BBC RD 1994/15

Research and Development Report

THE SOUND INSULATIONS OF STUDIO DOORS: Part 2: Door Seals

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Part 2: Door Seals

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Summary

The acoustic performances of a range of proprietary acoustic door seals were measured in the Transmission Suite. The seals were fitted to a standard BBC lead-cored door hung in a purpose-built blockwork wall. As a result of the work, suitable plant-on magnetic perimeter seals and drop-down threshold seals are recommended. The use of these seals will simplify the existing door frame design and should reduce costs without compromising the acoustic performances.

The sound insulations were also measured of a range of door blanks with the intention of improving the performances. This work is documented in a companion Report (BBC RD 1994/14).

Issued under the Authority of

General Manager
Research & Development Department

Research & Development Department,
Engineering Division
BRITISH BROADCASTING CORPORATION

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1. INTRODUCTION

The perimeter seals fitted to existing BBC acoustic doors are magnetic seals of the same type as those fitted to the doors of domestic refrigerators. The seals are fitted in machined rebates in the hardwood door frames. They are secured with purpose-made pieces of aluminium flat which must be drilled and countersunk for fixing. The installation cost is high and the seals are difficult to adjust. It should be possible to reduce the overall cost of installation, and facilitate the installation and adjustment by the use of proprietary plant-on seals.

The threshold seals fitted to existing BBC doors contain a foam rubber insert which seals against a sloping hardwood threshold. The machined threshold is expensive and the adjustment of the seal is very critical. The seal compresses with age and needs frequent adjustment. The use of proprietary drop-down threshold seals would allow a horizontal threshold to be installed. Such seals are very easy to adjust on fitting and subsequently require very little maintenance.

It is sometimes important that the door should remain sealed in the event of a fire. In such situations, the door frames could be fitted with additional intumescent strip seals, as at present. Night latches are required on some BBC studio doors. It was therefore desirable that plant-on seals should have hidden fixings or additional stops if removal of the seals would allow access to the latch. In the past, BBC doors have not used positive latching because of the audible click that occurs on closing the door. It was considered worthwhile to retain this approach if possible.

It was necessary to build a substantial masonry wall between the source and receive rooms of the Transmission Suite, into which the test doors could be installed. The construction of the test wall is described in the Appendix of the companion Report, BBC RD 1994/14. The seals to be tested were fitted to a standard BBC lead-cored door installed in the wall.

It must be emphasised at this point that the purpose of the work was to determine the most appropriate door seals for use with BBC studio doors. Often, this meant that the seals were being tested in a way that the manufacturer never intended. Therefore, any comments about poor performance are *not* intended to reflect badly on the seals or the manufacturers. The mode of operation of BBC studios dictated the ways in which the seals were used. It is likely that the performances of some of the seals would have been significantly higher if the seals had been used as recommended. Similarly, any comments about the costs of the seals relate solely to BBC studio installations. It is recognised that for other uses or requirements, cheaper or more expensive seals than those selected may be more appropriate.

2. DOOR SEAL TESTS

Figs. 1 - 3 *(overleaf)* show cross-sections of all the seals tested. In the ideal situation, the performances of the perimeter and threshold seals would be determined independently. The thresholds could be tested having sealed the perimeter gap with acoustic sealant. The perimeter seals could then be tested having sealed the threshold gap with acoustic sealant. However, this method would not meet the requirements of the ISO-Standard measurement method[1] because it would not be possible to slam the door ten times before measurement. Also, the results would probably not match those for a door which had the seals fully installed and tested for best opening and closing.

Therefore, a number of measurements were performed to determine the best perimeter and threshold seals. Other perimeter seals were then tested having fitted the best threshold seal. The threshold seals were tested having installed the best perimeter seals. Results were gauged against those for the door blank sealed into the frame with acoustic sealant. The limiting factors which determine whether a true measure of the ultimate performance of each seal has been measured are the relative performances of the best threshold seal, the best perimeter seals and the sealed-in lead-cored door panel.

2.1 Perimeter Seals

There is often a difficulty when the door seals on the hinge side of the door scuff as the door is opened or closed. Manufacturers often recommend significant rounding of the edge of the door on the hinge side. Alternatively, the hinge side door seal can be fitted to the door or rebated into the frame. This subject is discussed in more detail later. The following Sections detail sound insulation measurements made on compression and magnetic perimeter door seals.

