



# Automatic Isolation and Restoration

(\* *Aislamiento y Reposición Automática*)

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**IBERDROLA**

## Control Structure

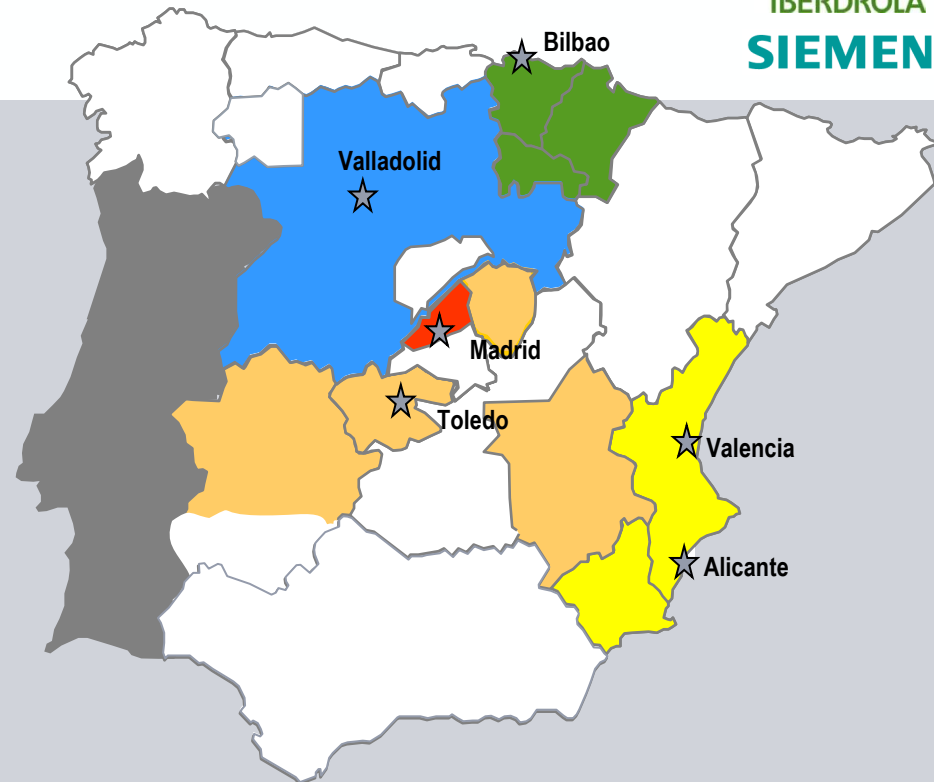
6000 RTUs:

1200 Main Substations

2600 Secondary substations

2100 pole RTUs

~ 500.000 RTU points



### ★ Control Centre (CC)

- 6 Systems of equivalent size covering ~2M customer
- Each of them operates hierarchically all voltage levels within the Region: from Transmission (meshed) to Distribution (radial)
- Hot/stand-by plus emergency configuration
- Same system version, integrating SCADA/DMS/OMS functionality except for EMS-NA only running Bilbao but operated remotely from the other CC

# Automatic Isolation and Restoration program

LAST YEAR

## Main Coordinates

- **MOTIVATION:** Improve the QoS.
- **CHALLENGE:** Assume automatic commands from Spectrum
- **PREREQUISITES** for the utility
  1. Change the “business as usual” operation
  2. Improve the model of the MV network
  3. Improve the quality of measurements
  4. Increase the penetration of local automation
- **CONDITIONS** in Spectrum
  - Avoid complex typification nor complex decision rules to be maintained
  - 100% reliable program (network topology, considers tags, etc..)
  - Must work in all Iberdrola Distribución
- **EXPECTED RESULTS:** reduce down to less than 3 minutes (regulatory limit) the first restoration actions. Operator’s response time can vary depending on the situation.

