

1 Proposed Deadband Process

The following seeks to explain the methodology and processes behind SGN's proposed Average Pressure Deadband, the aim of which is to provide GDN's with a level of protection against pressure increases driven by factors out-with their control (i.e. Weather).

This philosophy is underpinned by the principle that a change in pressure is directly proportional to the square of the change in flow conditions.

Having established a methodology to define average operating pressures associated with the outer limits of the Deadband, these could be easily used to establish the associated Shrinkage volumes.

Below is a description of the proposed GD2 Shrinkage Incentive Deadband methodology, followed by a real-life example of how the process would impact on the Scotland LDZ:

1.1 Methodology

Setting the Deadband Parameters

In order to enable the Deadband limits to be calculated, the following steps must be taken to enable each parameter to be set:

- **The Minimum Design Pressure** – This is set at 21mbar for each LDZ.
- **The 3-Year Average LDZ Pressures** – In line with one of the options contained within the Draft Determination, these are calculated from the actual LDZ average pressures published in the annual RRP (Tab 3.12) for 2017/18, 2018/19 and 2019/20.
- **Annual Average Daily Demand %** - (This process is based on actual recorded daily demand %'s from 1st April 2013, to 31st March 2020 to provide a wider sample on which to base and define high, medium and low annual average conditions). For each of the year's in RIIO-GD1 to date, record the average of the 365 recorded daily demand percentages, for each LDZ.
- **AVE Profile** - Calculate the average of the seven **Annual Average Daily Demand %'s** for each LDZ. This is regarded as the demand for an **Average (AVE) Profile %**.
- **HIGH Profile** - Select the highest of the seven **Annual Average Daily Demand %'s** for each LDZ. This is regarded as the **HIGH Profile %**.
- **LOW Profile** - Select the lowest of the seven **Annual Average Daily Demand %'s** for each LDZ. This is regarded as the **LOW Profile %**.

Calculating the Deadband

Once these parameters have been determined, the process outlined below should be followed to calculate the threshold of the Deadband:

- Using the **AVE, HIGH, and LOW Profile %'s** for each LDZ, calculate the % demand variances between each.
 - For the **HIGH % Demand Differential**, divide the **HIGH Profile %** by the **AVE Profile %**.
 - For the **LOW % Demand Differential**, divide the **LOW Profile %** by the **AVE Profile %**.
- Utilising and applying the relationship between changes in flow and pressure differential, calculate the square of each % **Demand Differential**, both **HIGH** and **LOW**, for each LDZ.
- Calculate the **Average Pressure Differential** (mbar). This is simply the **3-Year Average LDZ Operating Pressure**, minus the **Minimum Design Pressure** (21.0mbar).
- Multiply the **Average Pressure Differential** by the square of each % **Demand Differential**, both **HIGH** and **LOW**, for each LDZ. This will provide both the **HIGH** and **LOW Deadband Differentials** for each LDZ.
- Calculate the **Deadband Pressure Thresholds**.
 - For the **HIGH Deadband Pressure Threshold**, simply subtract the **Available Pressure Differential** from the **HIGH Deadband Pressure Differential**. This will give a positive value.

- For the **LOW Deadband Pressure Threshold**, simply subtract the **Available Pressure Differential** from the **LOW Deadband Pressure Differential**. This will give a negative value.
- Change the negative **LOW Deadband Pressure Threshold** into an **Absolute Value (+ve)**.
- Calculate the average of the **HIGH Deadband Pressure Threshold** and the **LOW Deadband Pressure Threshold** (absolute), to determine the parameters (+/-) of the Deadband for each LDZ (mbar).

1.2 Example – Setting a Deadband for Scotland LDZ

Scotland – Determining Demand Profile %'s

- **Minimum Design Pressure – 21.0mbar**
- **SC 3-Year LDZ Average Pressure – 26.42mbar (Based on 3-Year published LDZ averages)**
- **SC Average Annual Daily Demand %** - The average recorded annual daily demand %'s for Scotland, for RIIO-GD1, can be seen in the table below:

SC Average % Daily Demand – RIIO GD1								
Year	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	7-Year Average
Ave. %	43.47	41.92	42.03	39.07	40.53	37.53	39.03	40.51
Profile	HIGH					LOW		AVE

- The **7-Year Average Annual Daily Demand %** (40.51%) is considered the **AVE Profile** demand %
- The **Highest Average Annual Daily Demand %** (43.47%) is considered the **HIGH Profile** demand %
- The **Lowest Average Annual Daily Demand %** (37.53%) is considered the **LOW Profile** demand %

Scotland – Calculating the Deadband

- The three **Demand Profiles**, taken from the table above, can be seen below:

Average Profile	40.51%
HIGH Profile	43.47%
LOW Profile	37.53%

- Using the above **Profile Demand %'s**, calculate the **% Demand Differentials** between **HIGH** and **AVE**, and **LOW** and **AVE**. Then determine a value for the square of each.

