INTERNATIONAL IN-SITU CHEMICAL OXIDATION- LESSONS LEARNED REMEDIATION CASE HISTORY TRENTO, ITALY

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International Remediation Opportunities

- International Opportunities- Benefits
  - Opportunities rapidly increasing
    - Developing countries- Europe, South America, Asia
  - Introduction of New Technologies to these Areas

International Remediation Opportunities

- International Opportunities- Challenges
  - Global Communication/Translation Issues- Constant communication is key (email, phone, teleconference, digital photos).
  - Customs, Freight, Shipment- Delays in delivery, customs, fees, taxes.
  - National Regulatory Support- Technology Acceptance & Staffing
  - Local Infrastructure Challenges- Equipment, chemical delivery, water, electricity
  - Reagent Quantities & Field Equipment- unit conversion, electrical requirements.

Strategy for International Chemical Oxidation

- Teaming with Local Engineering & Environmental Consulting Companies in these Countries
  - Expediting Regulatory Approval & Compliance
  - Identify Local Infrastructure Support Resources

Recent International Field Application

- When we arrived On Site to Support Local Firm…
  - Chemical Flow Meters were in gallons
  - Chemical Mixing Tank Gauges were in Liters
  - Some chemical reagent weights were in kilograms, some were pounds, some volumes were in liters, some gallons.
  - Flow meter fittings were in standard units (inches)
  - Pipe diameters & chemical lines were in centimeters
  - Some equipment used 110V electric service, some used 220V

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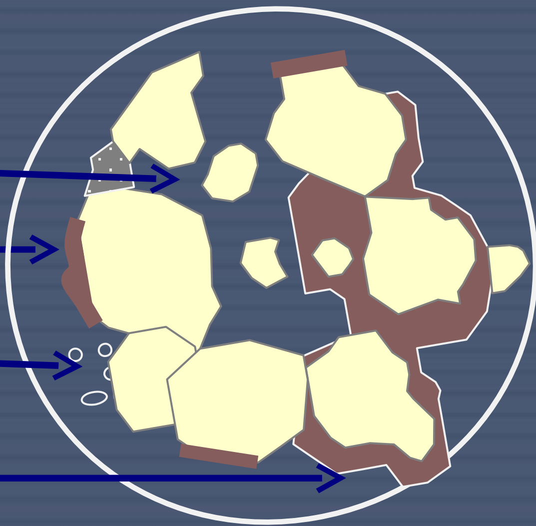
site background

