

# Tunnel Interventions

For a long time, tunneling has been limited to low-pressure environments and relied on basic technology.



# TUNNELS ARE BECOMING LARGER AND DEEPER

Country	City	Pressure bar(g)
China	Shenzhen	>10
China	Jinan Huanggang	>7
China	Wuhan Metro	>7
China	Hong Kong–Zhuhai–Macau	>6
China	Shenzhen-Zhongsha	>6
China	Yangtze River	>7
China	Shanghai Yangtze	>6
China	Guangzhou Metro	>7
China	Shenzhen Metro	>7
China	Dalian Bay	>6
USA (CA)	Lake Mead	>14
Turkey	Istanbul	>12
USA (WA)	Brightwater	>8
Hong Kong	Hong Kong	>6





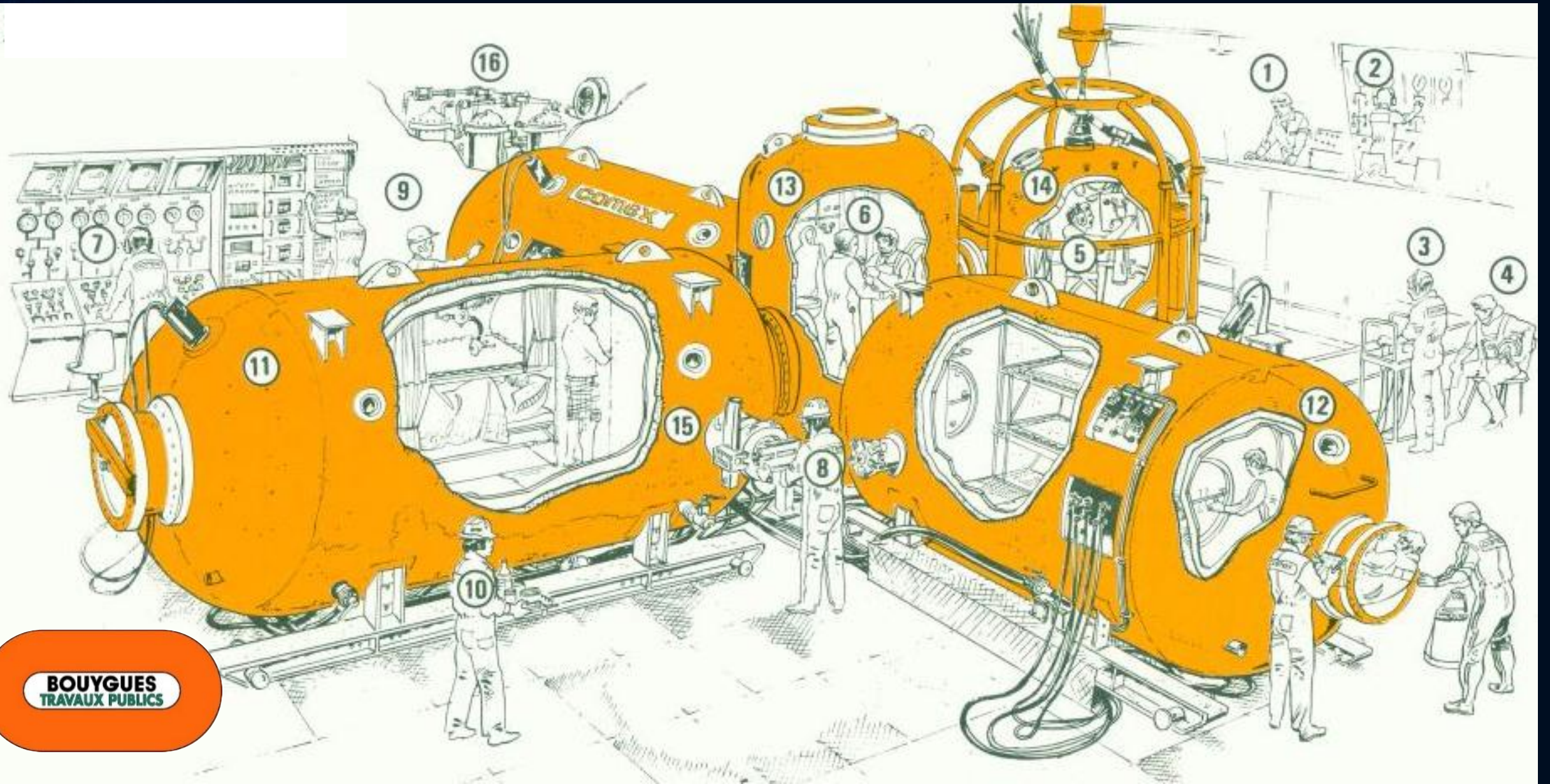
# TUNNELS ARE BECOMING LARGER AND DEEPER

China 2025: 400 Tunnel Projects





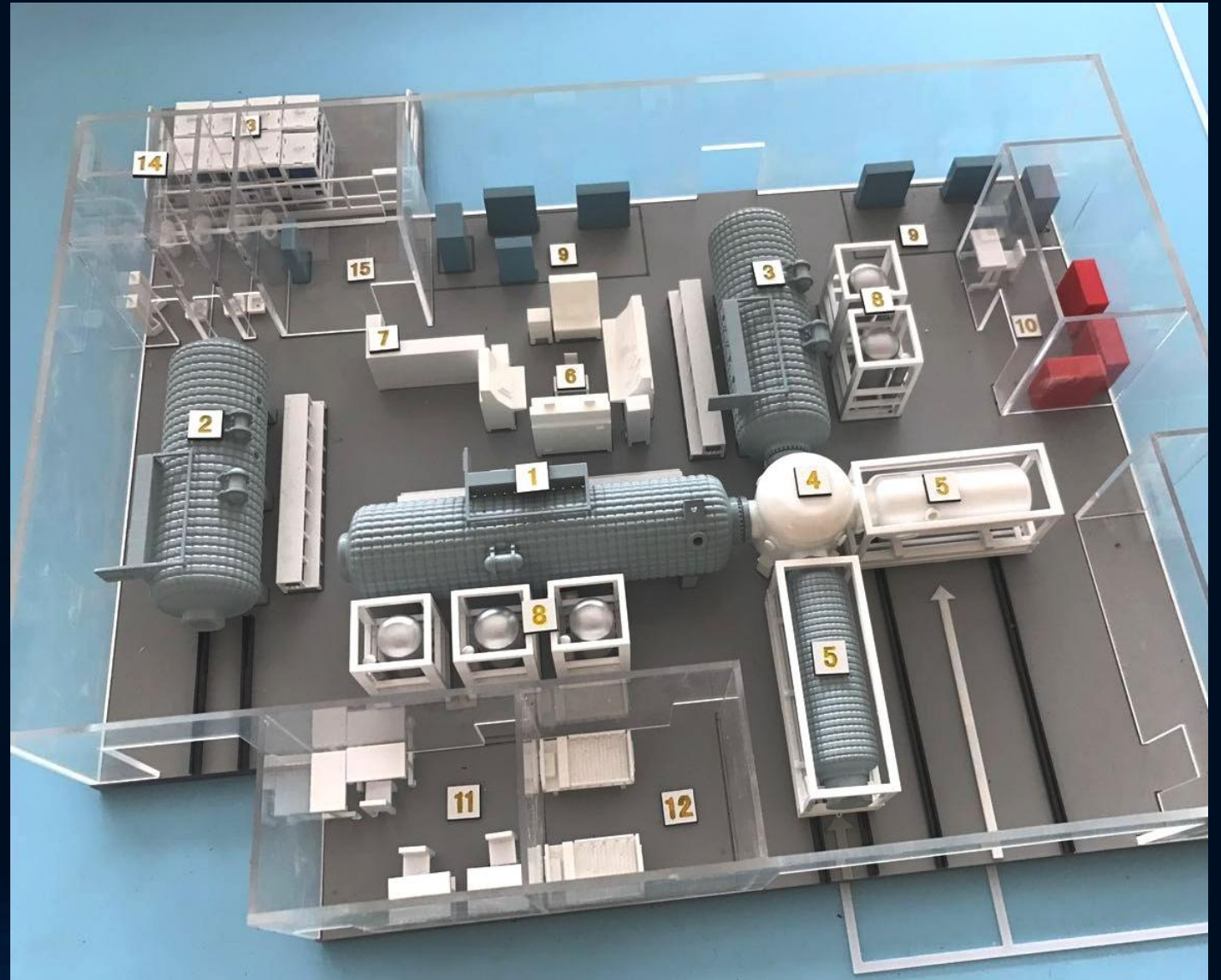
# Typical Saturation Complex Layout





# Hong Kong TMCLK Saturation Complex Layout

- 2 Chambers
- 1 Medical Chamber
- 2 Shuttles
- 1 TUPChamber
- 1 Gas & Control Panel



