nationalgrid

Safety Monitor
Methodology Document

Effective from 1st October 2016

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1.0 Introduction & Background

The Safety Monitor is an amount (and deliverability) of gas that needs to remain in storage, to ensure safety of the Gas Transmission System. This amount represents a total volume of gas across all storage sites owned by Shippers. The Safety Monitor is there to ensure there is enough gas available to keep customers that cannot be safely isolated supplied across the whole of the most severe winter. It also includes an amount required to isolate customers that can be safely isolated. It is there to ensure safety and integrity of the system and customers across the whole of the most extreme winter. It is not to ensure security of supply, which is met via other Gas System Operations commitments. Safety Monitors are a gas storage level which if breached could trigger a gas emergency. It was introduced to replace Top-up monitors in 2004.

It is National Grid's responsibility to keep the monitor under review (both ahead of and throughout the winter) and to make adjustments if it is appropriate to do so. As it is to ensure adequate pressure can be maintained in the network and thereby protect public safety, it is appropriate that a prudent approach is adopted in setting the Safety Monitor.

This document explains and illustrates the methodology that has been used to establish the 2016/17 Gas Safety (Management) Regulations (GS(M)R) Safety Monitors .

Prior to 1 November 2004, the Network Code required National Grid Gas to establish Top-up storage profiles (one per storage facility type) against which actual storage stocks could be monitored throughout the winter period. The purpose of the Top-up arrangements was to underpin security of supply to firm customers. However, following Ofgem's 2004 Top-up review, the Top-up arrangements were removed from the Network Code.

To ensure that sufficient gas is held in storage to preserve the ongoing safe operation of the gas transportation system, the concept of safety monitors has been introduced into the National Grid Gas GS(M)R Safety Case. The Uniform Network Code (UNC) (inter alia) requires us to publish the safety monitors and to provide regular reporting of actual storage stock levels for comparison with these monitors.

As the name suggests, the focus of the safety monitors is public safety rather than security of supply. They provide a trigger mechanism for taking direct action to avoid a potential gas supply emergency within GS(M)R .

In addition, the UNC requires National Grid to calculate and publish gas monitors based upon the forecast demands of consumers. The gas monitors are published solely for the purpose of providing further information to the market.

2.0 Overview of Methodology

There are two main steps in the assessment of the respective storage monitors:

- The calculation of the storage requirement at the start of the winter. There is both a Safety Monitor storage space requirement and a gas deliverability requirement.
- The assessment of the way in which this initial requirement decays as the winter progresses, known as the winter profile.

Section 3 sets out the safety monitor calculation process in detail.

2.1 Revisions to Safety Monitor methodology

Prior to winter 2016/17 we have made a number of changes to the Safety Monitor methodology,

These impact two elements:

- Non Storage Supply (NSS) assumptions used to derive the Safety Monitor.
- The assessment of the way in which this initial requirement decays as the winter progresses, known as the winter profile

2.1.1 Changes to Non Storage Supply assumptions

In previous years a purely historical approach was used to determine available NSS based on actual NSS flows experienced. Reductions in overall gas demand result in seasonal storage withdrawals occurring at increasingly lower gas demands. This has a consequential effect of reduced levels of NSS flows for a particular demand; but NSS availability has not reduced at a commensurate rate. This means it is no longer an accurate indicator to look at historical NSS flows compared to demand to assess NSS availability.

Therefore to address this change in the market, there has been a need to amend the method, from a one stage to a three stage process this year.

The old method is still being used to determine the shape of the NSS curve when compared to various demand levels. The changes are to add two extra steps to the processes. The first additional step is to adjust the curve to meet the most up to date NSS assumption for the coming winter. The second extra step is to incorporate any specific NSS risks for the winter that we feel are prudent to include. These are most likely to exclude a site, or type of supply that our latest intelligence determines is not reliable for this winter. This step can be recalculated during the winter, as greater confidence or new information relating to the availability of supply becomes apparent.

2.1.2 Changes to the Winter Profile.

The previous method used a complex process. It aimed to establish the last date when the coldest day in the winter may occur, to establish when the Safety Monitor requirement starts to reduce. This would be a theoretical peak day temperature in a 1 in 50 day coldest winter. This situation has never occurred in practice, so this method required a complicated process to establish a theoretical day, which was also relatively uncertain.