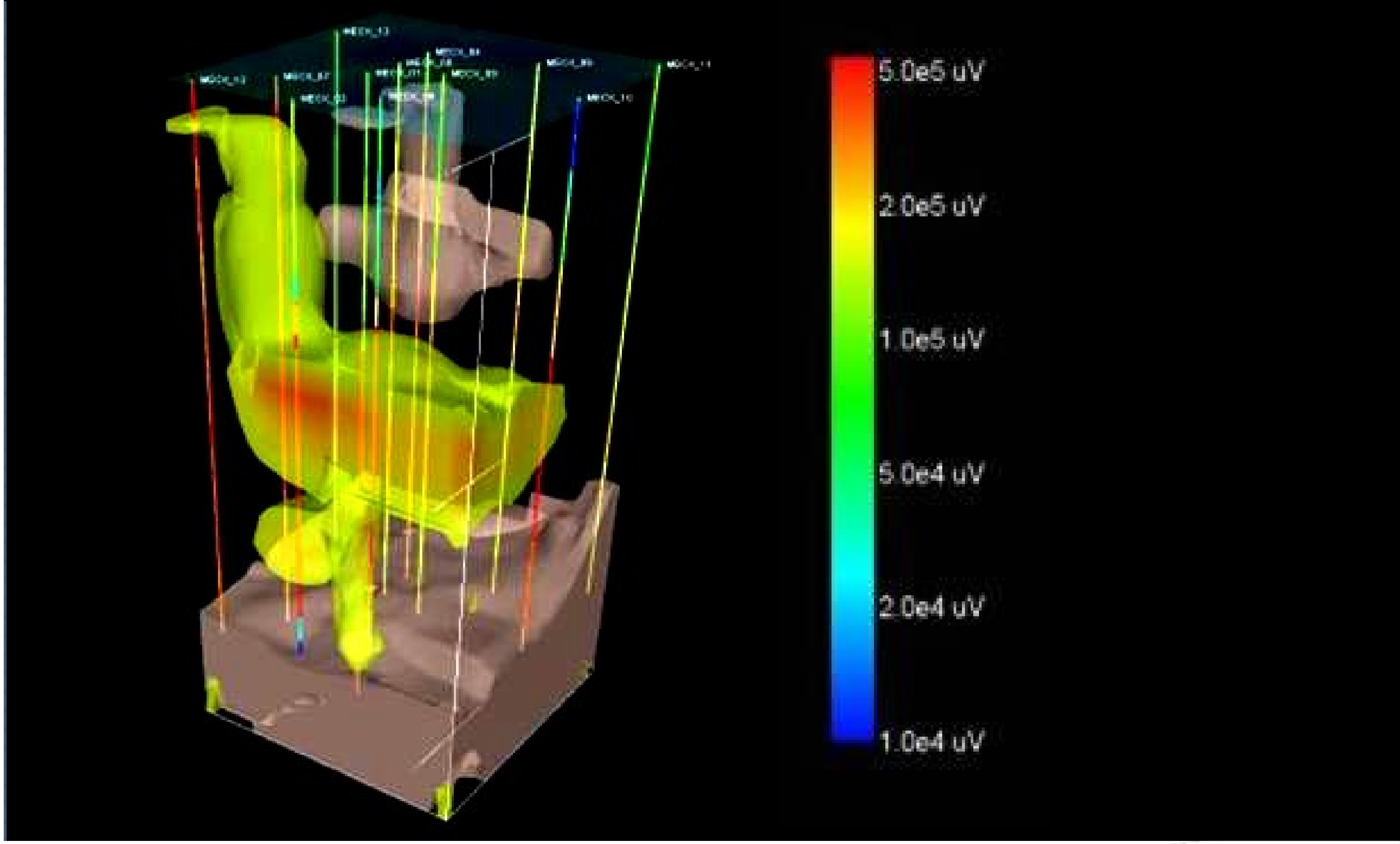
- petroleum tar chemical distillation plant
- source: closed treatment ponds
- geology: 0 – 6.5 feet bgs fill with brick fragments; 6.5-16 feet sand; 16-52 feet bgs sand
- flowing DNAPL tars in the bottom 6 inches
- most contamination present between 10-16 feet bgs
- depth to water: <10'

total mass evaluation

- Soil gas
- Sorbed
- Dissolved
- Non-aqueous phase liquid (NAPL) or phase-separated



Graphic source: Suthersan, 1996



pre & post assessment total mass

- Evaluate pre & post total contaminant mass
- Sorbed and non-aqueous phase mass dissolves during treatment
- Decrease in total mass may not be reflected in short term dissolved concentrations.

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project challenges

- viscous NAPL
- site constraints
- time to remediate
- regulatory permitting
- total mass destruction
- prevent migration/mobilization

MEC^{x} ISCO process

- oxidant and reagent screening
- oxidant demand modeling
- design parameter evaluation (treatability)
- field application

chemical oxidant screening

Oxidant	Volts[1]
Fluorine (F)	3.0
Hydroxyl Radical (OH•)	2.7
Sulfate Radical (SO4•)	2.6
Ozone (O_3)	2.4
Sulfate ($S_2O_8^{-2}$)	2.1
Hydrogen Peroxide (H_2O_2)	1.8
Permanganate (MnO_4^-)	1.7
Chlorine (Cl_2)	1.4

selected technology : sodium persulfate activated by catalyzed hydrogen peroxide (CHP)

Note: [1] = Data provided by FMC Corporation

activated persulfate

persulfate activation methods:

- presence of transition metals
- heat
- hydrogen peroxide
- elevated pH
- UV

designed synergistic activation via 3 of the 5 activation methods

process technical goals

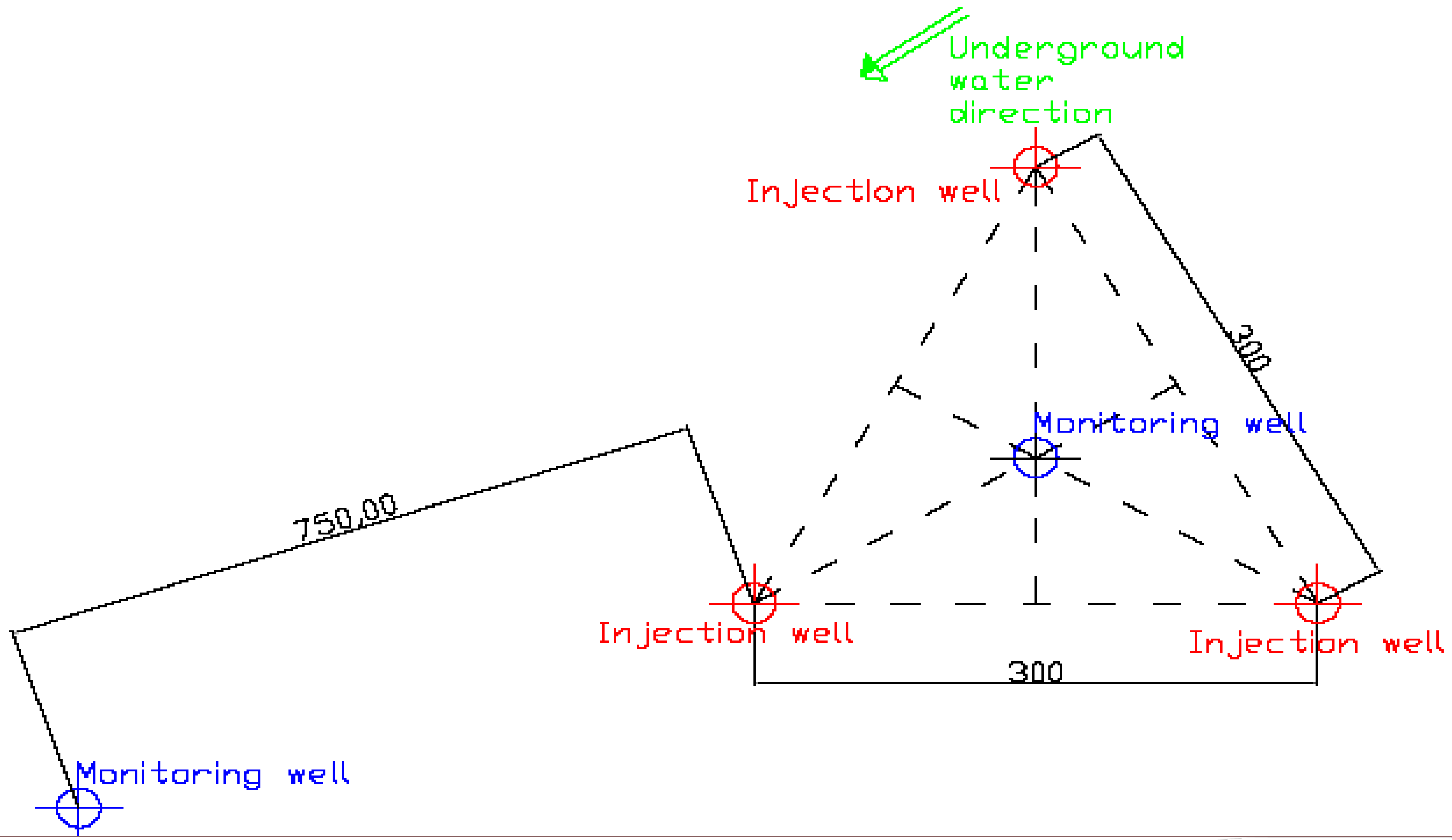
APL desorption

APL dissolution

ersistent oxidation

aximize oxidant radicals

otal mass reduction



site plan

Central monitoring well used for extraction, recirculation. Recirculation fluids were used as makeup water for the application of the sodium persulfate and iron catalyst.

pilot field application

ISCO wells

- 3 total
- 36-48 ft deep (total)

application performance

- 3 days on-site
- 0.25 gpm/well (initial) infiltration rate
- 2.0 gpm/well sustained during peroxide application