# Hong Kong TMCLK Saturation Complex Layout



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*LH facility at Tuen Mun–  
Chek Lap Kok Link Project.*





T2主幹路及茶果嶺隧道  
TRUNK ROAD T2 AND CHA KWU LING TUNNEL

土木工程拓展署  
Civil Engineering and  
Development Department  
CEDD

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Hyder  
MEINHARDT  
Hyder - Meinhardt JV

Hyder  
MEINHARDT  
Hyder - Meinhardt JV

HERRENKNECHT  
Tunneling Systems

T2主幹路及茶果嶺隧道

CEDD

土木工程拓展署  
Civil Engineering and  
Development Department

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# We solve different problems

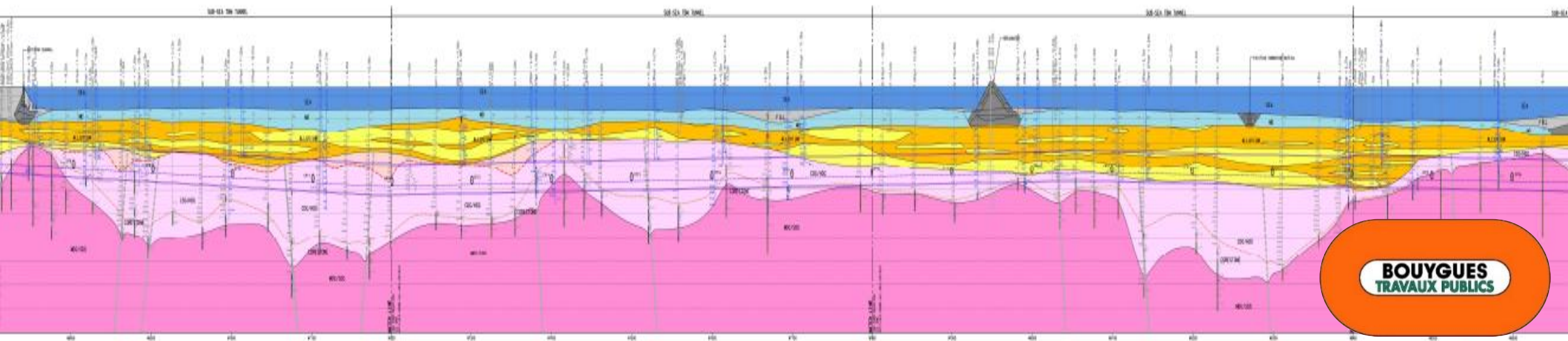


# We need different solutions



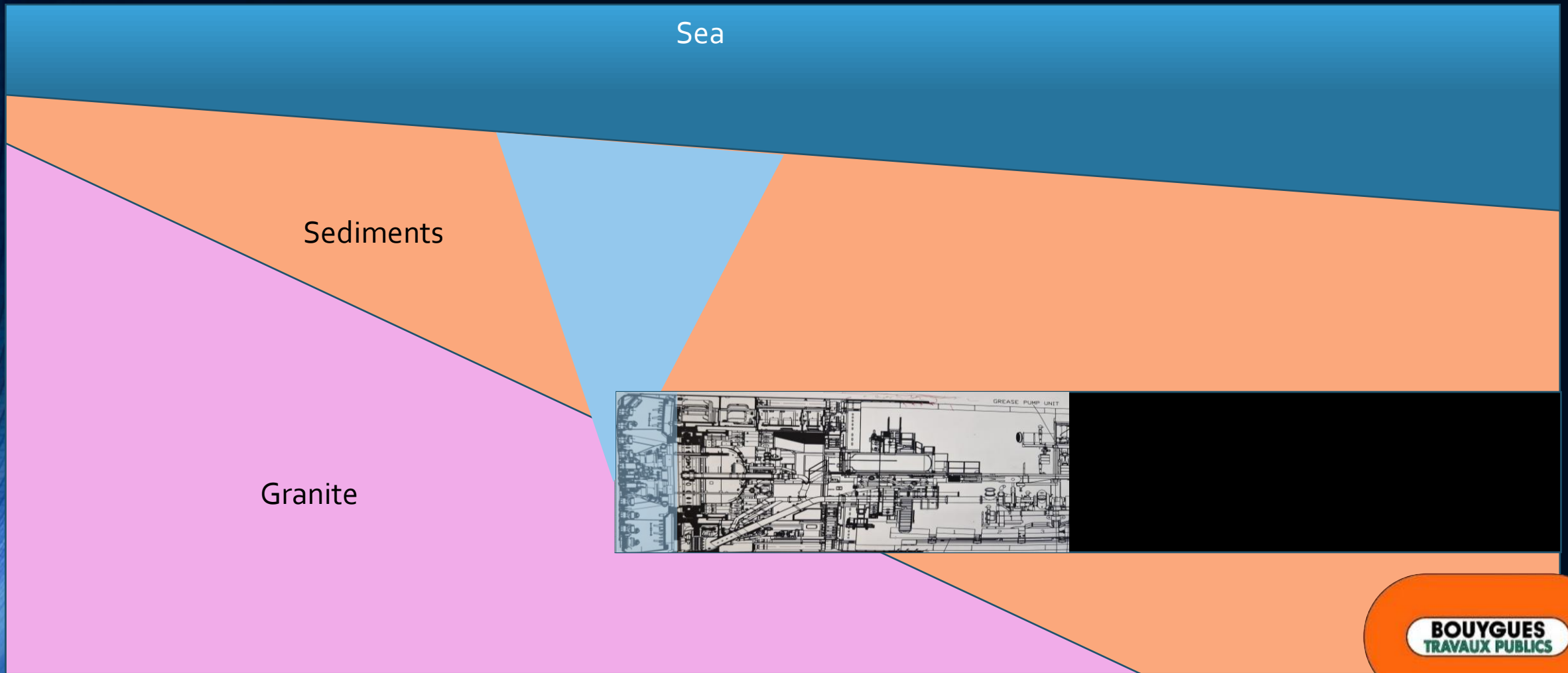
# INTRODUCING TRIMIX BOUNCE TABLES

## Hong Kong Trunk Road T2 Project



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# What Happened in T2?





