Testing Be certain.

Downhole Test Tool Experience in HPHT and Hostile Environments

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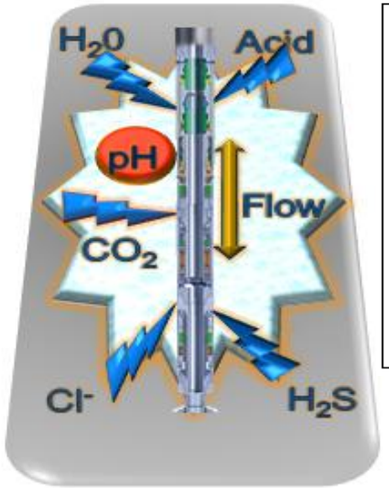
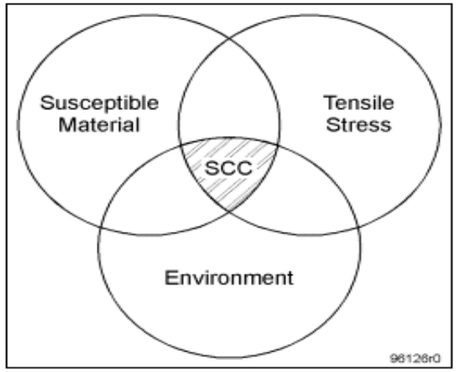
Why are HP, HT, and Sour Environments Different?

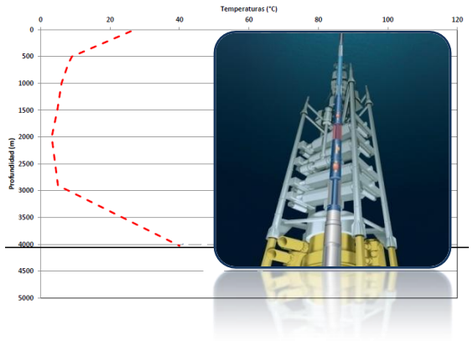
- Metallurgy
  - Yield strength
  - Corrosion resistance
    - Sulfide-stress cracking (SSC)
    - Stress-corrosion cracking (SCC)

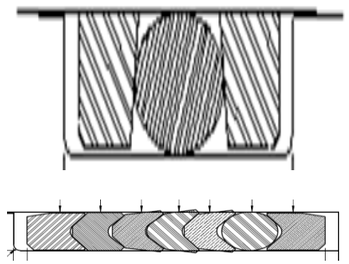




NACE INTERNATIONAL
ANSI/NACE MR0175/ ISO 15156-1

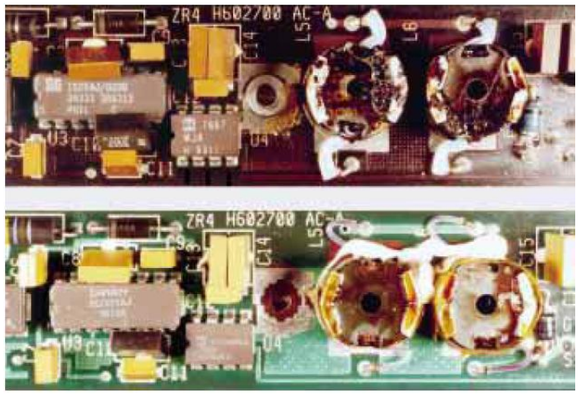
- Elastomers
  - Low- and high-temperature sealing
  - Explosive decompression
  - Chemical resistance
  - Dynamic or static





NBR, HNBR	FKM (Viton®, Fluorel®)	FEPM (Aflas®)	FFKM (Chemraz®, Kalrez®)

