QUANTIFYING LOSSES FROM CAST IRON NETWORK

AND ALTERNATIVES FOR THE RENEWAL

COMGÁS Natural

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01st – 03rd November 2010

COMGAS

Comgas is the **largest natural gas distribution company** in Brazil

Its concession region concentrates **27%** of Brazilian GDP, **35%** of energy demand nationwide, **29 million** people, **8 million** homes and **9 million** vehicles

Comgas distributes **30% of natural gas volumes** nationwide with **13 million m³ / day in 67 cities**

6,700 km of natural gas network

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COMGAS OPERATIONAL ENVIRONMENT

- Its controlling shareholders are **BG Group and Shell**
- **Workforce with 5,000 people** as direct employees and contractors
- **930,000** customers
- **100,000 new customers** to be connected every year.
- **Focus on residential customer connection** in existing gas network areas and peripheral areas.

CONTENTS

COMGAS NATURAL GAS DISTRIBUITION NETWORK

OLD MAINS. Comgas doesn’t expand the cast iron any more.

Network Material	Network extension [km]	% of Total
CAST IRON	627.0	10.5%
STEEL	1,978.1	33.1%
POLYETHYLENE	3,379.3	56.5%
TOTAL MAINS	5,984.4	100.0%

TOTAL SERVICE LINES	724.1

TOTAL SERVICE LINES	6,708.5

COMGAS CAST IRON NETWORK HISTORY

- It is about **50 years** old.

- Mainly located in the **old downtown of Sao Paulo** city

- During the 90's, the **process of conversion** from town (naphtha) gas to natural gas was started

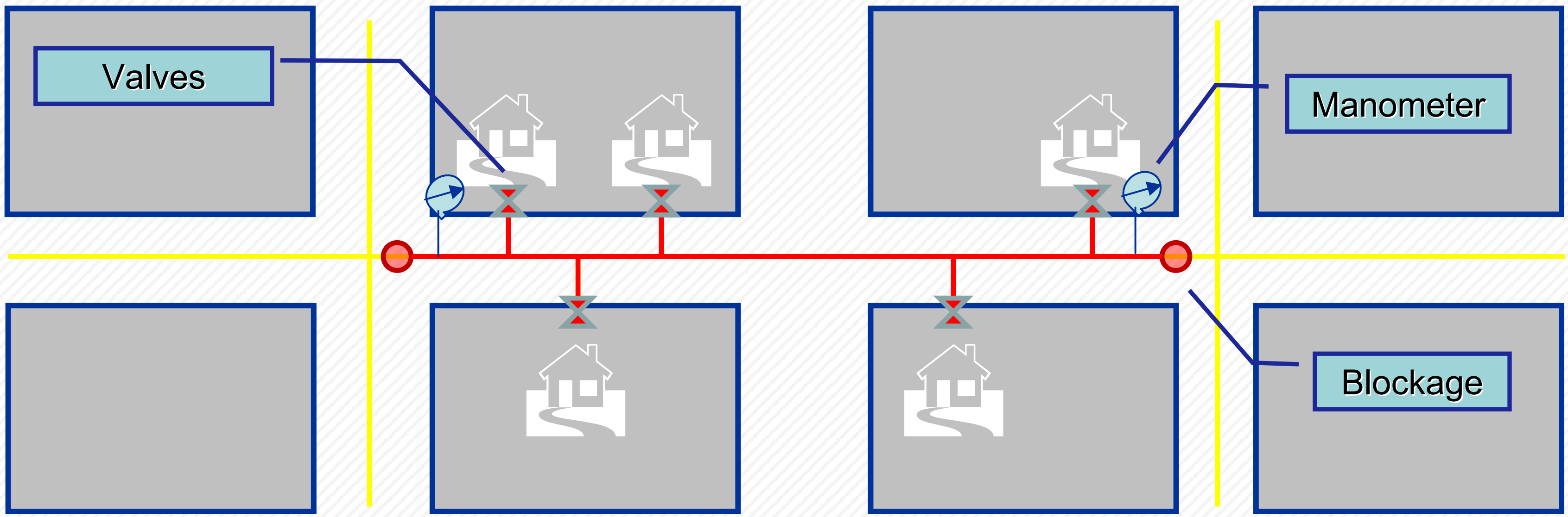
- From this period, the level of **escapes** in the cast iron network **increased**

- These escapes are related to **dehydration of the joints** due to the higher dryness levels of natural gas, when compared to town gas

- Another sources of escapes in cast iron network is related to **fractures** and also **higher pressure** of natural gas compared to town gas.