# RISK ANALYSIS

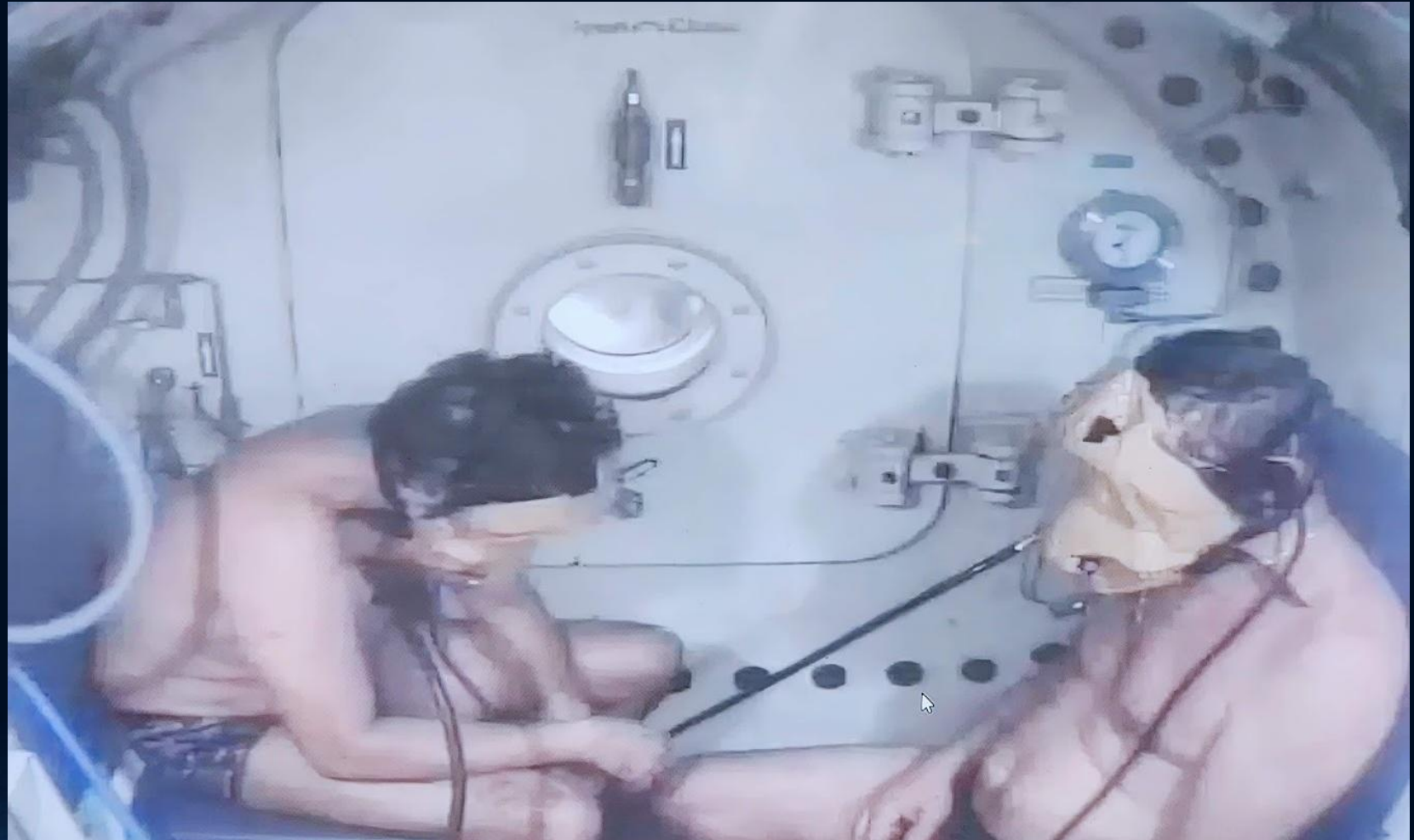
- CONFINED SPACE
- HARD WORK
- POLLUTION (BENTONITE, HYDRAULIC OIL, ETC.)
- HEAT & HUMIDITY
- LONG MOBILISATION TIME
- UMBILICAL MANAGEMENT





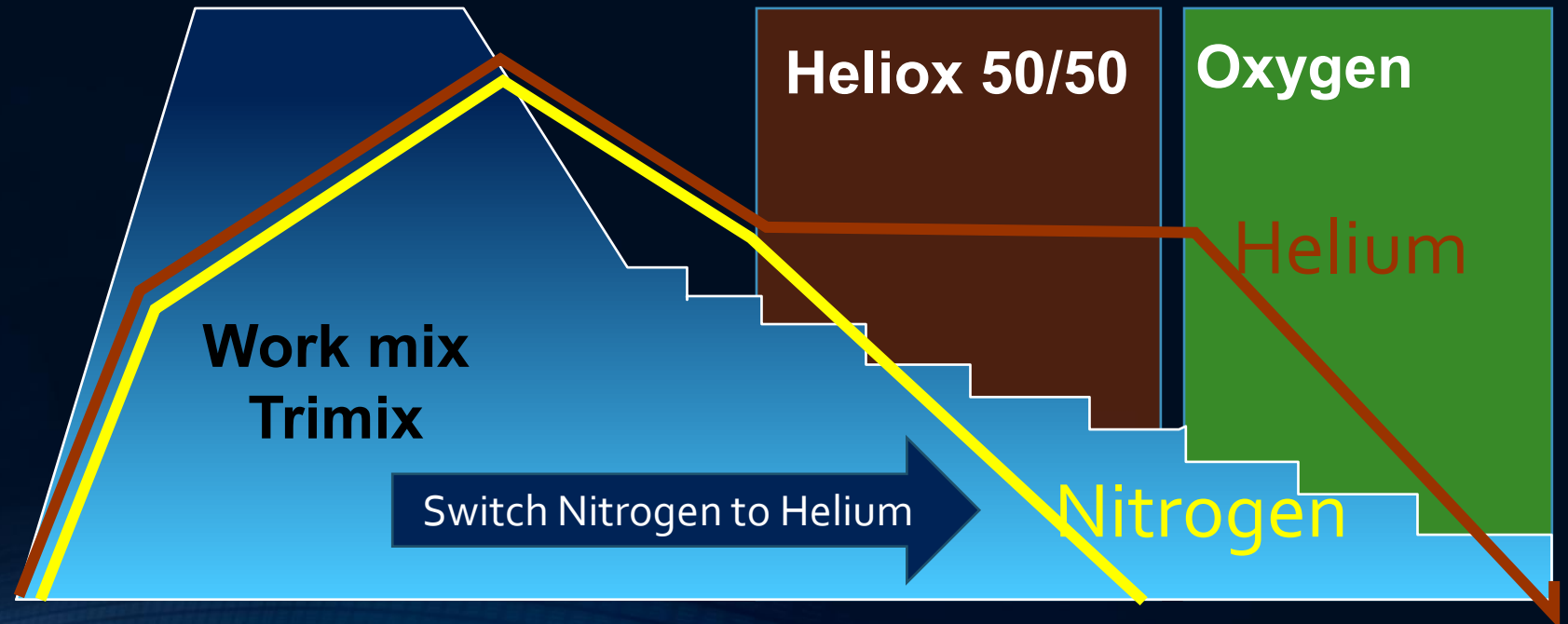
# THE SOLUTION: NEW TRIMIX BOUNCE TABLE

- Multi-day Diving
- 90 - 120 Min Bottom Time
- 40-55 meters



# THE SOLUTION: NEW TRIMIX BOUNCE TABLE

BOTTOM MIX Tx 20/40 > NORMOXIC  
EQUIVALENT AIR DEPTH 25 M > LOW GAS DENSITY  
DOUBLE PUSH-PULL > EFFICIENT DECOMPRESSION





