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# Quantitative comparisons of resilient channel designs and installation methods

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## ABSTRACT

The hypothesis that different brands and models of manufactured resilient channels have significantly different acoustical performance is common in North America. Additionally, there is ample evidence that improper installation reduces the performance of resilient channel assemblies. However, many of the differences in acoustical performance associated with brand and/or installation of resilient channel have not been systematically researched. This paper will separate the two elements and quantify their acoustical effects for one wall assembly. Results of laboratory comparative testing of different resilient channel types are presented and will include various manufacturers currently producing and marketing resilient channels in North America. The acoustical effect of specific installation errors based on comparative tests of laboratory assemblies is presented.

## 1. INTRODUCTION

Resilient channel is a common acoustical design element in wall and floor/ceiling construction in North America. Its purpose is to acoustically decouple the gypsum board from the underlying structure (usually wood studs, steel studs, wood joists or steel joists). Its popularity is warranted by the substantial improvement in acoustical performance that can be achieved for minor changes in assembly dimensions, along with relatively minor impacts to project scheduling and budget. However, two major categories must be studied to truly understand the acoustical performance of resilient channel assemblies.

### A. Brand and Model

There is copious evidence that the brand of resilient channel can cause large differences in acoustical performance. However, these deficiencies have not been analyzed systematically. In the paper often cited regarding differences in channel brand, "Update on the use of steel resilient

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channels for constructing sound rated walls"[1], Lilly reported test reports showing that the original USG RC-1 performed 3 STC points better than two unidentified resilient channels for one single wood stud construction having one layer of gypsum board on each side and fiberglass insulation in the stud cavity. Beyond this paper, there has been little published comparative data on different brands of resilient channel.

### B. Errors in Installation

It is a common tale among acoustical consultants in North America, especially those working on multi-family residential projects or as expert witnesses in legal cases: a resilient channel assembly with acoustical performance far lower than expected. Upon destructive testing, it is determined that the brand of channel installed was not equal to the USG RC-1, and that it was installed incorrectly. The assembly is rebuilt and the acoustical performance improves markedly.

Because there are generally multiple errors on these case studies, all of which are corrected at the same time, there is very little data on the individual common installation errors. The acoustical effects of these errors in installation have also not been systematically studied. We present controlled laboratory testing quantifying the acoustical effects of several common errors in installation.

## 2. DIFFERENCES BETWEEN BRANDS OF RESILIENT CHANNEL

### A. Description

Numerous manufacturers of metal products include "resilient channel" in their product line. However, there is no formal standardization of the properties of these products. The products described in this paper are commonly encountered and all share the following properties. They are made from corrosion-resistant steel, nominally 25 gauge (0.53 mm), and nominally 0.5 inches (13 mm) thick (the distance that the gypsum board is offset from the framing). They share the "Z" shape, with a narrow flange that is attached to the framing with screws and a wide flange to which the gypsum board is mounted.

The primary visual differences between the different channels are the width of the flanges (and hence the overall width of the channel) and the design of the web connecting the flanges. All of the products include holes or slots punched in the web, but the exact pattern of the holes and slots is unique to the brand and model.

Resilient channel was developed my USG roughly 50 years ago and designated "RC-1." Virtually all published tests of wall and floor/ceiling assemblies containing resilient channel were constructed with RC-1. USG no longer manufacturers any resilient channel, and the term "RC-1" has become in common use a generic descriptor of resilient channel and not a reference to a specific product. The interested reader can review Lilly[1] and Nash[2] for more details on the long and confusing history of resilient channel.

### B. Dietrich RC-Deluxe

The currently manufactured channel that is the closest to the original USG RC-1 design is manufactured by Dietrich Metal Systems as "RC-Deluxe," product code RCSD. This channel can be easily identified by the "dog bone" shape of the slots in the web, which are 3 inches (76 mm) long, 4 inches (102 mm) on center, and centered on pre-punched screw holes in the narrow flange. See Figure 1.

Some time in 2006 or 2007, Dietrich changed the dies used to manufacture RC-Deluxe, so that the shape of the slot changed from a dog-bone to an oval. By the end of 2007, Dietrich had decided to change the dies back to the dog-bone shape, which is the current production model.