QUANTIFYING LOSSES FROM CAST IRON NETWORK

1 -) Field data collection by renewal department – before the renewal



- Blocking of the gas pipeline before the renewal operation (including all the valves)
- Manometers installation
- Pressure and period data collection (every 2 minutes for at least 12 minutes)

QUANTIFYING LOSSES FROM CAST IRON NETWORK

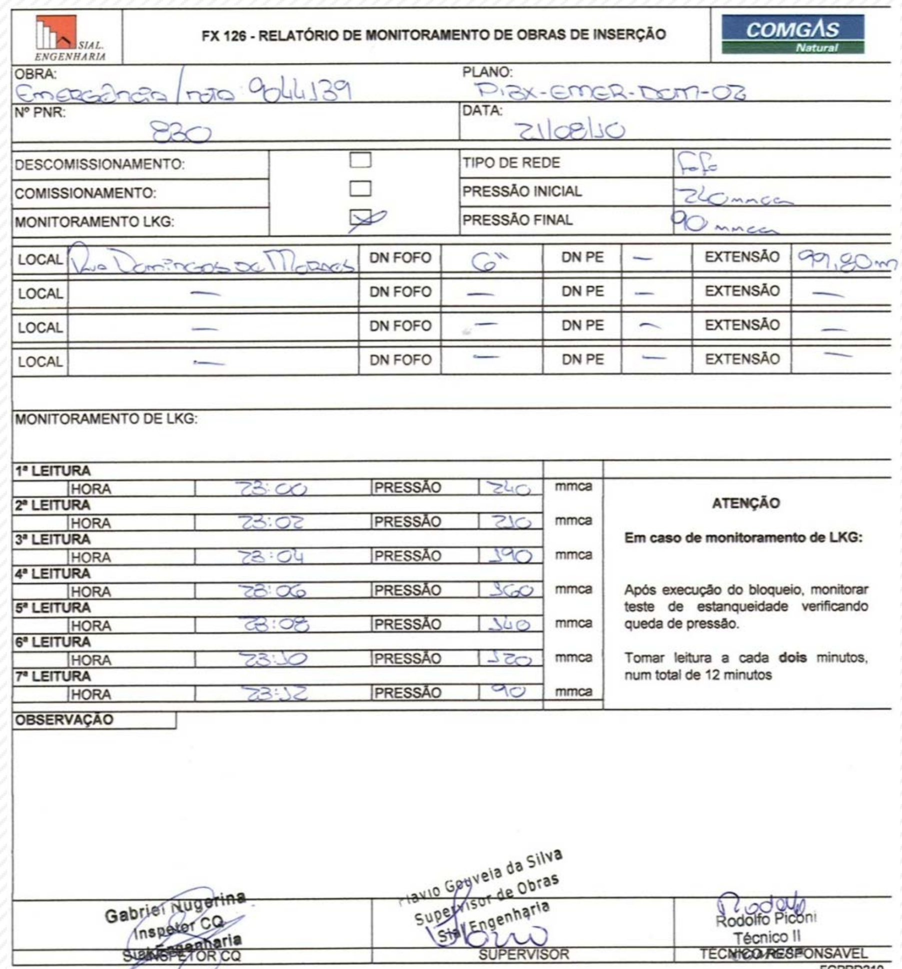
2 -) Filling out the form and sending to Comgas Control Room

