

Some experiences in full scale fire test and training in San Pedro de Anes facilities

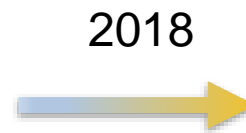
Applus⁺
TST



Norwegian Tunnel Safety Conference 2018
Fernando Garrido APPLUS+TST



TUNNEL SAFETY TESTING, S.A.



Full scale tunnel fire test and training

- Established in Spain, September 2005
- Operating company of the "San Pedro de Anes" Experimental Centre

ACTIVITIES



Full scale tunnel fire and ventilation tests



Training of fire fighters and rescue brigades



High temperature fan testing according to standard EN 12.101-3

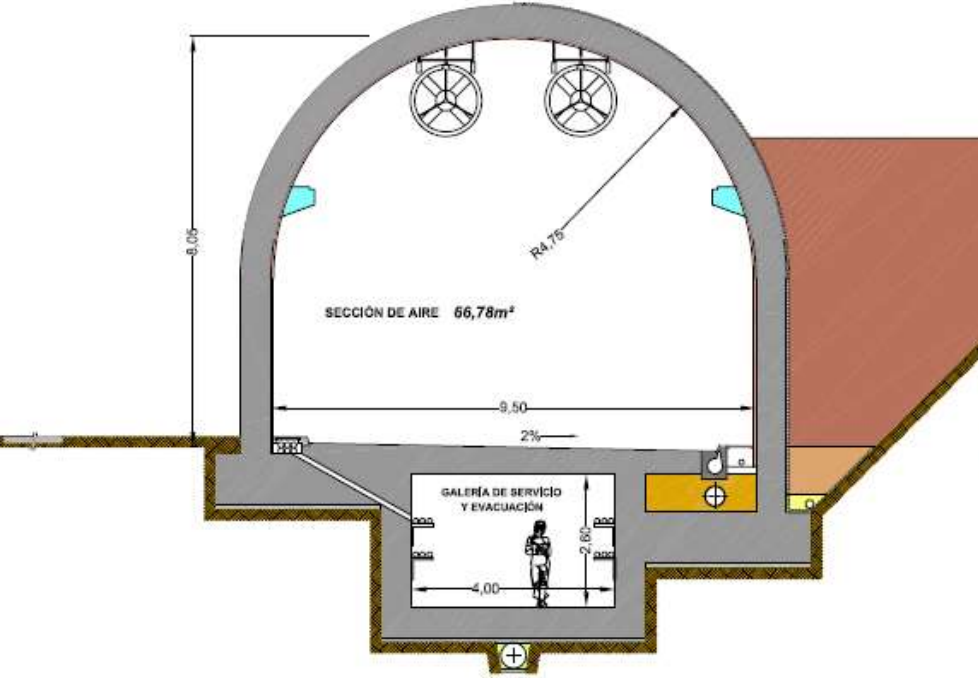
Full scale tunnel fire test and training



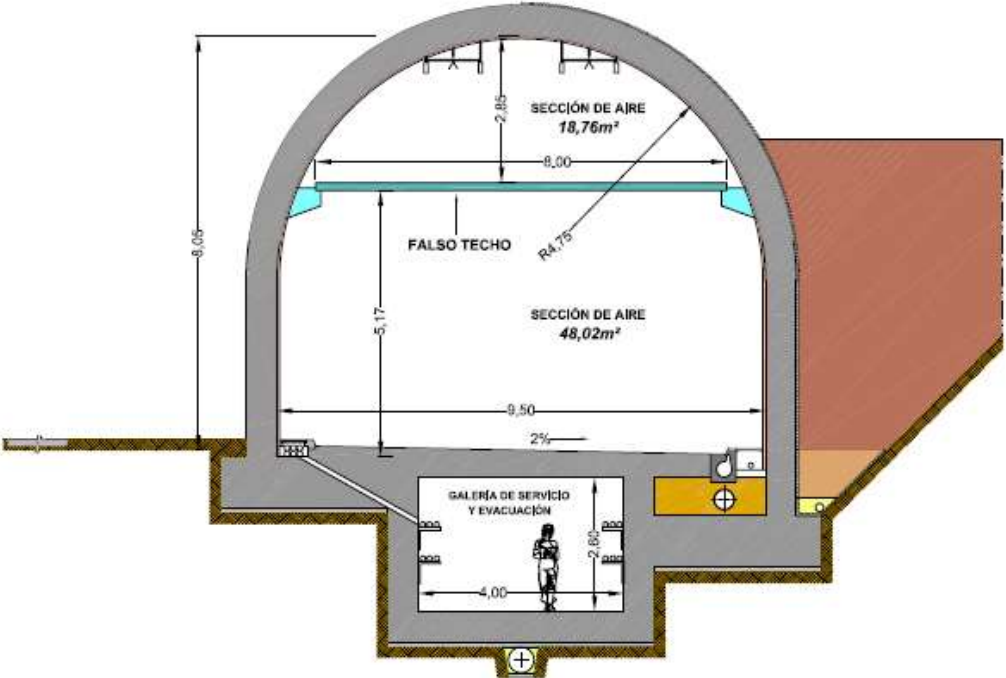
Full scale tunnel fire test and training