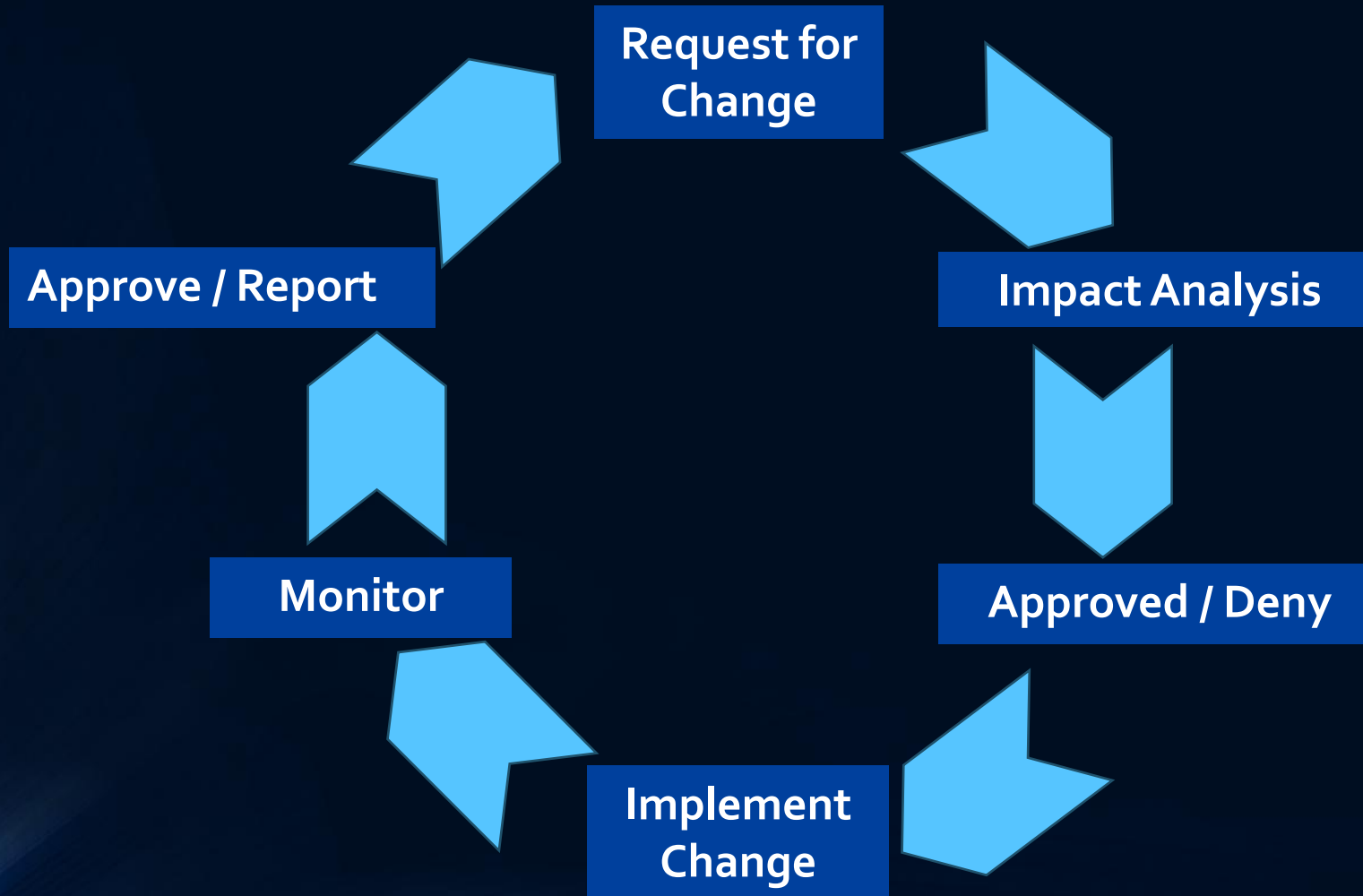
# CHALLENGE: VALIDATION AND ACCEPTANCE

Are you going to bend divers?  
Can we trust you?

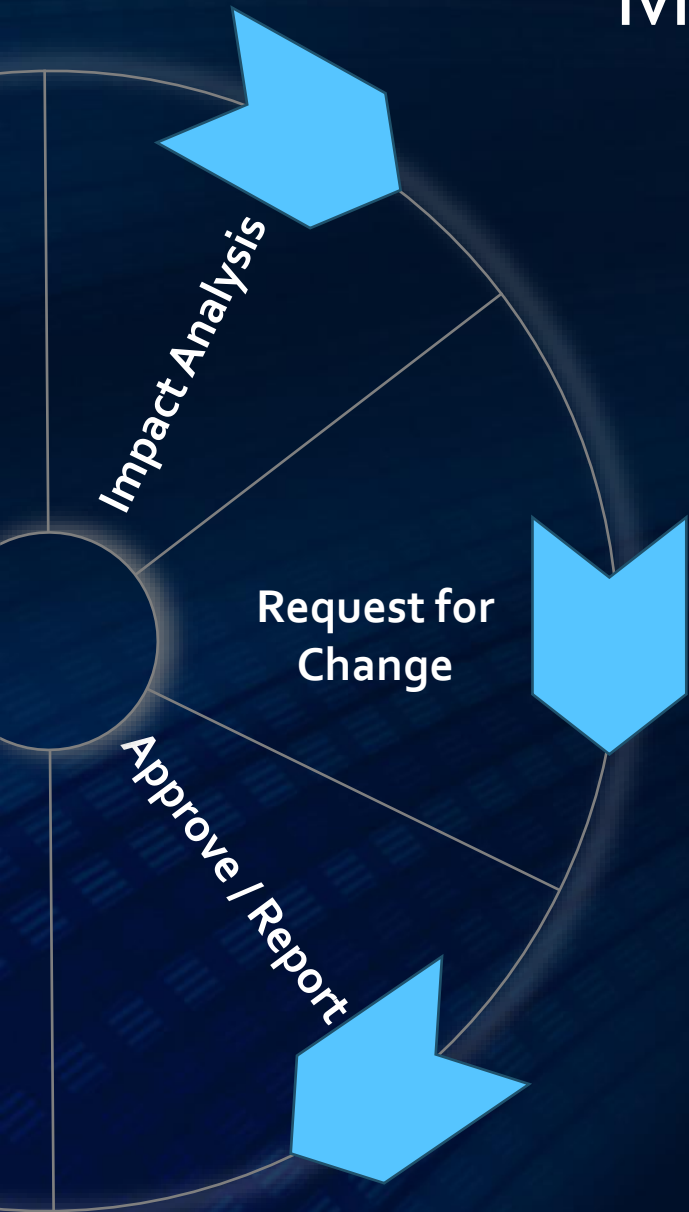
Assessing a risk is technical  
Accepting a risk is political



# Management Of Change (MOC)



# Management Of Change (MOC)



New tables are required with documented safety performances



# Management Of Change (MOC)



Tables use specific decompression techniques:  
Heliox 50/50 instead of air

The algorithm was published  
Tables were validated

# Management Of Change (MOC)

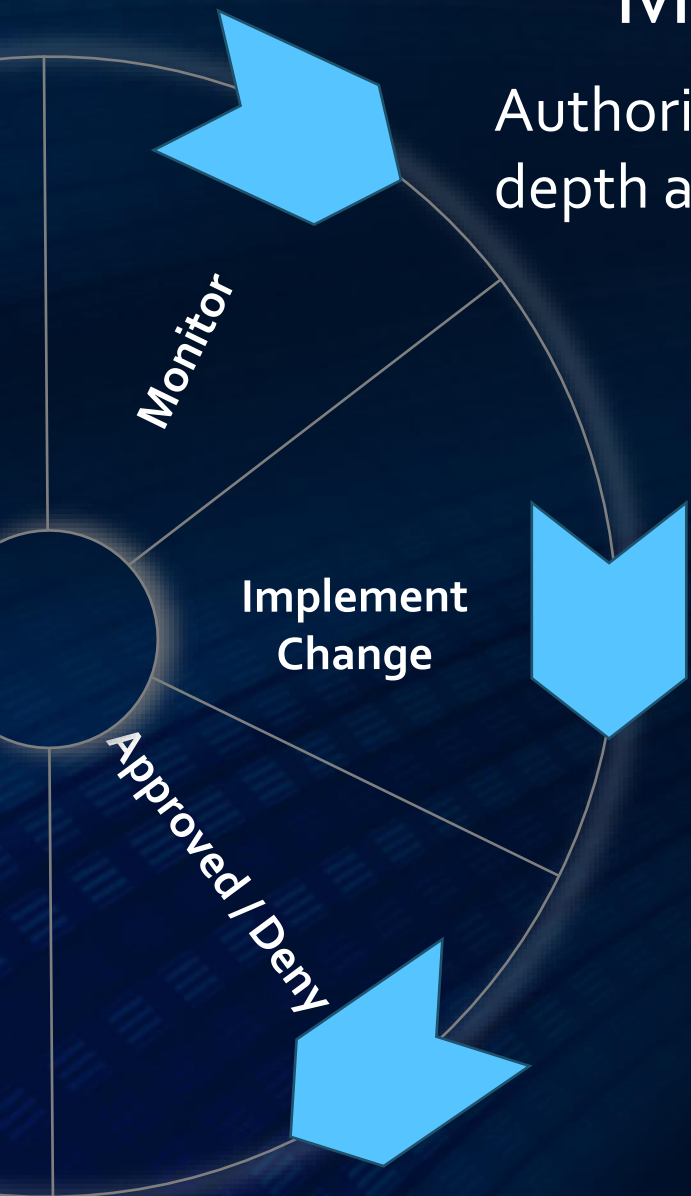
- Barcelona 2011
- 283 Interventions Between 40 to 52 msw
- No DCS





# Management Of Change (MOC)

Authorities requested demonstration dives to the maximum depth and max time during two consecutive days





