



# Monitoring of Fugitive Emissions in a Gas Transportation Infrastructure

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# Objectives and Goal of the Project

- Sources Identification and Estimation of fugitive emissions in a Gas Transportation Infrastructure (three compressor stations)
- In-field application of measurement techniques and emission factors estimation based on EPA 21 approach
- Database created with all of the items of the compressor stations and related emission factors
- Identification of the compressor station critical items
- Creation of a supporting tool for plant O&M planning targeting the reduction of fugitive emissions

**Eni R&M technical partner in the project design & development**

# Main Steps

- 1) Census and measurement campaign of the plant items
- 2) Data gathering and emission factors estimation
- 3) Results and conclusions

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# Gas Transportation Infrastructure

The infrastructure considered in this extensive campaign is:

- Three Compression Stations with turbomachines installed having a power of over 380 MW
- About 380 km pipeline (48" pipe diameter)

# Compression Station items census

- Gathering of all the plant documentation (CS P&IDs and manuals)
- Identification and classification of all of the items
- Creation of a database fed with items parameters

# Compression Station items census

Identification and classification of all of the compression station items

All of the items have been classified in two main types:

- Type A: items related to the turbo-compressors operation
- Type B: items related to the whole compressor station

	Type A [#]	Type B [#]	Total [#]
CSI	2700	1065	3764
CS2	400	1146	1546
CS3	670	2331	3001
Totale	3770	4599	8311

# Compression Station items census

## Creation of a database with all of the items parameters

### Parameters used in the database:

- ID
- P&ID code
- Item ID
- Type
- Plant area
- Size
- Stream type
- Pressure, temperature and mass flow
- Worked hours and last maintenance

	A	B	C	E	G	H	I	J	K
	ID	P&ID	Sigla Dispositivo	Tipologia	Descrizione	Area Impianto	Linea (se indicata)	Apparecchiatura	Tipo Stream
1									
2	62	700-GD-3B-08801 fe.9	RO 803	Bride		Area 48		MS 81	gas processo
3	63	700-GD-3B-08801 fe.9	RO 804	Bride		Area 48		MS 81	gas processo
4	64	700-GD-3B-08801 fe.9	FE 801	Instrumentation	Aspirazione TK8	Area 48		TK8	gas processo
5	65	700-GD-3B-08801 fe.9	MOV 806	Vanne gaz process	Aspirazione TK8	Area 48	P801	TK8	gas processo
6	66	700-GD-3B-08801 fe.9	VNR 803	Vanne gaz process	Aspirazione TK8	Area 48	P801	TK8	gas processo
7	67	700-GD-3B-08801 fe.9	MOV 801	Vanne gaz process	Aspirazione TK8	Area 48	P802	TK8	gas processo
8	68	700-GD-3B-08801 fe.9	MOV 802	Vanne gaz process	Aspirazione TK8	Area 48	P802A	TK8	gas processo
9	69	700-GD-3B-08801 fe.9	VMA 801	Vanne	Aspirazione TK8	Area 48		TK8	gas processo
10	70	700-GD-3B-08801 fe.9	IdPS 804	Instrumentation	MOV 801	Area 48		TK8	gas processo
11	71	700-GD-3B-08801 fe.9	RO 801	Bride		Area 48		TK8	gas processo
12									
	ID	P&ID	Dimensioni Linea (")	Pressione (bar)	Temperatura (C°)	Portata massima (m3/h)	Ore di esercizio annue	Funzionamenti (avviamenti) /anno	Data Ultima Manutenzione
13									
14	62	700-GD-3B-08801 fe.9	2	54,5	0 -->32	750.000	6774	315	Febbraio 2007
15	63	700-GD-3B-08801 fe.9	2	54,5	0 -->32	750.000	6774	315	Febbraio 2007
16	64	700-GD-3B-08801 fe.9	20	54,5	0 -->32	750.000	6774	315	Febbraio 2007
17	65	700-GD-3B-08801 fe.9	20	54,5	0 -->32	750.000	6774	315	Febbraio 2007
18	66	700-GD-3B-08801 fe.9	20	54,5	0 -->32	750.000	6774	315	Febbraio 2007
19	67	700-GD-3B-08801 fe.9	20	54,5	0 -->32	750.000	6774	315	Febbraio 2007
20	68	700-GD-3B-08801 fe.9	4	54,5	0 -->32	750.000	6774	315	Febbraio 2007
21	69	700-GD-3B-08801 fe.9	4	54,5	0 -->32	750.000	6774	315	Febbraio 2007
22	70	700-GD-3B-08801 fe.9		54,5	0 -->32	750.000	6774	315	Febbraio 2007
23	71	700-GD-3B-08801 fe.9		54,5	0 -->32	750.000	6774	315	Febbraio 2007



