEL LEAKS

FTI performed fuel seal testing using a pressure pot assembly that conformed to MIL-STD-1312-19A. GromEx grommets were installed into a test plate that was bolted to the pressure pot assembly.

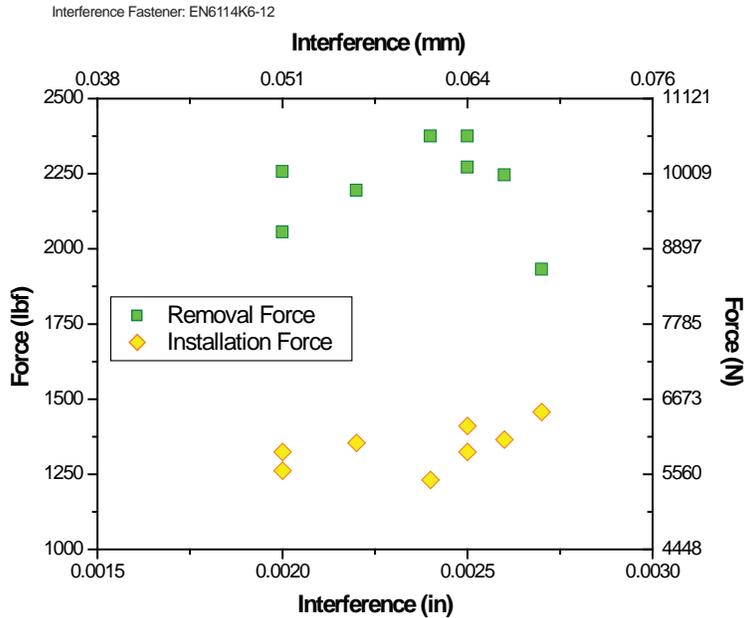
The GromEx grommets were installed with and without primer and interference-fit fasteners were installed into the GromEx grommets with and without sealant. The pressure pot was filled with fluids that were mixed with oil-soluble fluorescent dye. Both a static test to 17 psi (117 kPa) and a dynamic test to 50 psi (345 kPa) for 100 cycles were performed. None of the fastener configurations showed signs of leakage at any time in the testing.



Post-fuel seal leak test images showing no leaks to GromEx installations.

## Repeat Fastener Installations

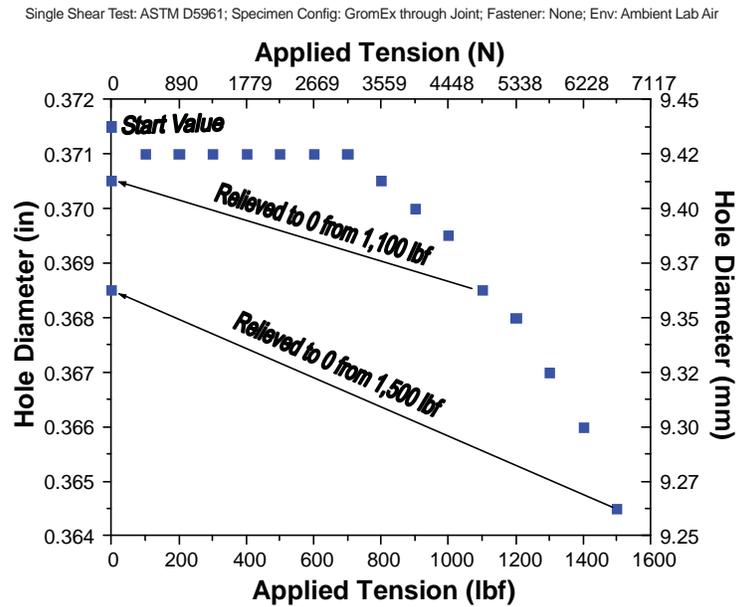
A unique characteristic of the GromEx system is that it allows repetitive interference-fit fastener installation and removal without requiring any additional machining or re-work of the hole. Fasteners maintained consistent installation and removal forces after multiple re-installations without dislodging the GromEx grommet. Also, the grommet inner diameter stayed within the dimensions required for the designed interference of the fastener.