# Motivation: penalties

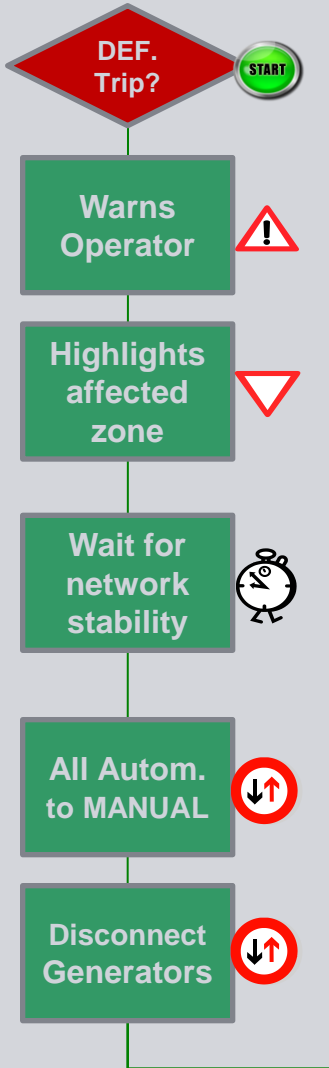
## INCIDENCIAS SIGNIFICATIVAS

Provincia	Instalación	Hora	Reposición (% Clientes)		Nº Clientes	Zona Afectada	ENS (MWh)	Coste TIEPI (ITC/3801/20 001)	Coste NIEPI (ITC/3801/20 001)	Causas, Actuaciones, Reperc...
VALENCIA	ST SAGUNTO ST MASSALFASSAR STR CAMPO OLIVAR ST PUZOL	10:39	6 min 9 min 13 min 1 h 20 min	43% 89% 99% 100%	28.998	Albuixech, Albalat dels Sorells, Albalat dels Taronchers, Betera, Puzol, Puig, Massalfassar	7,9	37.407	51.206	Dispara doble circuito L/66 kV Sagunto - Ma Campo Olivar y L/66 kV Puzol - Massalfassar caída de árbol sobre conductores (en salida Olivar hacia Sagunto). Provoca rotura y caída
CASTELLÓN	ST CASTELLÓN INGENIO	13:30	5 min 15 min 17 min 28 min 56 min	15% 43% 88% 98% 100%	34.598	Oropesa, y Benicassim	5,7	28.514	38.533	Dispara LMT Magallanes por avería en bote CT.
ALICANTE	ST VILLENA	4:40	5 min 14 min 42 min	9% 40% 100%	11.330	Villena, Bihar, Sax, y Salinas	5,4	28.923	29.208	Dispara transformador T-3 132/20 kV - 40 MW actuación del relé 51. Coincide con disparo d por avería en la posición de línea. Queda fuera de servicio el transformador par normalización de la L/22 kV
CASTELLÓN	ST LA PLANA	8:20	9 min 32 min 59 min	97% 99% 100%	6.051	Almassora, Villarreal	2,7	12.512	11.725	Dispara LMT por avería en cable subterráneo
CASTELLÓN	STR VILLARREAL	11:22	4 min 8 min 21 min 6 h 54 min	11% 94% 99% 100%	7.115	Almassora, Villarreal	2,6	12.827	20.353	Dispara LMT por puente cortado y conducto viento.
ALICANTE	STR JACARILLETA	11:30	5 min 6 min 7 min	6% 81% 100%	8.300	Almoradí, Orihuela, Rafal, y Catral	0,5	2.659	7.142	Dispara LMT por causas desconocidas. Viento

