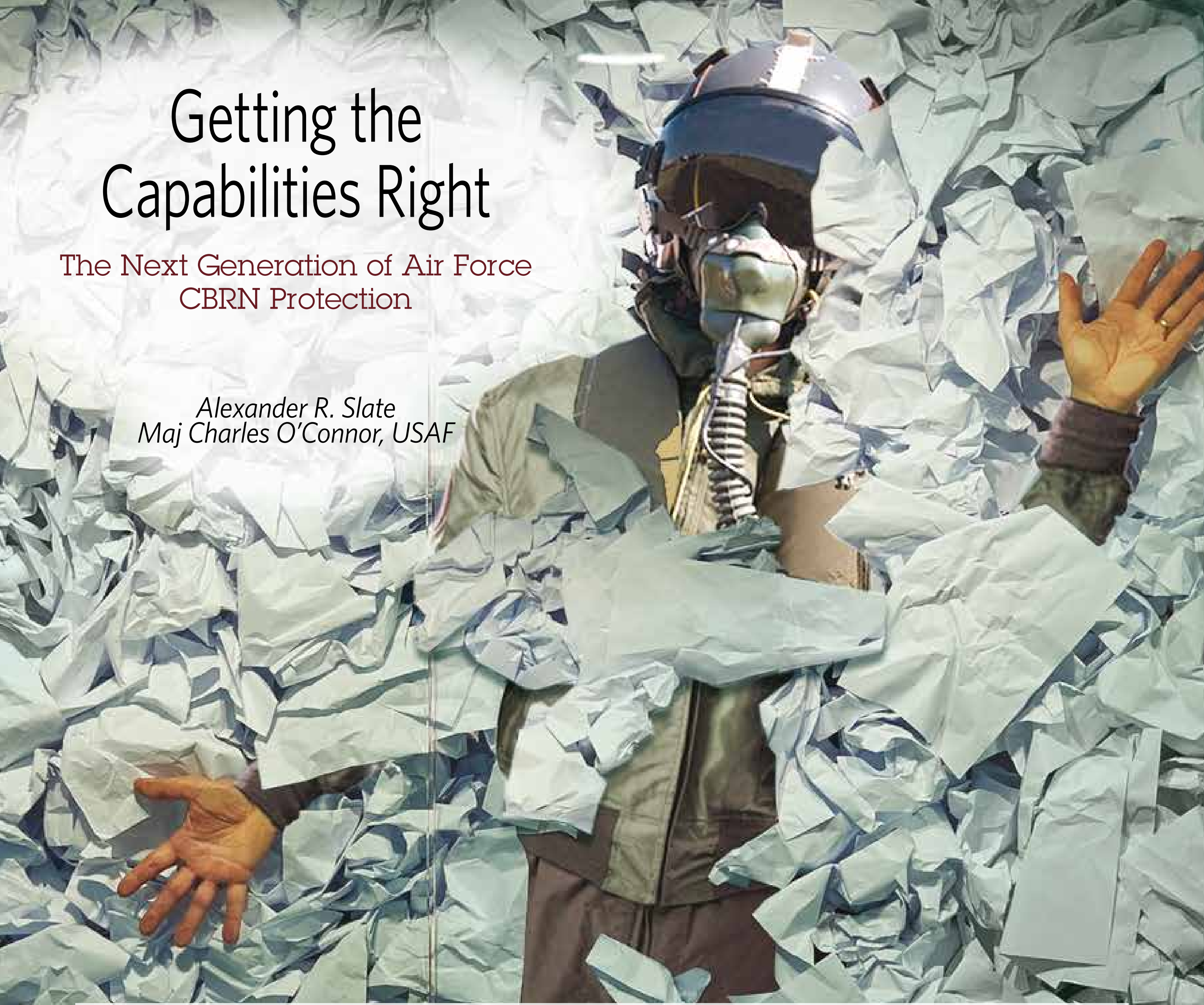
Getting the Capabilities Right

The Next Generation of Air Force CBRN Protection

Alexander R. Slate
Maj Charles O'Connor, USAF



Time after time, we try to develop what we think is the next evolutionary leap forward in systems and end up with a product that is a rather slight improvement and not the game changer we expected. Even more alarming, we sometimes lose sight of the real need in chasing the item itself. The examples provided are chemical and biological protection systems, but the concept is applicable across defense acquisition. Sometimes we need to step back and take a second or third look at program assumptions and figure out whether we think what we are doing makes sense in a context larger than the program itself.