# Compressor stations items census

## Sampling percentage of the different types:

Compressor Station	Type A	Type B	Total Items	Measured Items
CS1	33% (3TK)	100%	3764	1501
CS2	67% (2TK)	40-50%	1546	1088
CS3	60% (3TK)	40-50%	3001	1275

**Type A: turbo compressors (TK)**

**Type B: common items (filters, fuel gas lines, etc etc.)**

# Main Steps

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# Data gathering and processing

Per each compression station (CS) it has been:

- Estimated the total fugitive emissions
- Estimated the emission factors per each item of each type
- Identified the Over Range (OR)<sup>(\*)</sup> items and evaluated the OR distribution per CS, item group and weight over the total result

*(\*) item with a measure outside the measurability limits of the gauge*

# Compressor Station I

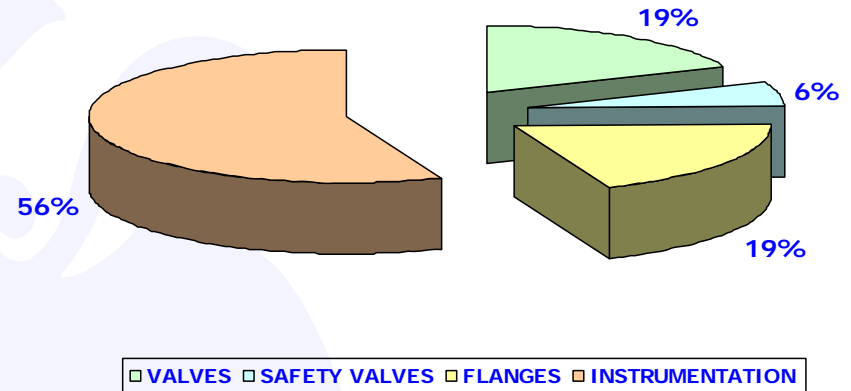
Fugitive emissions - **1501** items measured:

- Arrival terminal
- Slug catcher MSI00 -110
- Turbo compressors TK1, TK8, TK9  
(with filters, feeding and refrigeration systems)
- Fuel gas treatment plant + boilers

About 40% of the entire compression station has been measured

# Compressor Station 1

GROUP NAME	Emissions [% ]
CENTRIFUGAL COMPRESSORS	-
VALVES	18.7%
SAFETY VALVES	6.0%
FLANGES	19.2%
<b>INSTRUMENTATION</b>	<b>56.1%</b>
<b>TOTAL</b>	<b>100%</b>



- Instrumentation shows the highest emissions of the four groups
- About 5% if the measured items are over range
- About 98% of the emissions are caused by the over range items

