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Shrinkage Forum

Monday 27 June 2011, 31 Homer Road

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Leakage Model

Leakage Model

- Methodology developed in the early 1990s
- Currently a spreadsheet model
- Five main elements
  - LP Leakage
  - MP Leakage
  - AGI Leakage
  - AGI Venting
  - Interference Damage

Leakage Model Elements & Main Input Parameters

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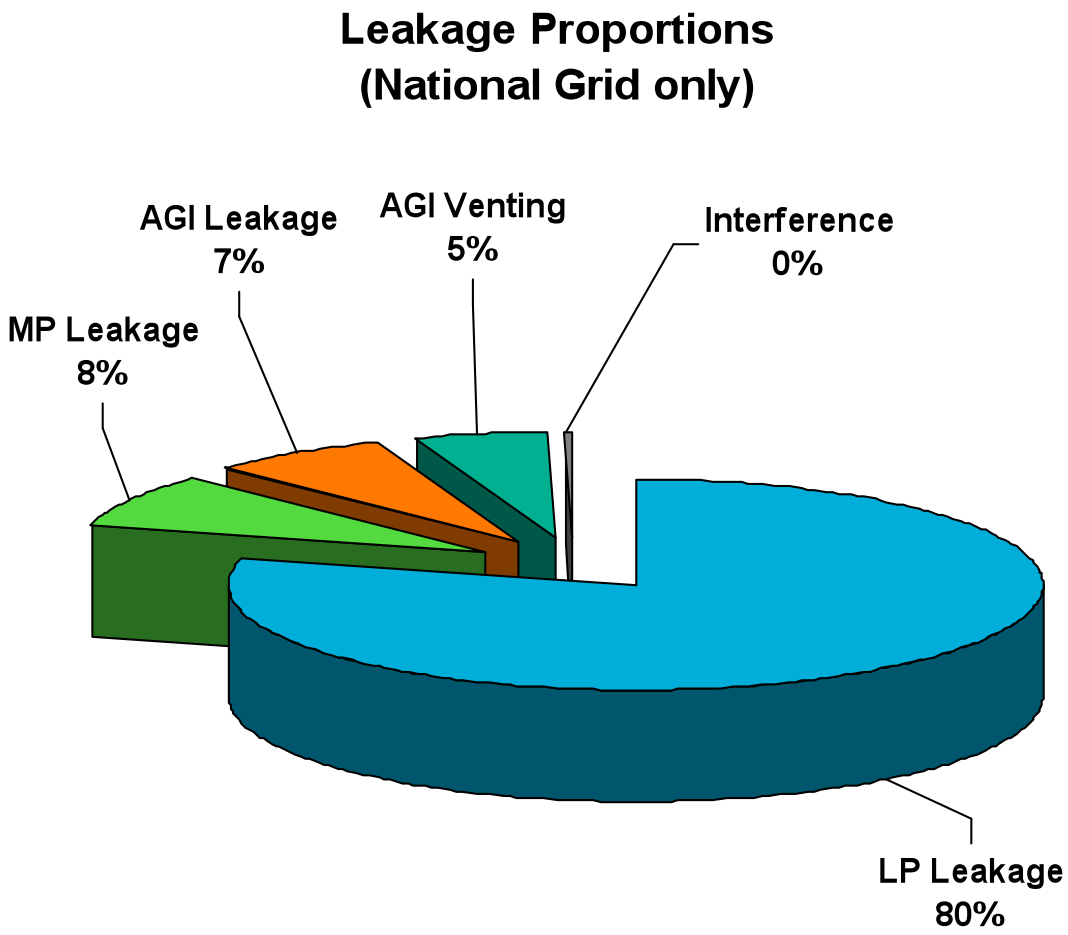


Low Pressure Leakage Model

- Approximately 80% of all leakage
- Leakage rates for 11 diameter/material bands, based on a national survey carried out in 2002/03
- > 2000 low pressure networks nationally
  - Average System Pressure - determined via recorded source pressure data and network analysis
  - MEG Saturation (where used) – determined from recorded data and network analysis
  - Pipe asset lengths (replacement of metallic mains has greatest impact)
  - No. of services

Low Pressure Mains (1)