Period	Pressure
T_0	P_0
T_1	P_1
T_2	P_2
T_3	P_3
$\mathbf{T_n}$	$\mathbf{P_n}$

+

Gas pipeline data

- Operation pressure
- Diameter
- Pipeline length



SIAL. ENGENHARIA

FX 126 - RELATÓRIO DE MONITORAMENTO DE OBRAS DE INSERÇÃO

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OBRA: Emergência / nota 9044139
PLANO: P13X-EMER-DCM-02
Nº PNR: 830
DATA: 21/08/10

DESCOMISSIONAMENTO:	☐	TIPO DE REDE	fofo
COMISSIONAMENTO:	☐	PRESSÃO INICIAL	240 mmca
MONITORAMENTO LKG:	☒	PRESSÃO FINAL	90 mmca

LOCAL	Rua Domingos de Moraes	DN FOFO	6"	DN PE	—	EXTENSÃO	97,80m
LOCAL	—	DN FOFO	—	DN PE	—	EXTENSÃO	—
LOCAL	—	DN FOFO	—	DN PE	—	EXTENSÃO	—
LOCAL	—	DN FOFO	—	DN PE	—	EXTENSÃO	—

MONITORAMENTO DE LKG:

Leitura	HORA	PRESSÃO	
1ª LEITURA	23:00	240	mmca
2ª LEITURA	23:02	210	mmca
3ª LEITURA	23:04	190	mmca
4ª LEITURA	23:06	160	mmca
5ª LEITURA	23:08	140	mmca
6ª LEITURA	23:10	120	mmca
7ª LEITURA	23:12	90	mmca

ATENÇÃO

Em caso de monitoramento de LKG:

Após execução do bloqueio, monitorar teste de estanqueidade verificando queda de pressão.

Tomar leitura a cada **dois** minutos, num total de 12 minutos

OBSERVAÇÃO

Gabriel Nugerina Inspetor CQ Sial Engenharia	Flavio Gouveia da Silva Supervisor de Obras Sial Engenharia	Rodolfo Piconi Técnico II
INSPETOR CQ	SUPERVISOR	TÉCNICO RESPONSÁVEL

FGPRD210

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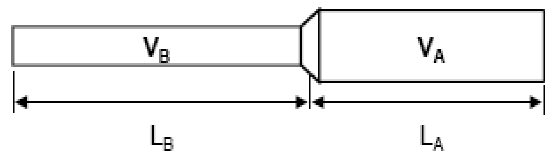
QUANTIFYING LOSSES FROM CAST IRON NETWORK

3 -) Pipeline volume calculation (V1)

- Just one pipe diameter:

$$V_1 = \frac{\pi \cdot D^2 \cdot L}{4}$$

- Two pipes diameters:



$$V_1 = V_A + V_B = \frac{\pi \cdot D_A^2 \cdot L_A}{4} + \frac{\pi \cdot D_B^2 \cdot L_B}{4}$$

EXAMPLE

Extensão	99,8	m
Diâmetro	6	pol
Volume da Tubulação	**1,8205**	**m³**

→ Pipeline volume

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4 -) Escaped volume calculation related to the period - Balanced volume (V0):

$$V_0 = \frac{P_1 \cdot V_1}{P_0}$$

Internal Pipe Pressure (P_1)

Pipeline Volume (V_1)

Atmospheric Pressure (P_0)