We therefore may refer to three different types of RC-Deluxe: the "old dog-bone" produced before 2007, the "oval" which was the interim model no longer in production, and the "new dog-bone" which is the currently produced product. Testing does not indicate a systematic difference between these three versions of RC-Deluxe, which is reassuring although largely moot.

**Figure 1:** Dietrich RC-Deluxe is easily identified by "dog-bone"-shaped slots which are centered on pre-punched screw holes at 4 inches on center.

## C. Comparison Testing

For comparison, airborne transmission loss testing was conducted for a wood stud assembly incorporating a wood shear panel commonly constructed encountered in multi-family residential projects. In addition to the Dietrich RC Deluxe, resilient channels were obtained from three manufacturers (referred to as Brand X, Y, and Z). The base assembly was a nominal 2x6 wood stud wall at 16 inches (406 mm) on center, with R19 batt insulation in the cavity. On one side was one layer of 5/8-inch (15.9 mm) type "X" gypsum board over one layer of 3/8-inch (9.5 mm) plywood shear panel. On the opposing side of the studs was either one or two layers of 5/8-inch (15.9 mm) type "X" gypsum board directly mounted to the studs or over the resilient channel models mounted at 24 inches (610 mm) on center.

In order to minimize the uncertainties in the test procedure, the assemblies were constructed, demolished, and tested on consecutive days in the same testing laboratory with the same personnel. The studs, gypsum board and other materials were all purchased at the same time from the same production lots. The walls were constructed by a professional drywall sub-contractor licensed in the State of California and familiar with the construction of the wall described. Testing was conducted at Western Electro-Acoustic Laboratory in Santa Clarita, California, who is accredited in the United States to perform the ASTM E90 and ISO 140-3 test procedures. The overall dimensions of the wall assembly evaluated for all of the tests was 96 inches (2.44 m) wide by 96 inches (2.44 m) high.

The results are shown in Table 1, and Figure 2 shows the transmission loss spectra for the assembly with one layer of gypsum board over the resilient channel. The Dietrich channel achieved STC ratings between 3–7 points higher than the other channels, with differences of up to 10 dB at some third-octave bands as shown in Figure 2.

**Table 1:** STC and $R_w$ ratings of 2 resilient channel assemblies with various brands of resilient channel

| RC Brand | STC ratings (ASTM E90) | | $R_w$ rating (ISO 140-3) | |
|---|---|---|---|---|
| | 1 layer gyp bd | 2 layers gyp bd | 1 layer gyp bd | 2 layers gyp bd |
| Dietrich RC-Deluxe | 59 | 63 | 58 | 62 |
| (new dog-bone) | 57 | 61 | 56 | 60 |
| Dietrich RC-Deluxe (oval) | 57 | 61 | 55 | 60 |
| Brand X | 54 | 58 | 53 | 56 |
| Brand Y | 53 | 57 | 52 | 56 |
| Brand Z | 53 | 56 | 52 | 56 |
| None | 44 | 47 | 43 | 47 |