- For Ductile Iron, Steel and PE Pipes
  - (Rate x Length x ASP)/Reference Pressure (30mbarg)
- For Pit Cast Iron and Spun Cast Iron pipes
  - Split into Lead Yarn jointed treated by MEG, Lead Yarn jointed not treated by MEG and non-Lead Yarn Jointed
  - Assumption 88.5% Pit Cast and 18.5% Spun Cast are Lead Yarn jointed
  - [(Rate x Length x LY% x Treated% x ASP)/Reference Pressure] x [MEG Factor/ Reference MEG Factor]
  - [(Rate x Length x LY% x (1-Treated%) x ASP)/Reference Pressure] / [Reference MEG Factor]
  - (Rate x Length x (1-LY%) x ASP)/Reference Pressure

Low Pressure Mains (2)

m^3/annum/km @30mbarg	D1	D2	D3	D4	D5
MATERIAL	**<=3"**	**4"-5"**	**6"-7"**	**8"-11"**	**>=12"**
PE	63.51				
Steel	3416.34	3854.34			
Ductile	719.18		576.40		
Pit Cast	2407.21	1639.85	2525.47	2203.98	7463.40
Spun Cast	1075.71				

- 2002/03 NLT
- 849 Tests
- 11 Categories from a combination of up to 5 Diameter Bands across the 5 Material Types
- 1990s test results used to determine sample size

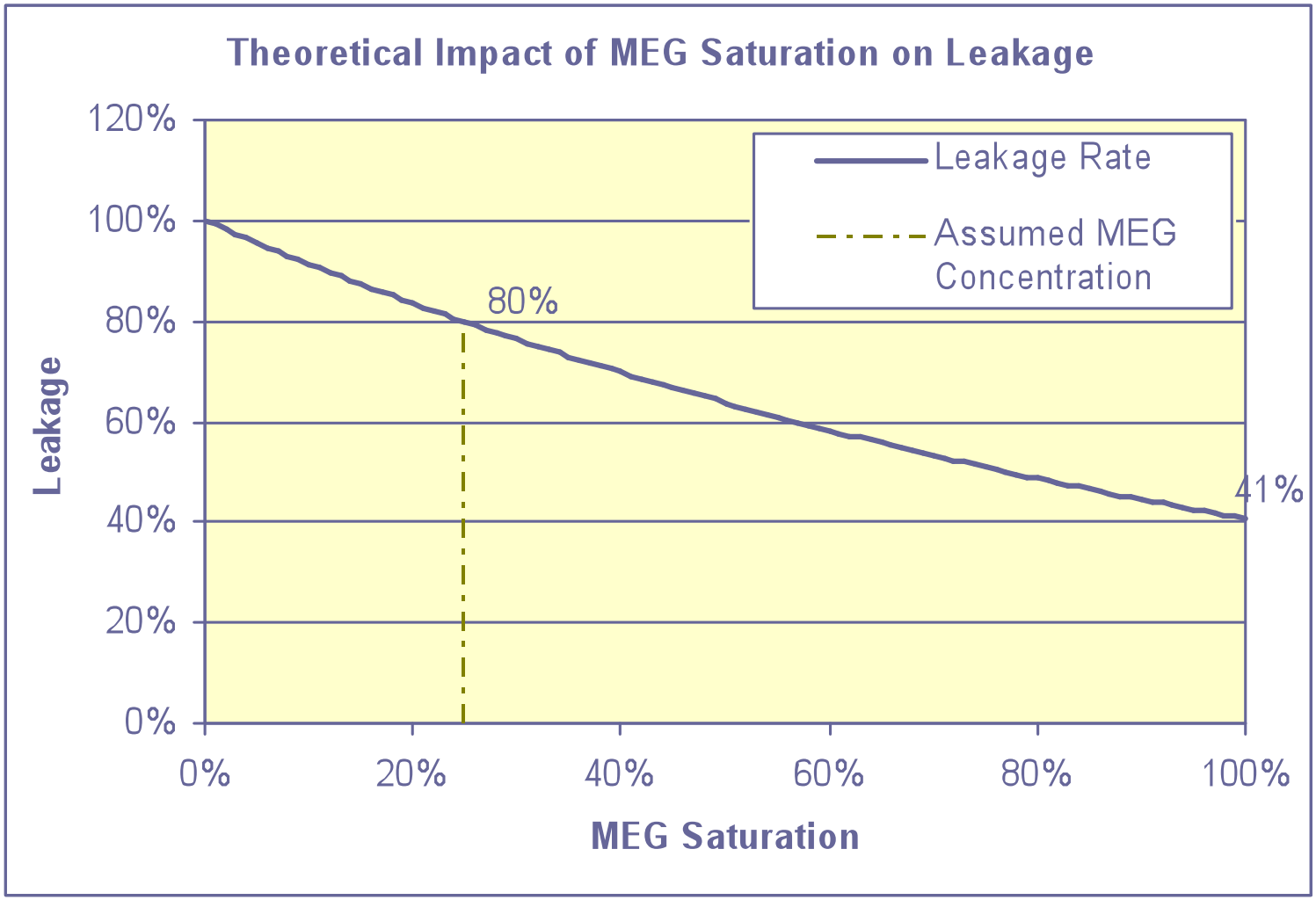
Low Pressure Mains (3)