# Compressor Station 2

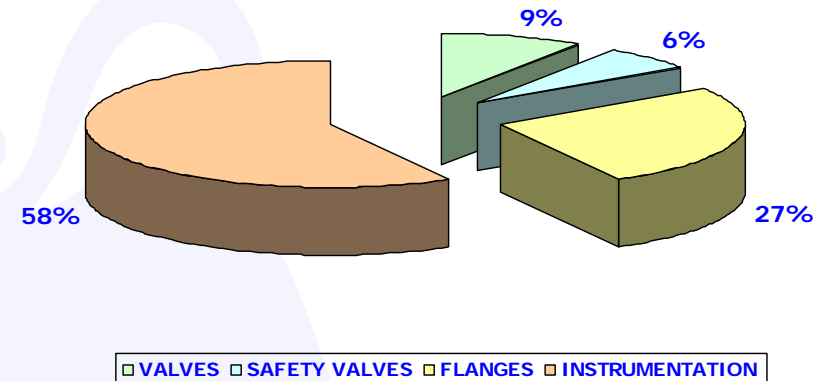
Fugitive emissions - **1088** items measured:

- Arrival terminal
- Turbo compressors TK1 and TK3 (with filters, feeding and refrigeration systems)
- Fuel gas treatment plant + boilers

About 70% of the entire compression station has been measured

# Compressor Station 2

GROUP NAME	Emissions [% ]
CENTRIFUGAL COMPRESSORS	-
VALVES	9.4%
SAFETY VALVES	6.1%
<b>FLANGES</b>	<b>26.5%</b>
<b>INSTRUMENTATION</b>	<b>58.0%</b>
<b>TOTAL</b>	<b>100%</b>



- Instrumentation and Flanges show the highest emissions of the four groups
- About 6% if the measured items are over range
- About 98% of the emissions are caused by the over range items

# Compressor Station 3

Fugitive emissions - **1275** items measured:

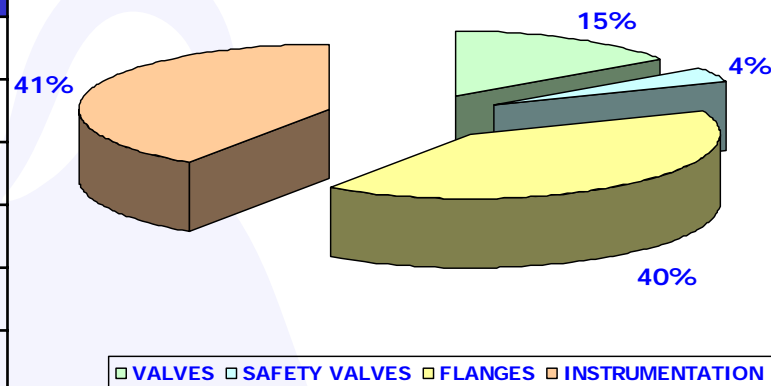
- Turbo compressors TK1, TK3, TK5 (with filters, feeding and refrigeration systems)
- Fuel gas treatment plant + boilers
- Delivery terminal

About 43% of the entire compression station has been measured



# Compressor Station 3

GROUP NAME	Emissions [% ]
CENTRIFUGAL COMPRESSORS	-
VALVES	15.2%
SAFETY VALVES	4.1%
FLANGES	40.0%
INSTRUMENTATION	40.6%
TOTALE	100%



- Instrumentation and Flanges show the highest emissions of the four groups
- About 6% if the measured items are over range
- About 98% of the emissions are caused by the over range items