# Management Of Change (MOC)

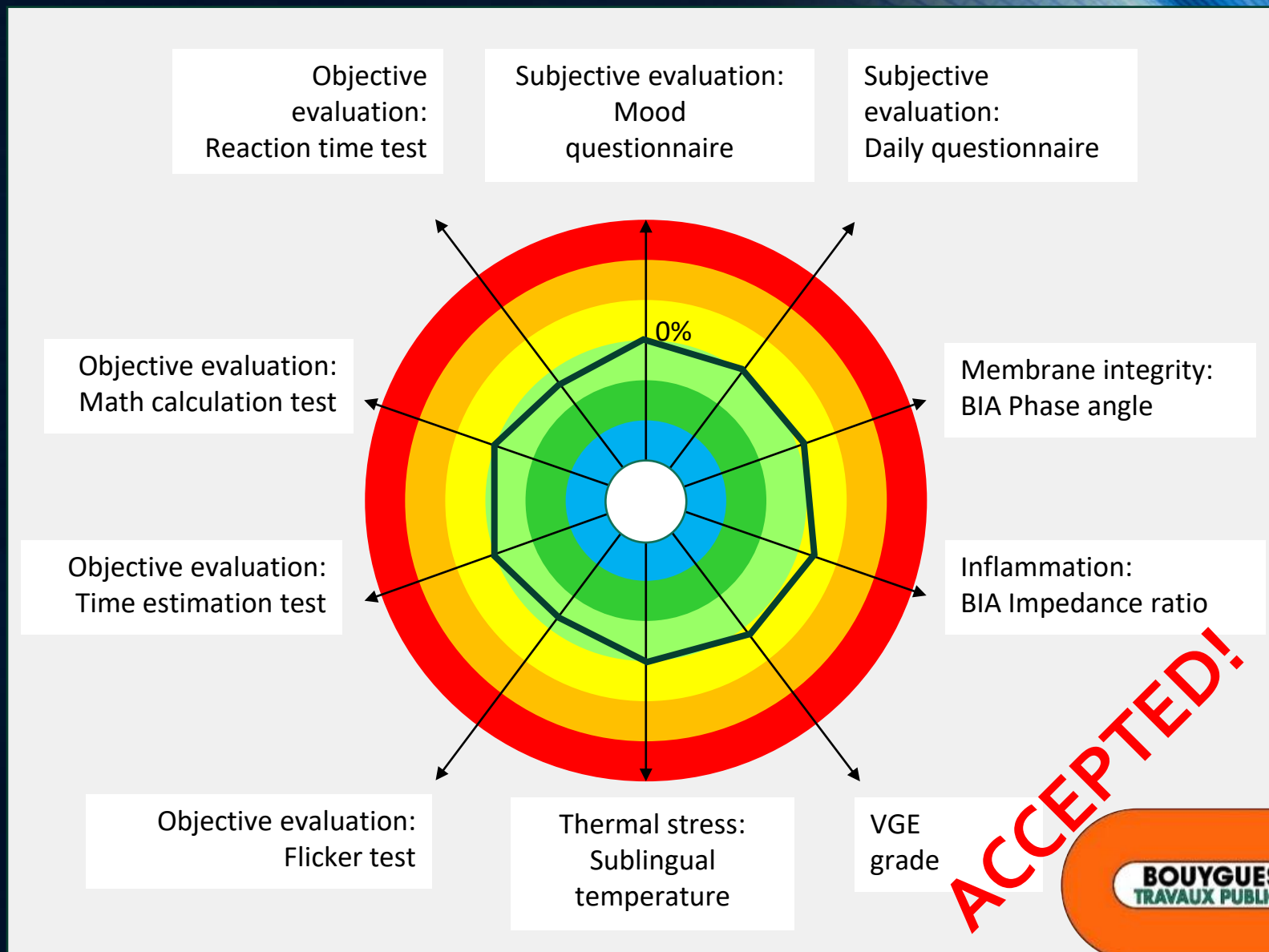


24/09

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# Management Of Change (MOC)