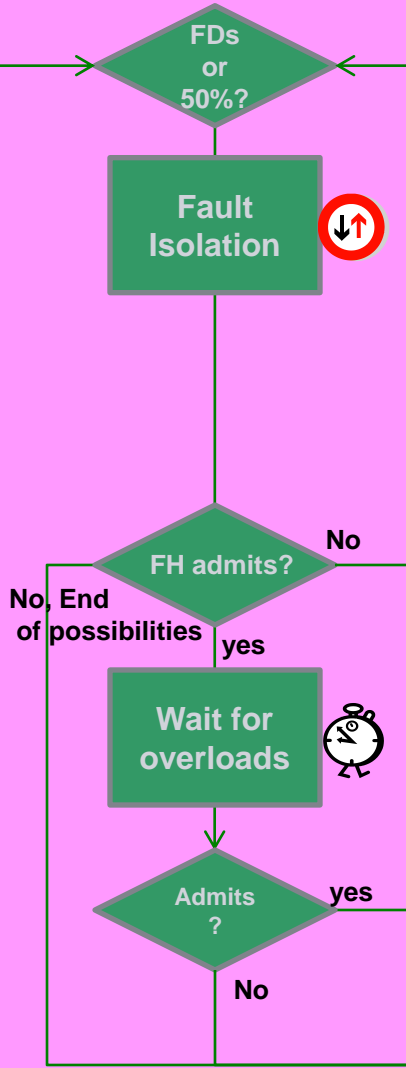


# Algorithm description

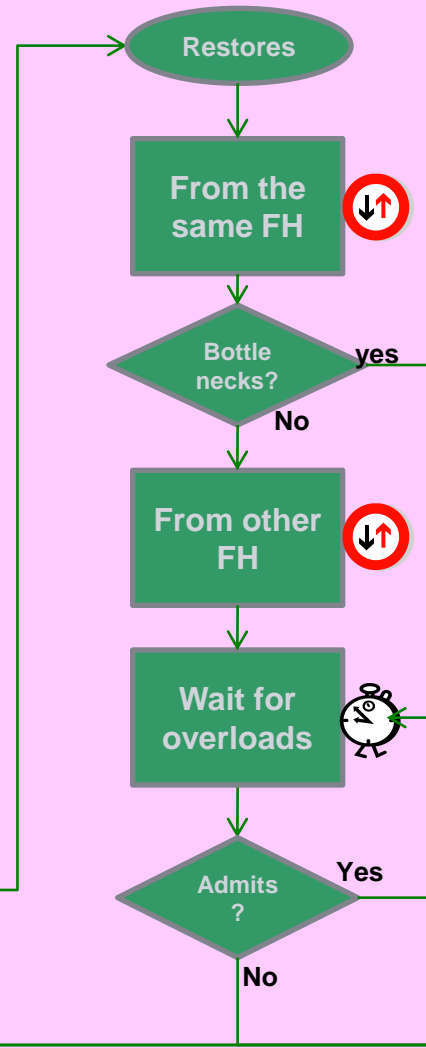
## Start



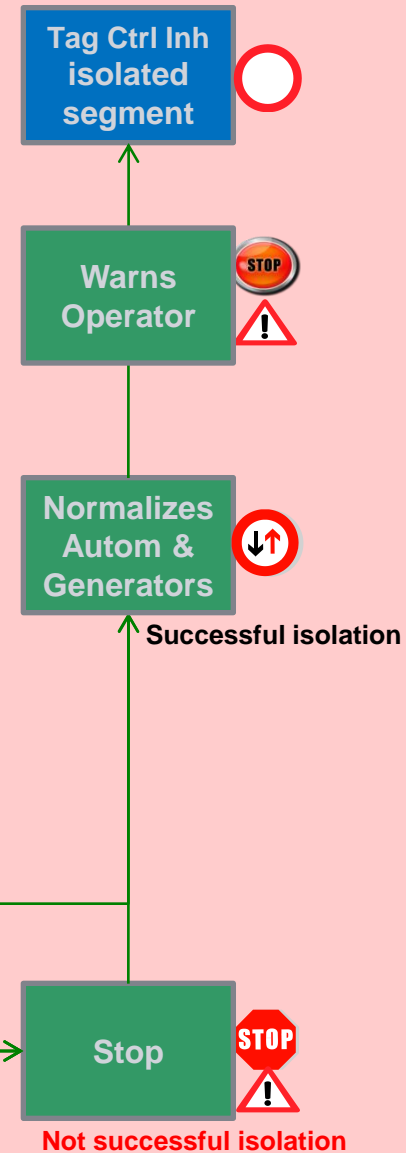
## Isolation



## Restoration



## Normalization



ARA

# Basic example, no FD

Operar

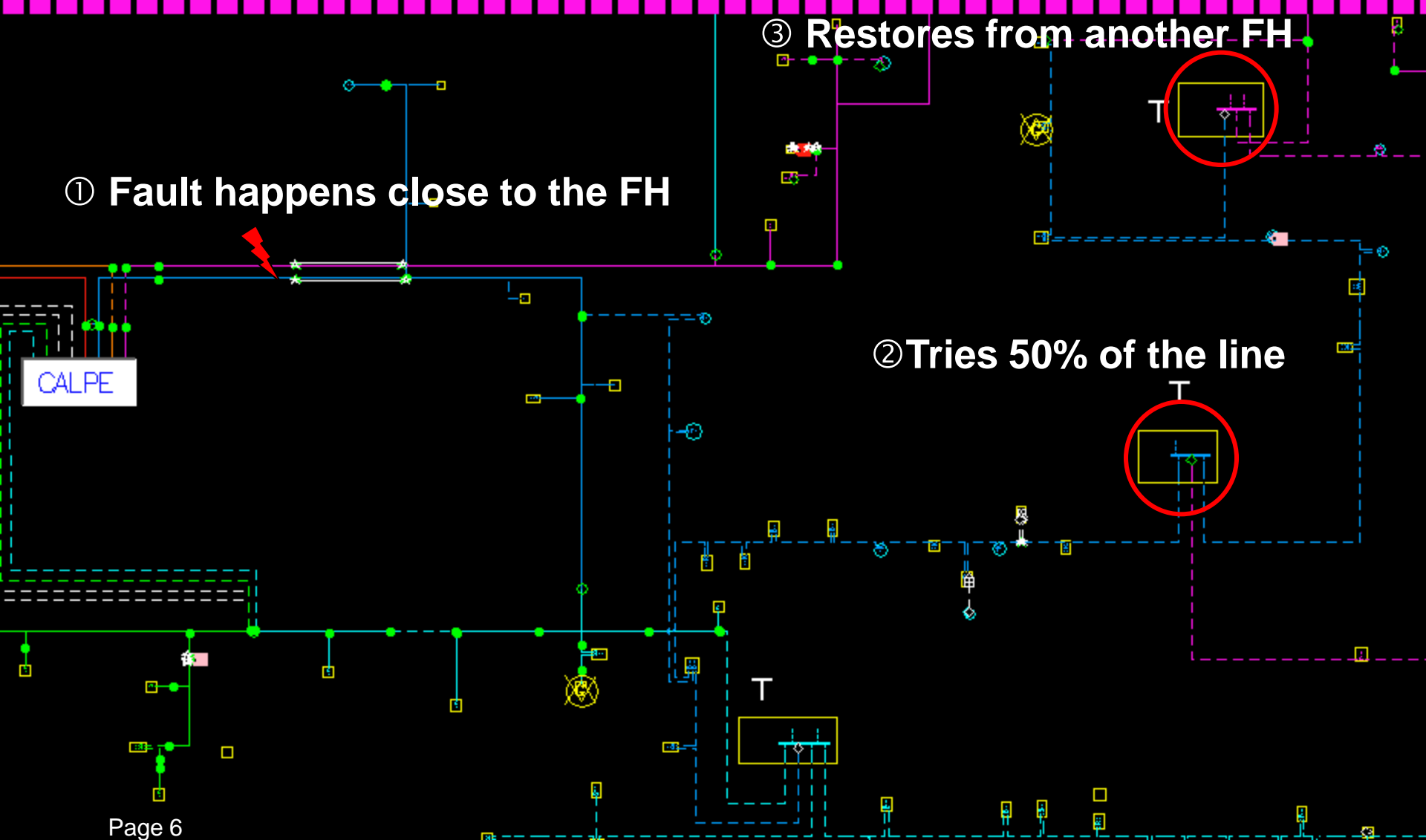
Consult

Fault close to the FH = ST CALPE /20kV /L08 CANUTA (Blue)