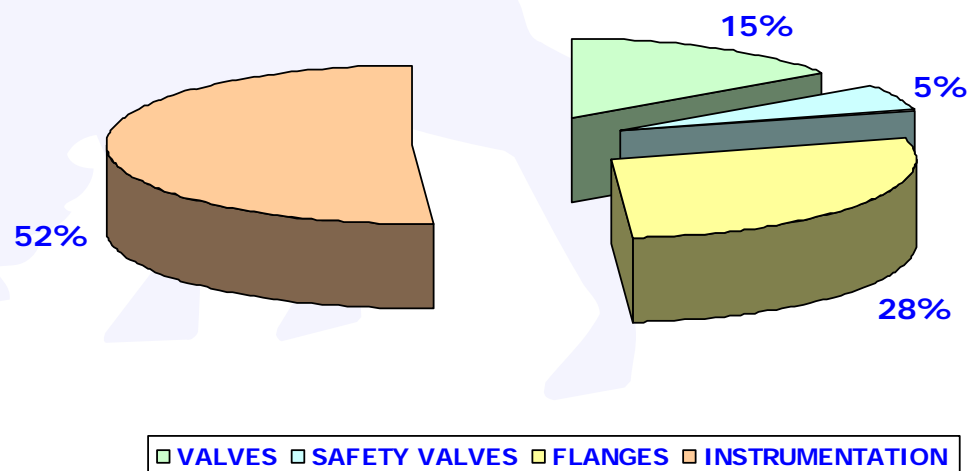
# Main Steps

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# Results

GROUP NAME	ITEMS [#]	ITEMS [%]	Emissions [%]
VALVES	2120	25.5%	15.4%
SAFETY VALVES	173	2.1%	5.4%
FLANGES	4369	52.6%	28.0%
INSTRUMENTATION	1649	19.8%	51.2%
TOTALE	8311	100%	100%

➤ Instrumentation and Flanges show the highest emissions of the four groups

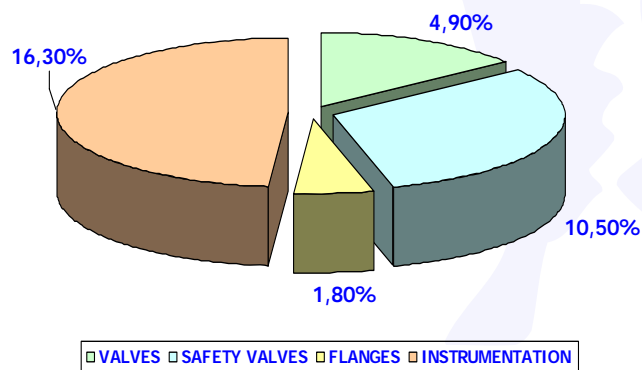


# Results

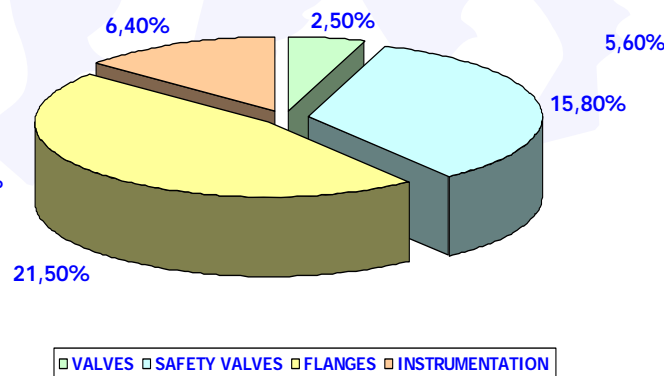
## II. Over Range distribution over the four groups:

GROUP NAME	CS1		CS2		CS3	
	#	%	#	%	#	%
VALVES	20	4.9	9	2.5	14	4.2
SAFETY VALVES	4	10.5	3	15.8	0	0.0
FLANGES	14	1.8	18	3.4	23	3.5
INSTRUMENTATION	42	16.3	40	21.5	34	12.7
<b>TOTAL</b>	<b>80</b>	<b>5.3</b>	<b>70</b>	<b>6.4</b>	<b>71</b>	<b>5.6</b>