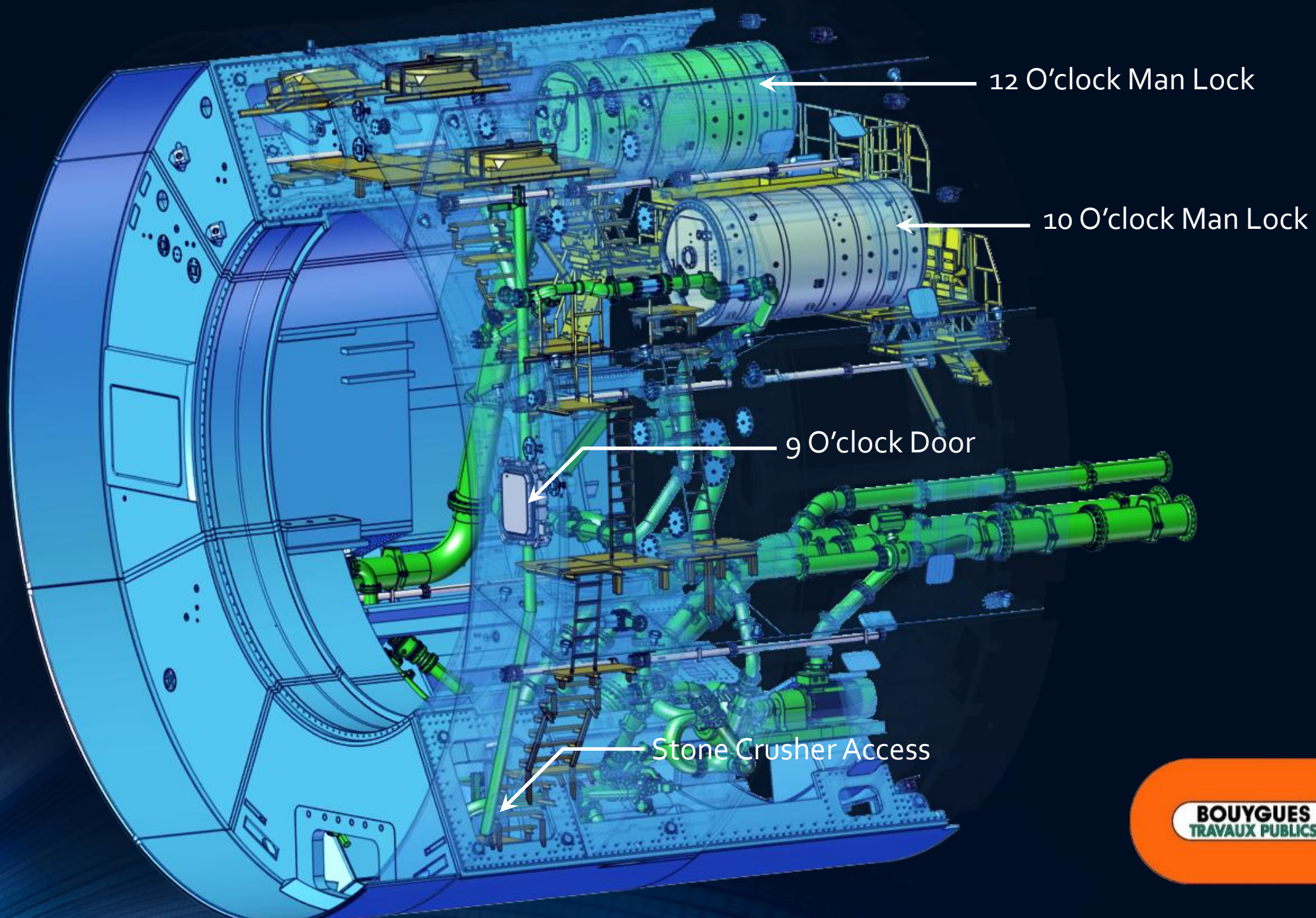


# ACCESS TO THE WORK

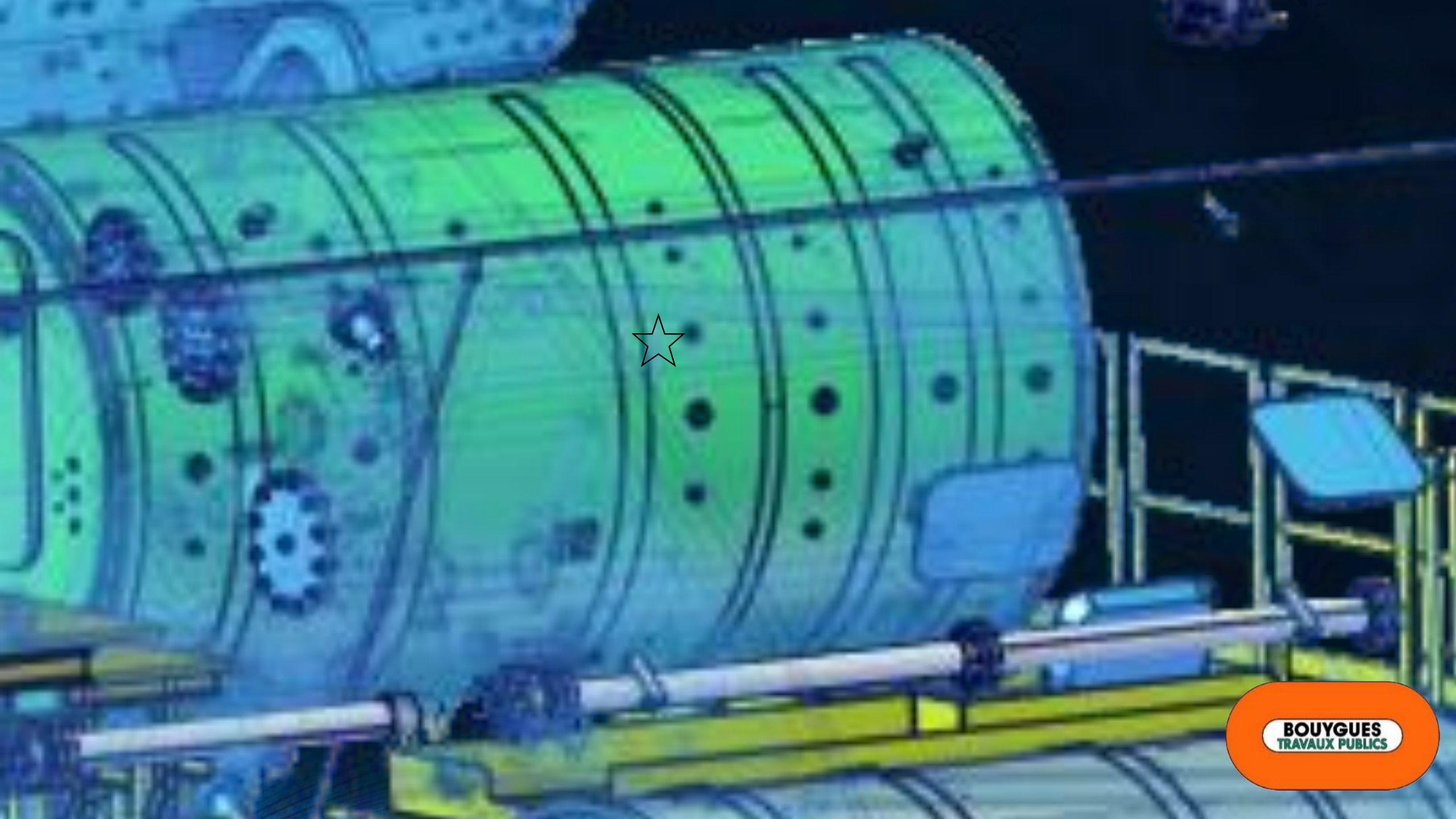










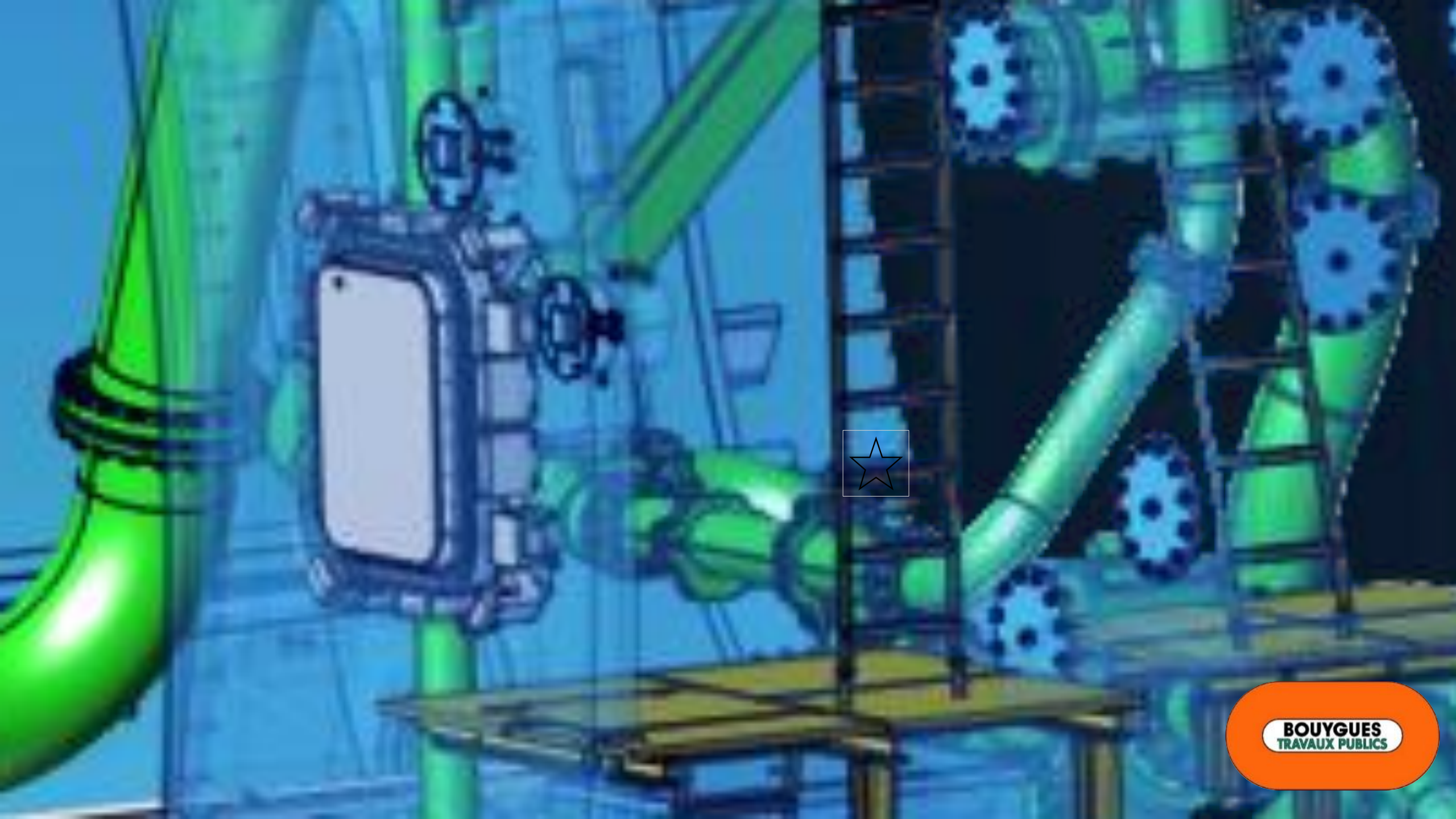




# Compression









18-12-2023 10:31:35

9 O'clock Door

Mobile 2