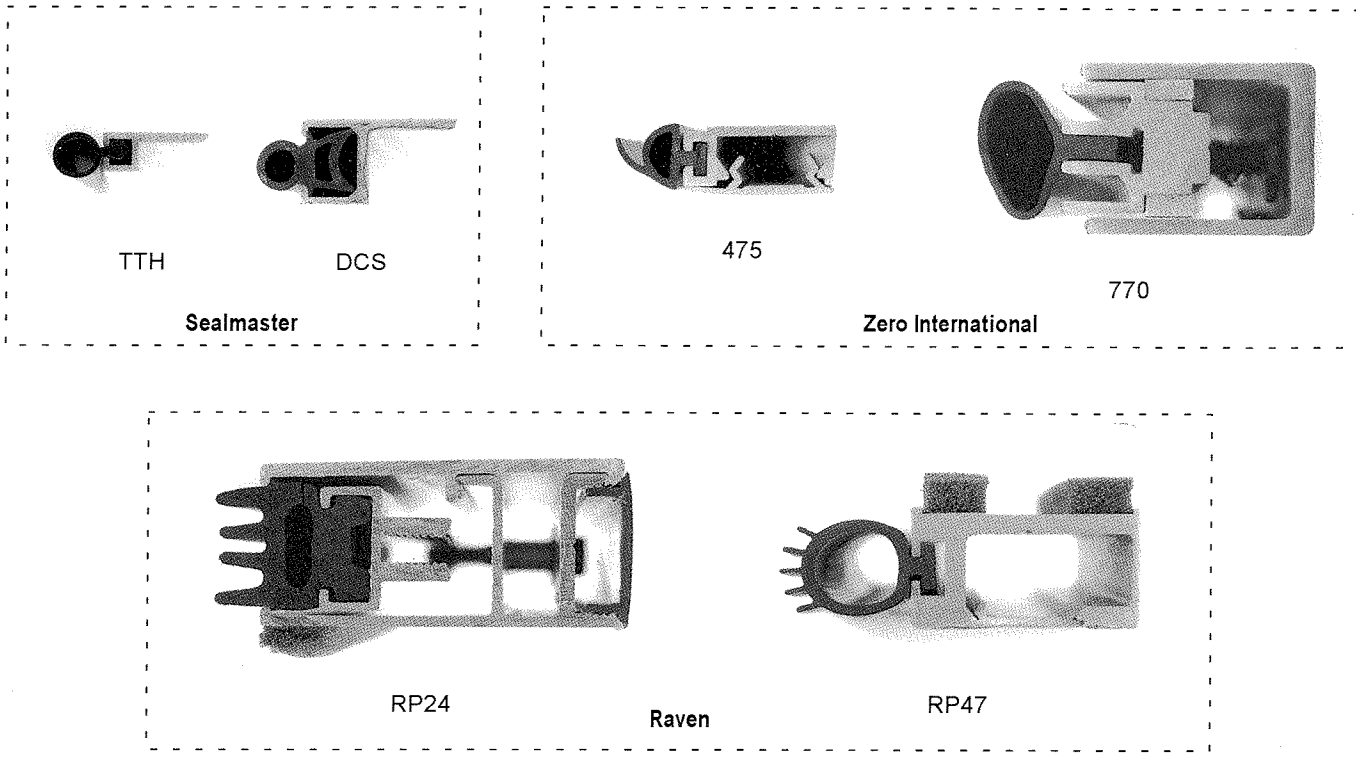
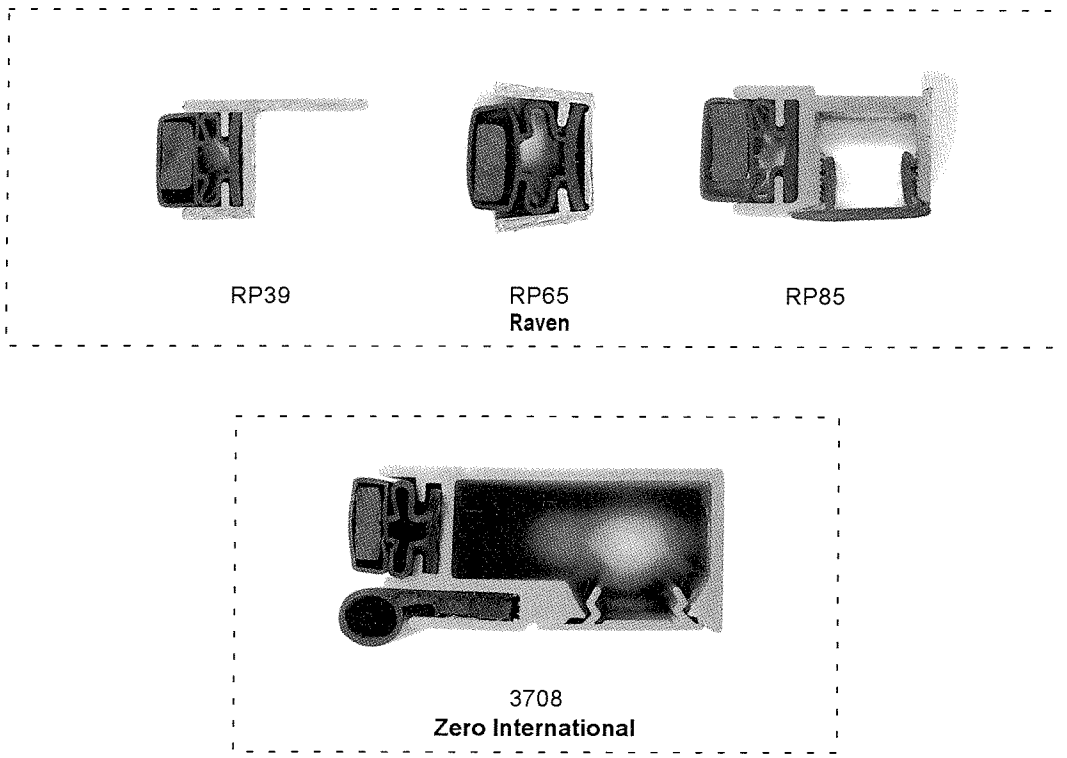
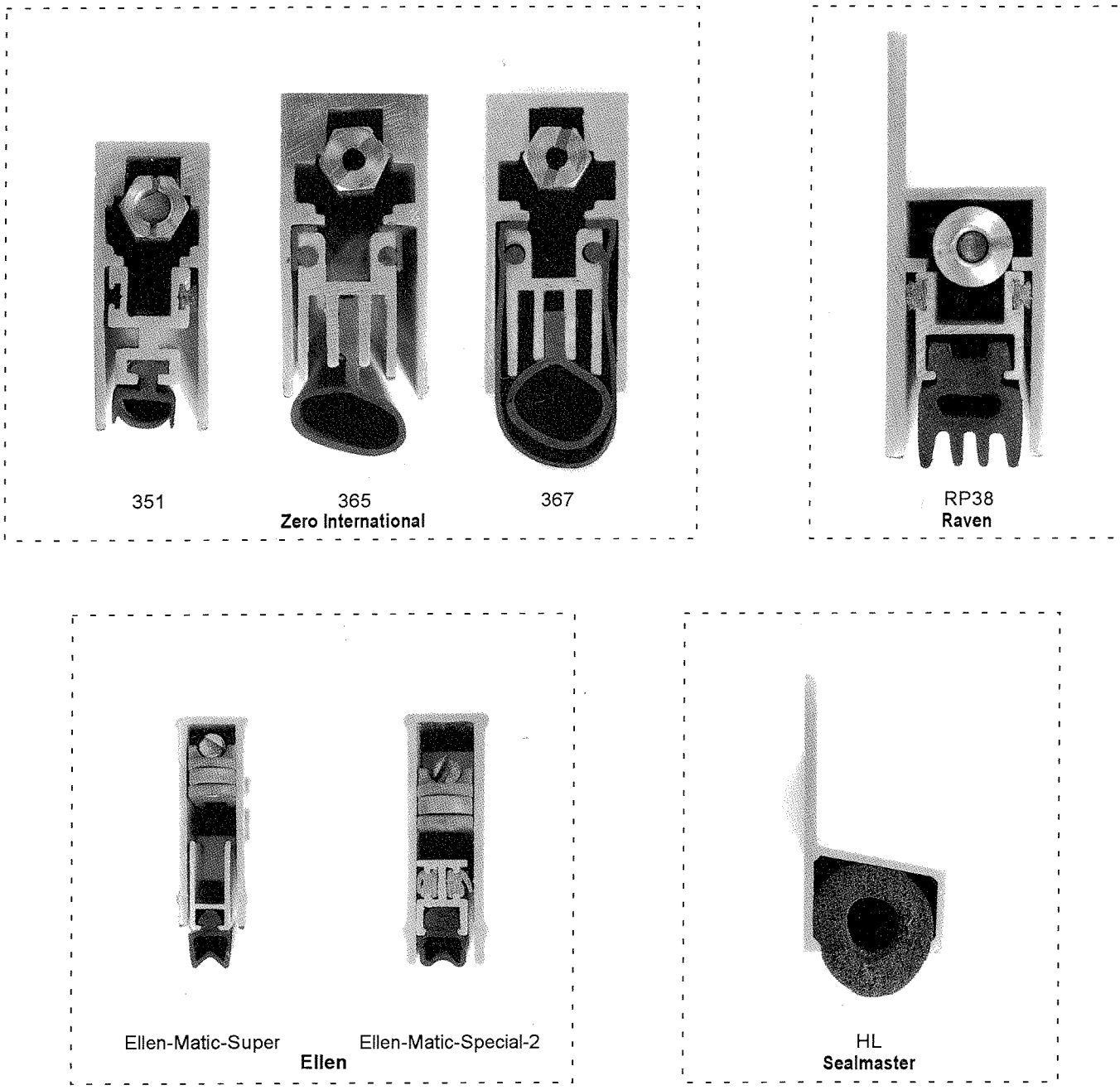