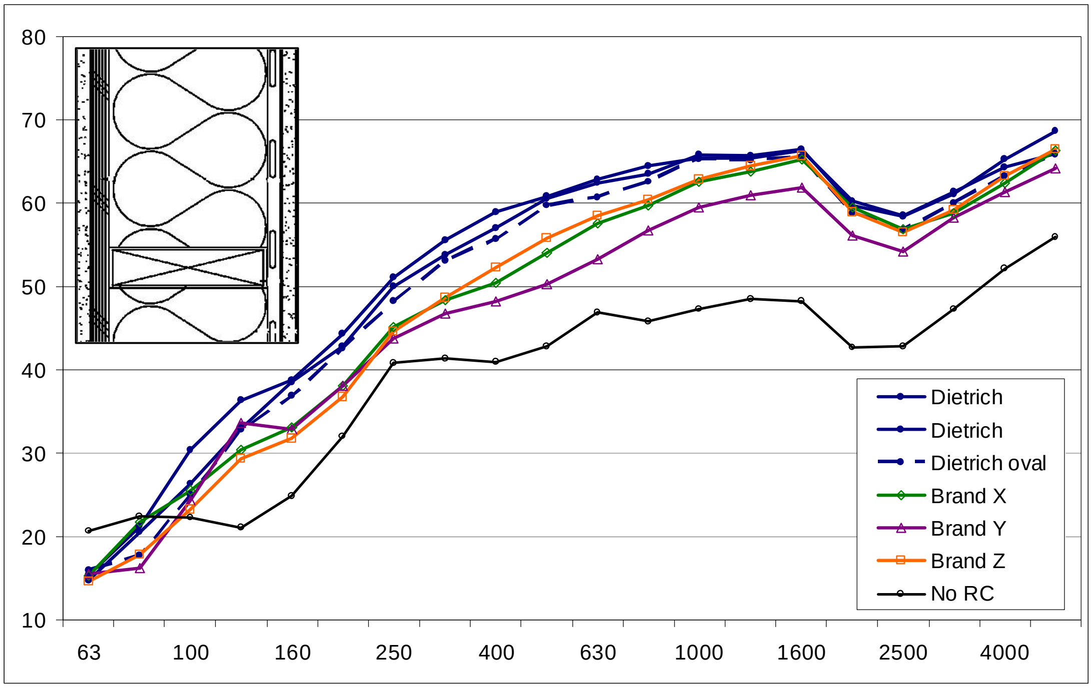


**Figure 2:** Transmission loss vs. third-octave band frequency (Hz) for the tests in Table 1 with 1 layer of gypsum board. The assembly is sketched schematically (inset) and is 5/8" type 'x' gypsum board, 3/8" wood shear panel, 2x6 studs at 16" o.c., R-19 fiberglass batt insulation, resilient channel, 5/8" type 'x' gypsum board.

## 3. ACOUSTICAL EFFECTS OF ERRORS IN INSTALLATION

### A. Short circuits from screws

Perhaps the most common lament among acoustical consultants who see large numbers of resilient channel assemblies is that the contractor uses screws that are too long, resulting in the screws penetrating through the resilient channel and into the framing member (stud). This is commonly described as a short-circuit. In this case, the decoupling action of the channel will obviously be reduced, but to what extent? Does it only take a small number of short-circuits to drastically reduce the performance of an assembly?

Several sets of tests were performed where the assembly was kept fixed, but measured multiple times as an increasing amount of short circuits were added. In all cases tested, the wall had 35 screws connecting the gypsum board to the resilient channel. The number of short circuits was increased in steps of 5 until all 35 screws where penetrating into the studs (short-circuited). The proper screw length for attaching a single layer of gypsum board to resilient channel is 1 inch (25.4 mm); the screw length used to create the short circuits was 1-5/8 inches (41.3 mm).

The first assembly was a nominal 2x6 wood stud wall with R19 batt insulation in the cavity, one layer of 5/8 inch (15.9 mm) gypsum board over Dietrich RC-Deluxe oval resilient channel on one side, and two layers of gypsum board on the other side. The second assembly was the same, except with 3/8-inch (9.5 mm) plywood shear panel replacing the inner layer of gypsum board. The third assembly was the same as the second, except with Brand Y resilient channel.

Finally, USG has recently published the results of a similar study[3]. Their test assembly was a nominal 2x4 wood stud wall with one layer of gypsum board on each side, Dietrich RC-Deluxe resilient channel, and batt insulation in the cavity. They similarly measured the STC rating as the number of short circuits was increased to 100 percent.

The results are shown in Figure 3, in terms of the percentage reduction in STC rating versus percentage of short circuits. When plotted in this way, the STC rating falls nearly linearly with increasing short circuits, to a maximum of almost 20 percent when fully short-circuited. This corresponds to between 8-10 STC points for the walls with Dietrich RC-Deluxe.