① Fault happens close to the FH

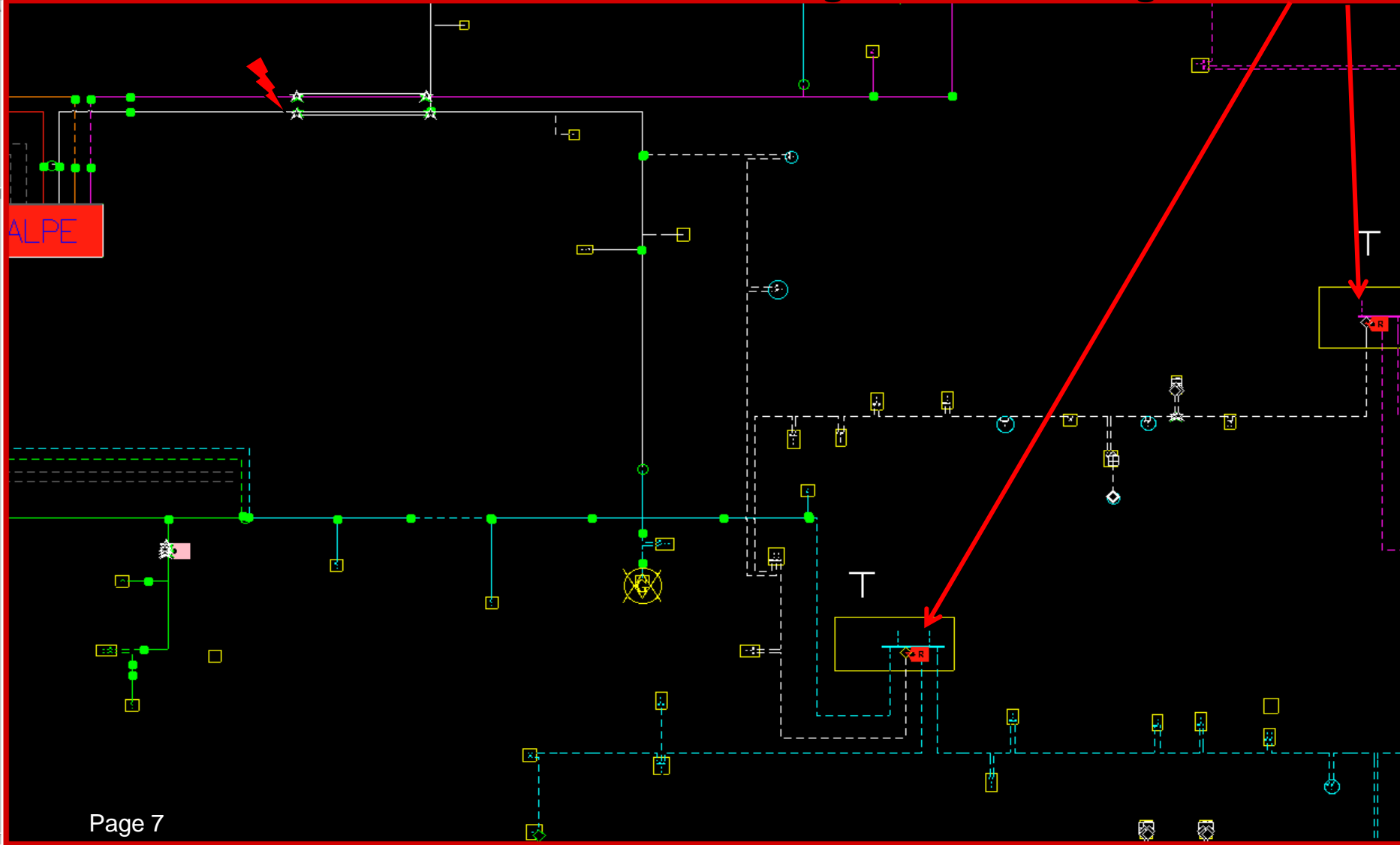
③ Restores from another FH

② Tries 50% of the line



Limpiar Subestac Amarillo ACTUAL Enfoque Auto Enfoque Operar Consulta **Traza** Info.Fuentes

Once STOPPED ARA will tag the isolated segment 





[ibdBa/mm01-20/ spectrum] Process/RealTime - Menu General - MANTENIMIENTO

Ventana Ver Capas

Comunic Canales RTUdes

HW BNM ICCP Sistema SDM

Aplicaciones

25/10/10 13:43

COD ALICANTE

IBERDROLA

REG.Este 2372 MW

Urgentes Todas Comunic. Sistema -ARA- Impiar

Urgentes NoUrg Comunic. v P act/deact Anular

Est.Anor Interrup. Tierras Ele.Temp BuscaTie Man/Loc

Retenido Ret.Man EnPrueba Desactiv. Etiquetas

Archivo Eventos Pruebas Sistema Llamadas Bye

MAT ALICANTE MURCIA SPM VAL

MURCIA ALICANTE AT MT Geo AT MT Geo

[ibdBa/mm01-21/ spectrum] Process/RealTime - Lista de Eventos

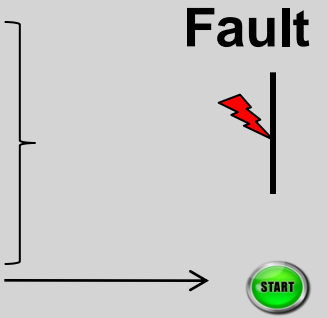

Ventana Ver Capas Medidas Estudio Oper

**Warns the dispatcher (button blinks) !**

Ayuda

## Basic example, fault close to the FH = ST CALPE /20kV /L08 CANUTA

### SINAUT Lista de Eventos Spectrum 26 / 27

25.10 14:00:01	ST VERGEL	20	P. BATERIA_____1	INTERRUPTOR	ABIERTO	POR_MANDO	
25.10 14:09:25	CTDM4660 ANTIGONES		04_L_ST_PALMERAL	RUPTOR	CERRADO		
25.10 14:09:25	CTDM4660 ANTIGONES		EB 2 3	RUPTOR	ABIERTO		
25.10 14:09:25	CTDT4660 BABEL (T)		04_L_SUCH	RUPTOR	ABIERTO		
25.10 14:09:25	CTDT4660 LA PAZ (T)		03_L_ANTIGONES	RUPTOR	CERRADO		
25.10 14:09:45	CTDT4660 LA PAZ (T)		02_L_MARCH	RU	RETENIDO	QUITAR ETIQUETA	
25.10 14:09:49	CTDT4660 LA PAZ (T)		02_L_MARCH	RUPTOR	CERRADO	POR_MANDO	
25.10 14:10:13	CTDT4660 POETA (T)		03_L_ARCHIVO_CEE	RU	RETENIDO	QUITAR ETIQUETA	
<b>ARA_TEST</b>							
25.10 14:13:28	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	ABIERTO	<b>Fault</b> 	
25.10 14:13:28	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	CERRADO		
25.10 14:13:28	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	ABIERTO		
25.10 14:13:58	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	CERRADO		
25.10 14:13:58	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	ABIERTO		
25.10 14:14:59	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	CERRADO		
25.10 14:14:59	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	ABIERTO		
25.10 14:14:59	ST CALPE	20	18_L_CANUTA	DISPARO_DEFINITIVO	DISPARO		
25.10 14:14:59	ST CALPE	20	18_L_CANUTA	DISPARO_DEFINITIVO	NORMAL		
25.10 14:14:59	ARA			AUTOMATISMO	ARRANCA		ARA } !
25.10 14:14:59	ST CALPE	20	18_L_CANUTA	PROGRAMA ARA	ARRANCA	022 } !	
25.10 14:15:10	ST CALPE	20	18_L_CANUTA	REENGANCHE	MANUAL	POR_MANDO 022 } !	
25.10 14:15:10	CTDT4672 GARBIMAR(T)		03_L_PORTALES	RUPTOR	ABIERTO	POR_MANDO 022 } !	
25.10 14:15:10	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	CERRADO	POR_MANDO 022 } !	
25.10 14:15:17	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	ABIERTO		
25.10 14:15:17	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	CERRADO		



