Group Test of Fire Retardant Sealers

Ok, here we go. Sorry to take so long. Had to assemble a new fire rig as the old one was long ago dismantled and recycled, and I decided to allow plenty of cure time for the test materials.

First, the candidates:

Cotronics Resbond 907GF (courtesy of Don Pansier)
Rectorseal Biotherm 100 (courtesy Dan Langhout)
Flamemaster CS1900 (courtesy Dan Langhout)
3M FireBarrier 2000
Permatex Ultra Copper

Practical notes, not fire related:

All are single-component except for CS1900, which requires mixing.

Resbond doesn't tool very well. The three silicones (Biotherm, FireBarrier, Ultra Copper) tool, well, like silicones; FireBarrier and Ultra Copper do best in this group. CS1900 is nothing like proseal and doesn't really tool at all. It is more like a blob of uncured rubber or

playdough.

The silicones stick well, the Resbond a little less so, and the CS1900 is not very adhesive.

When cured, Resbond is hard. The silicones are what you would expect. The CS1900 feels like soft tire rubber.

The setup:

18 x 24 sheet of stainless firewall material. At the top are simple strips of sealant on the front and back of the panel (staggered). At the bottom we have actual firewall electrical penetrations, very basic; 6-gauge tefzel wire through plastic snap bushings, then covered with sealant, without SS shields. I selected this sort of pass-through because they are commonly seen on experimental aircraft. On the left is a personal experiment, the pass-through style on my own airplane, a 2"x2" .032 plate with a 1.5" long .035 tube, welded 4130. The cable, wires, or whatever is inserted, then the tube is pumped full of sealant.

Here's the back of the panel. I made a point of equally filling each snap bushing with sealant


BACK SIDE OF PANEL
("CABIN SIDE")

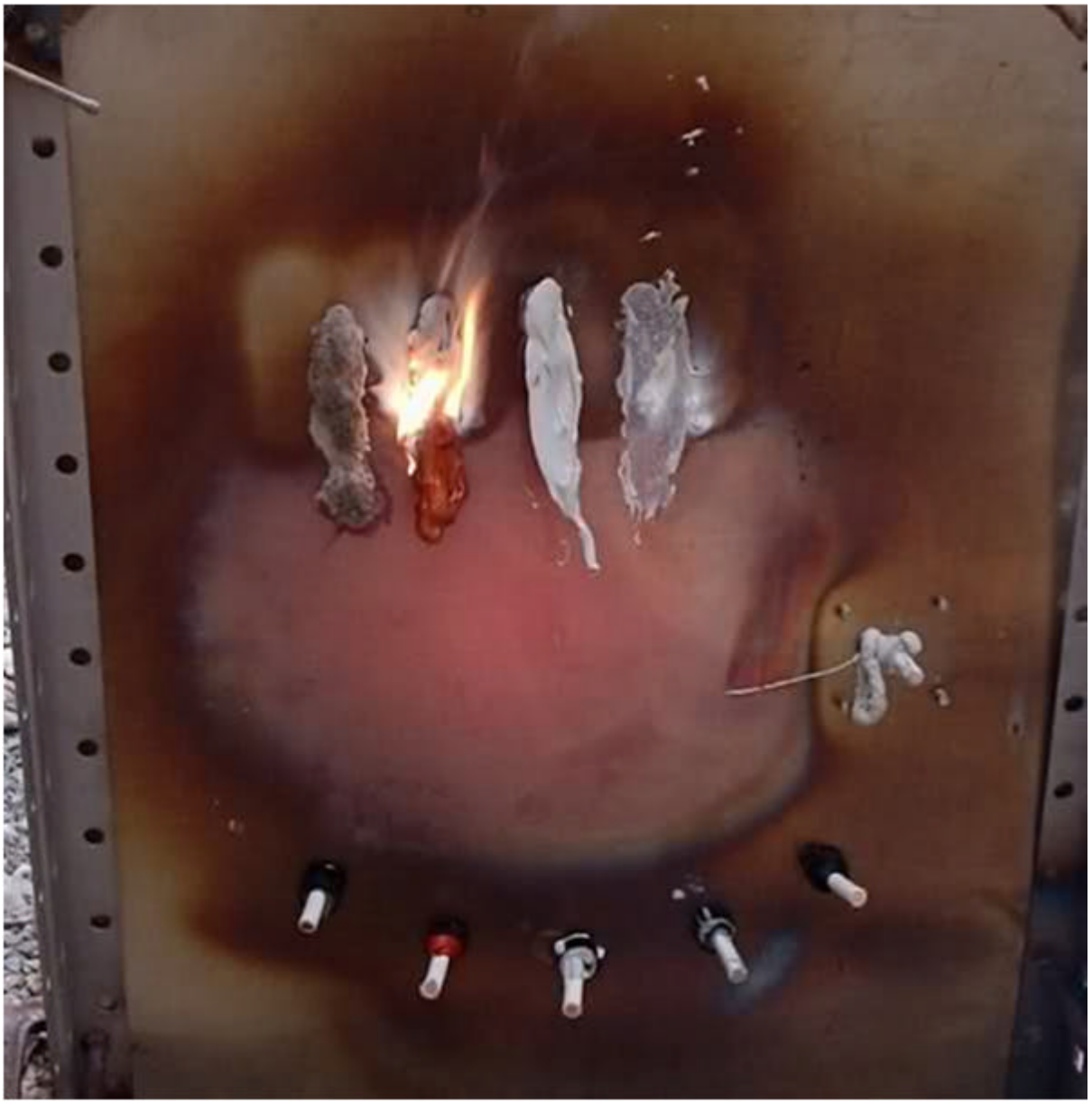
Bring on the heat.