Full scale tunnel fire test and training

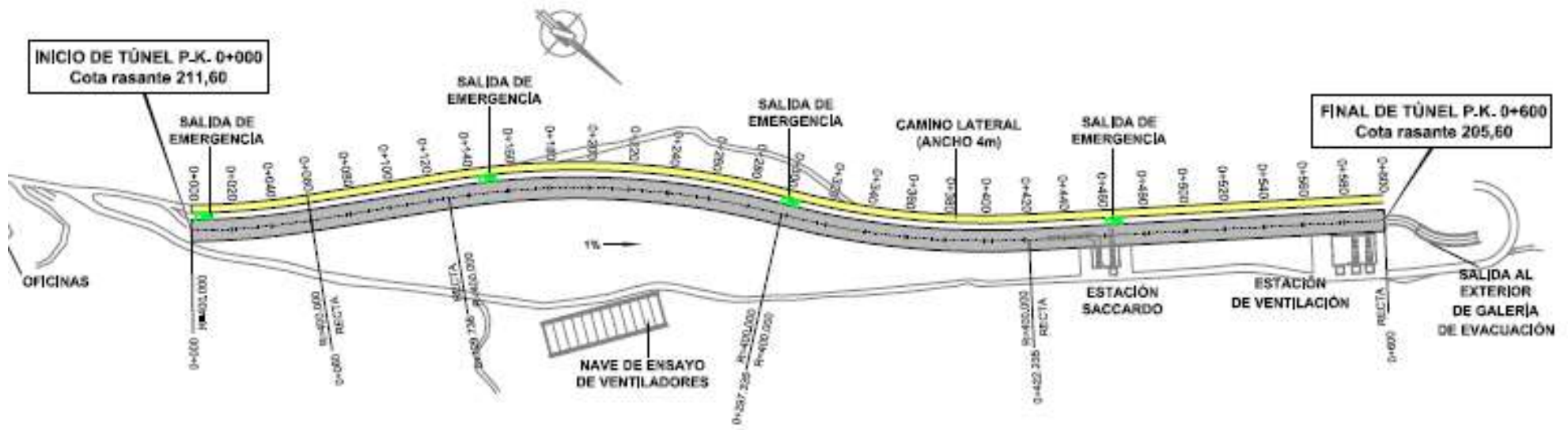


FULL SECTION



FALSE CEILING SECTION

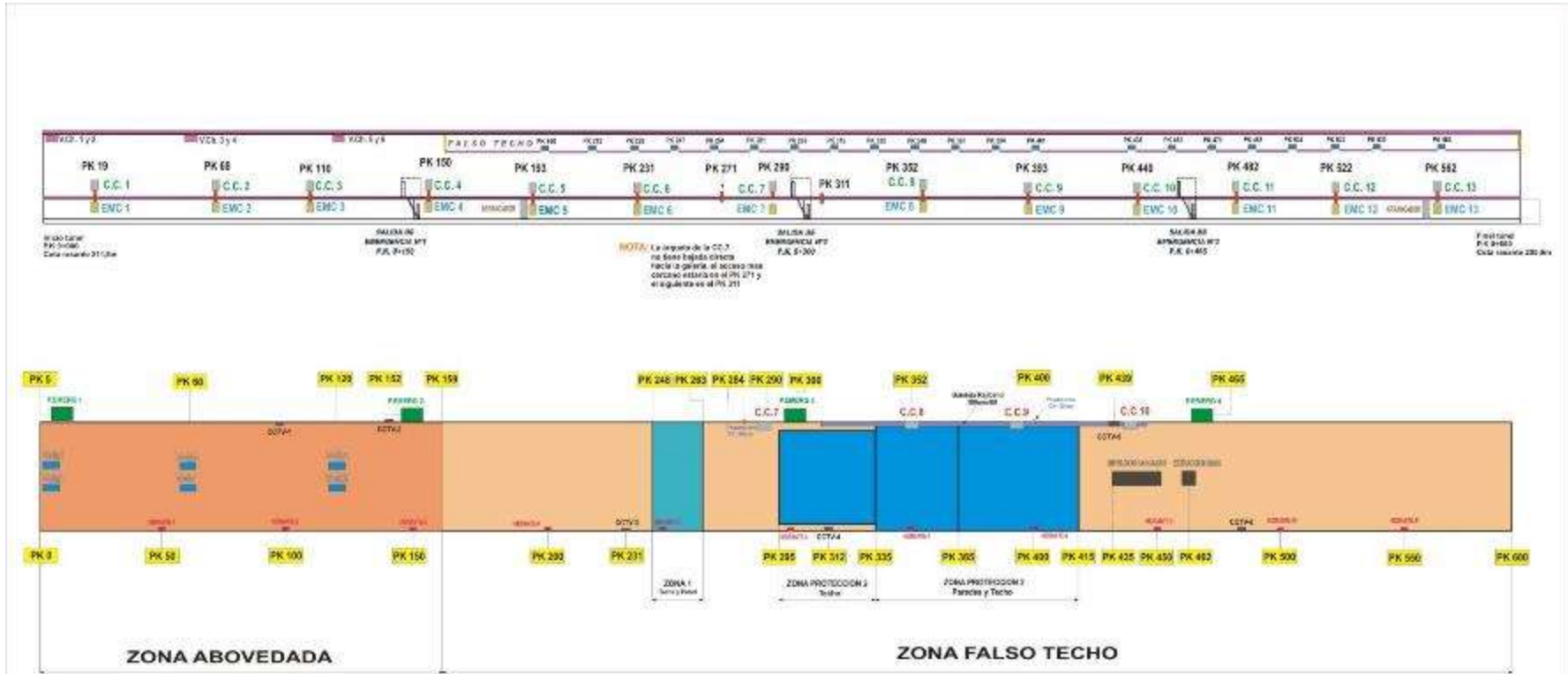
Full scale tunnel fire test and training



- 600 m long
- min. radius 400 m
- 4 emergency exits (every 150 m)
- 2 ventilation stations

Full scale tunnel fire test and training