Fig. 1 - Compression perimeter seals.



All seals shown actual size

Fig. 2 - Magnetic perimeter seals.



All seals shown actual size

Fig. 3 - Threshold seals.

2.1.1 Compression Seals

Fig. 4 *(see page 5)* shows the measured sound insulations of a standard BBC lead-cored door fitted with two different types of Sealmaster perimeter door seals. The door was fitted with a Zero International 367 drop-down threshold seal.

The two Sealmaster seals are lightweight seals that are intended to be fitted to doors having positive latching. Without positive latching, the performances of both Sealmaster seals were poor at most frequencies, but particularly at higher frequencies. They had similar performances to each other. On pushing the door shut the performance of the TTH seal was good (comparable to those measured for the magnetic seals, as described later). This shows that the Sealmaster seals perform very well when used as intended by the manufacturer. The dips at 800 Hz – 1.6 kHz and above 4 kHz were probably linked with the performance of the 367 drop-down threshold seal.

Fig. 5 *(see page 5)* shows the measured sound insulations with two different types of Zero

International perimeter door seals fitted to a standard BBC lead-cored door. The door was fitted with a Zero International 367 drop-down threshold seal.

In this type of installation, the performance of the 475 seal was very good (comparable with that of the magnetic perimeter seals tested later). The dip at 630 Hz – 1.6 kHz is probably linked with the performance of the 367 drop-down threshold seal. The 475 had the highest insulations of the compression seals tested and could be used without positive latching. However, the performance may be compromised by fitting a weaker door closer.

The performance of the 770 at most frequencies was not particularly good, because the seal at the hinge side of the door was scuffing and preventing the door from shutting properly. The soft neoprene seal was being pushed out of place and into the hinge gap.

Fig. 6 shows the effects of mounting the Zero International 770 perimeter door seal at the hinge side on the door rather than on the frame. The intention was to reduce the scuffing of the seal which was preventing the door from shutting properly. The insulation improved when the seal was fitted to the door, but the performance was still not particularly good.

Fig. 7 shows the measured sound insulations with two different types of Raven perimeter door seals fitted to a standard BBC lead-cored door. The door was fitted with a Raven RP38 drop-down threshold seal.

The RP38 did not have the best performance of the drop-down thresholds tested, but the Raven seals formed a system. With the RP38 drop-down threshold fitted, the results showed that, without positive latching, the RP24 and RP47 compression seals had lower performances than the magnetic seals above 800 Hz.

Fig. 8 *(see page 6)* shows the effects of the strength of the door closer on the measured sound insulations of a standard BBC solid-cored door fitted with Raven RP47 compression perimeter seals and an RP38 drop-down threshold. Fitting the stronger door closer increased the measured sound insulations. Similar increases would probably occur for most of the other compression seals, but fitting a stronger door closer would probably have little effect on the results for the magnetic seals.

Because the compression door seals are intended to be used with positive latching systems, the strongest acceptable door closer was used. The strong door closer was used in all the door seal tests described in this Report. The performances of the compression seals would have been better if positive latching had been used. However, it has been policy in the BBC not to use positive latching on studio doors for ease of access and to prevent an audible click on closing the door.

Other lightweight compression perimeter seals, such as those manufactured by Slottseal or Ellen, were not tested because they were very similar in design to the lightweight Sealmaster compression seals.

2.1.2 Magnetic Seals

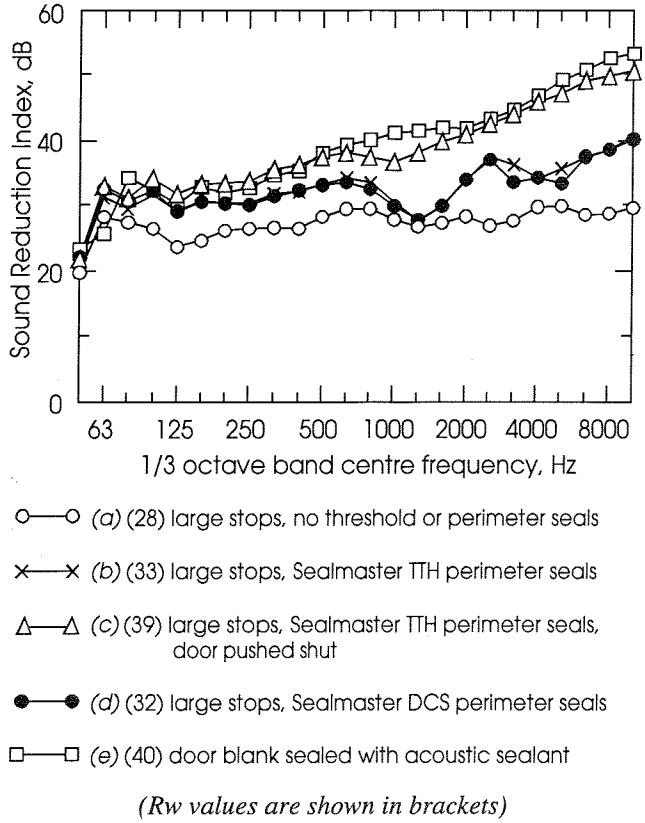
All the plant-on magnetic seals that were tested were easy to install. The seals were cut to size and planted on the steel flats that had been rebated into the lead-cored door (installed as in the existing door construction[2]). The seals were then screwed to the door frames.

