

# Fault Location in Submarine Cables

June 25, 2015



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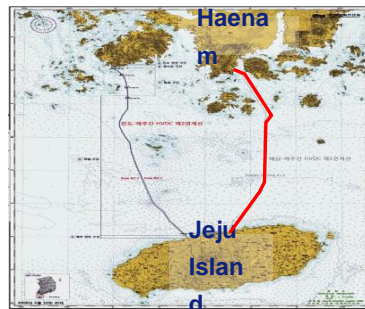
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**Improvement of Fault Location**



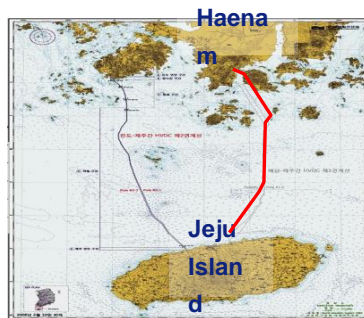
# Experience in Korea

<b>Transmission Line</b>	Haenam – Jeju (#1 HVDC)		
<b>System configuration</b>	Bipole + MI, 800mm <sup>2</sup> Cable,		
<b>Route Length</b>	96+5 km (Multiple Earthing connection, every 4 km)		
<b>Fault occurred</b>	2000. 10		
<b>METHOD</b>	<b>Pre-location</b>	Murray loop	13.2 ~ 13.7 km
		TDR	13.4 ~ 14.7 km
	<b>Pin pointing</b>	Search coil	13.01~13.4km
		Visual inspection	<b>13.08 km</b>



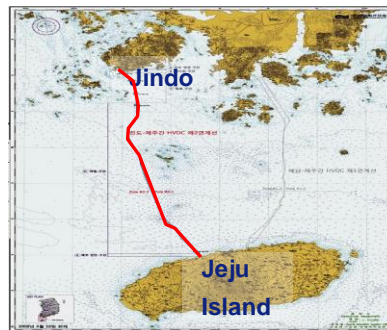
# Experience in Korea

<b>Transmission Line</b>	Haenam – Jeju (#1 HVDC)		
<b>System configuration</b>	Bipole, MI 800mm <sup>2</sup> Cable,		
<b>Route Length</b>	96+5 km (Multiple Earthing connection, every 4 km)		
<b>Fault occurred</b>	2000. 10		
<b>METHOD</b>	<b>Pre-location</b>	Murray loop	11.3 ~ 13.8 km
		TDR	13.5 ~ 14.0 km
	<b>Pin pointing</b>	Search coil	Failed
		Visual inspection	<b>13.44 km</b>



# Experience in korea

<b>Transmission Line</b>	Jindo – Jeju (#2 HVDC)		
<b>System configuration</b>	Bipole , MI 900mm <sup>2</sup> Cable,		
<b>Route Length</b>	105 + 17 km (Multiple Earthing connection, every 4 km)		
<b>Fault occurred</b>	2013. 04		
<b>METHOD</b>	<b>Pre-location</b>	Murray loop	Failed
		TDR	10.2 km
	<b>Pin pointing</b>	Search coil	N/A
		Visual inspection	10.835km



# Limitation (of Pre Location)

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## ■ Fault location in Submarine Cables

- Pre-Location : TDR(Time Domain Reflectometry), M/L(Murray Loop)
- Pin pointing : Search Coil, Acoustic sensor

## ■ Limitation of Pre-Location

	Accuracy	Remarks
TDR	$\pm 1\%$	Max. error = 2km in 100km route length
M/L	$\pm 1\sim 2\%$	Max. error = 4km

**After pre-location, Pin-pointing is needed**

- **Search Coil**
- **Acoustic method**

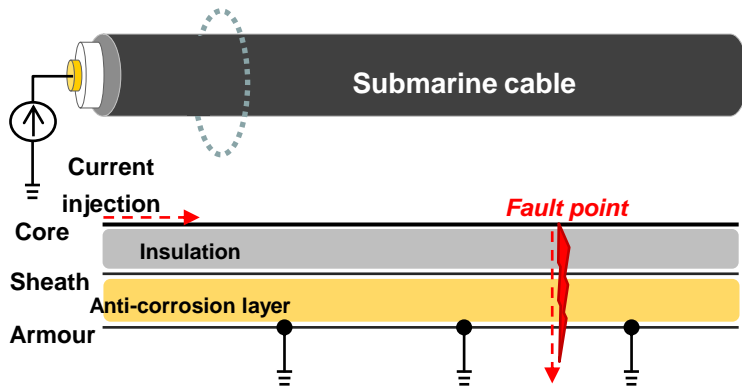




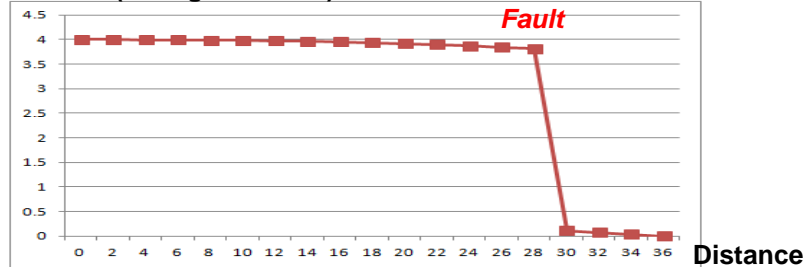
# Limitation (of Search Coil)