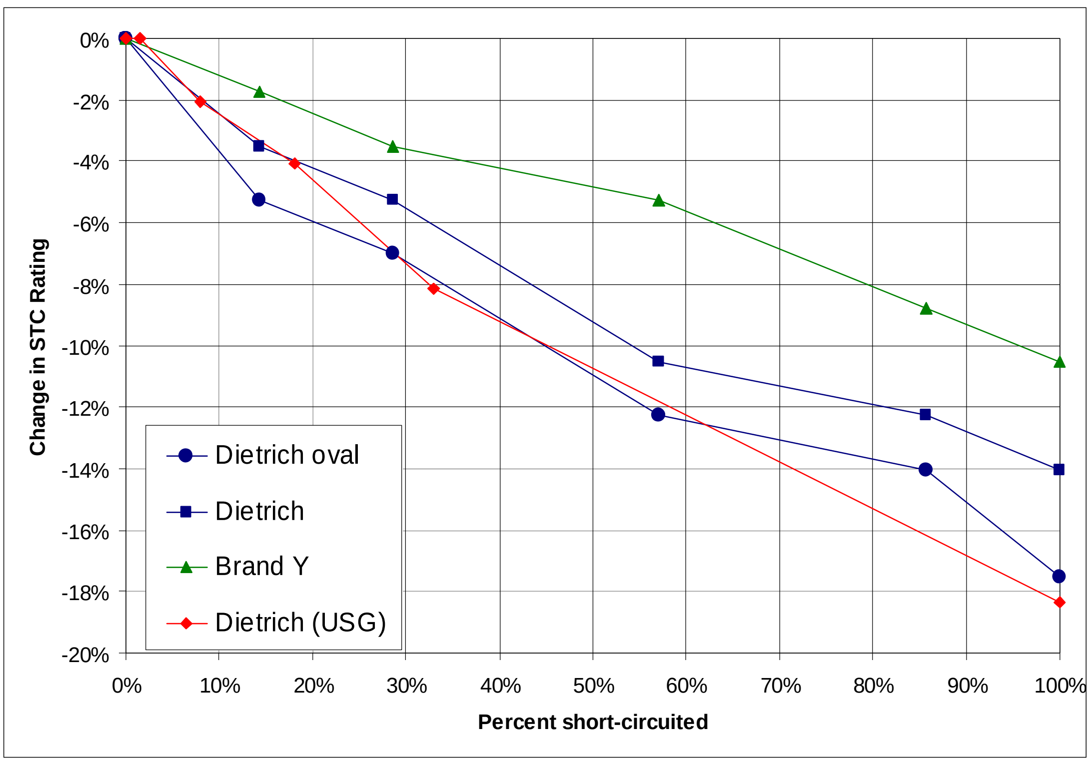


**Figure 3:** Reduction in STC rating with increasing percentage of short circuits (1-5/8 inch screws penetrating through resilient channel into wood studs).

There are a number of interesting observations from this graph. Even when fully short-circuited with screws into the studs, the wall still performs about 10 rating points better than a similar wall constructed without resilient channel (refer to Table 1). This is reasonable considering that coupling through the screws should be much less efficient than if the gypsum board were in direct contact with the entire face of each stud. Second, the effect of short-circuiting is noticeable but not extreme: it takes half (50%) of the screws to be short-circuited in order to reduce the rating by 10 percent. This shows that it takes a large quantity of installation errors in wall construction to result in a significant acoustical performance change. Third, the effect of short-circuiting on the Brand Y channel was about half of the effect with the RC-Deluxe. This is not surprising considering that the Brand Y channel, as shown above, starts out about 5 STC points lower than RC-Deluxe when installed properly. Lastly (not shown on this graph), the reduction is constant across the third-octave bands and does not show any frequency dependence.

## B. Location of slots

Lilly[1] quoted former USG employee Mr. Stan Roller who stated that it is important that the framing member be centered on the slots in the RC-Deluxe. This would require a contractor using the pre-punched screw holes (assuming framing is installed at 16 or 24 inches on center) when installing the channel. To our knowledge, a comparison of the acoustical performance when this installation procedure is strictly followed or neglected has never been documented.

Three walls were constructed on nominal 2x6 wood studs with RC-Deluxe and one or two layers of 5/8 inch (15.9 mm) thick gypsum board on each side and R19 batt insulation in the cavity. Each wall was constructed both with the RC-Deluxe mounted as intended using the pre-punched screw holes, and also with the channel offset laterally about two inches (50 mm) so that the metal web between the slots was aligned with the studs. The results are shown in Table 3. The change as a function of frequency is shown in Figure 4.