# Isolation & restoration done from another FH = ST CALPE /20kV /L21 IFACH

SINAUT Lista de Eventos Spectrum 27 / 27

25.10	14:15:17	ST CALPE	20	18_L_CANUTA	INTERRUPTOR	ABIERTO					
25.10	14:15:17	ST CALPE	20	18_L_CANUTA	DISPARO_DEFINITIVO	DISPARO					
25.10	14:15:17	ST CALPE	20	18_L_CANUTA	DISPARO_DEFINITIVO	NORMAL					
25.10	14:15:21	ST CALPE	20	21_L_IFACH	REENGANCHE	MANUAL	POR_MANDO	022			
25.10	14:15:21	ST CALPE	20	21_L_IFACH	INTERRUPTOR	ABIERTO	POR_MANDO	022			
25.10	14:15:21	CTDT4672 P.PARCIAL UNO N-1(T)		03_L_SOROLLA	RUPTOR	CERRADO	POR_MANDO	022			
25.10	14:15:21	ST CALPE	20	21_L_IFACH	INTERRUPTOR	CERRADO	POR_MANDO	022			
25.10	14:16:21	ST CALPE	20	21_L_IFACH	REENGANCHE	AUTO	POR_MANDO	022			
25.10	14:16:21	ST CALPE	20	18_L_CANUTA	PROGRAMA ARA	PARADO		022			
25.10	14:16:21	ARA			AUTOMATISMO	PARADO		ARA			
25.10	14:16:21	ST CALPE	20	18_L_CANUTA	IN	RETENIDO	PONER	ETIQUETA	022		
25.10	14:16:21	CTDT4672 GARBIMAR(T)		03_L_PORTALES	RU	RETENIDO	PONER	ETIQUETA	022		
25.10	14:16:21	CTDT4690 LA CANUTA 3(T)		03_L_LA CANUTA IV	RU	RETENIDO	PONER	ETIQUETA	022		

- All actions are associated to a sequence number, (*in this case 22*)
- Wait for overloads is parametrizable (*now one minute*) as other timings
- In the OMS all actions are associated to the same outage
- In case of not successful isolation all actions done were always in the right direction

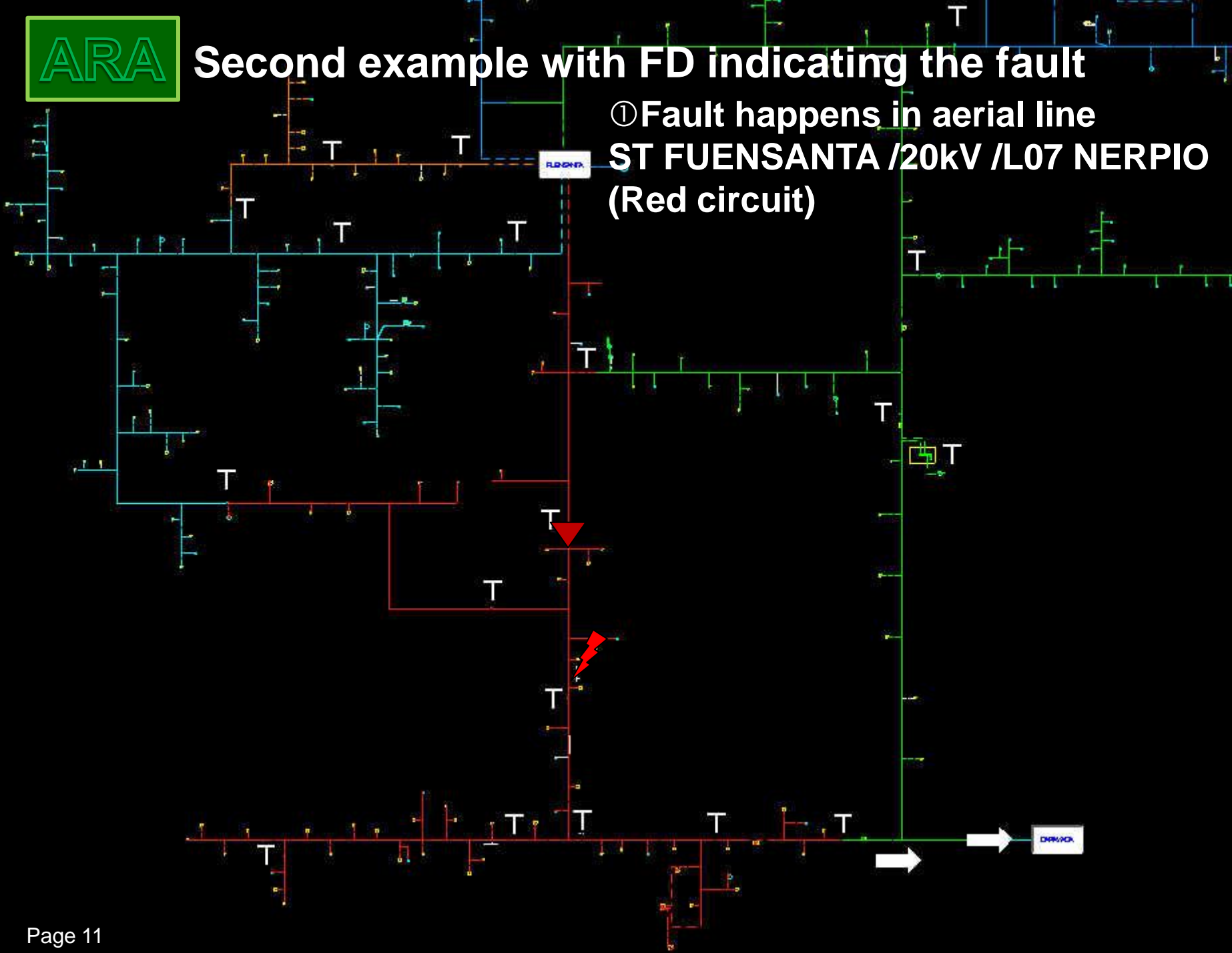
**ARA response time was 2:22 minutes vs 5:38 dispatchers reaction**