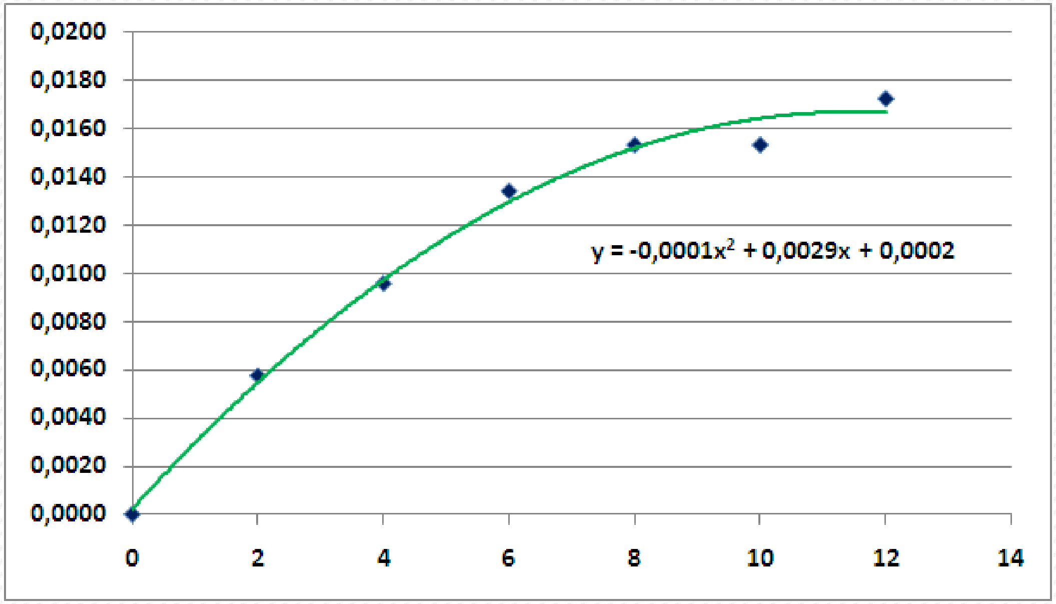
Tempo [min]		Pressão [min]	V1 [m³]	P0 [mmca]	V0 [m³]	DeltaV0	DeltaP	V vazado [m³]
T0	0	240	1,8205	9510	0,04594	0	0	0,0000
T1	2	210	1,8205	9510	0,04020	0,0057	30	0,0057
T2	4	190	1,8205	9510	0,03637	0,0038	20	0,0096
T3	6	170	1,8205	9510	0,03254	0,0038	20	0,0134
T4	8	160	1,8205	9510	0,03063	0,0019	10	0,0153
T5	10	160	1,8205	9510	0,03063	0,0000	0	0,0153
T6	12	150	1,8205	9510	0,02871	0,0019	10	0,0172

Volume Loss

- V0 data tabulation related to the period t0, t1, t2, ..., tn;
- ΔV0 calculation (V0 tn+1 – V0 tn);
- Escaped volume = Σ ΔV0.

QUANTIFYING LOSSES FROM CAST IRON NETWORK

5 -) Plot the escaped volume X period



6 -) Derivative – to obtain the gas flow formula

$$\frac{dV}{dt} = \frac{d}{dt}\left(-0{,}0001 \cdot t^2 + 0{,}0029 \cdot t + 0{,}0002\right) = -0{,}0001 \cdot t + 0{,}0029$$

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QUANTIFYING LOSSES FROM CAST IRON NETWORK

7 -) For t = 0 → Maximum gas flow

When the pressure is the operational pipe pressure

$$\left.\frac{dV}{dt}\right|_{t=0} = Q' = 0{,}0029\ m^3 / min$$

In a regular operation, the internal pipe pressure is invariable, so Q' can be considered in the study

8 -) Average escape rate

Q = Q' / Pipe length [l / m*h] → $Q = \frac{0{,}0029 \bullet 60 \bullet 1000}{99{,}8} = 1{,}7435 \frac{l}{m \bullet h}$

- The more measurements are made, the more the database will be !!
- The database of all measurements made can be extrapolated to all the cast iron network, excluding "the points outside the curve"