**Table 3:** STC ratings of resilient channel assemblies

| | STC ratings (ASTM E90) | | $R_w$ rating (ISO 140-3) | |
|---|---|---|---|---|
| Wall configuration | Correct: slots centered on studs | Incorrect: metal centered on studs | Correct: slots centered on studs | Incorrect: metal centered on studs |
| 1 layer over RC<br>1 layer on other side | 55 | 52 | 53 | 51 |
| 1 layer over RC<br>2 layers on other side | 58 | 57 | 57 | 56 |
| 2 layers over RC<br>2 layers on other side | 63 | 61 | 62 | 60 |

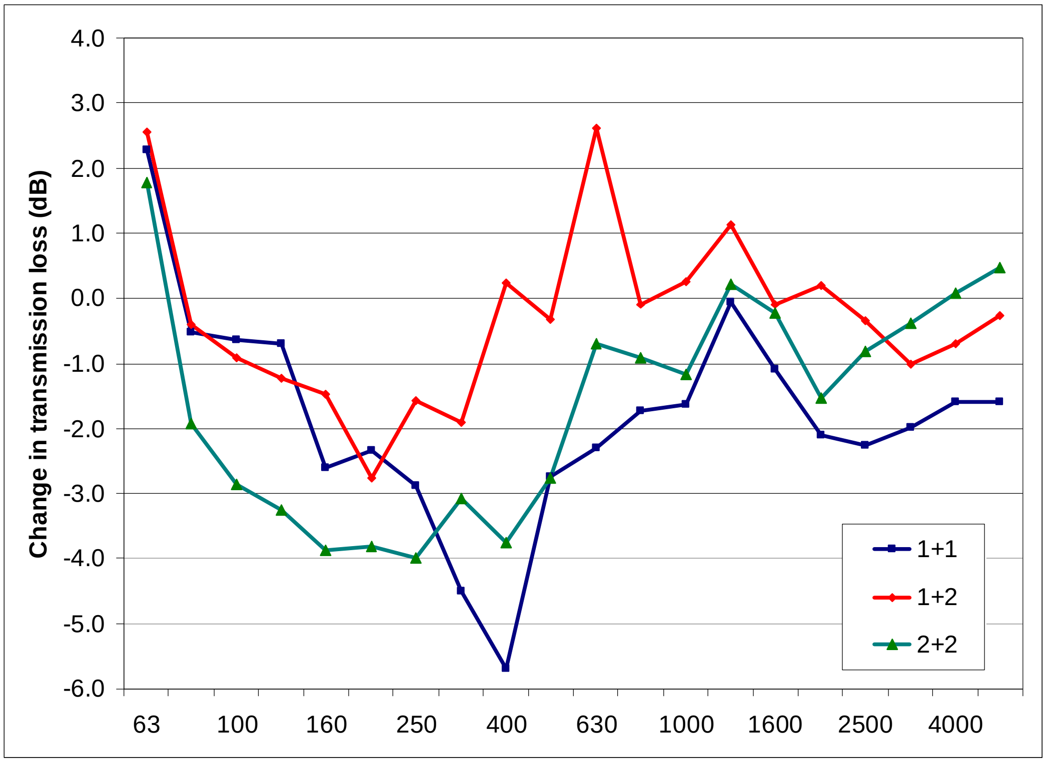


**Figure 4:** Reduction in transmission loss when studs are not centered on slots.

This reduction due to the installation error varies with assembly type and frequency. The difference is most pronounced from about 100–500 Hz. In contrast, the performance is unchanged or even slightly improved at higher frequencies around 1250 Hz. This is consistent with the hypothesis that the improper installation is modifying the resonant frequency of the system. The magnitude of the effect, 1–3 rating points, is not large.

### C. "Sandwich" installation

Another common design is for the resilient channel to be installed onto a solid surface such as a plywood shear panel, so that the channel is sandwiched between the shear panel and the gypsum board. This is a well-known error in construction, but again there is little published data showing the magnitude of the effect.

This condition was tested on a nominal 2x6 wood stud wall with batt insulation and 2 layers of 5/8 inch (15.9 mm) thick type X drywall on one side. A layer of nominal 1/2-inch (12.7 mm) plywood shear panel was installed to the studs, RC-Deluxe was attached to the shear panel, and 1 layer of gypsum board installed. The wall was also tested with the same amount of material but without the resilient channel, and with the resilient channel installed correctly beneath the two layers of gypsum board on the other side of the studs.

The results are shown in Figure 5. This is a catastrophic construction technique from an acoustical perspective, virtually negating the value of the resilient channel over much of the frequency range.