- Average System Pressure
  - Determined via Network Analysis
  - LP Sources set at average annual pressure
    - Determined by profiling data, data loggers, clock settings etc
  - Demand set at 25% 1 in 20 Peak Six Minute Demand (typical average demand level experienced over the year)
  - ASP = length weighted average of the average pressure in each pipe in the network

Low Pressure Mains (4)

- MEG
  - Monoethylene glycol, used to treat lead yarn jointed mains, which applies Cast Iron pipes only (Pit and Spun)
  - Saturation is measured throughout the year
  - % of cast iron treated determined using the same network analysis model as used for determining ASP
  - Cast Iron leakage rates are deemed applicable to a MEG saturation level of 25%, which reflects a 20% reduction in leakage.
    - If less or no MEG is used, leakage rates are uplifted
    - if more MEG is used, leakage rates are reduced

Low Pressure Mains (5)



Low Pressure Mains (6)

- Example Calculation:
  - <=3” Pit Cast; Original Length = 5.163; Proportion of CI treated = 75%; MEG Saturation = 40%; ASP = 30mbarg
    - Lead Yarn Length (5.163 x 88.5%) = 4.569
    - Lead Yarn Treated Length (4.569 x 75%) = 3.427
    - Lead Yarn Untreated Length (4.569 – 3.427) = 1.142
    - Non Lead Yarn Length (5.163 x (1-88.5%)) = 0.594

Low Pressure Mains (7)

- Example Calculation continued:
  - Lead Yarn Treated Length Leakage =
    - 3.427km
    - x 2407.21 m^3/km/annum@30mbarg [Leakage Rate for D1 Pit Cast]
    - x 30mbarg [ASP]
    - / 30mbarg [Ref Pressure]
    - x 69.78% [MEG Factor Associated with achieved 40% MEG Saturation]
    - / 79.86% [MEG Factor Associated with the reference 25% MEG Saturation]
    - =7,208scm

Low Pressure Mains (8)

- Example Calculation continued:
  - Lead Yarn Untreated Length Leakage =
    - 1.142km
    - x 2407.21 m^3/km/annum@30mbarg [Leakage Rate for D1 Pit Cast]
    - x 30mbarg [ASP]
    - / 30mbarg [Ref Pressure]
    - / 79.86% [MEG Factor Associated with the reference 25% MEG Saturation]
    - =3,443scm

Low Pressure Mains (9)

- Example Calculation continued:
  - Non-Lead Yarn Length Leakage =
    - 0.594km
    - x 2407.21 m^3/km/annum@30mbarg [Leakage Rate for D1 Pit Cast]
    - x 30mbarg [ASP]
    - / 30mbarg [Reference Pressure]
    - =1,429scm

Low Pressure Services (1)

- Methodology updated in 2009
- Old methodology assumed fixed relative proportion of metallic and plastic services
  - Many metallic services have been replaced since original assumptions
- New methodology uses the old model output for 2006/07 to fix a baseline for the number of metallic services and actual service replacement numbers are used to estimate the current population

Low Pressure Services (2)

- (No. Services x Rate x ASP)/Reference Pressure
- 2002/03 leakage tests determined that only connections to metallic mains had any significant leakage

TYPE	Rate m^3/annum/ service@30mbarg
Metal $ - Metal	10.592
Metal $ - PE	0
PE $ - Metal	2.194
PE $ - PE	0

Low Pressure Services (3)

