Using Calculations to Determine Internal Residual Overpressures in Explosive Breaching Applications

By Ed Stark and Charles O'Connor

In a word: *DON'T!*

Why not?

Because they simply don't work to determine anything useful in the explosive breaching world.

Should you still use them? Yes.

Why?

One: Because they validate to YOU that they don't work to determine anything useful in the explosive breaching world.

And Two: Because you can't take our word for it, and have to prove it to yourself firsthand—this is the only way for you to be that *subject matter expert* we all MUST be.

When it comes to contemporary tactical explosive breaching training and practices today, the community is besieged with data and information for the purpose of making the "operator" more knowledgeable in the discipline of using explosives in a surgical manner, while reducing the chances of bodily injuries and/or collateral damage.

This is done with the introduction of scientific equations and formulas to hopefully give the breacher a somewhat accurate prediction of where it's safe for them to stack, or what can be expected on the inside of the target objective. And it makes us look really, really smart too!

Here lies the problem—many of the calculations being used in this community (and the "industry" in general) are being applied incorrectly, and trainers/users have absolutely no knowledge of where these "magical" formulas originated, or for what purpose they were created. Yet the data continues to be regurgitated from one source to another, over a period of years, to the point that it's now considered to be the standard—when it truly provides nothing pertinent for us.

Worse yet, it's responsible for getting people hurt and causing a tremendous amount of unpredicted damage, leading to unnecessary litigation, the end of programs, and the complete loss of credibility for breaching teams.

And now there are some "new" math equations being introduced to our community by people who don't even have a fundamental knowledge of what tactical explosive breaching really entails in an urban environment.

One issue is people blindly following what they were taught, without having the first hand experience or the reference information to support such action. The ol' "that's what they told me in school," or "he said so, and he's really smart" doesn't quite cut it on its own merit, and won't protect you as the subject matter expert you are expected to be.

On that note, let's discuss the "Weibull" formula that breachers everywhere are told will predict residual internal overpressure within a specific internal volume (i.e. room), by plugging in your net explosive weight (in pounds of TNT). This will purportedly tell you if you can stage a team within a room and predict the damage inside.

$$P = 2410\ (W/V)^{.72}$$

For argument's sake, let's completely ignore the fact that everybody has their own opinion on the correct RE chart to determine the TNT equivalent for your explosives. This is more about your understanding why you use what you do, rather than actual resulting values. Let's also forget that some people don't even use this equation properly. How many breachers have been using this to determine safe stacking locations for their personnel? Too many. Why? Because they've been taught that it will do exactly that.

"Even a broken clock is accurate two times every 24 hours."

If you can't articulate what a "Weibull" is, where it came from, or why it's being applied (but still use it for one reason or another), then you've already failed as that subject matter expert in the field. Truth is, most people out there teaching the formula can't tell you either, but unfortunately for you, they aren't the ones who will be held responsible for YOUR improper use of it. And improper use by some, will then often lead to judicial overview, affecting the rest of us.

Hans R.W. Weibull of the Royal Swedish Fortifications Administration published a paper using this equation entitled "Pressures Recorded in Partially Closed Chambers at Explosion of TNT Charges (U)", Annals of the New York Academy of Sciences, Vol. 152, Art. 1, pg. 357, 1968, which resulted from a series of tests conducted in 1966 to determine some basis for designing an explosion chamber of a **nuclear blast simulator.** Hmmm... so far this isn't translating very well to my explosive breaching strip charge.

Playing devil's advocate for a minute, let's just say it actually has some relationship with breaching charges and the effects one can anticipate within a 3 dimensional environment (which it doesn't). More recent studies have concluded that this formula ignored important "physical phenomena" that makes it "impossible to extend to any other explosives other than TNT." Okay, do we need to buy some TNT now to make this work?

Tests of this nature are usually performed with either spherical or cylindrical explosives suspended from the air and center detonated (which also produces a completely different effect than what we use in breaching). And contrary to popular belief, most of us aren't doing nuclear detonations.

So let's just use logic to figure this all out:

If, by properly doing the math in the formula, we get an answer of, for example, 2 PSI within a room, where exactly is that "2 PSI" suppose to be? Talking to hundreds (if not thousands) of breachers

trained to use this calculation, they are clearly under the impression that anywhere within that volume there would exist a "2 PSI" value. So with that understanding, does that mean you can stand one inch from the charge and still sustain only 2 PSI?... One foot from it?... Ten feet? What about reflective surfaces, intersection points and corners? 2 PSI as well? And if you ARE using this to predict potential injuries and/or damages, which charts and exposure durations are your references to make those determinations: *1 millisecond exposure? 10 milliseconds?* And what is a safe PSI value to stack inside a room anyway? Another one of those elusive questions with various answers out there; all vague.

Others believe that the magical 2 PSI can be found in the center of the room... Another myth which has been disproved time and time again.

Complicated? You bet. But if you're planning to use something like this calculation, you better understand how and why it was developed, because ***YOU ARE THE EXPERT and responsible for that release of energy.***

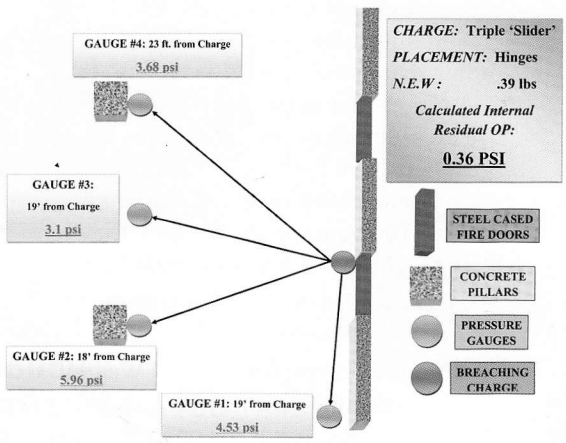
From performing thousands of detonations inside real structures, we know that the Weibull calculation provides you with nothing useful in explosive breaching, except to validate that it doesn't work. This comes from years of conducting internal shots, where the volume is intentionally made to be smaller than it actually is, providing us with a "worst case scenario" calculation. Understanding also, that this is an environment where we actually have the ability to do measurements, but not under operational situations where we'd be very unlikely to do so.