Fig. 9 *(see page 6)* shows the measured sound insulations with two different types of Raven and one type of Zero International perimeter door seal fitted to a standard BBC lead-cored door. The door was fitted with a Zero International 367 drop-down threshold seal.

The performances of the magnetic seals are much the same as each other. The results were the best achieved from seals fitted to this door. Compared to the door blank installed with acoustic sealant, there was a shortfall in insulation between 500 Hz – 1.6 kHz and above 4 kHz. This shortfall was probably linked with the performance of the 367 drop-down seal. The irregularity in the results between 50-80 Hz was associated with the different mechanical coupling conditions (note that the door fitted with seals actually had a lower sound insulation than the unsealed door at 63 Hz). The 3708 seal had the best insulation of the magnetic seals tested (although not by a large amount). However, it is more expensive than the other seals. The Raven RP85 was the best compromise of sound insulation and cost when fitted to a BBC lead-cored door.

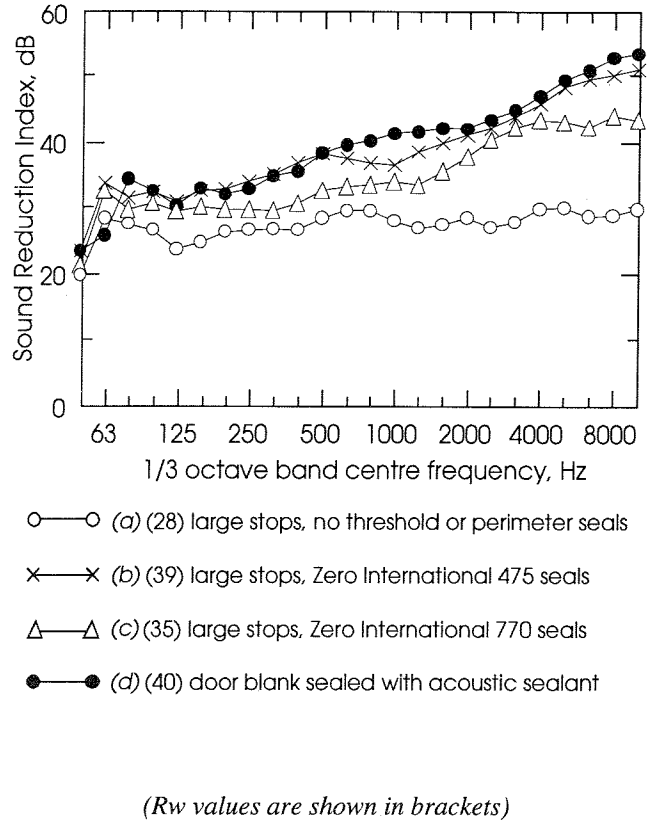
The Zero International 3708 magnetic seals have additional neoprene sponge compression seals. The performances indicate that this additional compression seal did not provide any extra sound insulation in this type of installation.

Fig. 10 *(see page 6)* shows the measured sound insulations of the best compression perimeter door seals fitted to a standard BBC lead-cored door. The results are compared with those of the Raven RP85 magnetic seals fitted to the same door. The door was



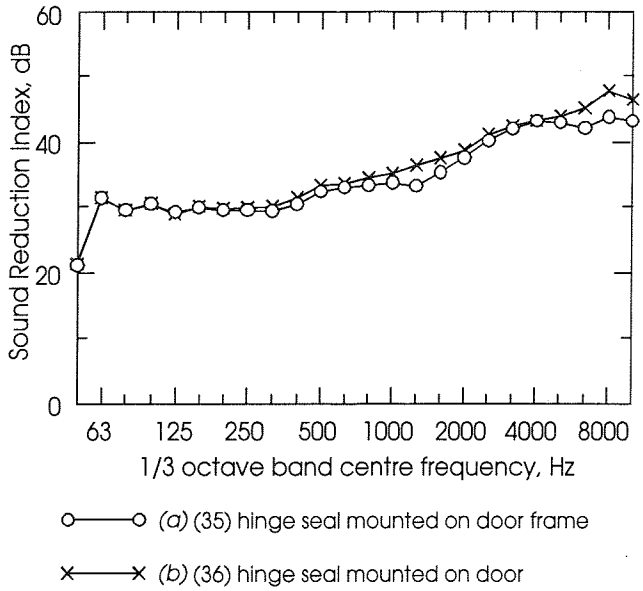
(Rw values are shown in brackets)

Fig. 4 - The measured sound insulations of the lead-cored door blank fitted with a Zero International 367 drop-down threshold and different compression perimeter seals.



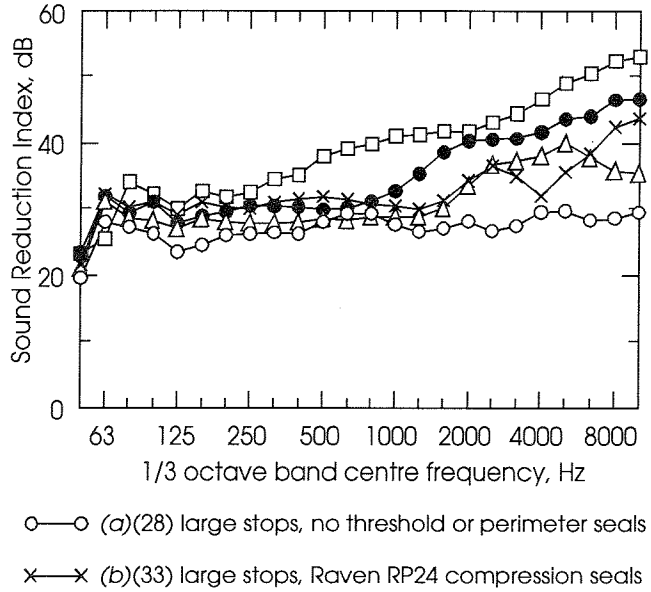
(Rw values are shown in brackets)

Fig. 5 - The measured sound insulations of the lead-cored door blank with a Zero International 367 drop-down threshold and different compression perimeter seals.