Slate *is a systems engineer and analyst with Camber Corporation supporting the U.S. Air Force Chemical, Biological, Radiological, and Nuclear Defense Systems Branch at Aberdeen Proving Ground in Maryland.* **O'Connor** *is a program manager and cyber operator for the Air Force Pentagon office in Washington DC and a former portfolio manager for the Air Force CBRN Defense Protection.*

There is no such thing as warfare without casualties. In years past, in many people's minds, the "at-least unstated" rule in chemical, biological, radiological and nuclear (CBRN) protection was that chemical casualties were not allowed. This meant protective gear and processes were necessarily bulky and hot. We haven't stopped and asked ourselves, "How many casualties have been caused by the loss of operational effectiveness while wearing this gear?" CBRN protection affects all the Services in different ways. This article focuses specifically on the Air Force and how requirements have traditionally been met.

The Problem

While both chemical and biological warfare go back a long way, modern CBRN begins with the chemical warfare of World War I. With the advent of cyanide gas and nerve gases, the levels of lethality increased greatly. As a result, levels of protection also increased. But at what cost?

As an enterprise, bulky and thermally burdensome protective garments have become the norm, along with protective masks that greatly restrict vision and head mobility. This protective gear interferes with accomplishment of mission objectives. The impact is exacerbated in warm to hot weather in which there is a great reduction in the work that can be done before thermal stress sets in.

It is time to consider the future chemical and biological agent protection that our soldiers, sailors, airmen and Marines will need and how to provide that protection. Historically, there has been an incorrect focus on what constitutes important system requirements. We've been acting as if chemical and biological protection is the mission instead of understanding that protection is only a characteristic that allows our personnel to accomplish the mission under certain specific conditions. Phrased differently, we have been emphasizing the wrong system requirements.

When the Joint Service Aircrew Mask (JSAM) program started more than 15 years ago, it was meant to be a single mask design for all aircraft. This lofty goal proved a bridge too far, and only the JSAM-Rotary Wing (RW) mask will be a system similar to the original vision. The JSAM-Strategic Aircraft (SA) mask will adapt a ground crew mask for aircrew use but will not provide the ability to transition to and from a fully protected posture easily as originally hoped. Finally, the pilots of tactical aircraft essentially will fly with the same masks they have used since the 1980s, with marginal increases in capability and possibly greater limitations on combat effectiveness in certain scenarios.

The Joint Service–Lightweight Integrated Suit Technology (JSLIST) program was a milestone in its day; both for how it was managed and for the testing methodology and technologies derived from it. Despite the improvements in the acquisition and testing of the new JSLIST system, the actual product delivered to the warfighter brought only marginal physiological burden and mobility gains. It did introduce suits that could be laundered, but 20 years later we are preparing to abandon that idea. In the end, JSLIST offered no significant improvement to the warfighter's operational capability.

The JSLIST and JSAM taught us that systems acquisition is severely limited by initial assumptions. This is compounded by acquisition professionals lacking the proper and appropriate testing protocols, modeling and analysis to achieve the warfighter's goals. Continued testing followed that looked for the same thing each time and only yielded minor improvements in the systems fielded. In a sense, the old adage applies: "The definition of insanity is to do the same thing over and over and expect different results." Perhaps the most damning assumptions are that any "improvement," no matter how small, is better than nothing and that we need to field something new.

Twenty years of effort on the JSAM program for tactical aircraft and the discussions involving the Uniform Integrated Protective Ensemble II requirements (the proposed replacement for the JSLIST) led to the realization that the CBRN Acquisition Community had taken the wrong approach to CB protection. For many years, program management teams questioned the necessity of specific system requirements—such as the ability of aircrew systems to survive a 600-knot ejection while maintaining the same chemical protection as a brand-new system. But it goes much deeper and is more fundamental. Someone else (not the authors) recently said, "CBRN is not a mission; it is an environment in which we need to perform the mission." CBRN defense is not a mission, but it should be an enabler. Instead, today it is one part enabler to two parts stumbling block.

Mission Impact

If the disadvantages are parceled out evenly—when both sides in a conflict are subject to the same burdens and disadvantages in using these types of weapons—the limitations previously discussed would not pose such a great problem. However, the United States and most, if not all, of its allies eschew use of this type of weapon. As a result, the disadvantages mostly are one-sided.

The focus of CBRN protective requirements should therefore be on mission impact. For air power, the most telling element of mission impact is the number of combat air sorties generated. Reducing combat air sorties by just 10 percent has a very real and tangible battlefield impact. Lowering combat effectiveness to the 25 percent to 50 percent range severely hampers a commander's ability to deliver airpower when and where it is needed. But it isn't only a matter of the number of sorties. If we also decrease the level of mission effectiveness or a pilot's required endurance to conduct a sortie, we have magnified the effects of reduced sorties generation.