ACTUAL TUNNEL LAYOUT



LEYENDA

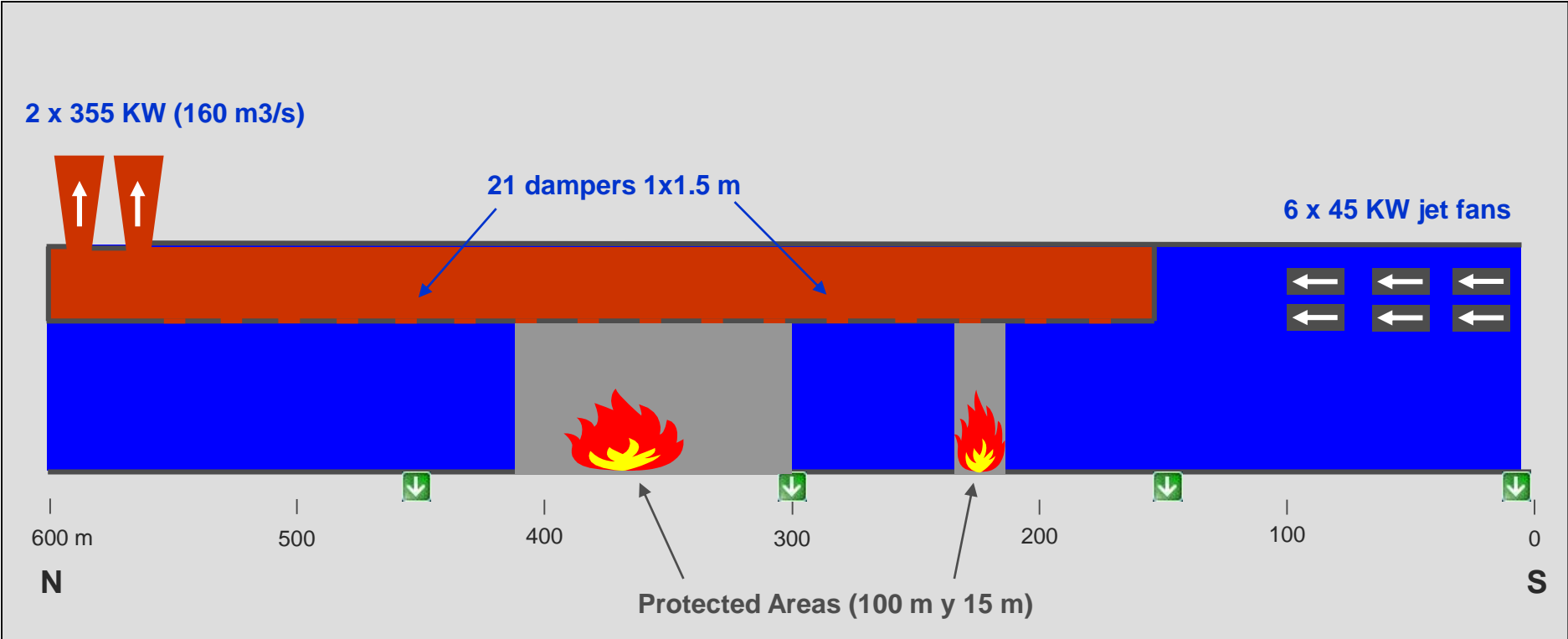
- C.C. x : Caja de Conexiones.
- EMC x : Estación de monitorización y control.
- Vch x : Ventilador de chorro.
- CCTV x : Registro circuito cerrado TV.
- Trapecio falso techo
- Conduito entre túnel y galería. 2x160mm²
- PK. x : Señal indicadora de posición en túnel. (Máx. 3)