The new process considerably simplifies this by not looking for days the monitor starts to reduce, but looking at the day the monitor reduces to zero. This means it no longer tries to establish when the coldest day in a 1 in 50 winter would be, but the last time the UK would ever be likely to experience the n^{th} coldest day. As the n^{th} coldest day is not as severely cold, there are many days in the weather history when the temperature is below that of the n^{th} coldest day. We then look at when the last one of these was in the winter, and the day after this is the day the Safety monitor profiles becomes zero.

The new method simplifies the calculations and during extensive comparison tests, the results remained similar; with the new approach being slightly more prudent.

3.0 Safety Monitor Calculation Process

The concept behind the safety monitor is to ensure that sufficient gas is held in storage to support those gas consumers whose premises cannot be physically and verifiably isolated from the gas network within a reasonable time period. To achieve this, all gas consumers are categorised into one of two groups:

- Protected by Monitor - Gas is held in storage to facilitate continuity of supply to these consumers even during a 1 in 50 winter
- Protected by Isolation – Network safety would be maintained if necessary by physically isolating these customers from the network

The categorisation into these groups is summarised in Table 1 below:

Table 1: End Consumer Categorisation for Safety Monitors

Protected by Isolation - Sites which can be safely isolated from the network	**Protected by Monitor** - Sites which require protection under the safety monitor
NTS Power	Priority[1] DM[2]
NTS Industrial	NDM[3]
DM[2] (excluding priority customers)	Exports to Ireland for NDM
Exports to Ireland for DM	

The safety monitor storage space requirements comprise two elements:

1. **Supply-demand**: Storage required to support 'protected by monitor' loads, assessed using a severe (1 in 50) winter load duration curve and assumed supply levels;
2. **Non Supply-demand**: Storage required during the process of demand reduction, effectively to support 'protected by isolation' loads during the period in which these loads are isolated from the system.

These two components are considered separately in the next two sub-sections.

3.1.1 Safety Monitor storage space requirements – Supply Demand - 'Protected by Monitor' Load

This element of the stored safety gas requirement is calculated using a traditional approach of matching supplies to demand.

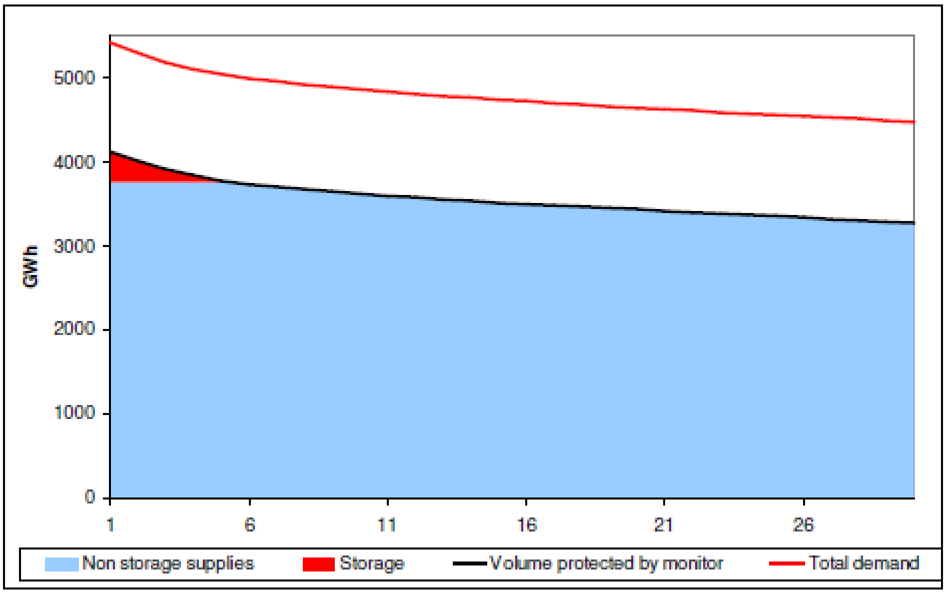
It ultimately establishes by how much the Non Storage Supply[4] (NSS) could be deficient to supply the protected loads over the whole winter period. This deficit is the amount of gas that needs to be kept in store for 'Protect by Monitor'.