- Electronics and batteries
  - Stability
  - Longevity



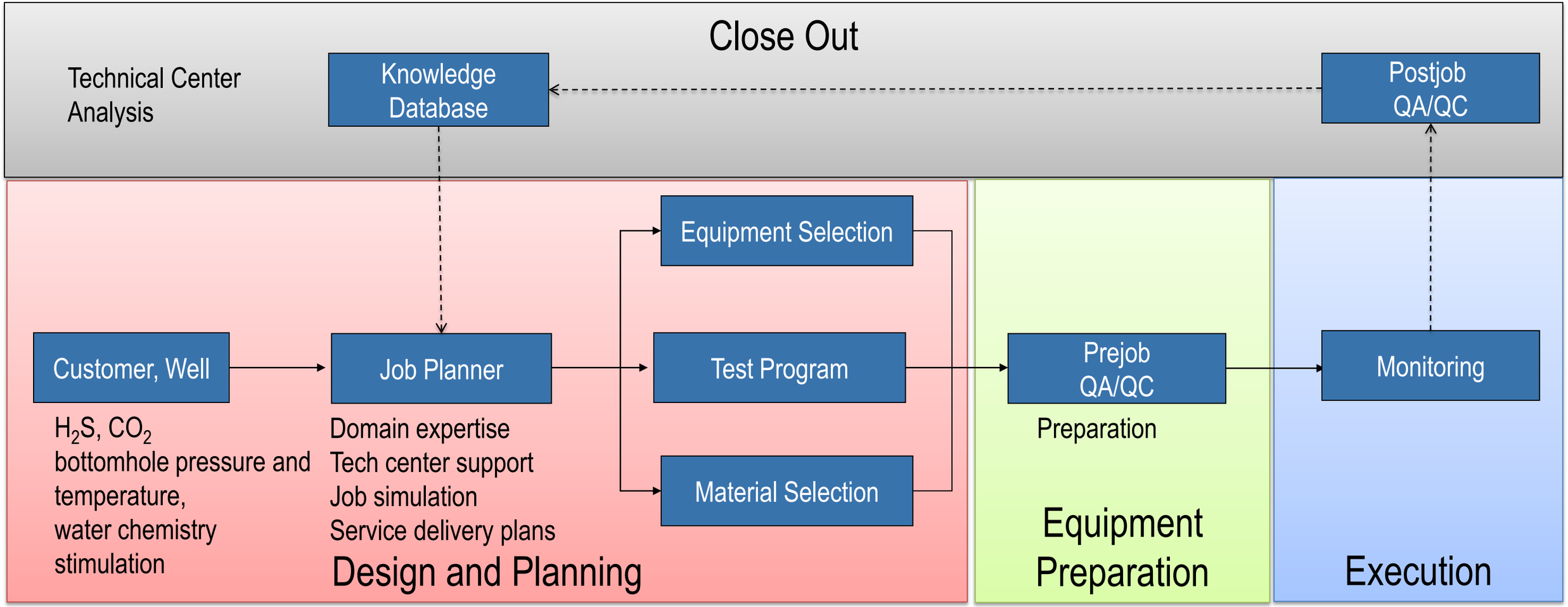
Temperature effects on logging tool circuits. The damaging effects of high temperature on electronics can be seen by comparing a scorched circuit board (top) from a tool that was exposed to 350°F bottomhole temperatures with a new board (bottom).

Hostile Regions

H_2S, %	CO_2, %	Pressure, psi	Temperature, degF
0	70	11,000	230
1	20	6,000	350
1	25	6,500	330
3	10	12,000	400
5	5	10,000	350
5	10	5,000	230
15	10	7,000	270
20	6	11,000	230
20	2	17,000	360
30	10	6,000	300
>46	>52	5,500	230
50	24	15,000	340

Approach to Hostile Environments

A Complex Problem Made Manageable With the Right Process



Hostile Well Test Operation

Objective
Perform two downhole test runs, testing and sampling two zones per run, without pulling out the string.