Dibujado	Fecha	Firma	
Revisado	7-04-2007	RMS	
Aprobado	15-05-2012	RMS	
Escala	Proyecto: Túnel experimental San Pedro de Anas		Nº:
Formato	Descripción: Configuración túnel de "San Pedro de Anas"		Revisión:
A3	Situación zonas de protección, falso techo, equipos		Hoja: 1 de 1
			CD:

Full scale tunnel fire test and training



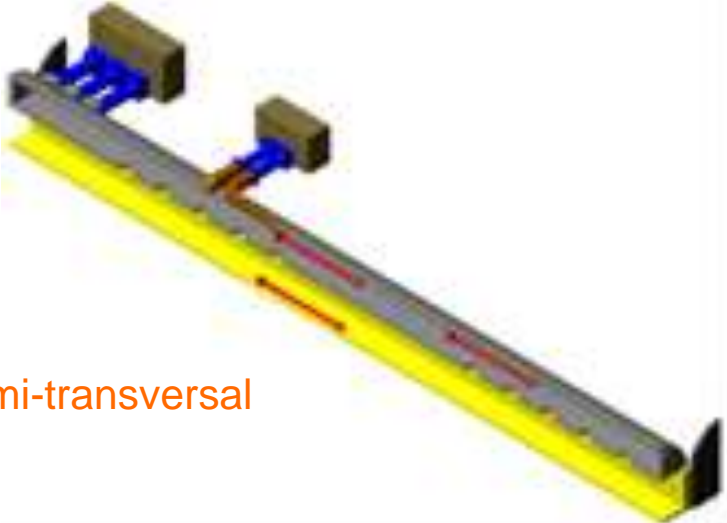
ACTUAL TUNNEL LAYOUT



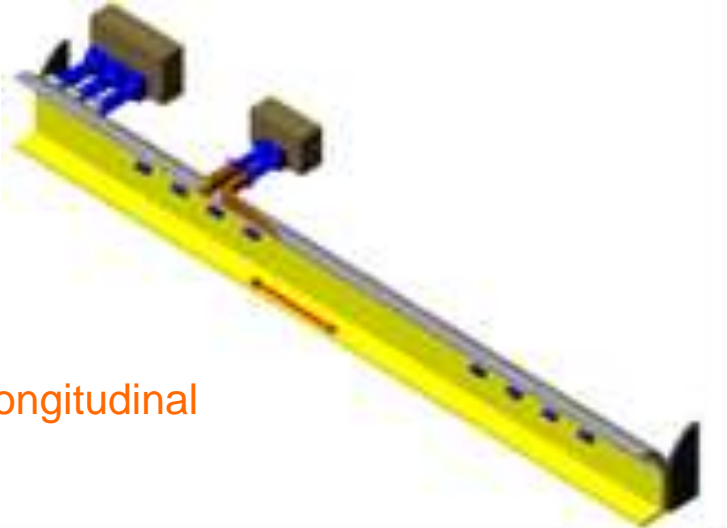
Full scale tunnel fire test and training