25.10.10 14:31

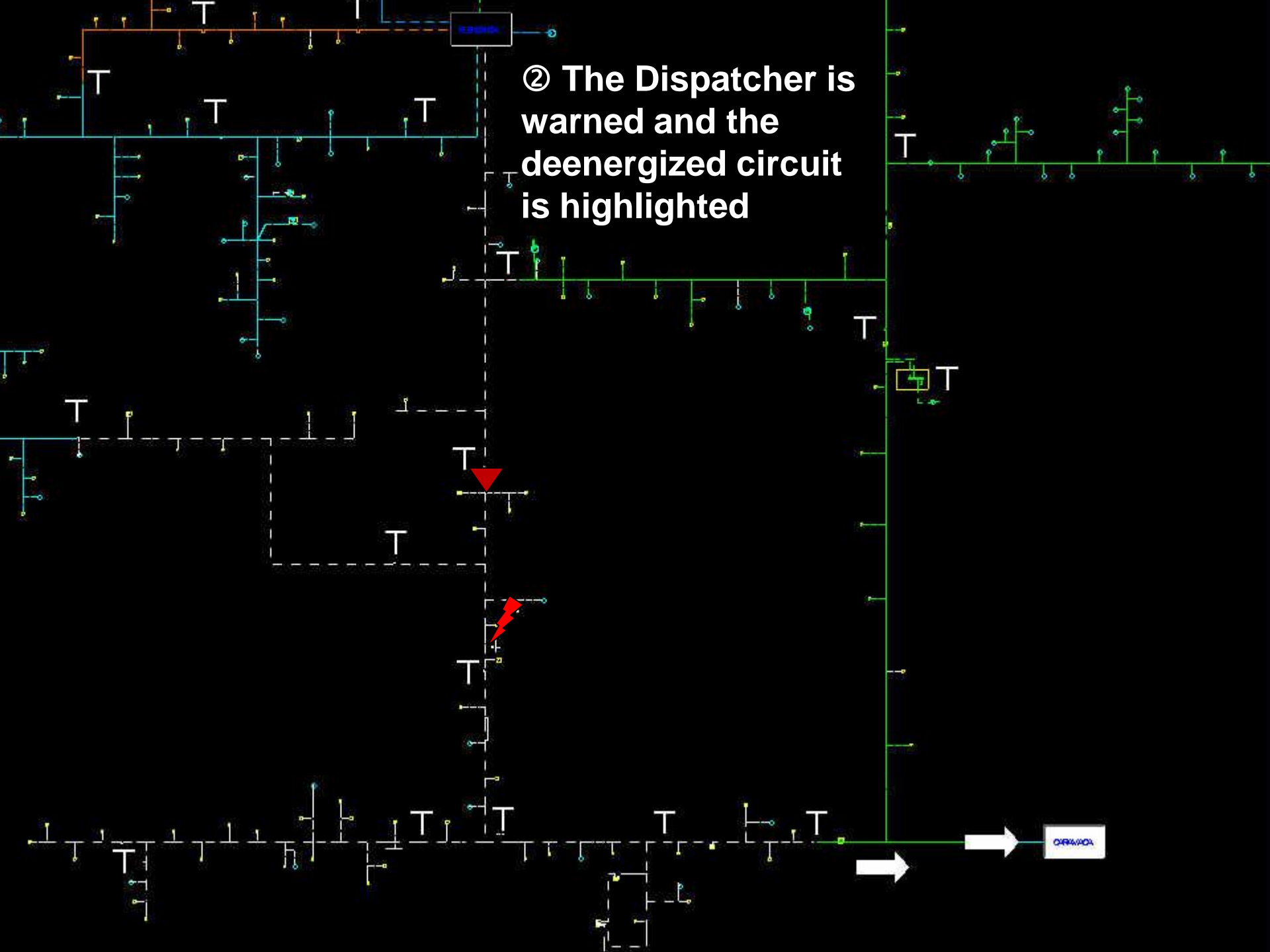
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## Second example with FD indicating the fault