Pin-pointing with search coil is difficult, in case that cable has multiple earthing connection or high fault resistance

Without Earthing Connection

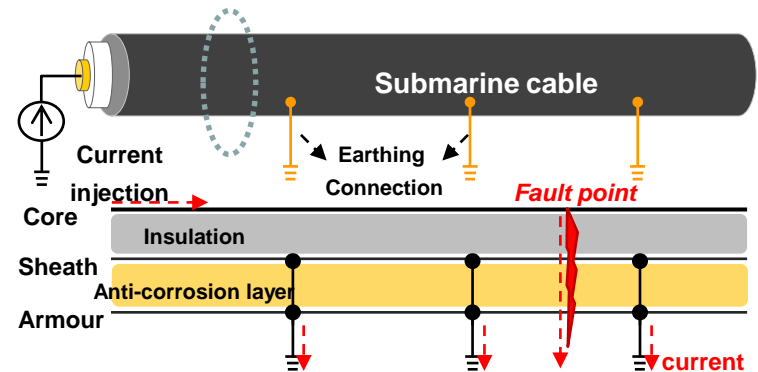


Current ( $\propto$  Magnetic field)

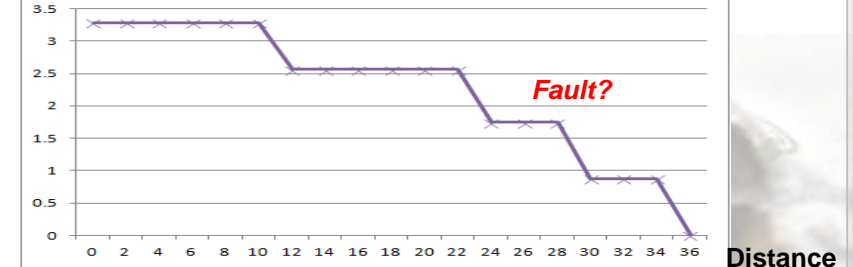


→ Fault POINT can be identified

With Earthing Connection



Current ( $\propto$  Magnetic field)

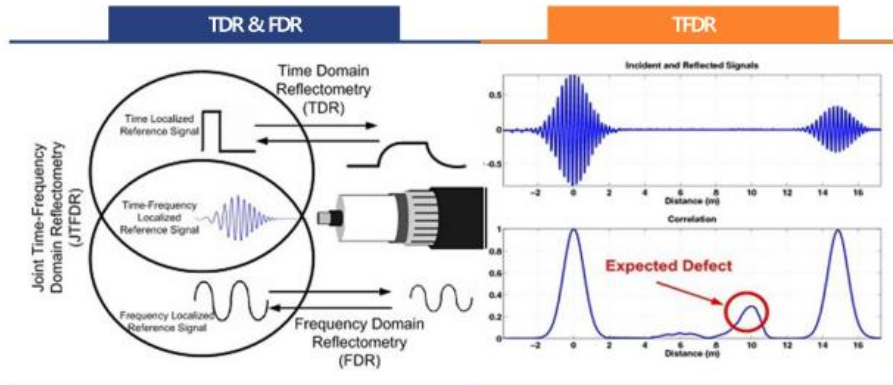


→ Difficult to identify fault location

# Improvement

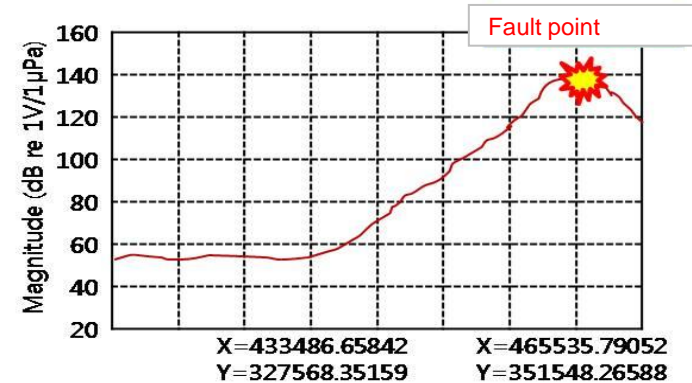
## Pre-Location

- TFDR (Time-Frequency Domain Reflectometry)



## Pin Pointing

Acoustic method can Complement Search coil method



	TDR	TFDR
Information	Time Domain	Time + Freq. Domain
Noise Robustness	Weak	Strong
Finding high resistance fault	Difficult	Easy

	Search Coil	Acoustic
Multiple Earthing Cable	-	Good
Fault Resistance	Low	Good
	High	-
	-	Good