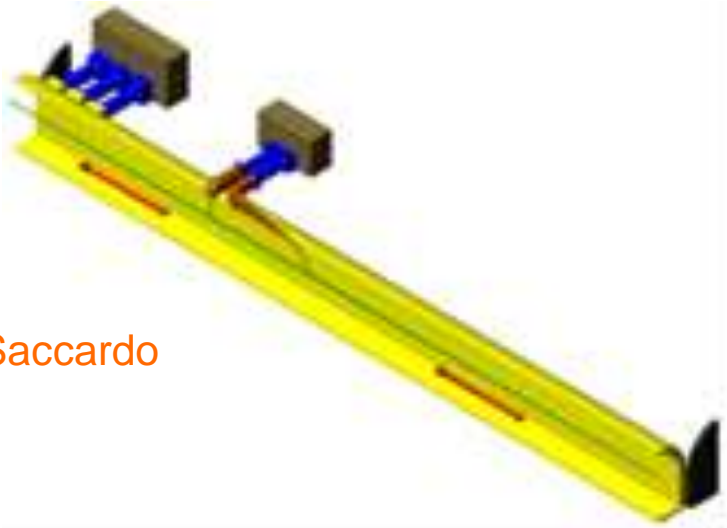
VENTILATION SYSTEM



Semi-transversal



Longitudinal



Saccardo

Full scale tunnel fire test and training

VENTILATION SYSTEM - LONGITUDINAL



6 JET FANS (45KW each)

Full scale tunnel fire test and training

VENTILATION SYSTEM – AXIAL FAN



- North station: 2 x 355 KW (160 m³/s)
- Saccardo station: 2 x 355 KW (120 m³/s)

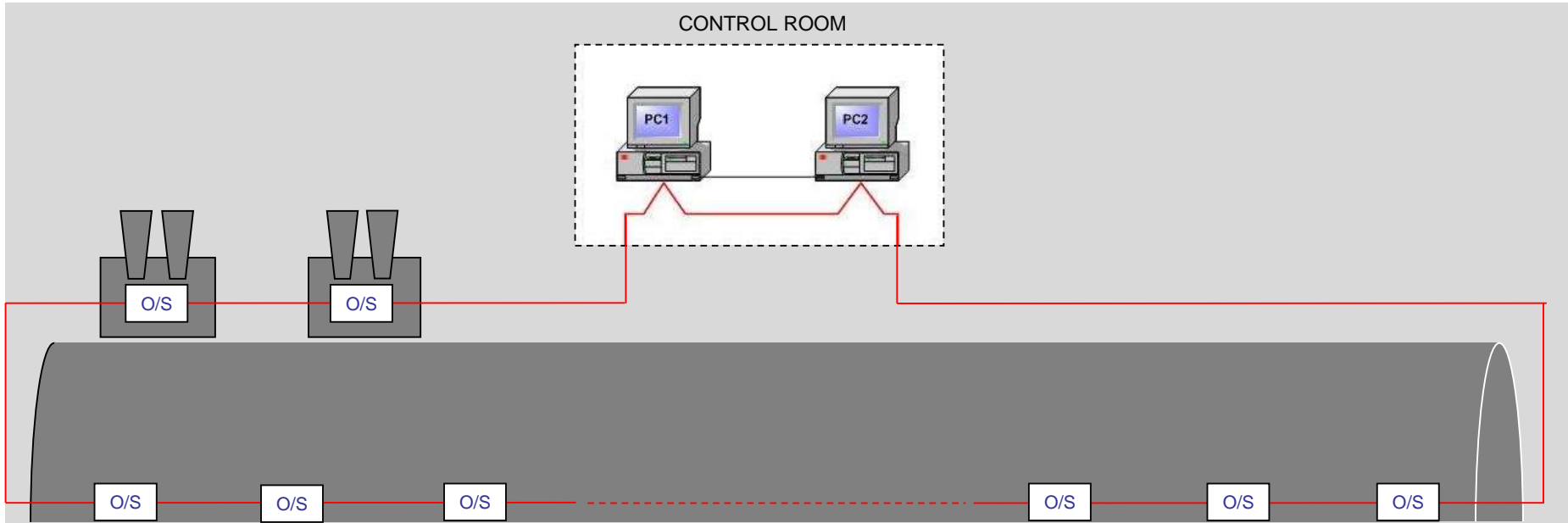
Full scale tunnel fire test and training