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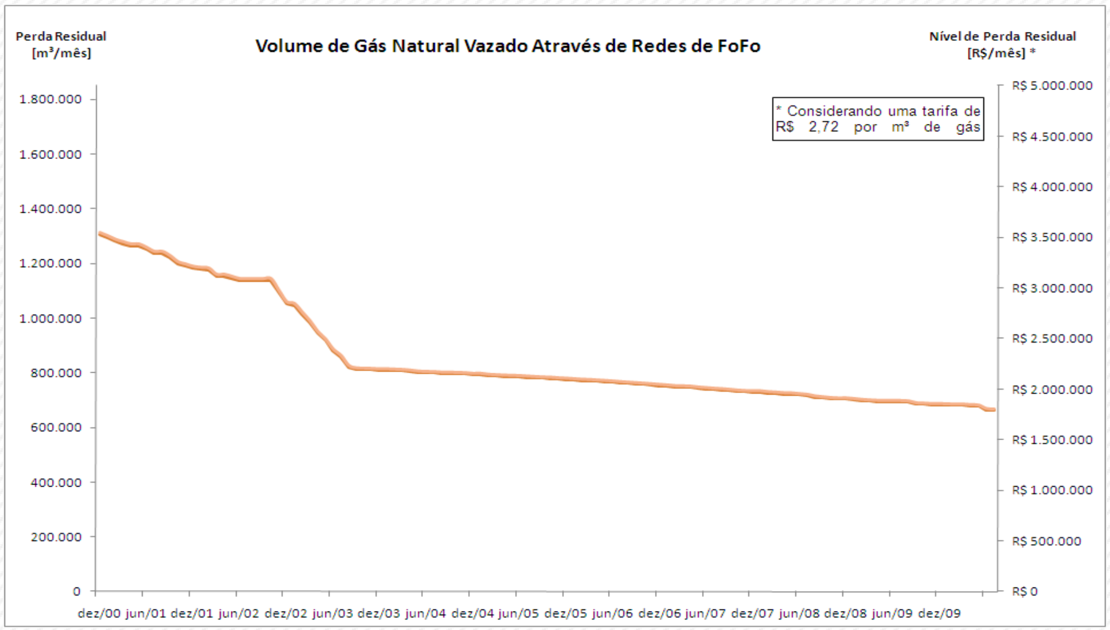
QUANTIFYING LOSSES FROM CAST IRON NETWORK

- These values average are used by Comgas to quantify the losses from cast iron network



Today:

$$Q = 1,625 \frac{l}{m \bullet h}$$

or

$$Q = 809,2168 \frac{scf}{mile \bullet year}$$

Database: 950 values

LUAG Estimation = Q * Network length

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THE CONSEQUENCES ON THE GREENHOUSE EFFECT

The primary component of natural gas, the metane, is a powerful greenhouse gas.

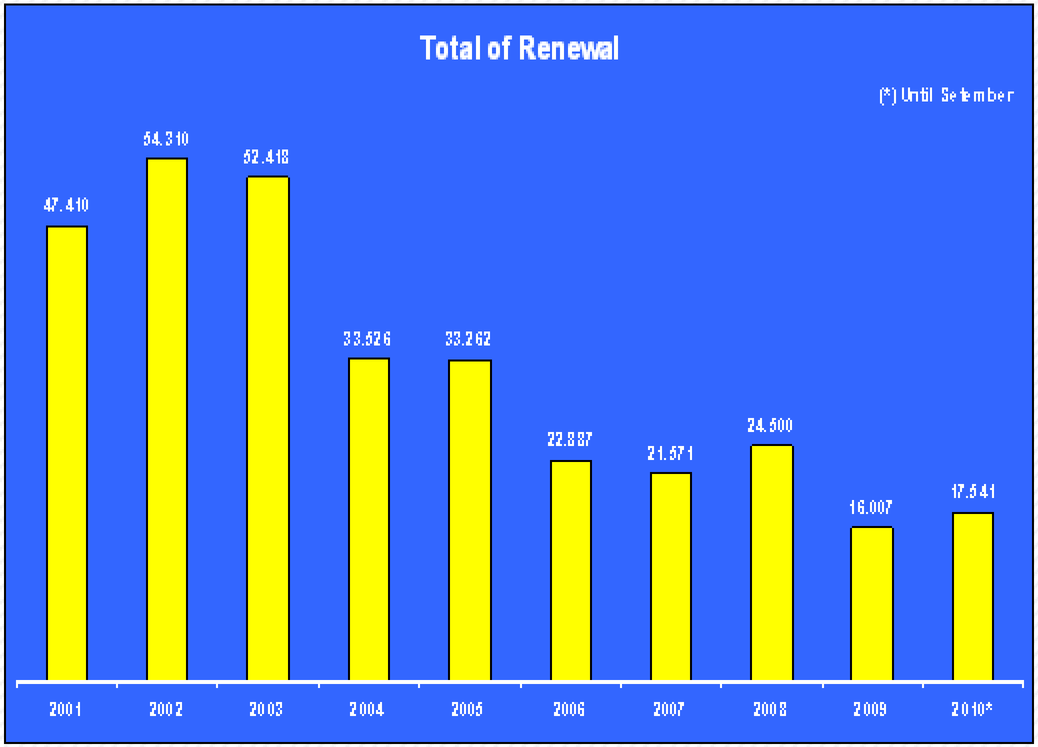
Natural Gas is over 20 times more powerful than the carbon dioxide (CO_2) !!