Design parameters
Downhole conditions included 5,500-psi pressure, 290-degF temperature, 25% H_2S, and 10% CO_2 for 30 days

Solution

Use customized downhole test string that included ultraHPHT DST tools with special seals for sour service and inline fluid reservoir sampling tools

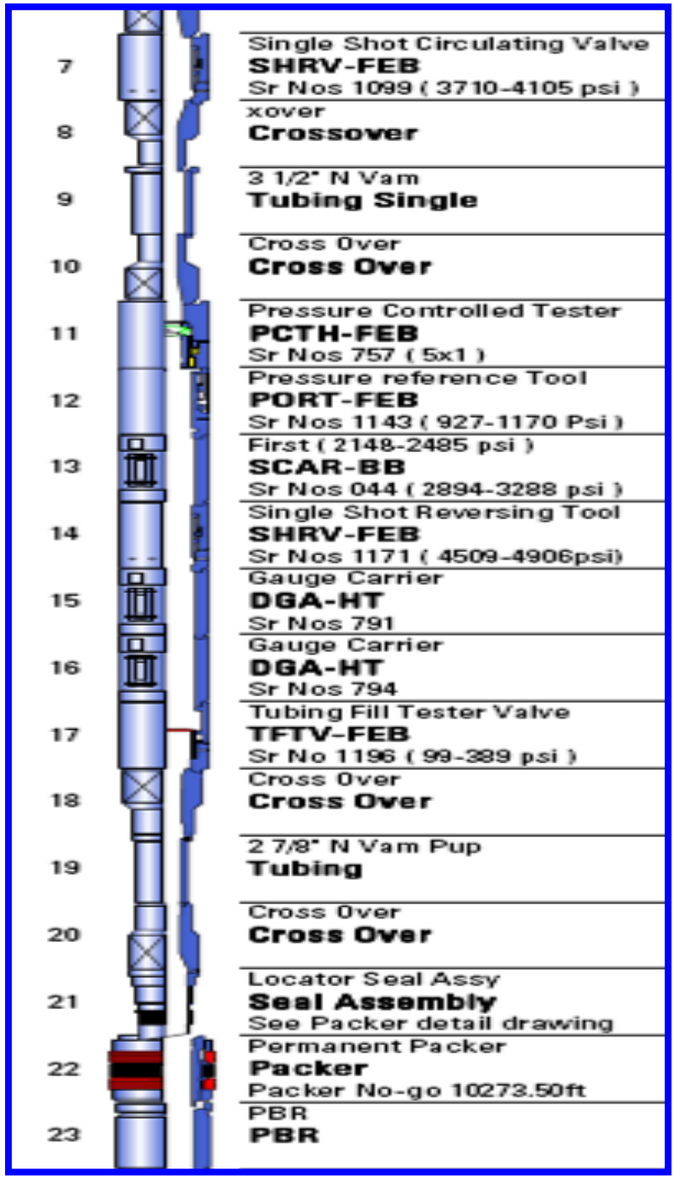
Well configuration

Permanent packer, safety valve, and wellhead in place

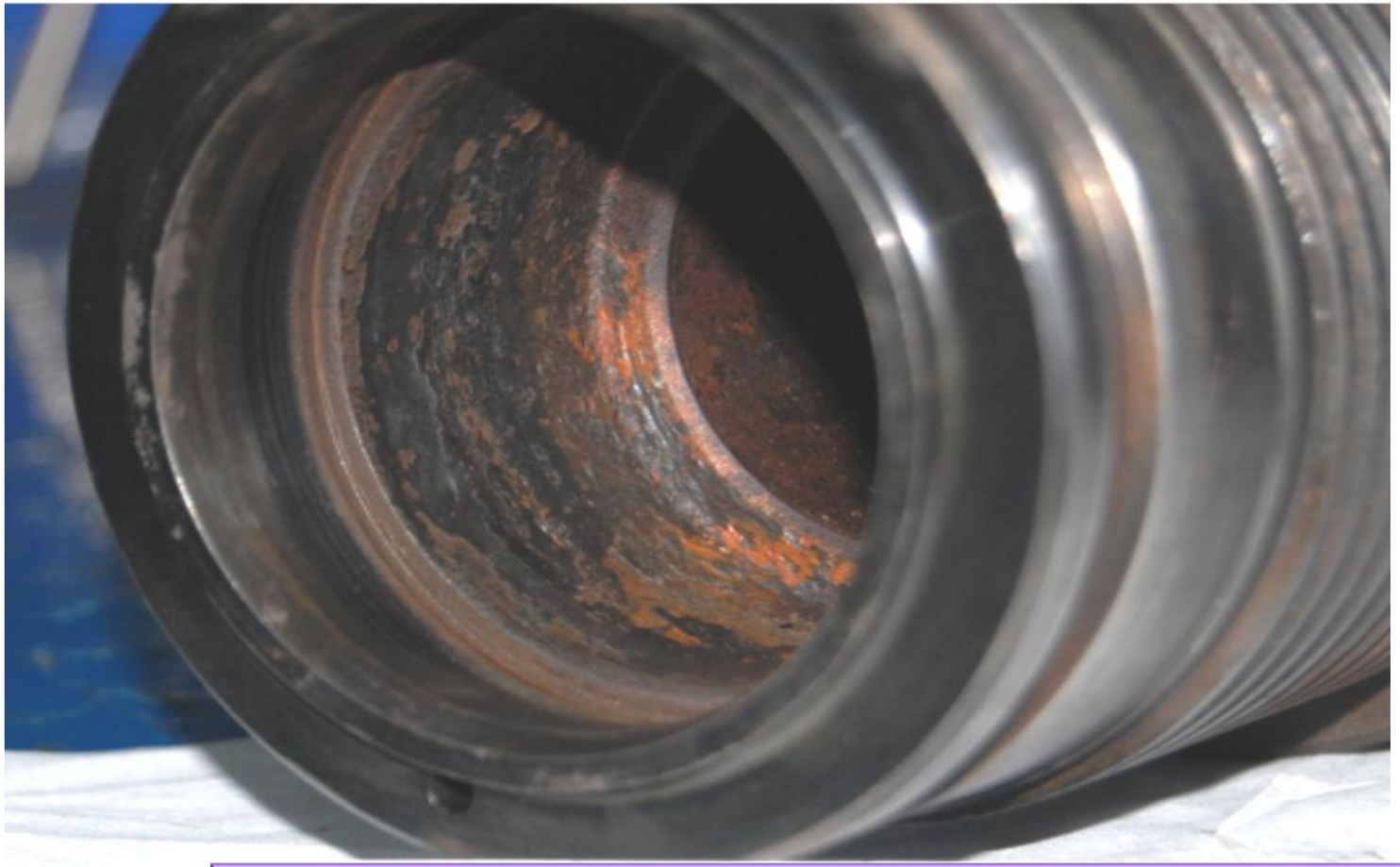
Procedures

- Run downhole test string with seal assembly.
- Perforate through tubing with wireline in first zone
- Stimulate with coil tubing (acid job)