VENTILATION SYSTEM – AXIAL FAN



Full scale tunnel fire test and training

DATA ACQUISITION SYSTEM

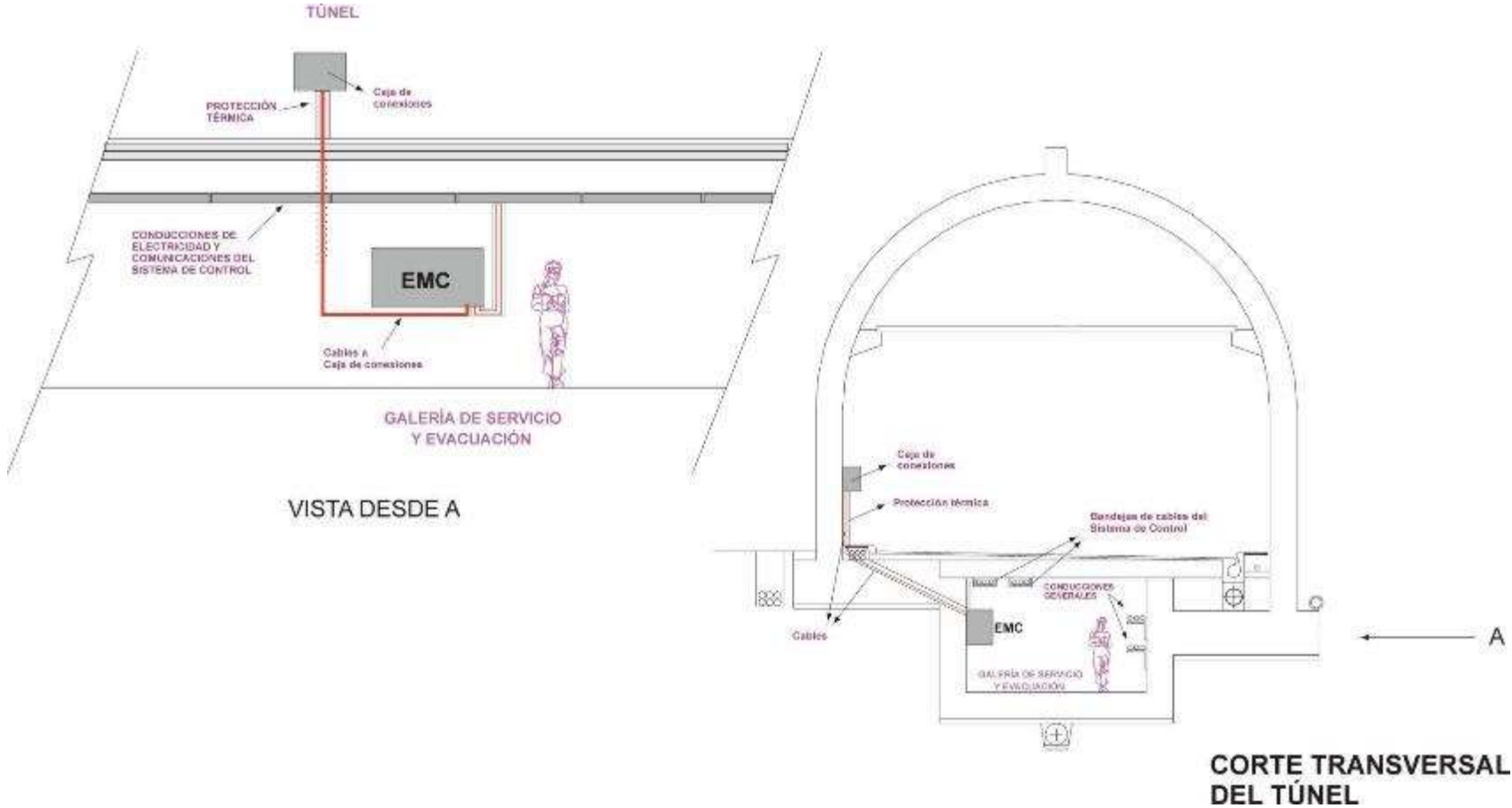


- Distributed control (15 monit. & control Outstations)
- Multiple format inputs/outputs
- Fiber optics loop (100 MBS on TCP/IP)
- Uninterrupted Power Supply
- Redundant computer system

Full scale tunnel fire test and training



LOCATION OF CONTROL STATIONS



Full scale tunnel fire test and training



JET FANS MONITORING AND CONTROL

Estación Meteorológica - Saccardò

Velocidad Viento = 0.06 m/s
Dirección Viento = 142.6 °
Temperatura = 6.3 °C
Humedad Relativa = 97.7 %
Presión Abs = 1001.0 hPa