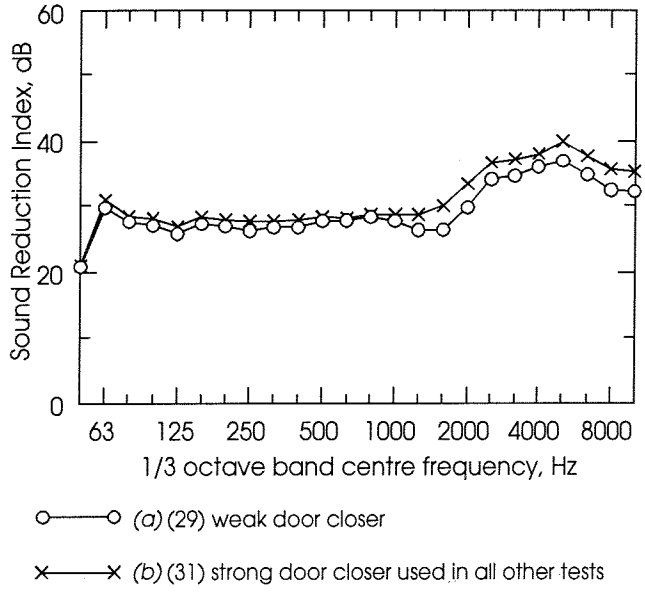
(Rw values are shown in brackets)

Fig. 6 - The measured sound insulations of the lead-cored door blank fitted with a Zero International 367 drop-down threshold and 770 compression perimeter seals.



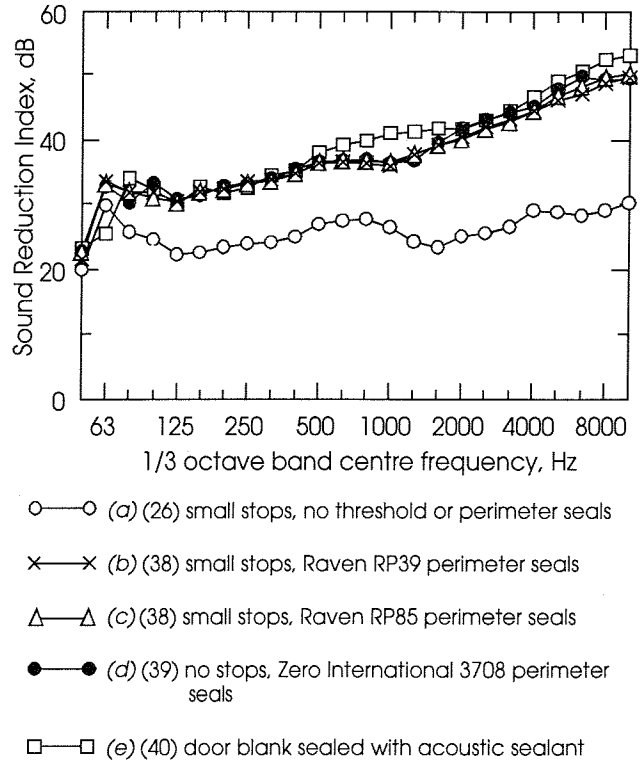
(Rw values are shown in brackets)

Fig. 7 - The measured sound insulations of the lead-cored door blank fitted with a Raven RP38 drop-down threshold and different compression/magnetic perimeter seals.



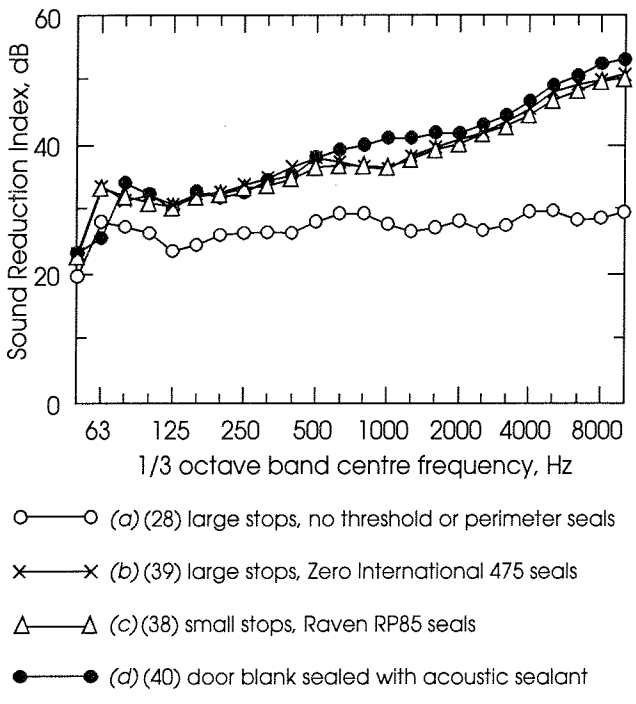
(Rw values are shown in brackets)

Fig. 8 - The measured sound insulations of the lead-cored door blank fitted with a Raven RP38 drop-down threshold and RP47 compression perimeter seals.



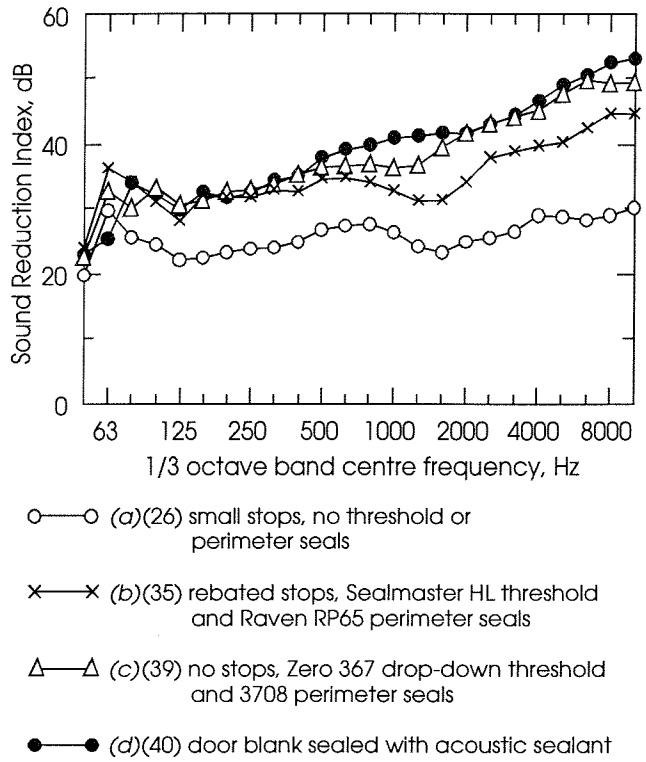
(Rw values are shown in brackets)

Fig. 9 - The measured sound insulations of the lead-cored door blank fitted with a Zero International 367 drop-down threshold and different magnetic perimeter seals.