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29-03-2025 Sat 02:06:48

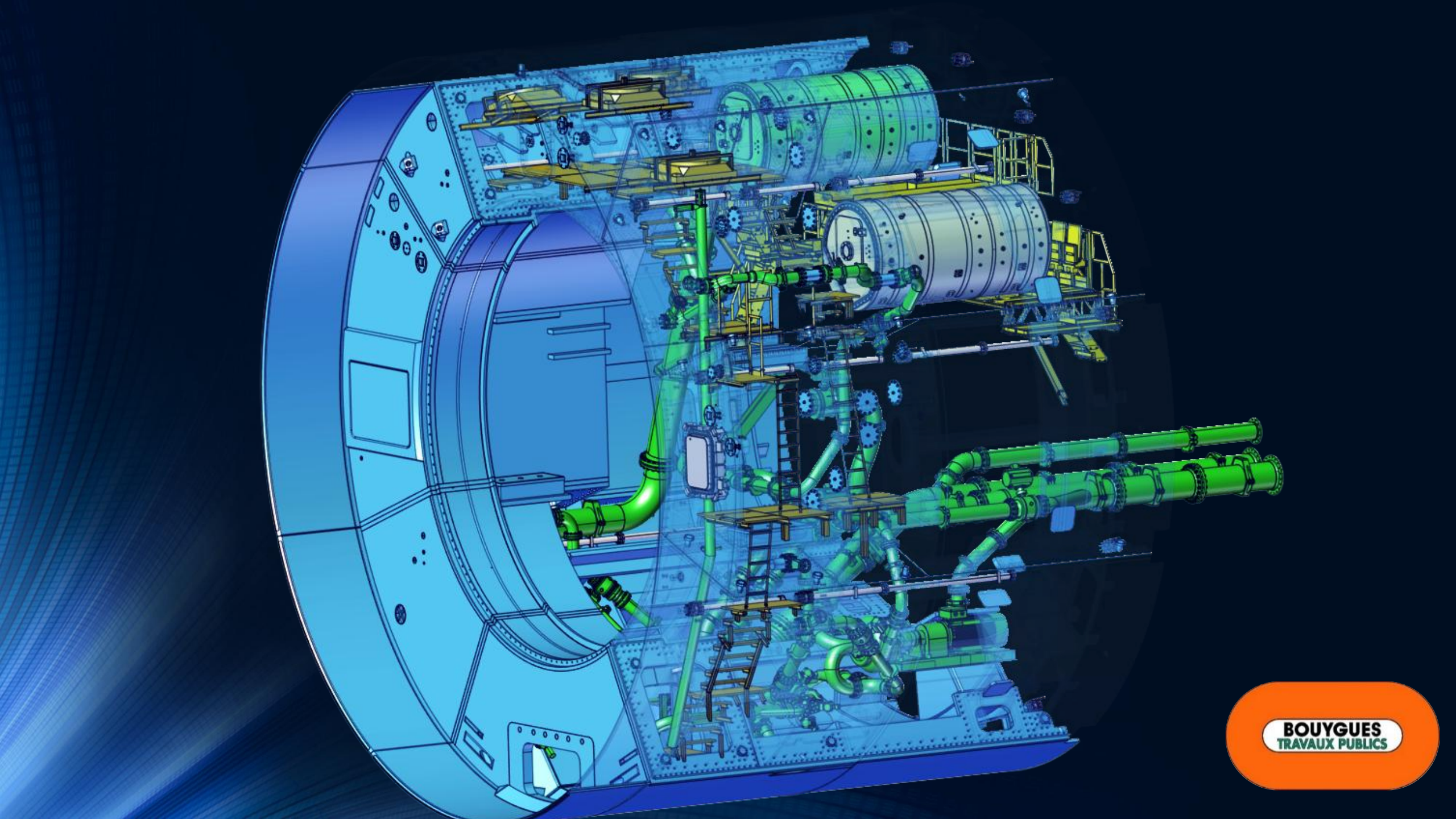
# Stone Crusher Door



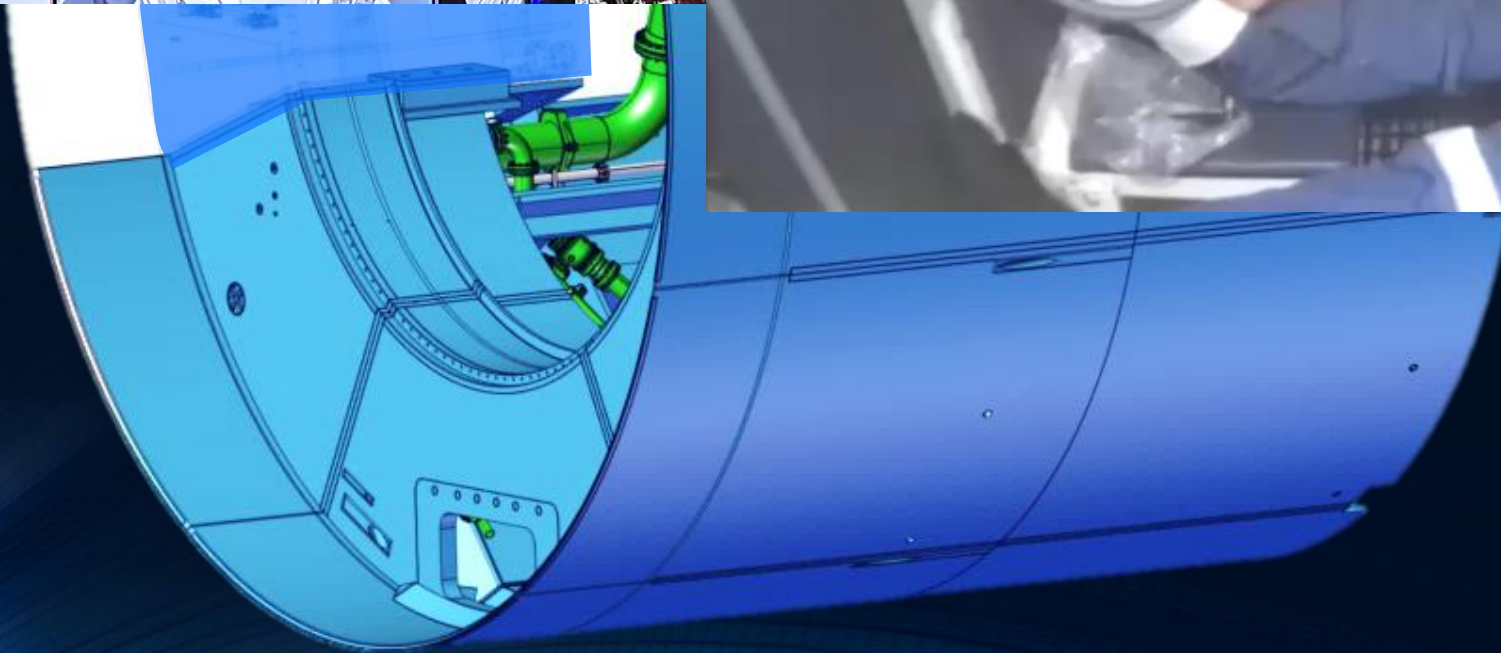
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Mobile 2