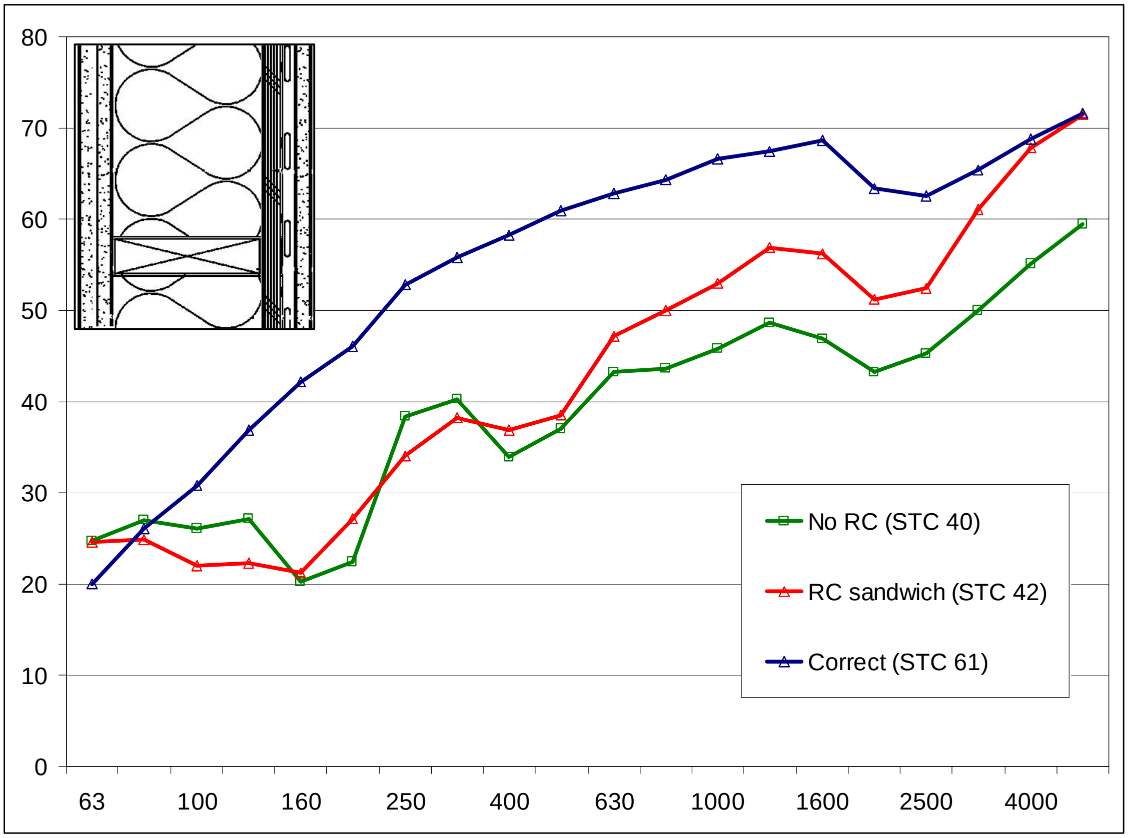


**Figure 5:** Transmission loss when resilient channel is sandwiched between plywood and gypsum board. The assembly is sketched in the insert and is 5/8" type 'x' gypsum board, RC-Deluxe resilient channel, 1/2" wood shear panel, 2x6 studs at 16" o.c., R-19 fiberglass batt insulation, 2 layers of 5/8" type 'x' gypsum board.

## 4. CONCLUSIONS

We have performed and reported controlled laboratory tests on the effects of brand of resilient channel and installation methods on airborne sound isolation in single stud wall construction. Many of these results are part of the conventional wisdom in the North American acoustical community. However, there has been limited data and no systematic studies quantifying these effects.

Our data show that the Dietrich RC-Deluxe channel, which is the closest to the original USG RC-1 design of the currently manufactured channel, remains the channel having the best acoustical performance when compared with other commonly manufactured channels. Installation of resilient channel by other manufacturers results in a reduction of 3–7 STC points, consistent with previous work and anecdotal testimony. Of the common installation errors presented, installing the resilient channel over a solid surface ("sandwiched" resilient channel) is by far the most egregious, resulting in up to a 20 dB reduction in performance. Installing the RC-Deluxe without centering the studs on the slots resulted in a measurable, small reduction in acoustical performance of 1–3 STC points. Short-circuiting the resilient channel with screws penetrating into the studs resulted in a linear decrease of acoustical performance with percentage of short-circuits, resulting up to a 10 STC point reduction.

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