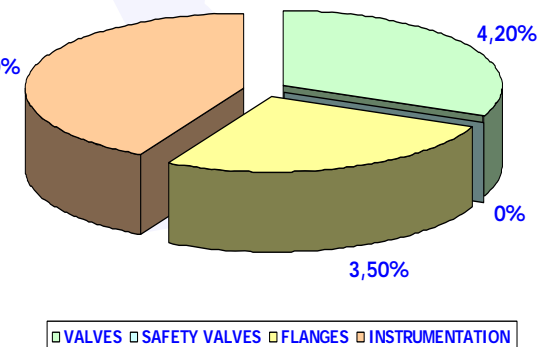
Compressor Station 1



Compressor Station 2

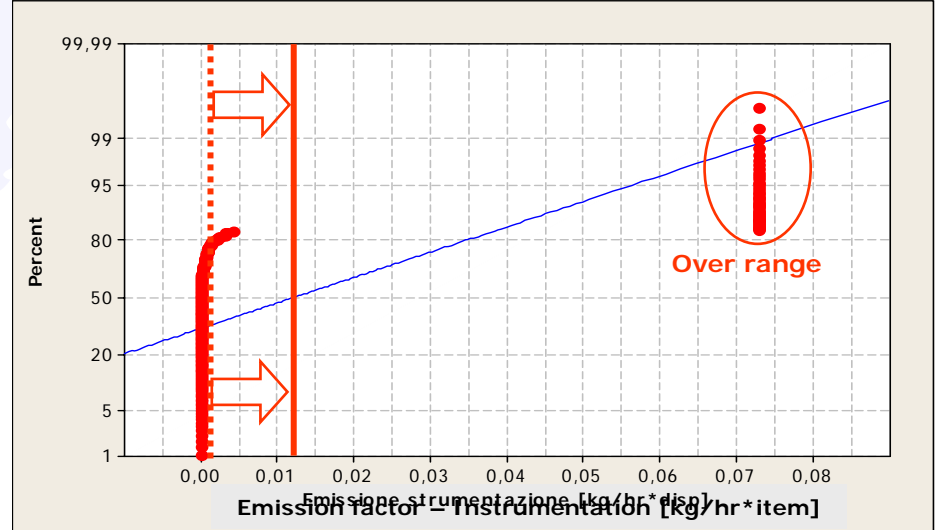
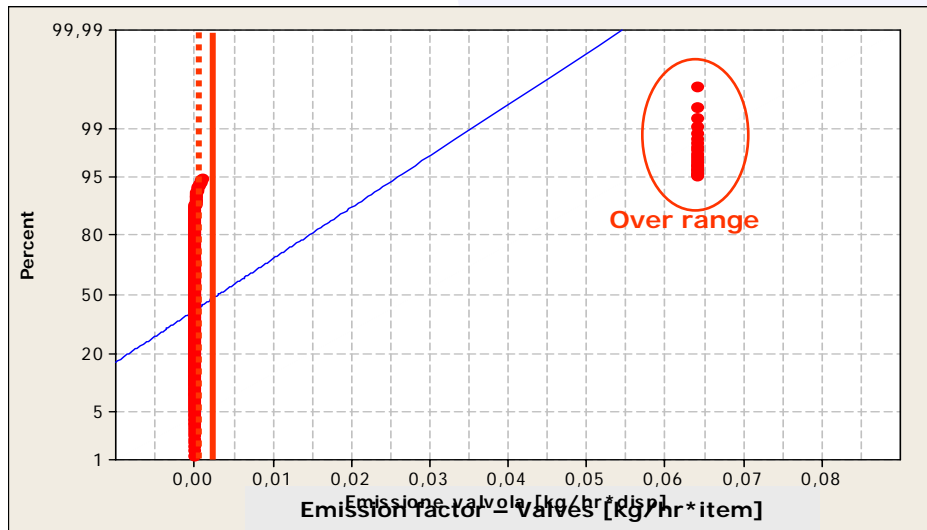
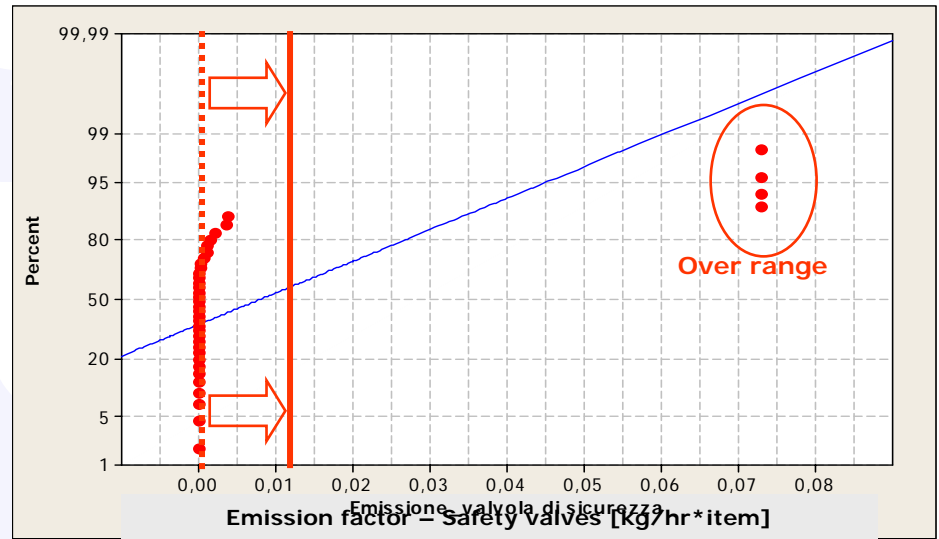
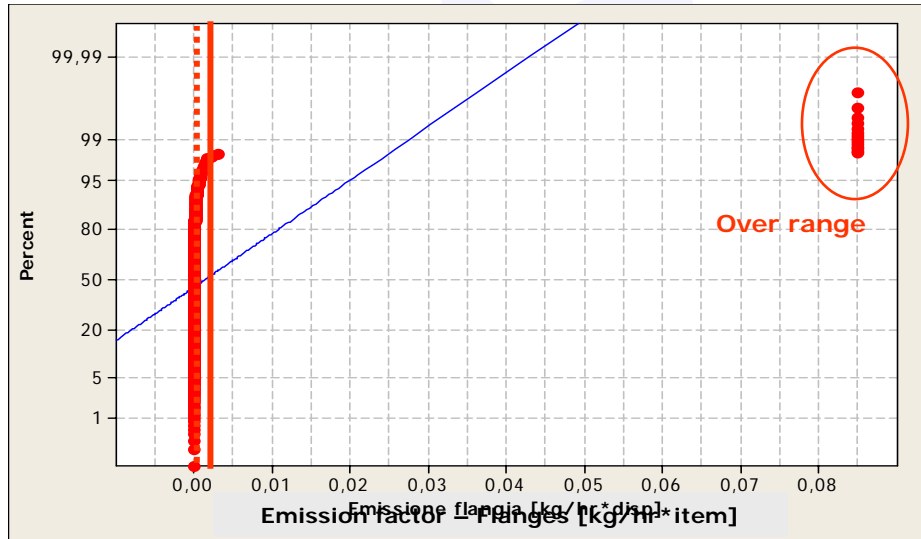


Compressor Station 3



# Results

## III. Example of Over Range items impact on emission factors (Compressor Station I)



# Conclusions

- Three compressor stations have been considered for an extensive measurement campaign... about 50% of the installed items have been measured
  - Based on EPA 21 correlation approach, per each measured item an emission factor has been estimated
  - Out of the four group categories, two of them, Flanges and Instrumentation, are responsible of more than 80% of the total emissions
  - About 5% of all the items installed have been found as Over Range, but are responsible of 98% of the total emissions
- 
- A specific focus on the two categories identified can guarantee a significant impact on total emissions
  - In particular, the usage of a specific gauge (like the one that has been used for the measurement campaign) will allow Company running the CS an easier job in finding and fixing Over Range items
  - A detailed database has been built with all the items characteristics, measures and emission factors and can be used for O&M planning



**Any questions?**



**Thanks for your kind attention**