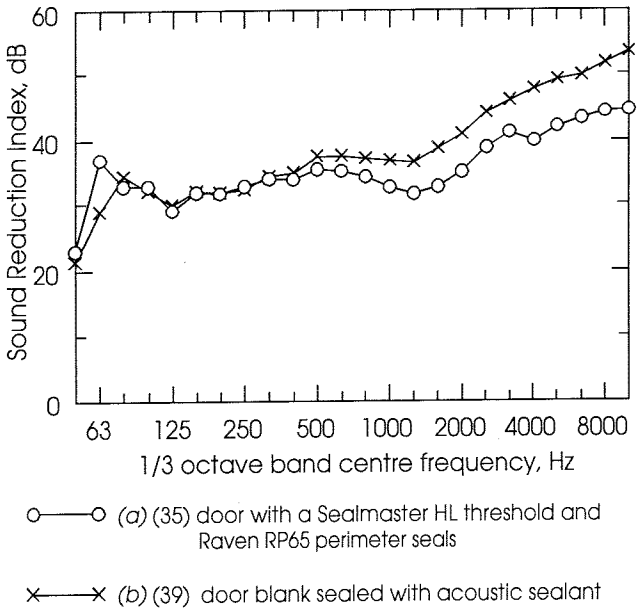
(Rw values are shown in brackets)

Fig. 10 - The measured sound insulations of the lead-cored door blank fitted with a Zero International 367 drop-down threshold and different compression/magnetic perimeter seals.



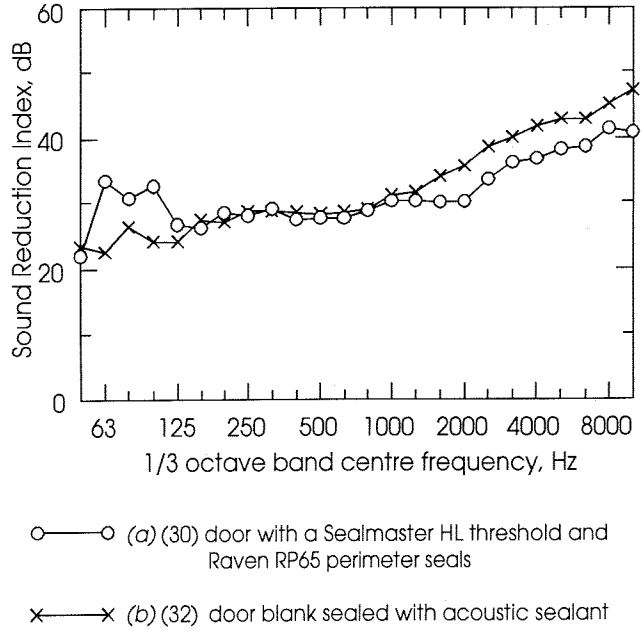
(Rw values are shown in brackets)

Fig. 11 - The measured sound insulations of lead-cored door blank fitted with different seals.



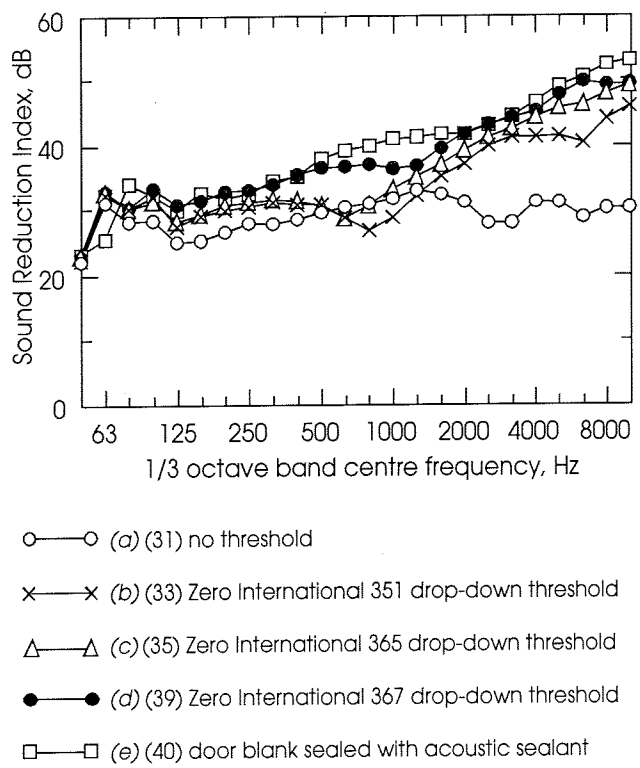
(Rw values are shown in brackets)

Fig. 12 - The measured sound insulations of the polymer-cored door fitted with a Sealmaster HL compression threshold and Raven RP65 magnetic perimeter seals.



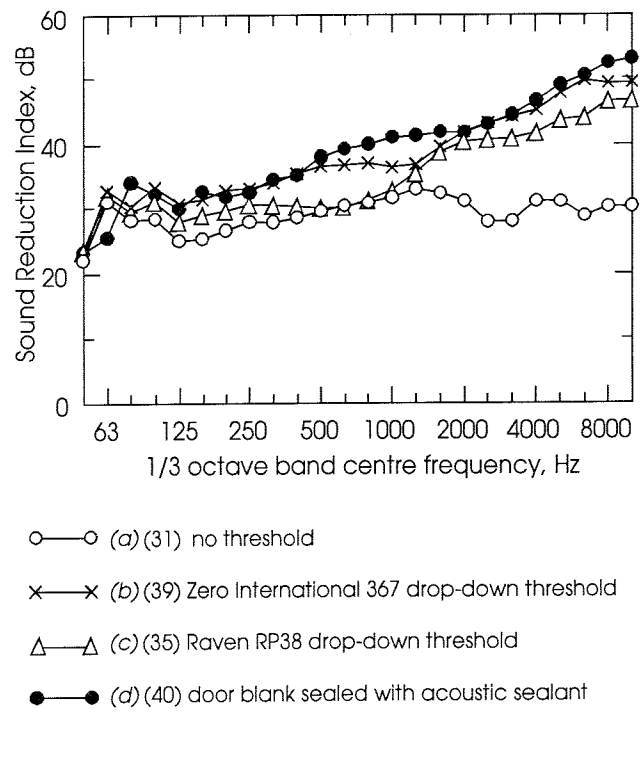
(Rw values are shown in brackets)

Fig. 13 - The measured sound insulations of the solid-cored door fitted with a Sealmaster HL compression threshold and Raven RP65 magnetic perimeter seals.