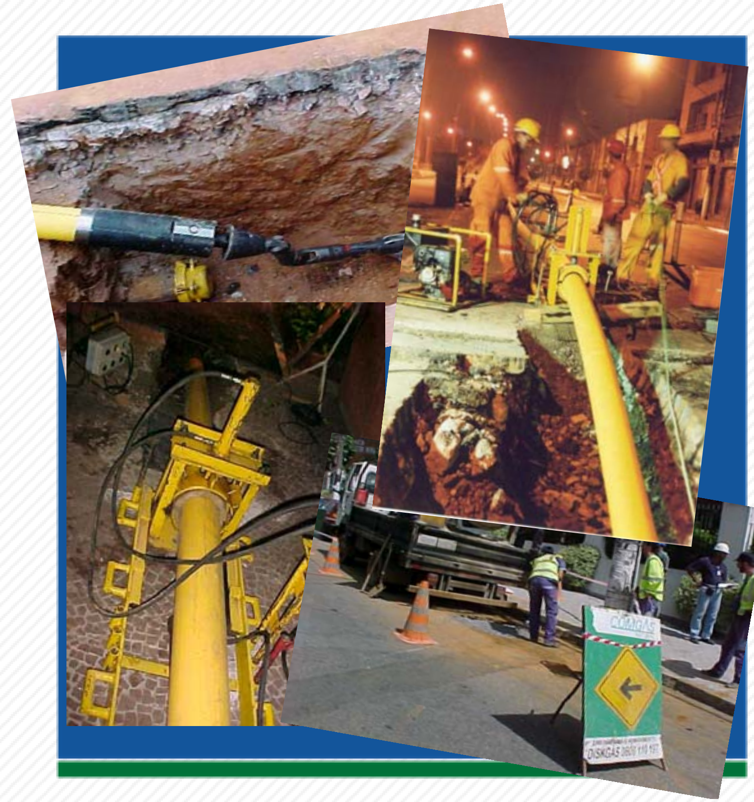
Alternatives to mitigate risks of escapes include **joints treatment** and **network replacement**

Comgas has chosen the network replacement,
also reinforced by the regulatory body.

THE RENEWAL OF THE OLD CAST IRON NETWORK

- Since 2000, Comgas has already renovated around **330 km** of the cast iron network





- The main method used for the renewal until 2009 had been the Insertion

- Through these actions, Comgas has already avoided the emission of around **55 million m³** of natural gas to the atmosphere, which corresponds to about **900.000 ton of CO_2** equivalent.

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THE RENEWAL OF THE OLD CAST IRON NETWORK

Insertion of polyethylene pipe in the old cast iron network

Advantages:

- Complete **elimination** of escapes;
- **Less risks** during operations;
- **Lower** level of excavated **trenches**;
- **Lower cost** with improved productivity;
- New polyethylene pipe **is protected** by old cast iron pipe, with possible use of pipe locator;
- **Higher** operating **pressure** and stabilization during peak demands

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THE RENEWAL OF THE OLD CAST IRON NETWORK

Operation of Insertion

Local of the Renewal: Risk-based approach according to area profile and historical information of escapes.