Fastener installation and removal forces for multiple iterations of interference-fit fastener into GromEx grommet. (FTI Report #313678)

## Resistant To Applied Loads Even Without Fasteners Installed

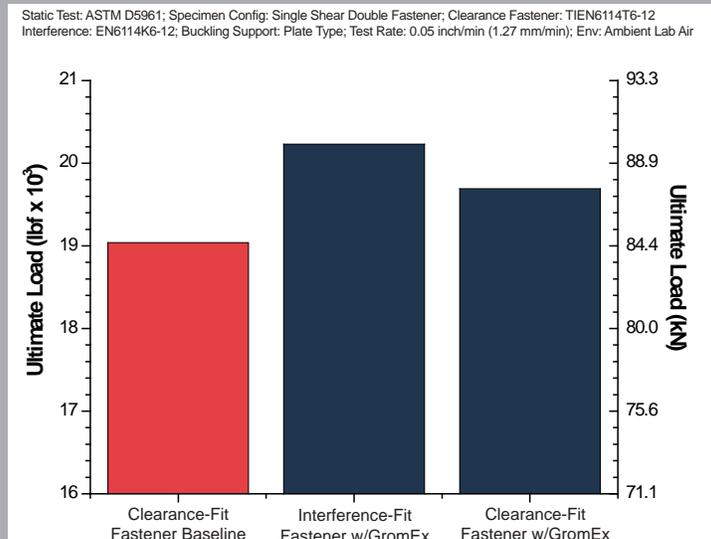
In certain situations, it may be necessary to transport an assembly that has GromEx installed without fasteners in the grommets. Static testing proved that GromEx grommets could withstand significant loading and maintain integrity without a fastener installed.



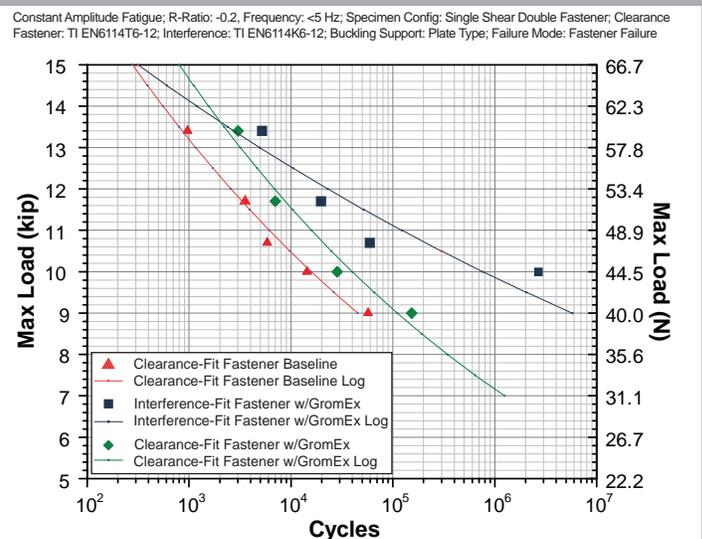
Double-fastener single shear test where grommets were installed through both halves of the specimen with no fasteners installed. (FTI Report #313678)

## IMPROVED STATIC AND FATIGUE PERFORMANCE

FTI also performed mechanical testing to compare the performance of fasteners installed into GromEx grommets and fasteners installed into bare holes. These included both static and dynamic tests, using single-shear specimens per ASTM D5961. The results of this testing show that the use of GromEx does not impair and can actually improve product life over bare-hole configurations.



GromEx static test results. (FTI Report #313678)



GromEx dynamic test results. (FTI Report #313678)

FTI designs and manufactures a full range of cold expansion products for the aerospace industry. These products are specifically engineered to achieve aircraft production and cost initiatives; meet design goals, production rates, and aircraft performance objectives; and provide life-cycle cost savings.

Here are some of FTI's other innovative products:



### ForceMate®

#### Bushing Installation System

- Reduces labor time and installation costs
- Consistent interference fit damage tolerance of holes
- Resists migration and rotational forces
- Improves fatigue life and damage tolerance of parent structure
- Superior installation reliability



### ForceTec®

#### Rivetless Nut Plate

- Fast, consistent installation
- Meets or exceeds NASM25027
- Easily replaceable nut element – sealed or non-sealed
- Resists lightning strike damage in composite structures



### TukLoc®

#### Blind Fastening System

- Easy hole preparation
- No additional sealants required
- Rapid installation
- Highly reliable process



### Flexmate®

#### Advanced Aerospace Fitting

- Fatigue life improvement
- Simple one-piece design
- Minimum envelope
- Minimum weight
- Excellent sealing and electrical conductivity



FTI's corporate headquarters and manufacturing plant is located just 5 minutes from the Sea-Tac International Airport and 10 minutes from downtown Seattle, Washington.

## FTI SERVICES

Fatigue Technology is the world leader in cold expansion technology. We have pioneered this science since 1969 and have advanced the cold expansion process to develop cost savings ideas for production simplification, manufacturing and maintenance time-saving, and improved aircraft structural performance. We offer our customers a full range of services to support their applications.

#### THESE SERVICES INCLUDE:

- On-site product support
- Technical training
- Engineering/design support
- Product and materials testing
- Research and development services
- Field repairs and upgrades

Please contact us to discuss your current application.



**FATIGUE TECHNOLOGY**

A PCC Company

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