"Pouring the Foundation" for Requirements Generation and Analysis

So, what is required for future CBRN acquisitions? We first need to realize the extremely low likelihood that we can prevent all casualties from CB hazards. This means that an honest discussion is needed among stakeholders to determine an acceptable loss rate. Acceptable loss is not limited to deaths but also loss of combat effectiveness, although fatalities should be considered as well.

How much reduction in effectiveness can be tolerated? How can we accept that decrease of effectiveness during the combat sortie mission, the number of sorties that can be generated, or a mixture of both? What will be the mode of the decrement—task inefficiency or casualties? In considering what level of casualties might be "allowable" (as opposed to "acceptable"), casualties come with special costs—emotional impacts on surviving crews, public reaction and the cost of personnel and supplies needed to care for the casualties.

The next need is to understand the existing protective capability of the regular duty uniform gear and aircrew flight equipment. Given current operational constructs and hazard expectations, what types of casualties would be experienced in the absence of CBRN-specific protection equipment? What kind of exposure could our personnel survive before moving into the zone of unacceptable risk? Next, could we change our tactics and procedures to reduce personnel risk and casualties to a more acceptable level? What operational effectiveness is produced by these changes? Suppose only the normal duty uniform is worn, augmented by a protective mask?

Following this discussion, we need to decide whether to proceed with a material solution. Even if it is determined that a material solution is needed, the results of the analysis to the aforementioned questions of operational effectiveness must be kept and used as the baseline state to compare with a new material solution. When the material development process is completed, the levels of operational risk and effectiveness should be compared to the "baseline" results to determine if the devised solution was a success and should be fielded.

Protective Mask Considerations

What are the issues with protective masks—in particular for aircrew personnel? The key performance parameters (KPPs) in the most recent aircrew capabilities document focused on the chemical and biological protection afforded by mask and filter. The masks provided the desired protection. However, the problems posed for the Air Force are not matters of chemical or biological protection. Rather, the problems revolve around performance, including the ability to prevent pressure spikes due to rapid decompression during descents from higher altitudes, the masks' restrictions on head movement and the wearer's ability to even see cockpit control displays as well as the outside environment and the resultant effect on situational awareness. There also are broader issues when the bulkiness of the mask portions below the neck interfere with finding and safely operating emergency controls.

To a lesser but very palpable degree for pilots, there is the discomfort of continually wearing the breathing mask sufficiently secured to provide protection during an entire mission set in aircraft operating at high acceleration—rather than being able to loosen the mask during regular, noncombat flight. In other words, the mask's performance characteristics can affect "flyability" and flight safety.

The rigidness and assumptions of the stated KPPs drive design elements to meet protection requirements at the expense of lesser key attributes (the ability to fly the plane). In the case of any other piece of equipment on an aircraft, these lesser key system attributes are KPPs. So why is that not the case for CBRN aircrew masks?

Protective Clothing Considerations

Protective clothing is simpler to understand than aircrew protective masks. Beyond protection levels, there are three somewhat interrelated primary concerns regarding protective clothing: bulk, mobility, and thermal burden. The fourth aspect is cost (which, though unstated, also is a consideration regarding protective masks). And cost brings into play a number of other technical aspects such as durability, service life and shelf life.

Aircrew protective ensembles are a bit easier than those for the ground crew because mobility and durability concerns are less strenuous in air-crew clothing. In the case of thermal burden, the chemical protection is not the worst contributor of heat stress compared with existing aircrew life-support equipment. Pilots have equipment layered on top of their ensemble and a good portion of their torsos are covered by the metal, plastic and fabric of the cockpit seats. In addition, the aircrew's exposure to a threat that could penetrate the skin would be greatly reduced by the closed cockpit.

The ground crew is a different matter. Here balancing protection and other aspects is trickier. Ground crews are much likelier to be exposed to a potential threat over a longer time. The required range of motion for ground personnel also is much greater. And for many specialties, the plain, normal and everyday physical hazards posed to the suits are much greater. For example, firefighters deal with high heat and flame, civil engineering personnel deal with rough material, and aircraft maintenance face the tight quarters and snag hazards found in relatively small maintenance hatches.

Conclusion

This article has touched on a number of different concerns, but an in-depth analysis is needed to deliver the capabilities required in future operations. This article is offered to foster discussion and generate thought. The last 25 years have seen only relatively small incremental improvements in CBRN equipment. Protection factors have increased, but very little has been done to improve our ability to "Fly, Fight and Win" in a CBRN-contested environment. In fact, at this juncture, CBRN protective equipment is a mission hindrance. It is time to change that, to start over from basic past assumptions and re-evaluate the idea of acceptable risk. It is necessary that we do so!

The authors can be contacted at **alexander.r.slate.ctr@mail.mil** *and* **charles.v.oconnor.mil@mail.mil**.