NSS Supply and protected demands are ranked via a load curve[5]

[1] Currently, priority daily metered (DM) loads represent less than 2% of protected by monitor demands.
[2] Daily Metered
[3] Non Daily Metered
[4] Gas Supply from sources that are not storage, such as UK Continental Shelf, liquefied natural gas, and imports
[5] Load curve – "ordering demand (and supply) against days ranked against temperature (day 1 is the coldest day, day 2 the second coldest day etc.)

This can be seen in Figure 1. The protected by monitor requirement is the area under the protected by monitor demand curve where it exceeds expected NSS. This area represents the volume per day and the number of days the requirement exists. The total area in red represents the total protected by monitor requirement.

Figure 1 – Supply and demand components resulting in protected by monitor requirement.



The demand is derived from National Grid's Demand Statements that are published in the Gas Ten Year Statement. It uses the severe (1 in 50 diversified) load duration curve and only includes those demands that are protected by monitor in Table 1.

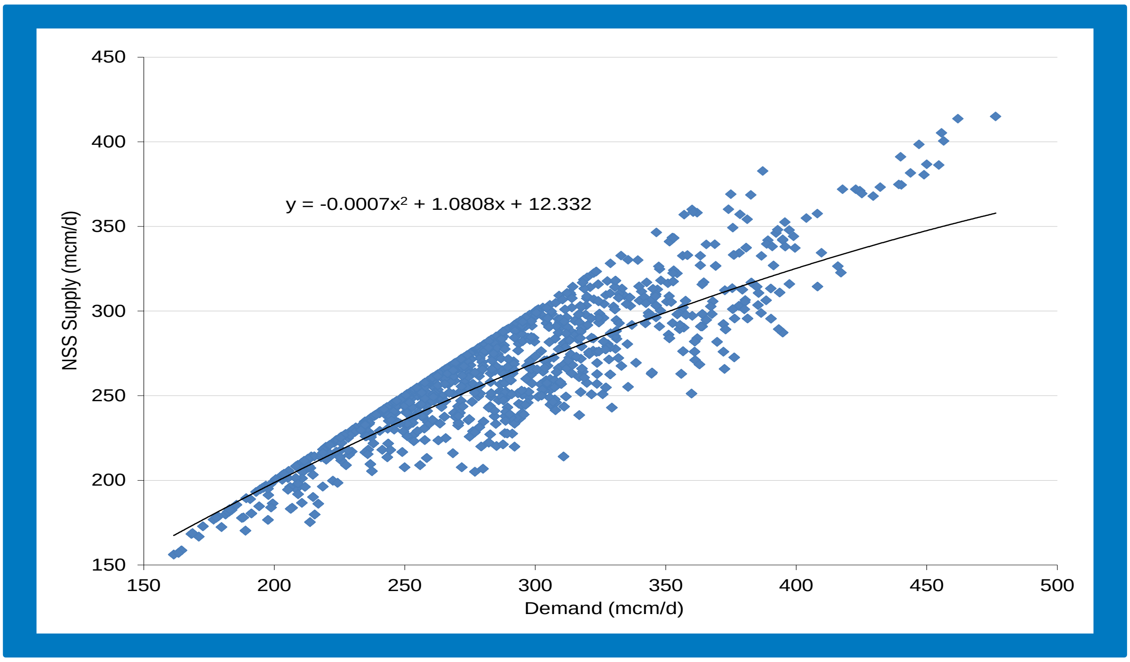
Supply assumptions are more involved. Total Non-Storage Supply, is required to assess how much deficit there is for NSS to provide cover for demand in a 1 in 50 winter, and therefore how much gas is required in storage – (the Safety Monitor).

NSS assumptions are assessed via a 3 stage process:

- Stage 1 – establish historical NSS for varying demand levels to create a profile of NSS against demand.
- Stage 2 –adjust the profile to intersect our latest view of NSS on a high demand day.
- Stage 3 – adjust the profile for any likely NSS disruptions in the coming winter.