Over the years, and with the assistance of folks out there with really big brains (unlike our small ones), various national labs using sophisticated blast pressure monitoring equipment and cameras, have confirmed this much—depending on exactly WHERE within that volume you monitor, you could experience dangerously high values when the Weibull calculation falsely provides you with what you may consider a very "safe" figure. Again, we know and see this from examining thousands of shots on real structures; none of which can be properly duplicated on ranges or facades in open terrain.

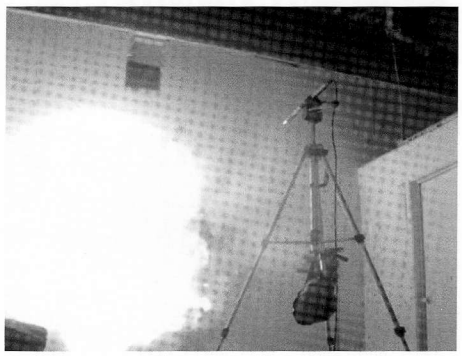
Here are some examples:

Example #1: A "slider" breaching charge was placed on a metal outward opening door inside a large structure. The area of the breach point "room" was absolutely humongous, and the resulting PSI prediction based on the charge and volume using Weibull was an estimated value of .36 (psi). It should be noted that the calculated volume was reduced and "cubed" significantly to create a "smaller" than actual area and produce a higher "worse case" figure using the calculation and did not take into consideration large openings leading to the building exterior, halls, stairways and numerous other rooms and areas which would allow blast pressure to vent. Pressure monitors at various locations throughout captured readings from the breach point as follows: 3.1 psi (19 feet), 3.68 psi (23 feet), 4.53 psi (19 feet) and a whopping 5.96 psi at only 18 feet away! So where exactly was this .36 psi suppose to be anyway?

Example #2: Another door charge with a higher NEW in the same environment, and a resulting estimated value of .51 psi residual internal overpressure (according to the formula) was obtained. Using the computerized gauges (again at various locations within that area) we obtained readings from 3.44 at 27 feet away, to 10.2 PSI at 20 feet.



Setup for Example 2.



Sensors setup for Example 3 shot.

Example #3: An internal thru-wall charge inside an industrial building office; 32 feet span from the charge to the back wall. Using the formula, the calculated psi was determined to be .92 inside the breach point room. Pressure gauges were again placed at various locations, with one (Gauge #2) placed 12 feet directly behind the charge. Monitoring equipment captured the incident overpressure on Gauge #2 initially at 2.53 psi; but it was struck again due to reflective surfaces, and re-spiked to 3.5 psi. That gauge received the highest values of the six pressure gauges used in this test, making the area near the center of the room more than three times the calculated psi... and on secondary reflection.

So again, how did this calculation, in any way, help us? It doesn't.

And for that matter, how can any formula out there (with the uncertainties of reflective surfaces and intersection points) ever provide us with the information we need to determine property damages, and/or a protected place inside a structure? Experience and training in those environments is the only way to make those predictions accurately.

Under most circumstances, a team should be inside an adjoining room, outside of the breach point, since you CANNOT calculate or predict reflective pressure or intersection points—which can truly ruin your entire day and keep you from focusing on the threat you're facing. The belief that you just need to "suck it up" and get "punished" by gaining a few feet distance advantage is misguided. If the stack can't focus on the

Debris pattern to interior of a wall breach.

mission at hand because of injuries, or having their bell rung, the entry is now jeopardized.

And since these calculations are being used by the majority of the breaching community, it's imperative that the contemporary breacher, as a subject matter expert, be familiar with the calculation, the history of its use and purposes. But more than that, they must know the dangers of following along because "somebody said so," without validating the results themselves.

Unfortunately the community, by embracing this calculation, has now required you to disprove this theory with your own life experiences (and not with our "heresay"). Of all the words in the vocabulary of serious breachers, two of the favorites should be show me, and they should be used everytime there are claims that using this or that will make your job safer (whether it be calculations, equipment or even tactics).

Relying solely on a calculation to determine the personal safety of team members, potential hostages, bystanders and suspects in explosive breaching applications, without taking into consideration everything in your environment, is like driving down the street with your eyes closed—you may get away with it... this time.

This falls directly in line with the commonly misused practice of relying on a calculation to determine a "4 PSI" safe staging location for personnel (whether inside or out)—or the insane belief that by using a ballistic shield, the team can reduce by half the calculated "minimum safe distances" from the breach point... maybe on a range, in the middle of the desert, or someplace else that is without any reflective surfaces.

But in real life, in the real world, depending on these and some of the other "new" calculations being offered out there (versus your training and experience) will get you in a world of trouble—eventually.

But that's another story.

About the Authors

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O'Connor and Stark (members of Region 1) presently work with national laboratories and lead the only team currently providing an 80-hour DHS-certified tactical explosive breaching course in the country. Their group is also recognized and approved by International Traffic in Arms Regulations (ITAR) and Special Operations Command to provide this training to various Allied countries.