- Test and sample
- Run coil tubing and cement-plug first zone
- Repeat the process for second zone
- Pull out of hole
- Follow the same method for second DST with new string

Source: Hollaender, F., Salsman, A. and Ali Neyaei, F.: "Multizone Well Testing with Downhole Tools in Extreme Sour-Gas Conditions," paper SPE SAS-716, 2011.



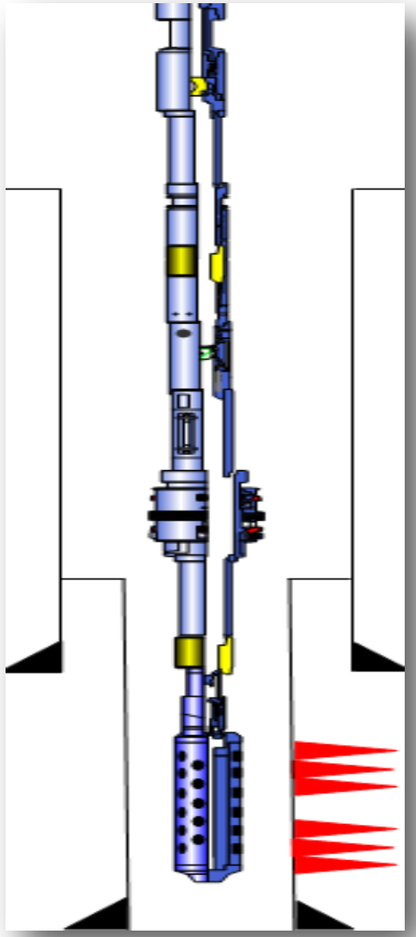
Postjob Inspections



Component exposed to 290 degF, 5,500 psi, 25% H_2S, and 10% CO_2 for 720 h

Testing in Hostile Environments with High-Performance Downhole Reservoir Testing System