Estación Meteorológica - Sora Lindi

Velocidad Viento = 0.01 m/s
Dirección Viento = 350.4 °
Temperatura = 7.8 °C
Humedad Relativa = 96.2 %
Presión Abs = 1001.0 hPa

VCH1 VCH3 VCH5

Directo **Marcha** Inversa

Directo **Marcha** Inversa

Directo **Marcha** Inversa

RESET

BOCA NORTE

VCH 1 VCH 3 VCH 5

VCH 2 VCH 4 VCH 6

BOCA SUR

Directo **Marcha** Inversa

Directo **Marcha** Inversa

Directo **Marcha** Inversa

VCH2 VCH4 VCH6

V2 V1 V2 V1

Código de colores:

- Marcha
- Parada
- Fallo

Zona Protección-1	Estación Norte
Zona Protección-2	Estación Saccardò

Secciones Velocidad

23/12/2008 18:05:16

Full scale tunnel fire test and training

SACCARDO MONITORING AND CONTROL

VENTILADOR 1 IMPULSIÓN

Bombas 11, PTC 11, PTC 12, PI 100 12: 26,7 °C

Vibraciones V1: 0,8 mm/seg

Consumo V1: 0,5 Amp

Variable 1: ESTADO

Caudal V1: 0,0 m3/seg

Regimen Giro V1: 1 rpm

VENTILADOR 2 EXTRACCIÓN

Bombas 21, PTC 21, PTC 22, PI 100 21: 27,4 °C, PI 100 22: 27,2 °C

Vibraciones V2: 0,2 mm/seg

Consumo V2: 0,7 Amp

Variable 2: ESTADO

Caudal V2: m3/seg

Regimen Giro V2: 1 rpm

DAMPER 1

CERRADO

TERMICO

CENTRIFUGO

TERMICO

PARADA

DAMPER 2

CERRADO

TERMICO

SELEC V1 **SELEC V2** **SENTIDO**

REF_VELOCIDAD

CONSIGNA: V1 IMPULS Hz: 0,0 Hz, V2 EXTRACC Hz: 0,0 Hz

PARADO

MODO **COMUNIC**

SETA EMERG

MARCHA

RESETE

Full scale tunnel fire test and training

ADDITIONAL TUNNEL EQUIPMENT



- Hydrants line at 9,5 bar (each 50 m)
- 3 water tanks (total capacity 570 m³)
- Water supply of 3000 l/min at 3,5 bar
- 50 m³ settling basin for tunnel spills
- 250 W luminaries (each 15 m)

Full scale tunnel fire test and training

FULL SCALE FIRE



Full scale tunnel fire test and training

TEST CAMPAIGNS

MADRID CALLE 30

SOLIT PROJECT I and II

DATFORD TUNNEL (UK)

EUROTUNNEL (Channel Tunnel)

MONT BLANC TUNNEL

SAN MAMES (SPAIN)