(Rw values are shown in brackets)

Fig. 14 - The measured sound insulations of the lead-cored door blank fitted with a Zero International 3708 magnetic perimeter seal and different drop-down thresholds.



(Rw values are shown in brackets)

Fig. 15 - The measured sound insulations of the lead-cored door blank fitted with a Zero International 3708 magnetic perimeter seal and different drop-down threshold.

fitted with a Zero International 367 drop-down threshold seal.

The compression seal had a comparable performance to that of the magnetic seal. However, the compression seal is more expensive.

Figs. 11 *(see page 6)*, 12 and 13 *(previous page)* show the measured sound insulations of Raven RP65 magnetic perimeter door seals fitted to lead-cored, polymer-cored and solid-cored doors respectively. The Raven RP65 seal is a magnetic seal which is used in a similar way to that of the standard BBC door seal, except that the RP65 is difficult to adjust after installation. The doors were fitted with a Sealmaster HL compression threshold seal. The seals had good performances up to 315 Hz. Above 315 Hz, the performances were worse.

2.2 Threshold Seals

Fig. 14 *(previous page)* shows the measured sound insulations of Zero International drop-down threshold seals fitted to a standard BBC solid-cored door. The door was fitted with Zero International 3708 magnetic perimeter seals.

The 351 and 365 drop-down seals performed poorly at most frequencies. At frequencies where the performance was less than that with no threshold fitted, the drop-down threshold seal was probably preventing the door from closing properly.

The 367 seal was the best drop-down threshold seal of those tested. The shortfall in sound insulation between 500 Hz – 1.6 kHz and above 3.15 kHz was probably linked with the 367 threshold, rather than in the 3708 perimeter seals. The extra sheath (see Fig. 3) was probably responsible for the improved performance over those of the other two Zero drop-down seals.

Fig. 15 *(previous page)* shows the measured sound insulations of a Raven RP38 drop-down threshold seal fitted to a standard BBC solid-cored door. The door was fitted with Zero International 3708 magnetic perimeter seals. The acoustic performance of the RP38 was rather poor in this particular installation.

Fig. 16 shows the measured sound insulations of Ellen drop-down threshold seals fitted to a standard BBC solid-cored door. The door was fitted with Zero International 3708 magnetic perimeter seals. The performances of both Ellen seals were not particularly good when fitted to the BBC lead core door.

Fig. 17 shows the measured sound insulations for Sealmaster HL compression and Raven RP38 drop-down threshold seals fitted to a standard BBC solid-cored door. Either Raven RP65 or Zero International 3708 magnetic perimeter seals were fitted. All the results show that both the Sealmaster HL and Raven RP38 threshold seals had poor performances.

3. STANDARD BBC DOOR TESTS

The Raven RP65 magnetic perimeter seals are usually used in a similar way to the standard BBC door seals and they have similar neoprene seal inserts. However the RP65 seals are difficult to adjust after installation.

Figs. 18, 19 and 20 *(for Fig. 20 see page 10)* show the measured sound insulations of the standard BBC solid- cored, polymer-cored and lead-cored (respectively) acoustic doors fitted with Raven RP65 magnetic perimeter seals and a Sealmaster HL compression threshold seal (using a standard sloping threshold).

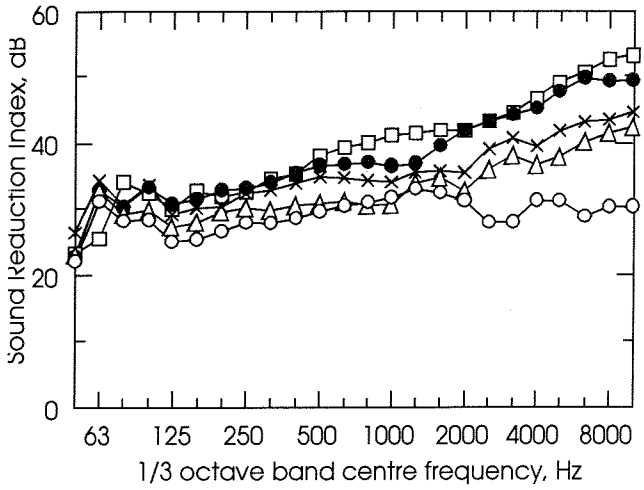
Despite the limitations of the seals, the performances of the installed lead and polymer doors were still higher than that of the solid-cored door. The use of the seals rather than acoustic sealant improves the sound insulations at the lowest frequencies. This is because the seals provide a less rigid mechanical bond than the acoustic sealant, lowering the fundamental resonance frequencies of the door panels.

4. SELECTION OF THE MOST SUITABLE SEALS

Of the compression seals, the Zero 475 seal had the best acoustic performance. Its performance was comparable to those of the magnetic seals. However, it was more expensive than some of the magnetic seals which makes it less desirable.

Of the magnetic seals, the Zero International 3708 was too expensive for use in typical BBC installations. The Raven RP65 is difficult to adjust after installation. Both the Raven RP39 and RP85 seals have similar good performances. The RP39 seals should be used when the fixings do not have to be hidden and the RP85 seals should be used when the fixings must be hidden.

The Zero International 367 threshold seal had the best performance of the thresholds tested. However, it is also the most expensive of the threshold seals tested. It is felt that the superior performance of this seal justifies its cost. The overall savings in



(a) (31) no threshold

(b) (36) Ellen-Matic Super drop-down threshold

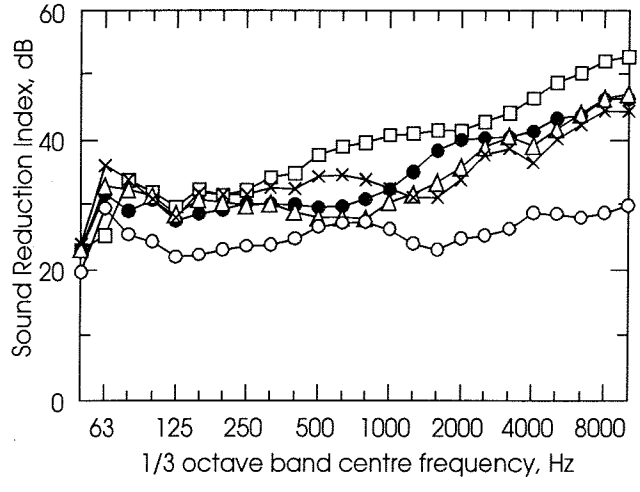
(c) (33) Ellen-Matic Special-2 drop-down threshold

(d) (39) Zero International 367 drop-down threshold

(e) (40) door blank sealed with acoustic sealant

(Rw values are shown in brackets)

Fig. 16 - The measured sound insulations of the lead-cored door blank fitted with Zero International 3708 magnetic perimeter seals and different drop-down thresholds.