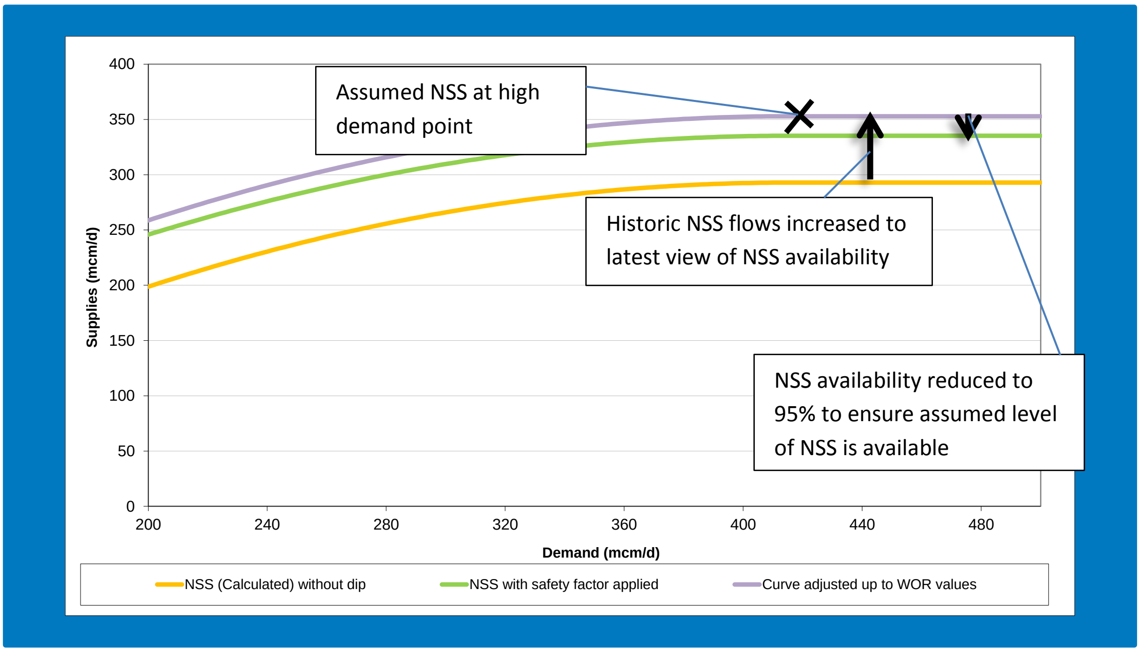
Stage 1 is based on an analysis of the last five winters. It uses a variable NSS assumption which is demand dependent. This shows how NSS is likely to vary with demand to reflect the variation in flexible supply options available within GB. This was the way NSS was assessed until 2016. This is shown in Figure 2.

Figure 2 – Historic NSS supply compared to demand



Stage 2 moves whole curve up to intersect our NSS assumptions for our cold demand day assumption. For winter 2016/7, this represented an increase of 60 mcm for the whole curve to pass through 352 mcm NSS at a demand of 402 mcm/d. As with the method prior to 2016/17, it is important that the assumed level of NSS used for calculating the Safety Monitors is available throughout the winter, notably at times of high demand. Hence in calculating the Safety Monitors, NSS at lower levels (95%) are used. This process is shown in Figure 3.

Figure 3 – Adjustments applied to Historic NSS Supply, to establish NSS availability



Stage 3 is the option to adjust the NSS curve downwards to represent the risk of an event occurring, such as a site potentially being unavailable for a prolonged period. This is a called the Winter Risk Factor. The Winter Risk Factor for 2016/7 was zero as we felt there were no specific sites at high risk of prolonged outage that winter.

3.1.2 Safety Monitor storage space requirements – Non Supply-Demand – Protected by Isolation

For those consumers that are protected through physical isolation from the network, there is an additional storage requirement to reflect the time that such a process could take, for example as a result of:

- Time taken for the request to reach a large number of end consumers
- Time taken for isolation to take place (to avoid damage to plant, bringing on of alternative fuels etc.)
- Refusal of GS(M)R direction to cease taking gas (in this event National Grid Gas might need to visit the site in order to effect isolation

To determine the storage requirement for isolation, a number of assumptions are made, e.g. regarding the level of demand when isolation is called and the response rate of the consumer groups identified in the protected by isolation column of Table 1.