Well	Bottomhole pressure, psi	Bottomhole temperature, degF	H_2S, %	CO_2, %	Duration, days
1	11,000	314	15	5	15
2	7,800	291	38	10	10
3	7,700	303	20	6	10
4	10,400	327	38	3	15
5	9,400	320	5	4	11
6	2,800	222	0.8	40	10



- Dual valve
- Quartz gauges
- Inline independent reservoir fluid sampling

- High-integrity reservoir test isolation system

- $2^7/_8$-in guns with explosive automatic gun release
- Deep-penetrating perforating shaped charges

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Experienced Outcome in Hostile Testing

Design Considerations

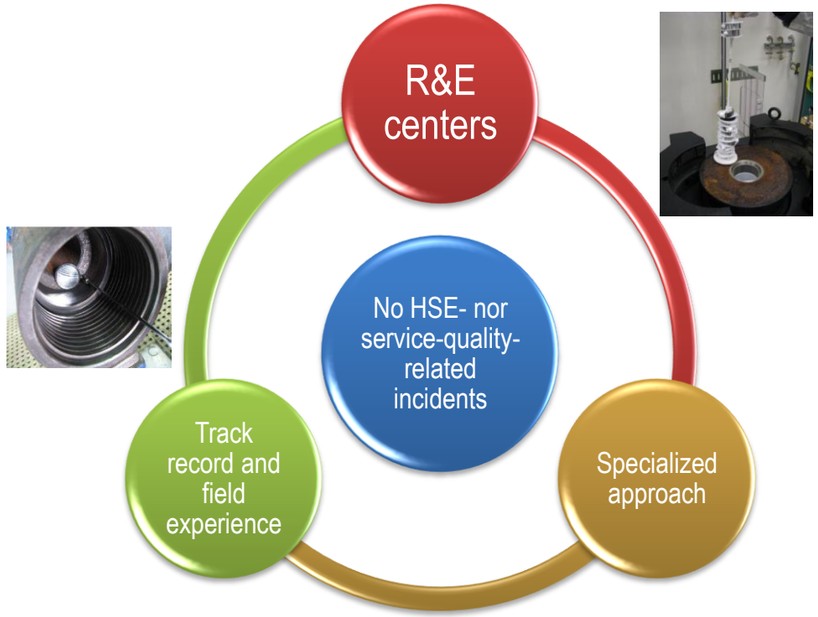
- **Primary concern**—cracking
  - Addressed by following NACE recommendations
- **Secondary concern**—general corrosion and pitting
  - Mitigated by using corrosion-resistant alloys (CRAs)
- **Sealing concern**
  - Elastomer selection based on fluid compatibility

Best Practices

- Job design, planning, preparation, and monitoring
- Project-management approach
- Equipment traceability of equipment
- Tools redress and inspection at the base
- Test design optimization
- Minimization of well intervention as no cables are required

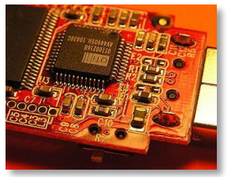
Key to Success

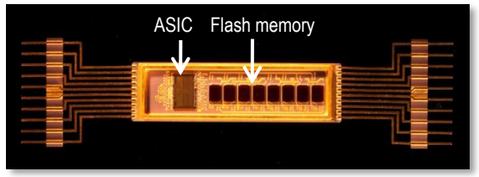
- Metallurgy
  - Systematic approach
  - Return of experience
  - Extensive testing and qualifications



- Elastomers
  - Fit for purpose sealing technology
  - Return of experience
  - Extensive testing and qualifications

- Electronic and batteries
  - Development of new battery technology
  - Multichip module electronics
    - Highly integrated electronics
    - Reliable performance in high temperatures





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