First the burn rig was calibrated to approx 2000F using copper sheet. Note that (compared to previous firewall tests) I have reworked the torch nozzle to obtain a tighter, more horizontal hot spot pattern. Also note that none of the sealant samples here are actually in the 2000F hot spot.

Let's go closer:

Approx 30 seconds into the burn. The CS1900 has burst into flame. All three silicones are also outgassing flammable material, but not like the CS. The Ultra Copper sample is the worst of the silicones in this regard. The burn exhibited by these four samples is not entirely a bad thing, as the probable operating scheme is to form an insulating char. The Resbond appears to be inert. Compare the silicones to the previous setup photo and you'll see the Biotherm and FireBarrier samples are exhibiting some degree of intumescence, swelling and expanding. Now look at the 6-gauge wires; so far all the sealant samples are holding up ok (even if outgassing flammable material), but the wire insulation is burning away. I point this out because sometimes I bump into a builder who assumes Tefzel insulation to be fireproof.....it ain't so.

Back of the panel at about 45 seconds:



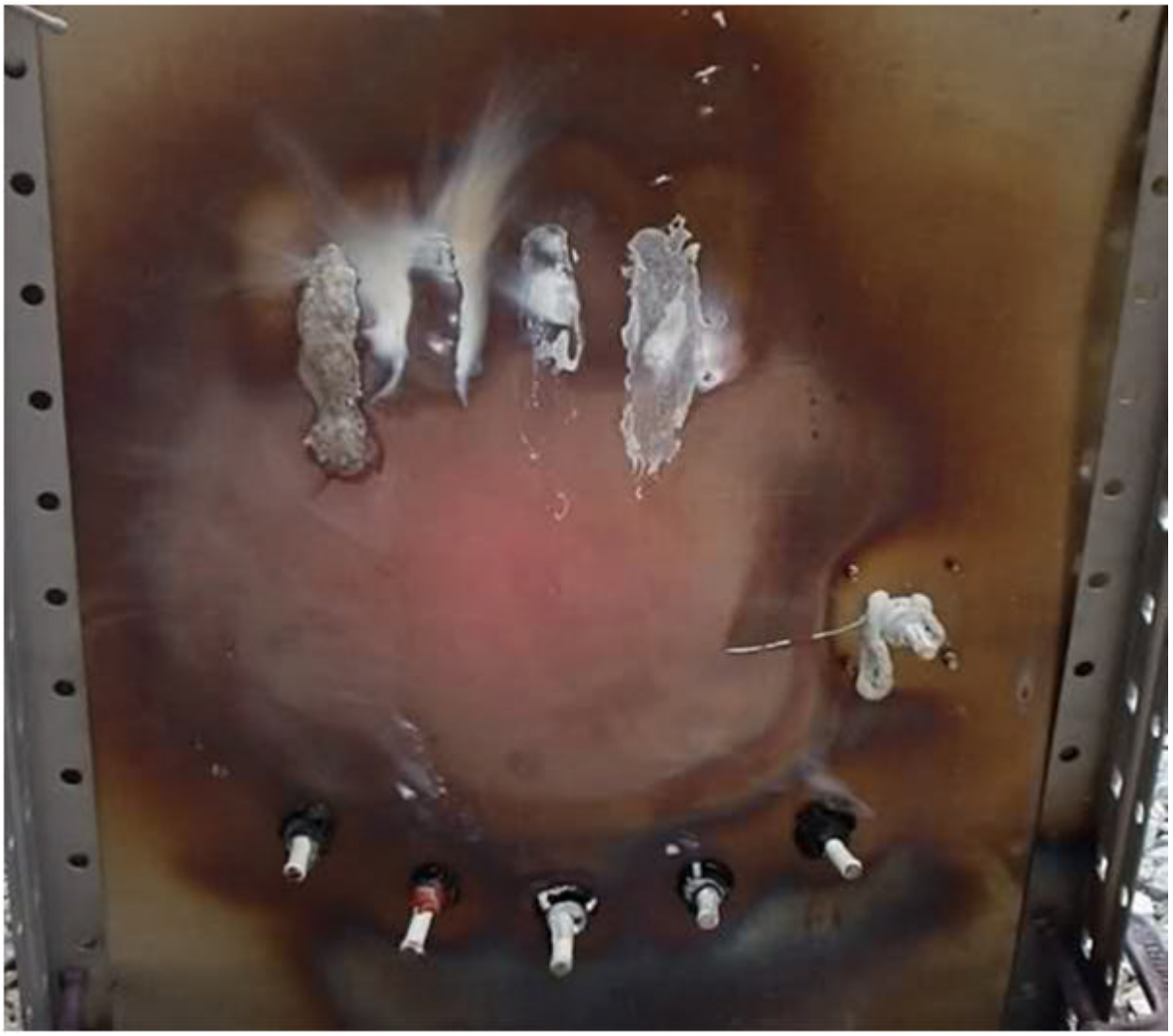
Hmmm...the Ultra Copper strip sample has burst into flame. The Biotherm sample had flamed slightly and then fallen away leaving some adhered residue. The CS1900 has peeled and fallen away cleanly, not even leaving a mark. Resbond and FireBarrier are doing fine.