325 gallons of liquid reagents applied to each well

site photos

pilot test area

future treatment area

temperature and pressure monitori

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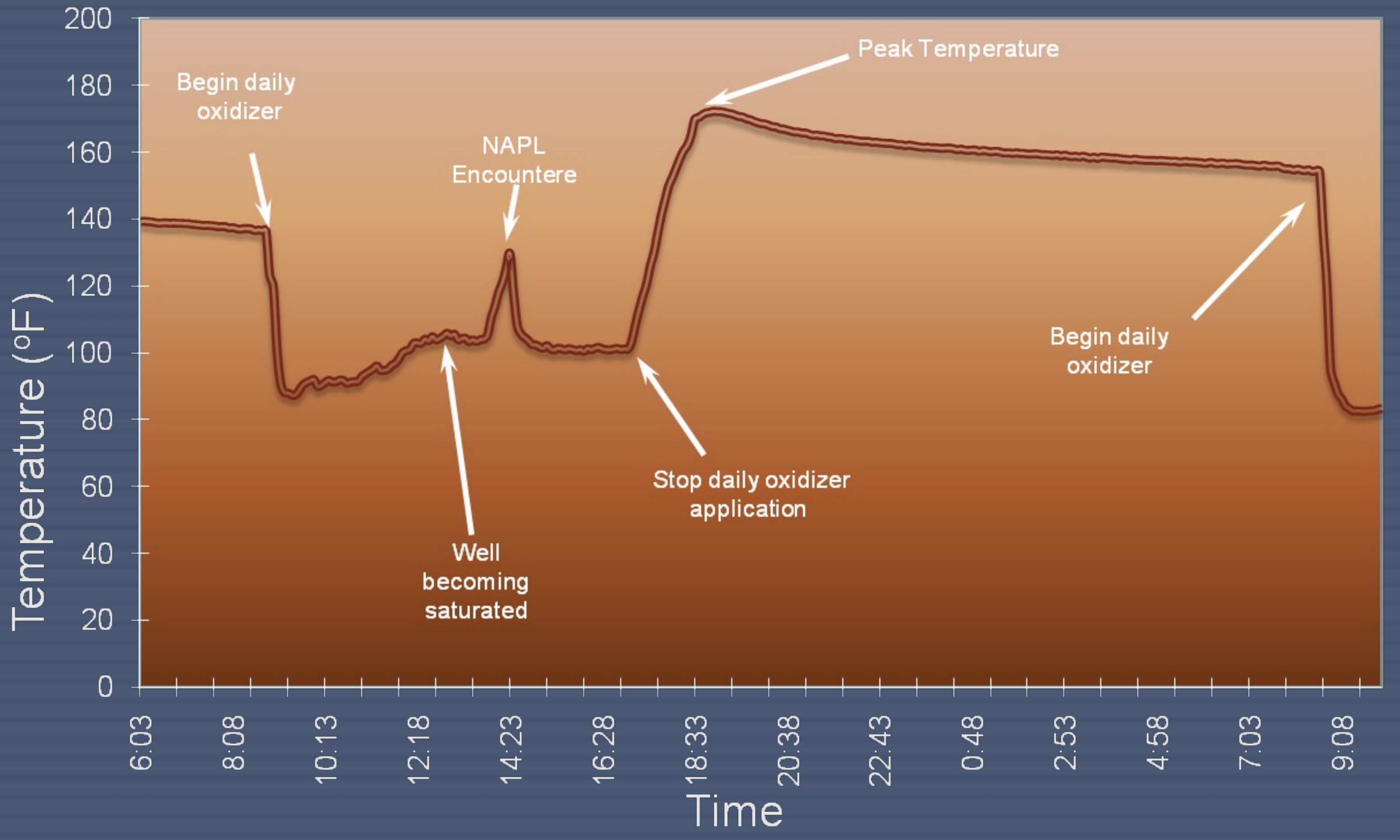