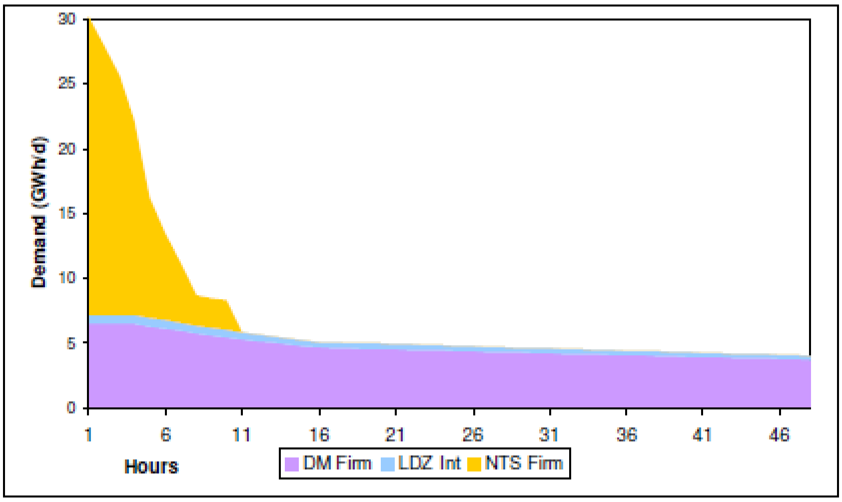
Our key assumptions in this area include:

- Demand reduction would take place over a 48 hour period, although heavily weighted to the start of this period.
- For the load shedding profiles of NTS firm sites and DM sites, we have used results from operational exercises. This includes an assessment of those loads where physical isolation would be required due to a refusal to cease taking gas.

The assessment of this storage requirement requires an examination of all the demand days at the top end of the 1 in 50 load duration curve (in a demand range of approximately 5000 to 3000 GWh/d), to cater for all possible demand levels at which such an isolation process could occur.

Assuming this isolation process took place at a demand level equivalent to Day 1 followed by Day 2 on the 1 in 50 load duration curve, the estimated demand profile for 'protected by isolation' loads over the 48-hour period is shown in Figure 4.

Figure 4: Demand Profile for Isolation (Day 1 then Day 2 demand levels)



These hourly demands are summed and then added to the estimated demand of the 'protected by monitor' sector, to derive estimates of the total daily demand on the two days of the assumed isolation process. This allows the total storage requirement on those days to be assessed. This calculation is repeated for every day at the top end of the 1 in 50 load duration curve.

3.1.3 Safety Monitor storage space requirements – total requirements

The total Safety Monitor storage space requirement is the sum of 'Protected by Monitor' and days 1 and 2 of 'Protected by Isolation'.

Once the monitor starts to reduce, the requirement reduces as described in section 3.3 Winter Profiles.

3.2 Stored Safety Gas Deliverability Requirement

The revisions made to the safety monitor methodology prior to winter 2016/17 do not change the overall storage deliverability requirement. The deliverability requirement for any day is the isolation requirement for the first day of isolation(of the two days of isolation in the isolation requirement calculation).

In theory it could conceivably be the higher of this or the Protected by Monitor requirement for any day in question, however in practice this will never be the case. The first day of isolation is always higher of the two, and therefore will be the deliverability requirement, unless very unlikely demand and supply assumptions were to exist.

3.3 Winter Profiles.

The winter profile establishes:

- the time when the Safety Monitor requirements for space and deliverability start decaying
- and the profile of this decay, down to zero requirements for both

The method has changed for 2016/7 so the calculation can be based on more data. This makes it more robust, and considerably simpler.

The change focusses on establishing when the final day of a Safety Monitor requirement exists in the winter and works backwards. This change means the reference temperature is higher, and therefore has been seen many times in our historical reference period, and hence there is enough data to base analysis on. This is unlike the previous method that had no data to reference, as the reference temperature was so cold that it does not appear in our historical reference (over 80 years of weather data).

The method for the profile has several stages:

- It establishes how many days of Safety Monitor requirement there are.
- It uses this to establish what day number on the severe demand curve the requirement ends.
- It assesses the temperature of this day from our cold weather temperature duration curve.
- It looks at the latest time in winter this temperature has ever occurred, by comparing it to our full weather history (from 1928 to present).
- It then calculates the day after this date is the time the Safety Monitor requirement becomes zero.
- It then assumes all the coldest days occur for all the previous consecutive days before this (to provide the most robust test).
- It performs a calculation of Safety Monitor space and deliverability for every day before this.
- It reorders the order of the consecutive days in the decay curve to ensure the profile covers the worst case scenario.

This process can be illustrated by example. From a year where the Safety Monitor was as shown in Table 2.

Table 2: Example Safety Monitor Space and delivery requirements

Space (GWh)	Deliverability (GWh/d)
1325	743

It establishes how many days of Safety Monitor requirement there are from the calculation of protected by monitor.