HIGH	
% Demand Diff	Square
1.073	1.151395
LOW	
% Demand Diff	Square
0.926	0.858227

- Calculate the **Average Pressure Differential** - For Scotland, this is the **3-Year Average LDZ Pressures** (26.42mbar), minus the **Minimum Design Pressure** (21.0mbar).

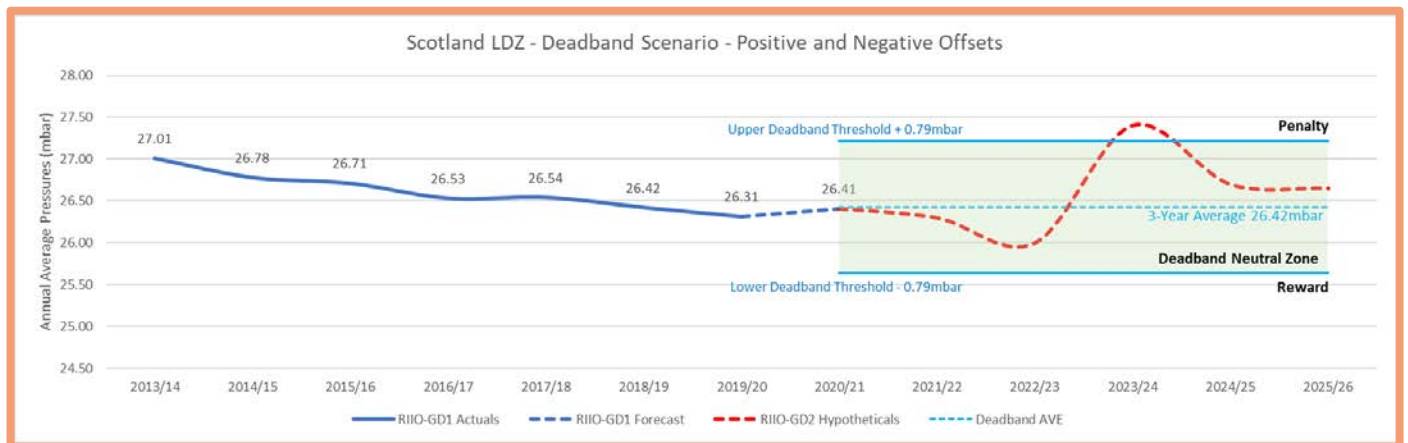
Available Pressure Differential	5.42 mbar
---------------------------------	-----------

- Calculate both the **HIGH** and **LOW Deadband Pressure Differentials** by multiplying the **Average Pressure Differential** by the square of the associated **% Demand Differentials**.

HIGH Deadband Pressure	6.24 mbar
LOW Deadband Pressure	4.65 mbar

- Using the variances (mbar) between both the **HIGH and LOW Deadband Pressure Differentials** (6.24mbar and 4.65mbar respectively) and the **Average Pressure Differential** (5.42mbar) calculate both **Deadband Pressure Threshold**. In this case, the **Deadband Pressure Differentials** are:
 - HIGH Deadband Pressure Threshold:** $6.24 - 5.42 = 0.82\text{mbar}$
 - LOW Deadband Pressure Threshold:** $4.65 - 5.42 = -0.77\text{mbar}$
- Change the **LOW Deadband Pressure Threshold** value into an absolute (+ve) figure and calculate the average between the **HIGH and LOW Deadband Pressure Thresholds**.
- For Scotland, the calculated **Deadband Pressure Threshold** is **(+/-) 0.79mbar**.

The graph below illustrates hypothetically how the above example may progress through RIIO-GD2 and highlights the necessary level of insulation against external influences, out-with SGN's control, that would inevitably impact on average pressure performance.



Note:

Although both LOW and HIGH settings are virtually equal for the example above, other LDZ's will invariably show a difference in these values, necessitating an average figure to be used.

1.3 Appendix

Screenshot from Calculation Spreadsheet

Average Annual Peak Demand % (AVE, HIGH, LOW Years)			
AVERAGE	40.51%		
HIGH	43.47%		
LOW	37.53%		
HIGH			
% Demand Diff	Square		
1.07	1.15		
Average Pressure Differential (mbar)	5.42		
HIGH Deadband Pressure Diff (mbar)	6.24		
HIGH Deadband Threshold (mbar)	0.82		
LOW			
% Demand Diff	Square		
0.93	0.86		
Average Pressure Differential (mbar)	5.42		
LOW Deadband Pressure Diff (mbar)	4.65	Absolute Value	
LOW Deadband Threshold (mbar)	-0.77	0.77	
Average (+/-)	0.79 mbar		

Difference between 3-Year
Average Pressure and Design
Temperature

Average Pressure Differential * Square of % Demand

Cold Deadband Pressure Differential - Average Pressure
Differential