Looking at the steel pass-through, we see intumescent FireBarrier squeezing out of the gaps in the joint. Same is true at the plastic bushing (center). So far all the plastic bushings are holding up ok, which means all the sealants are doing a decent job of slowing heat transfer; in thick sections they are serving as insulators.

Front of the panel at about 1 minute:

All the pass-through samples have remained intact and formed an insulating char. Of the strip samples, only the CS1900, FireBarrier, and Resbond remain adhered. The difference is mechanical; the 6-gauge wire is keeping the sample in place over each of the bushings. There's a lesson here; give your sealant a mechanical advantage!

Back of the panel at about 1-1/2 minutes:



The snap bushings are now melting. The copper wire cores are very hot, so the tefzel insulation is beginning to soften and swell. All the strip samples have peeled away, except for the Resbond.

Full failure at less than 2 minutes; the bushings melt, leave a gap, and hot gas is free to do its thing. The CS1900 and Resbond plugs remain pretty much intact and block most of the opening, while the wire stubs collapse the soft silicone chars and fall out of the holes.

I've moved the torch to aim directly at the welded steel pass through; note the new location of the glowing hot spot. The intumescent FireBarrier is squeezing out everywhere. The fitting remains gas tight despite the heat.

Front side again. The CS1900, FireBarrier, and Resbond strips are still hanging. The torch is aimed directly at the welded tube fitting, which is glowing red. In another minute or two the red hot copper wire core will ignite the tefzel insulation on the opposite side, at which point I ended the burn.

Hot-side chars collected post-burn. They are soft and fragile, puffballs really:

Note the CS1900 char still intact on the wire. It was tougher than the silicone chars. Also note the Resbond strips. Although entirely intact, they released from the stainless with no effort.

Conclusions are subjective, and my opinion...

CS1900 looks like an excellent sealant for use between fay surfaces and in thick sections with mechanical fixation. Good resistance to direct flame but with a lot of smoke and burning, so I'd be very careful about allowing any more than a trace to show on the cabin side of a firewall. Adhesion is poor. Mixing is a PITA.

Resbond can be called fireproof for our purposes, or close to it. I noticed no smoke or outgassing. The catch is its hardness; it has little flexibility when cured and none after heating, when it become about like a charcoal briquette. I did a separate test by applying a sample to stainless sheet. After cure I bowed the stainless 20 degrees and the Resbond strip popped off intact; it doesn't bend. Although the hands-down champ for fire resistance if used in the absence of flex or vibration, I doubt it will stay sealed in a highly dynamic application. Still, very interesting material...

FireBarrier is easily the best of the silicones. It has excellent cold adhesion and about the same hot adhesion as Resbond. Obviously flexibility and dynamic sealing is good. The char is not as tough as CS1900 char and may blow away in high velocity air, and for the same reason is not as resistant to direct flame exposure. It is highly intumescent, expanding to fill voids as other components burn away.

Biotherm had poor hot adhesion. Ultra Copper also had poor hot adhesion and was surprisingly flammable. I'd pass on both.

None are "best". Each has particular properties which need to be carefully considered for a particular application. Sorry, building airplanes requires some thought.

Me? I used FireBarrier silicone in two ways.

Cables and wires got tubular steel fittings like the one in this test. In the real world FireBarrier is intended for fire sealing cable and pipe passages through walls and ceilings. The surface char insulates the remaining sealant, which is well supported inside the passageway. If the pipe or wire burns away the intumescent property seals the void. No surprise that the same principles work in this airplane adaptation.

The firewall perimeter got a filet of FireBarrier before adding the foil/insulator sandwich, the edges of which were sealed with another filet.

k, the rest of the story...

Some time ago Mike sent a sample of the insulation installed on the cabin side of his RV-10 firewall. It came to him via a third party rather than a vendor. Mike didn't know for sure what it was, and he had become concerned. Although I could not identify the brand with certainty, I was pretty sure it was a polyester fiber insulation similar to a sample previously tested, and probably the same as that involved in a recent RV-10 incident. I suggested he remove it ASAP.

This weekend my buddy Stan and I were standing around the shop enjoying a cool one after doing the sealant burn and I remembered Mike's sample, still in the envelope on the shelf. We walked outside, clamped it to a stainless panel, and hit the burner. This was 15-20 *seconds* later:

In this photo the burner has been turned off almost a minute. Consider how long that minute might be in the air.