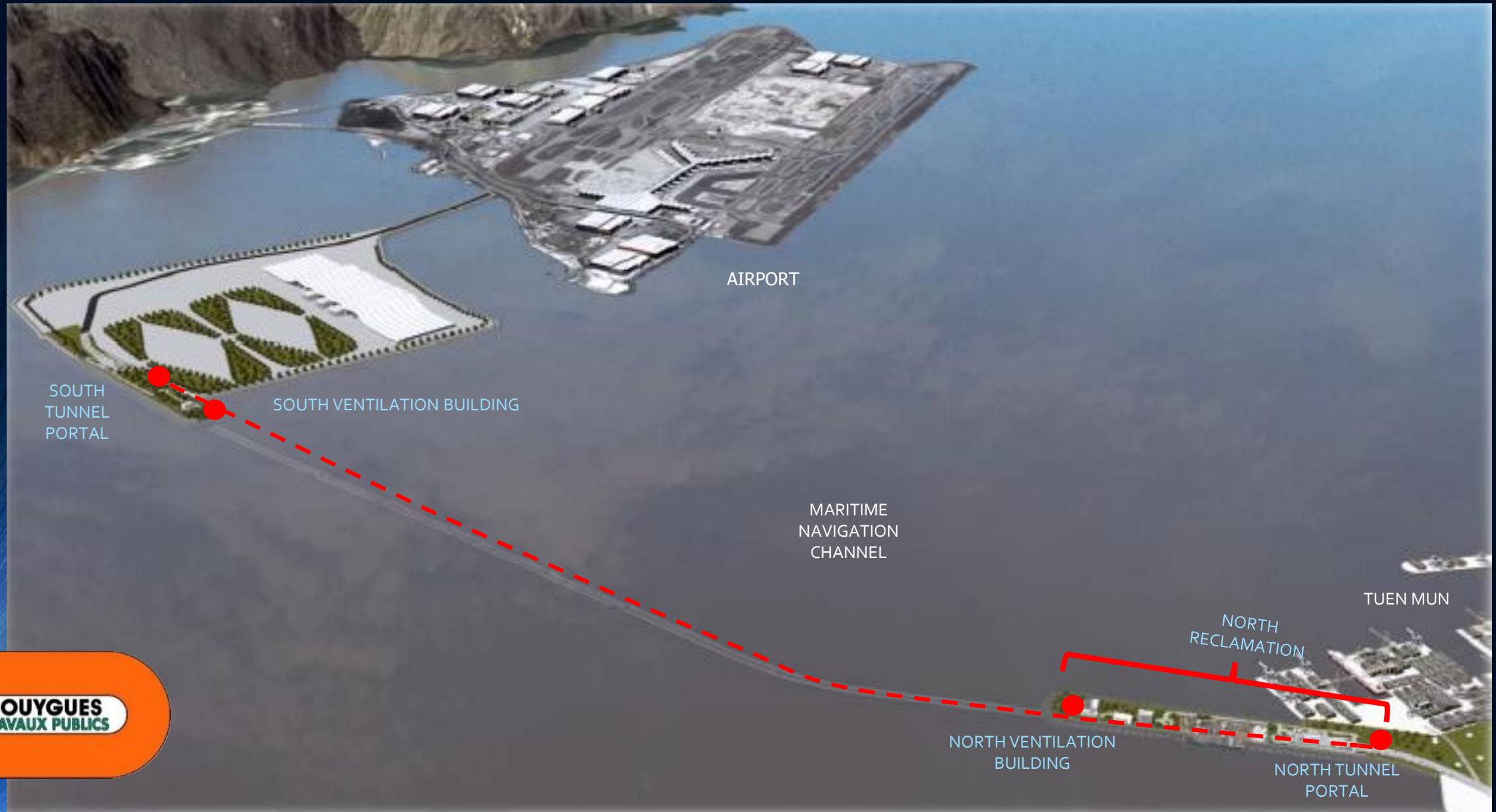
# Trunk Road T2 Project





# TWO TUNNELS AND ONE SATURATION

## Hong Kong TMCLK Project







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AECOM

路政署  
HIGHWAYS  
DEPARTMENT

港務局  
Dragages  
Hong Kong

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THE SAFE WAY IS THE ONLY WAY  
安全為上

Tunnelling Systems

CHEK MUN - CHEK LAP KOK LINK  
NORTH-SOUTH TUNNEL SECTION

AECOM

Qin Lianyu

Tunnelling Systems

Willis

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# RISK ANALYSIS

- SATURATION DIVING REQUIRED
- MODERATE PRESSURE 4-6 BAR(G) 40 - 60 MSW
- NARCOTIC SHOCK IN CASE OF MASK LEAKAGE (TRIMIX)
- REDUCED GAS DENSITY
- TWO TBM AT TWO DIFFERENT PRESSURE
- MAX PN<sub>2</sub> MAX = 2 BAR
- SEEK MINIMAL EXCURSION DISTANCE



# STORAGE PRESSURE STRATEGY

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PRESSURE



TBM 1



TBM 2

High  
amplitude

Low  
amplitude

Low  
amplitude

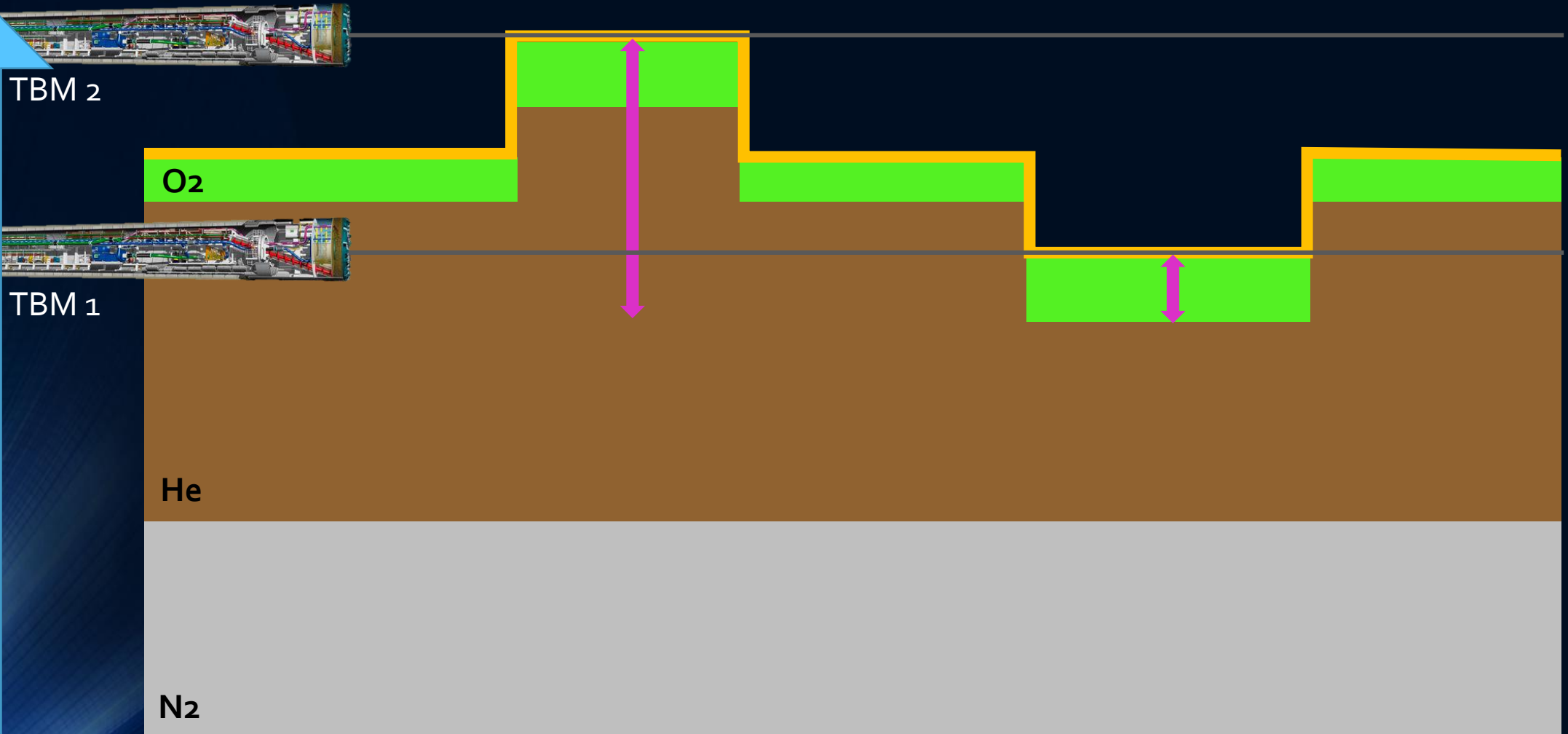
EXCURSION DISTANCE LESS THAN 50% OF THE OFFSHORE EXCURSIONS



# INERT GAS STRATEGY

- Prox-Mix-Tunneling And Compression Based on Helium

PRESSURE





# TMCLK Breakthrough

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# Hong Kong TMCLK Results

- Interventions up to 5.8 Bar.
- 18 Months of Uninterrupted Saturation Operations.
- 315 Shuttle Runs.
- 1500 Cutter Discs Changed.
- 34 Hyperbaric Workers in Saturation Operations
- No DCS





# TRAINING STANDARDS

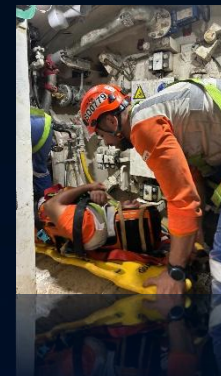
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# RESCUE DRILLS

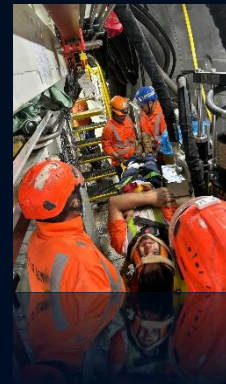
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# RESCUE DRILLS

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# RESCUE DRILLS

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# RESCUE DRILLS





# CONCLUSION

NOTHING NEW UNDER THE SUN