(a) (26) small stops, no threshold or perimeter seals

(b) (35) Sealmaster HL compression threshold, Raven RP65 perimeter seals

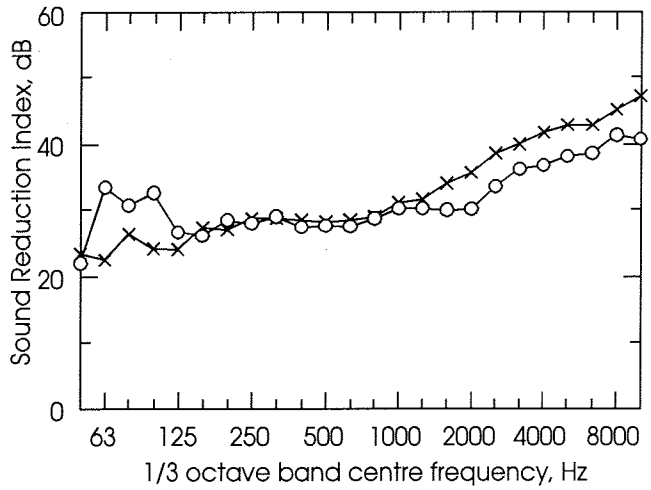
(c) (32) Raven RP38 drop-down threshold, Raven RP65 perimeter seals

(d) (35) Raven RP38 drop-down threshold, Zero 3708 perimeter seals

(e) (40) door blank sealed with acoustic sealant

(Rw values are shown in brackets)

Fig. 17 - The measured sound insulations of the lead-cored door fitted with different threshold and magnetic perimeter seals.

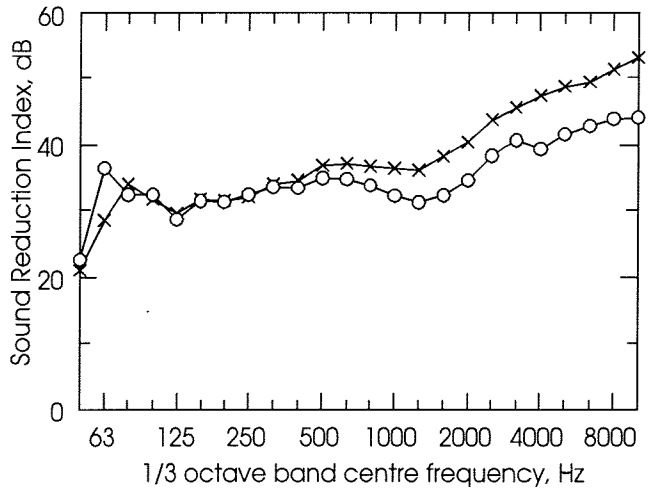


(a) (30) door installed with seals

(b) (32) door blank sealed in with acoustic sealant

(Rw values are shown in brackets)

Fig. 18 - The measured sound insulations of a BBC solid-cored door fitted with a Sealmaster HL compression threshold and Raven RP65 magnetic perimeter seals.



(a) (35) door installed with seals

(b) (39) door blank sealed in with acoustic sealant

(Rw values are shown in brackets)

Fig. 19 - The measured sound insulations of a BBC polymer-cored door fitted with a Sealmaster HL compression threshold and Raven RP65 magnetic perimeter seals.

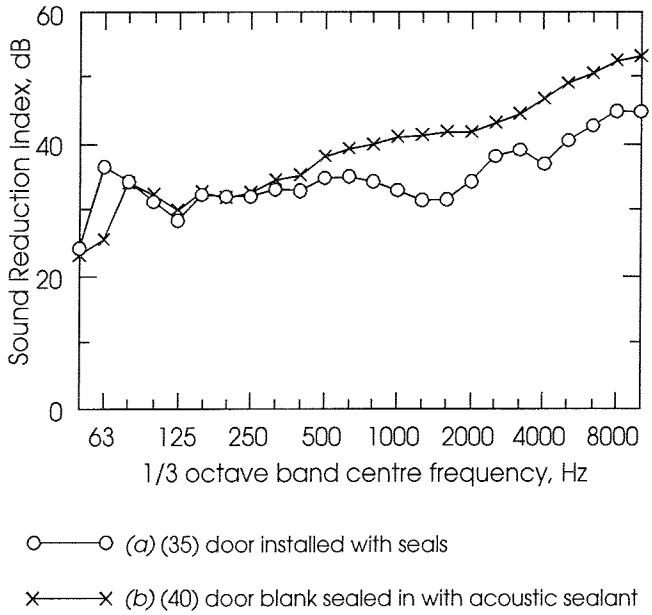


Fig. 20 - The measured sound insulations of a BBC lead-cored door fitted with a Sealmaster HL compression threshold and Raven RP65 magnetic perimeter seals.

construction effort and the reliable performance of the seal would make its use worthwhile.

5. CONCLUSIONS

Without positive latching of studio doors, the acoustic performances of compression perimeter seals are typically quite poor. Plant-on magnetic perimeter seals usually have good performances and the cheaper magnetic seals are very cost-effective.

Different drop-down threshold seals have very different performances. It seems that the seal must have a complicated construction to ensure reliably good operation. Drop-down threshold seals should be relatively maintenance free and are very simple to fit.

It is expected that the performance of a door fitted with the recommended seals would typically be higher than that of an existing studio door, because of the reliably good sealing. If the performance was significantly higher than that of an existing studio door, then it is possible that further savings in construction costs may be made. For instance, it may be that double doors between studio areas would not be required in some situations, or that the requirements for sound lobbies may be less stringent.

6. RECOMMENDATIONS

A field trial should be carried out using the Raven RP39 or RP85 magnetic perimeter seals and Zero International 367 drop-down threshold seal fitted to a studio door. This would show up any practical construction weaknesses and other relevant factors.

7. REFERENCES

1. BS 2750: Part 3: 1980. Methods of measurement of sound insulation in buildings and of building elements. Part 3: Laboratory measurements of airborne sound insulation of building elements.

2. ROSE, K.A., 1990. Guide to acoustic practice. Architectural and Civil Engineering Department publication. 2nd Edition. p. 49.