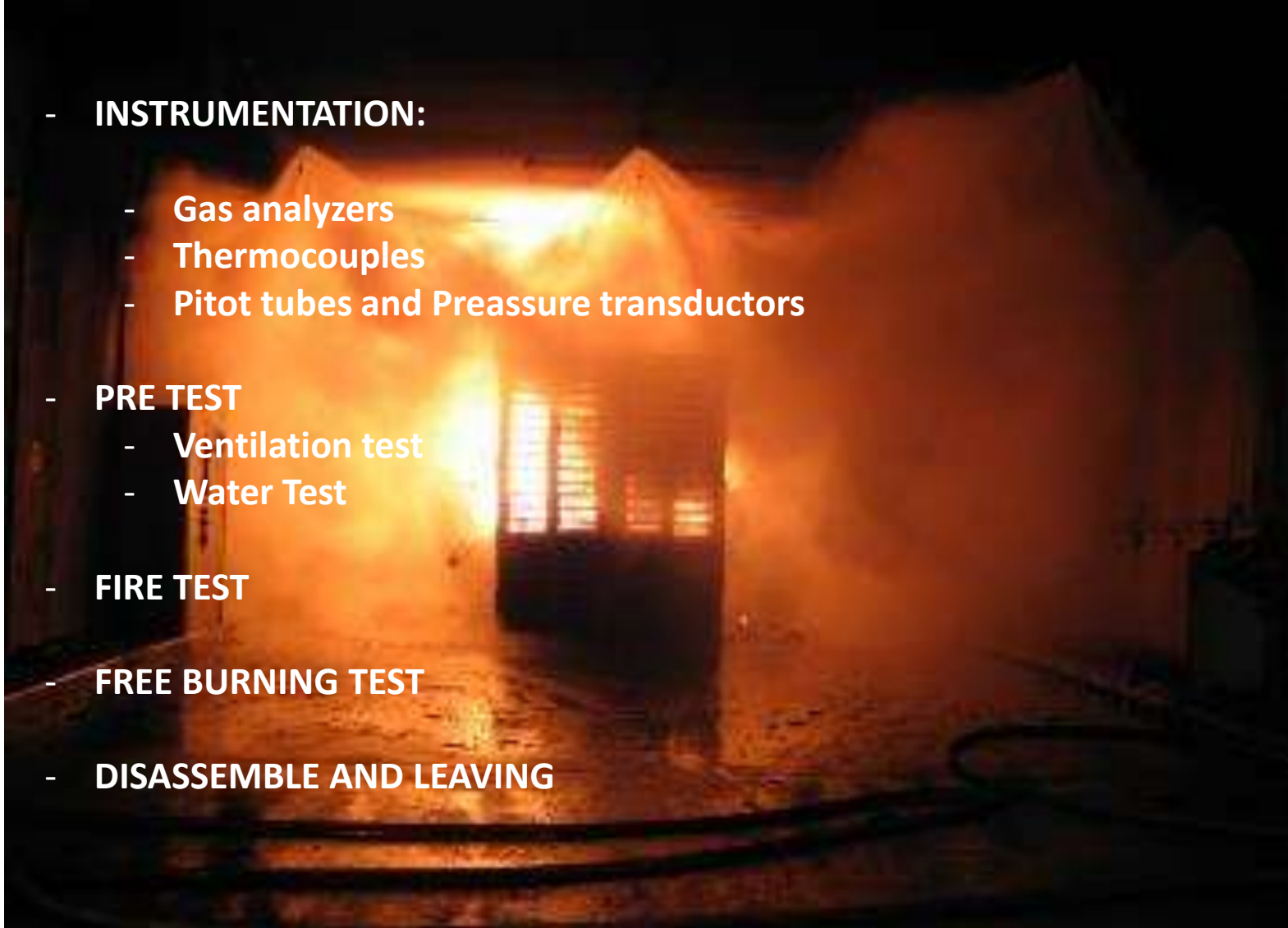
LTA SINGAPORE (2012 AND 2018)

CABLE TUNNEL SONGAPORE



Full scale tunnel fire test and training

SCHEDULE

- **INSTRUMENTATION:**
 - Gas analyzers
 - Thermocouples
 - Pitot tubes and Pressure transducers
 - **PRE TEST**
 - Ventilation test
 - Water Test
 - **FIRE TEST**
 - **FREE BURNING TEST**
 - **DISASSEMBLE AND LEAVING**
- 

Full scale tunnel fire test and training



FIRE TEST INSTRUMENTATION I



Full scale tunnel fire test and training



FIRE TEST INSTRUMENTATION II



Full scale tunnel fire test and training

PRE TEST



Full scale tunnel fire test and training



FIRE TEST



Full scale tunnel fire test and training

FREE BURNING TEST

[Minuto 1.mp4](#)

[Segunda parte.mp4](#)

[Tercera parte.mp4](#)

[Spalling.mp4](#)



Full scale tunnel fire test and training

WATER MIST TEST (PALLETS)

AGUA NEBULIZADA
pallets.m2ts



Full scale tunnel fire test and training

WATER MIST TEST (DIESEL POOLS)



Full scale tunnel fire test and training

FIRE IN TUNNELS TRAINING COURSES



OBJETIVES

- Problem analysis.
- Addressing the intervention.
- Implementation.

FIRE IN TUNNELS TRAINING COURSES

THEORY



- Fire evolution
- Active protection systems
- Special equipment
- Ventilation systems
- Case study
- Practical events
- Risks during intervention
- Operational procedures
- Staff control
- Management and control
- Legal framework

FIRE IN TUNNELS TRAINING COURSES

PRACTICES



- Smoke evolution:
- Orientation and search:
- Penetration with long lays and tracking sectorization.
- Penetration with heavy-duty urban pump:
- Penetration through entrances:
- Simultaneous penetration:
- Multiple penetrations:

Full scale tunnel fire test and training

FIRE GALLERY



- 150 m long
- Two different fire areas
- 8 different exits (same, upper and lower level)
- Fires up to 15 MW

Full scale tunnel fire test and training



FIRE IN TUNNELS TRAINING COURSES



**THANK YOU VERY MUCH
FOR YOUR ATTENTION**

Applus 

Together
beyond
standards

www.tunneltest.com