- Determination of the number of services example
- Total No. Services = 60,000; Baseline No. Metallic Services = 24,000; cumulative annual replacement = 12,000, PE Proportion of Network = 0.48; Network as % of LDZ = 60%
- Metal services
  - Baseline No. – (%LDZ x No. Replaced in LDZ)
  - 24,000 – (60% x 12,000)
  - 24,000 – 7200 = 16,800
- PE Services
  - Total No services – Excluded Services – Metallic Services
  - 60,000 – 3,002 – 16,800 = 40,198

Low Pressure Services (4)

- PE to PE
  - No. PE Services x PE proportion of network
  - 40,198 x 0.48 = 19,186
- PE to Metal
  - No. PE Services – No. PE to PE
  - 40,198 – 19,186 = 21,012
- Metal to PE
  - No. Metallic Services x 0.1807097 (fixed assumption)
  - 16,800 x 0.1807097 = 3,143
- Metal to Metal
  - No. Metallic Services – No. Metal to PE
  - 16,800 – 3,143 = 13,657

Low Pressure General (1)

- Excluded Pipe Lengths
  - Reflects small isolated sections of a larger network that tend to be all PE and operate at higher pressure
  - Pipes are assumed to operate at the same pressure as the length weighted average pressure of the other all-PE networks in the LDZ
  - PE Pipe Leakage is calculated as:
  - [Network PE Leakage] + [Excluded PE Leakage]
  - [(Total PE Length – Excluded Length) x PE Rate x Network ASP / Reference Pressure] + [Excluded Length x PE Rate x All-PE ASP / Reference Pressure]
- Similarly, excluded service leakage is calculated at the All-PE ASP; however, these are deemed PE to PE services and, therefore, have a zero leakage rate

Low Pressure General (2)

- NONET Networks
  - These refer to pipe lengths that are not associated with a specific network and are included for completeness
  - Metallic pipes in the NONET category are deemed to operate at the length weighted average system pressure of the other mixed material networks in the LDZ
  - PE pipes in the NONET category are deemed to operate at the length weighted average system pressure of the All-PE networks in the LDZ. If there are no All-PE networks in the, the pressure defaults to that for the mixed material networks

Medium Pressure Leakage Model

- Approximately 8% of all leakage
- Leakage Rate x Length
- LP Leakage Rates used
  - MP Pit Cast deemed to leak at the same rate as Spun Cast. LP Pit Cast higher because of predominance of lead yarn jointing, which was not generally used for MP
  - Number of reported escapes per km of iron main generally lower, but of a similar order, for MP than LP. Therefore, it is assumed that there is a similar level of leakage per km.

AGI Leakage Model

- Approximately 7% of all leakage
- 5 leakage rates for AGI asset types, based on a national survey carried out in 2002/03:
  - Holders
  - NTS Offtakes
  - LTS Offtakes
  - District Governors
  - Service Governors
- Leakage = Number of Assets x Rate

AGI Venting Model

- Approximately 5% of all leakage
- Fixed values based on a national value from the 2002/03 AGI leakage test report apportioned by relative number of ‘venting’ AGI asset at time of Network Sales
  - Original source for data 1994 Watt Committee Report

Interference Damage Model (1)

- Approximately <0.5% of all leakage
- Based on:
  - >500kg release incidents
    - Actual release value where recorded/estimated
    - Else, No. Incidents x 500kg
  - Number other recorded incidents
    - Split by LP/MP (95/5)
    - Split by Puncture/Fracture (50/50)
    - Assumed leakage rates and response/fix times

Interference Damage Model (2)

- All Rates and response times are fixed within the model
- Severed Services
  - No Service Incidents/2 x Rate (17m^3/hr) x Response/fix time (2hr)
- Punctured Services
  - No Service Incidents/2 x Rate (5.66m^3/hr) x Response/fix time (2hr)
- Service leakage rates determined for by an experimental rig operating at 25mbarg
- Low Pressure Incidents
  - No Mains Incidents x 95% x Rate (42.45m^3/hr) x response/fix time (235 minutes)
- Medium Pressure Incidents
  - No Mains Incidents x 5% x Rate (283m^3/hr) x response/fix time (235 minutes)
- Mains leakage rates calculated for a 1” hole at 25mbarg operating pressure for LP and 2barg for MP