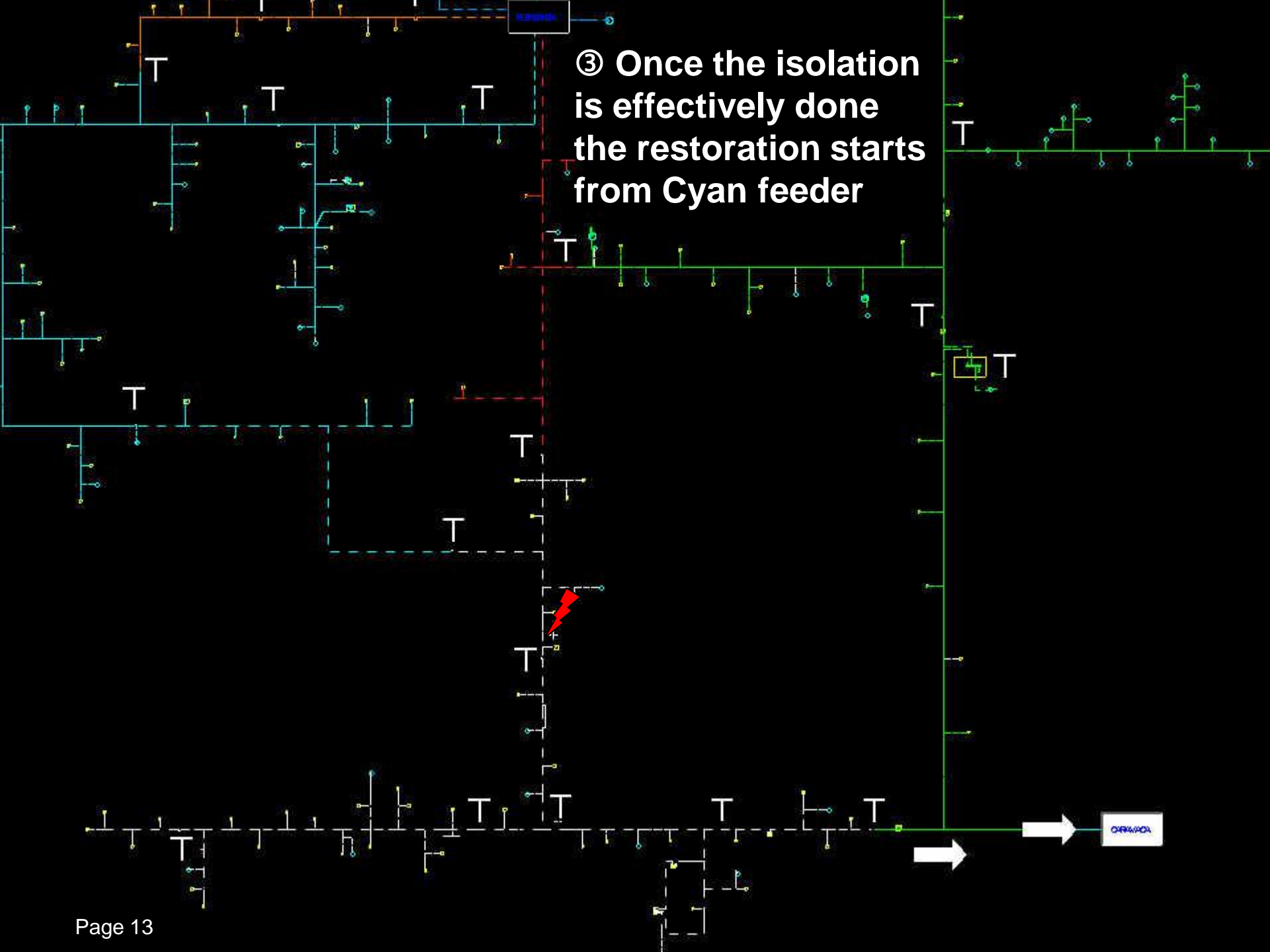
- ① Fault happens in aerial line  
ST FUENSANTA /20kV /L07 NERPIO  
(Red circuit)



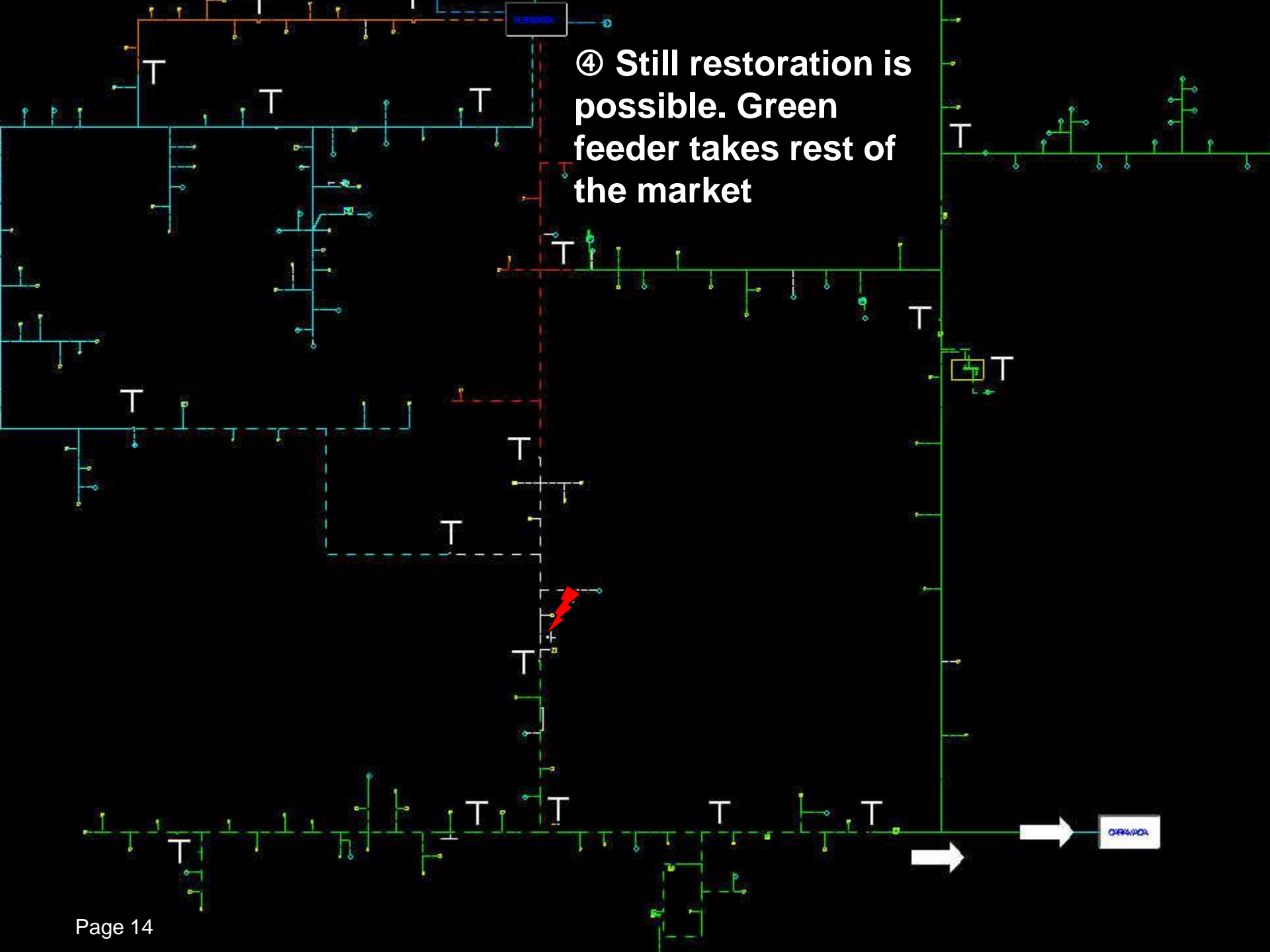
② The Dispatcher is warned and the deenergized circuit is highlighted