First day:

- Digging of **trenches** (main and service lines)

Second day

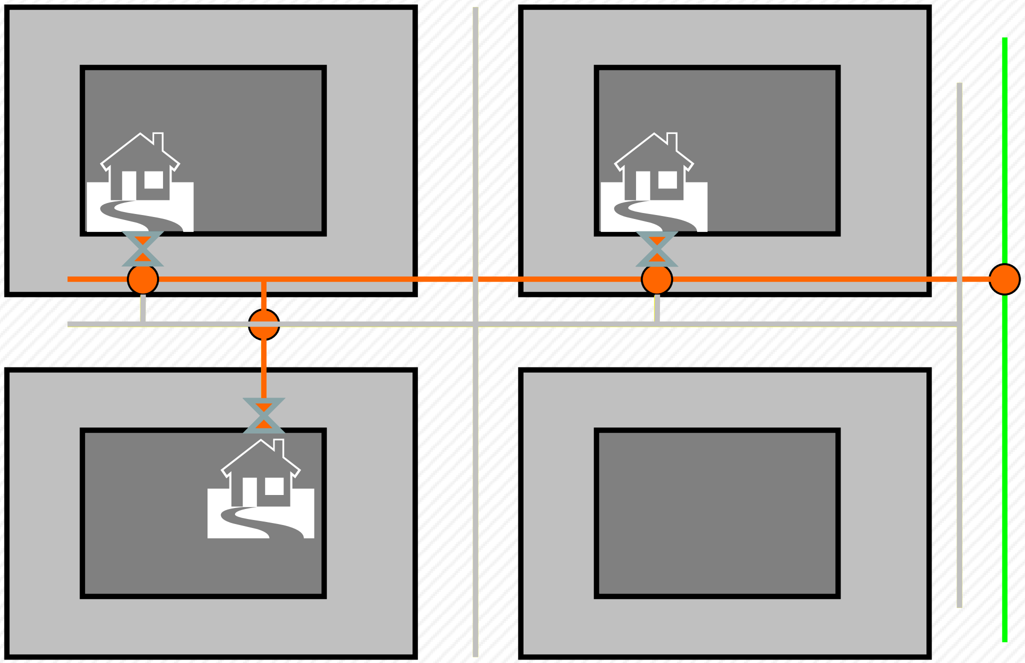
- **Interruption of supply** to customers
- **Network isolation** and purge of natural gas
- **Insertion** of polyethylene pipes in cast iron
- **Connecting** the new polyethylene pipeline into the existing netwo
- **Commissioning** of network and service line
- Re-connecting the **customers**

Third day

- **Compacting and concreting** of trenches (48 hours)
- **Asphalt** cover

THE RENEWAL OF THE OLD CAST IRON NETWORK

Sidewalk Pipeline – A New Method of Renewal



- **Construction** of a new polyethylene pipeline under the **sidewalk** by directional drilling and connection with a high pressure pipeline
- Connection to the **service lines**
- **Abandon** the old cast iron

Comgas intends to use this method for the next renewal plans!

THE RENEWAL OF THE OLD CAST IRON NETWORK

Sidewalk Pipeline – A New Method of Renewal

Advantages compared to insertion:

- **Lower cost** (about 50% less)
- **Less asphalt** recover
- **Less steel plates**
- **Less risk** during operations
- Less impact on **traffic**
- **High productivity** (about 50% more)

THE RENEWAL OF THE OLD CAST IRON NETWORK

Comgas intends to renovate **282 km** in the next **5 years**

This way, there will be a **reduction of 50%** of the present length.

As a consequence, the **emissions** will be reduced too

There is not a definition to renewal after 2015, but the renewal probably will be extended towards **zero of emissions!**