- There are 12 days when a Safety Monitor exists

It uses this to establish what day number on the severe demand curve the last day of the requirement exists.

- This will be day 12. The 12th coldest day on the severe demand curve

It assesses the temperature of this day from our cold weather temperature duration curve.

- This represents a GB weighted daily temperature of -2.97 ^{o}C (This is an average temperature throughout the whole of the GB across the whole of the day)

It looks at the latest time in winter this temperature has ever occurred, by comparing it to our full weather history (from 1928 to present).

- 27th February (There are 100 days in our whole weather history that are below this temperature. The last date when a temperature was at or below -2.97 ^{o}C was 27th February.)

It then states one day after this date is the time the Safety Monitor requirement becomes zero.

- 28th February

It then assumes all the coldest days occur for all the previous consecutive days before this.

- Therefore the last date the full Safety Monitor requirement required is 12 days before 28th February ie 16th February.

It performs a calculation of Safety Monitor space and deliverability for every day before this.

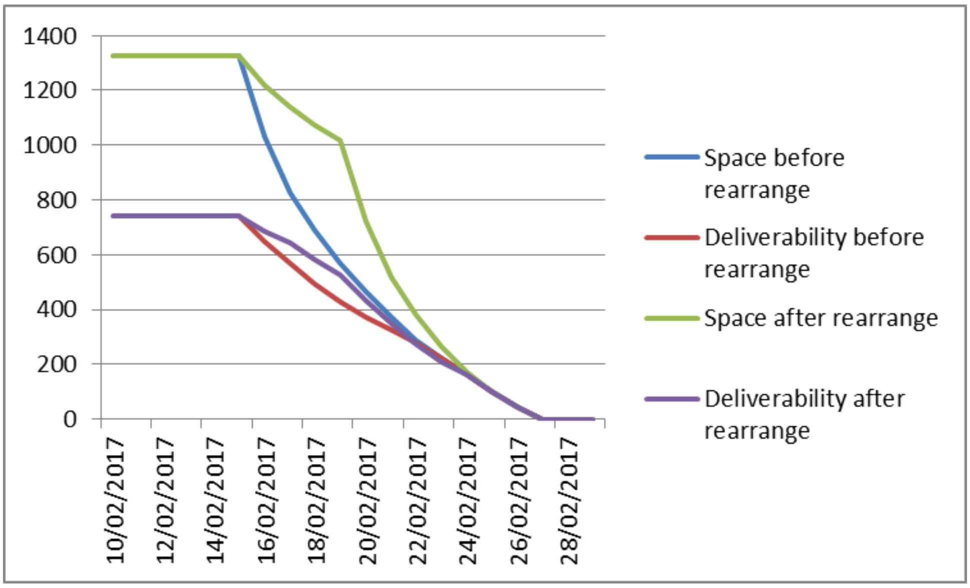
- Safety Monitor space and delivery are calculated for a winter:
  - without the coldest day for 17th February
  - without the coldest 2 days, for 18th February
  - without the coldest 3 days for 19th February
- until
  - -without the coldest 11 days for 27th February

It reorders the order of the consecutive days in the decay to ensure the profile covers the worst case possibility.

- The assumption that all the coldest days occur consecutively, could potentially result in the Safety Monitor requirement reducing too quickly when there are both many days of requirement and the Safety Monitor requirement is high.
- To ensure all Safety Monitor requirements are completely covered, the order of these consecutive days are rearranged once the Safety Monitor profile is established.

- The curve for the number of days when a Safety Monitor exists is split into thirds. The first third of the curve is placed in the middle of the profile. The next 2 thirds are split alternatively between the first and last third of the profile.
- In this example – the four coldest days are moved to the 21st, 22nd, 23rd and 24th February. The remaining 8 coldest days, where a Safety Monitor exists, are allocated to the periods before and after this in an alternative manner. This leads to the reductions shown in the Figure 5. Extensive testing has occurred in developing this process. All testing consistently concludes, the new method covers the whole period of the Winter Profile adequately and fully, with a minor but relatively immaterial margin over the old method.

Figure 5: Safety Monitor Profiles before and after rearrangement.



4.0 Conclusion

This method will be adopted for winter 2016/17. It will be reviewed each year but will remain in place until a further update is warranted.