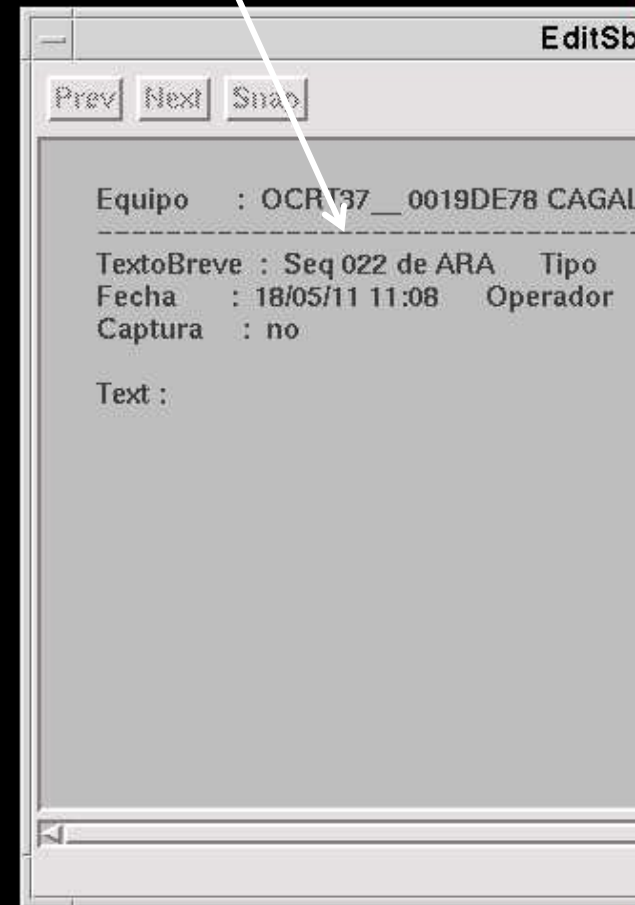
③ Once the isolation is effectively done the restoration starts from Cyan feeder



④ Still restoration is possible. Green feeder takes rest of the market



⑤ The isolated segment is tagged with CtrlInh with a predefined text



⑥ The outage is created and the crew is on the way. The Dispatcher will coordinate the works



# Description of ARA main parameters

- Waiting time to start ARA after the definitive trip, network stable
- Waiting time for overloads after a restoration action
- End time, to avoid endless loops in case of errors
- Number of command retries after command failure.
- Parameters to displace the 50% rule
- Available capacity (in %) before restoring from an other FH
- Maximum number of breaker closing actions against fault

## **ARA is defined to work only in the distribution radial network**

- When checking other FH capacity to resupply it uses the last hour average flow and evaluates the capacity to be restored (faster and more reliable than using DNA at this point)

# Experience with ARA in Iberdrola



- FAT passed in May 2010 in Madrid
- During FAT 15 parallel cases were successfully run simulating storm mode
- In July 2010 ARA first prototype was installed in Alicante CC
- **Since January 2011** it is available in the 6 CC at Iberdrola, but only used in the emergency system (disabled in the real time system)
- All definitive trips have been simulated and analyzed, helping Dispatchers to get confidence with the tool
- Dispatchers are receiving training on ARA
- In this time ARA has been successfully tested in many scenarios and no major problems have been detected at system level

**ARA restoration time is always less than 3 minutes since the definitive trip occurrence**

# Conclusions : ARA vs Dispatchers

- Differences on response time ARA vs Dispatchers average 4 minutes
- ARA is always faster than the Dispatcher
- In some situations the difference is more than 30 minutes (storms, parallel outages etc...) ⇒ ARA more important

**Regarding QoS and penalties the impact of ARA is significant**

However, it's wrong to consider ARA vs Dispatchers

- It's expected ARA to make **life of the Dispatchers easier**, reduce their stress, and let them concentrate in managing crews to solve outages



ARA



~~vs~~



# Conclusions: ARA and Automation

- Iberdrola is in the process of a large deployment of automation connected to the AMI project.
- Higher degree of automation  $\Rightarrow$  ARA more selective  $\Rightarrow$  less affected market
- In normal operation both ARA and Dispatchers can be dramatically affected by poor reliability of automation:
  - Command retries increase unnecessarily the response time
  - Wrong information from fault detectors can be handled but reduces the efficiency of ARA significantly

# ARA Next steps

Still some technical issues are been discussed in Iberdrola

- Closing actions with switches? Initially done only with breakers
- Reclosing strategy is evaluated: Reducing reclosing actions to just one retry and let ARA solve faster
- Using ARA in underground cables?
- Definitive trip signal not existing in old substations
- Checking bottleneck information
- Some response times could be reduced and optimized

If these issues are solved and the program behaves satisfactory in all control centers, the target is to have a **first prototype operative in the 3<sup>rd</sup>Q of 2011 and progressively in the other 5 CC**

**For Iberdrola Distribution it will be the first time to deploy automatic network commands from a control system in close loop**

# Thank you

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