daily temperature cycle

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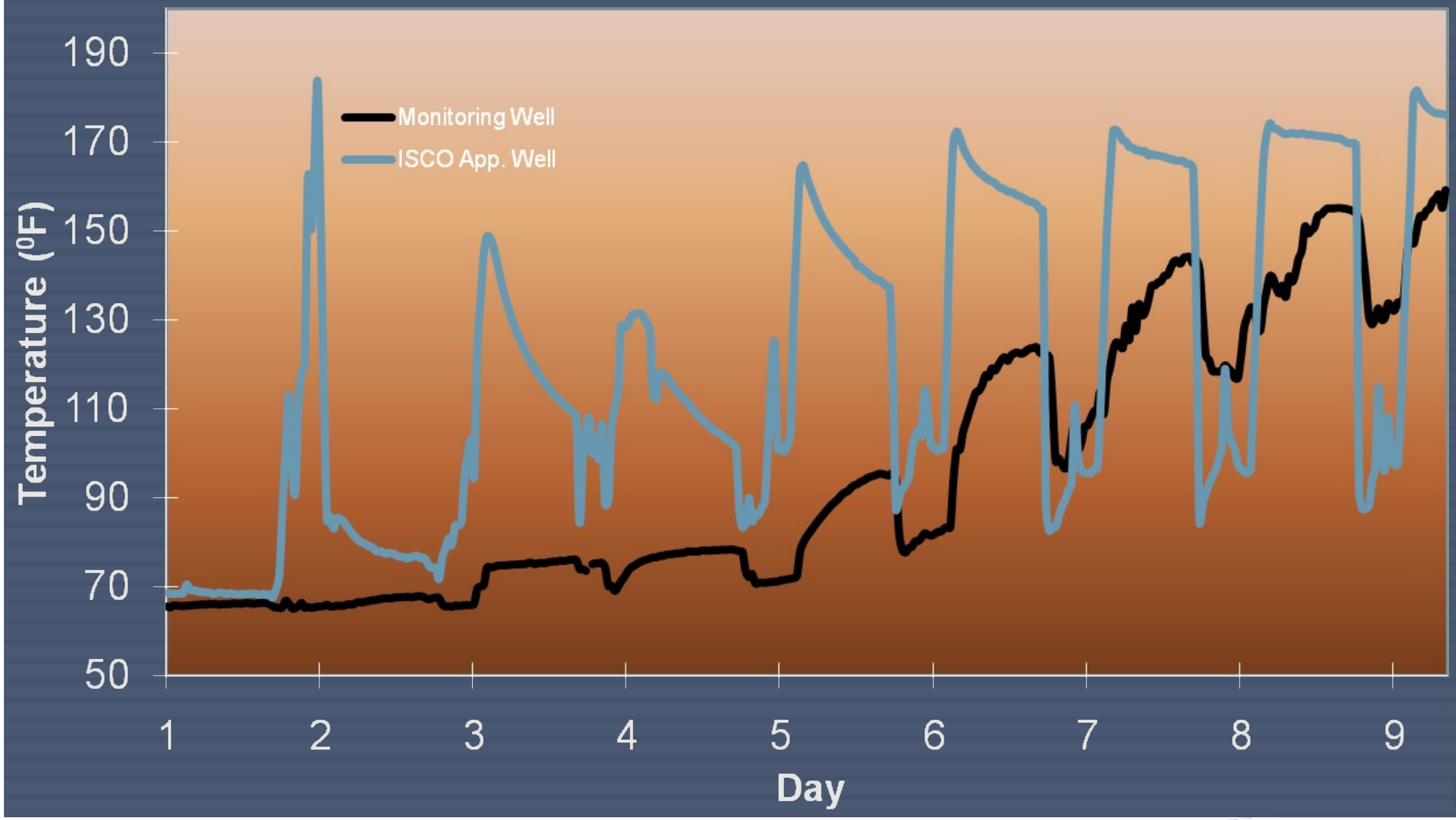

project temperature trend

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real time reagent monitoring

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NAPL viscosity change/recovery

DNAPL in AW's prior to Treatment

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application achievements

- temperatures were increased to $40^{o}C$ in all AW's
- all NAPL was removed from wells within 2 days
- all hydrocarbon odor eliminated from wells
- secondary indications of sodium persulfate oxidation activity for 6 weeks
- dissolved concentrations less than 100 ppb

conclusions

1. synergistic processes resulted in effective dissolution and oxidation of NAPL and contaminants
2. controlled application at low pressure controls preventing migration of NAPL
3. persistence of oxidants consumed organics eliminating repartitioning and/or rebound
4. 80 well full scale application planned for 2010

questions?

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