NIJ Certification for Bomb Suits
What is it, and why does it matter?

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Historically, bomb suit manufacturers relied on multiple performance standards, or test protocols, inspired from adjacent technical fields and adapted to the EOD context, in order to quantify, or characterize, the performance of their bomb suit design. Test methods were inconsistent between laboratories and many results could not be consistently reproduced, compared, or trusted, in part due to lack of standardization and documented detail. On occasion, bomb suit suppliers made unsubstantiated claims of their product's performance, based on their own technical misunderstanding, or provided questionable test data from laboratories which may not have adhered strictly to approved test methods. Naturally, it was not reasonable to expect that end-users would have the time or be sufficiently qualified to evaluate the diverse test reports for suitability, protocol adherence, results accuracy, or laboratory accreditation.

After more than a decade in development, the release of the US NIJ 0117.01 standard for public safety bomb suits in 2016 bridged this gap in standardized EOD PPE evaluation. It is intended to provide objective evidence and confidence in performance of EOD suits, once they are officially certified by the accredited authority. The need for an NIJ standard for EOD suits was originated by the National Bomb Squad Commanders Advisory Board (NBSCAB), facilitated by NIST (National Institute of Standards and Technology), supported by DoD (various Department of Defense laboratories where expertise resided) and industry participants, under the auspices of NIJ (National Institute of Justice).

NIJ certification can only be achieved through an NIJ-approved certification organization which undertakes all testing in accredited third-party laboratories that are qualified to adhere to the standard and test methods. This organization is intimately engaged during the entire certification process, including initial and annual testing, as well as audits of the manufacturing facilities where the suits are built. This third-party oversight is intended to instill confidence to the end-user community, in the performance stipulations under the standard, for certified bomb suits. A bomb suit design should offer at a minimum what is prescribed within NIJ 0117.01. A number of additional capabilities and features, not explicitly stipulated within the minimum standard, are expected by end-users and should be considered in the purchase of most modern bomb suits currently available, such as lighting, communications, cooling, feature control preferences, battery power longevity, electromagnetic signature management, and more.

The NIJ standard can thus help government agencies in the selection and procurement of EOD PPE, without needing wide ranging technical expertise to properly assess and qualify a bomb suit from all engineering disciplines, i.e., protection against all blast threats, human factors, optics, field of view, electronics, manufacturing quality, labelling, etc.

Highlights of the NIJ 0117.01 standard for Public Safety Bomb Suits

Protection

The NIJ 0117.01 V50 fragmentation methodology is inspired from MIL-STD-662. The pass/fail requirements are based on three different fragment simulating projectiles (17, 44, 207-grain, Figure 1). The large 207-grain (13.4 grams) fragment permits reliable V50 rating determinations for highly protective areas of the suit (frontal chest, neck and groin plates). Obtaining V50 fragmentation protection ratings based on the high-energy 207-grain fragment, representative of actual threats, for the highest protection regions of the suit, is the practical approach authorities have recommended. In the past, V0 ratings based on the smaller 17-grain fragment simulator have sometimes been used to characterize fragmentation protection for highly protective suit areas. However, 17-grain V0 ratings are practically impossible to obtain for such high protective areas based on STANAG 2920, given the requirement to fire fragments at 1.5 times the estimated V0 velocity (no known laboratory can perform this).

The standard includes the qualitative evaluation of bomb suit blast integrity against a spherical charge, comprised of 1.25 lbs (0.567 kg) of C4 explosive, at a standoff of 2 feet (0.6 m), with a Hybrid III mannequin in a kneeling position (Figure 2). Many qualitative requirements are included (protection to remain in place, no gaps exposed after a blast, etc.) Because the NIJ standard does not currently specify reductions in blast overpressure, the ASTM Working Group WG22759 has begun work to define a standardized test method for bomb suit quantitative overpressure evaluation. When published, this methodology will complement the NIJ suit blast integrity test. This new ASTM effort is supported by members of the end-user community, NIST and industry experts.

Prior to the release of the NIJ bomb suit standard, historical focus had been on overpressure and fragmentation, with minimal emphasis on impact. Field experience from actual blast events highlighted the need for helmet impact protection to mitigate the very common occurrence of traumatic brain injury (arising from either blast or direct impact). The NIJ 0117.01 standard thus mandates a stringent set of helmet testing to ensure that EOD helmets provide high impact protection. The test methodology involves 9 different helmets being dropped 8 times each, for a total of 72 impacts (Figure 3). The impact energies and pass/fail thresholds are customized for EOD operations, recognizing the importance of

Figure 1: **NIJ 0117.01 Fragment Simulating Projectiles (17, 44 and 207-grain)**

Figure 2: **High speed video images of the NIJ 0117.01 blast overpressure test. Kneeling facing 1.25 lbs (0.567 kg) of C4 explosive, at a standoff of 2 feet (0.6 m). Two mannequins used for more data**

head impact protection to mitigate the risk of traumatic brain injury. The tests are conducted at three temperatures (68°F/14°F/131°F, or 20°C/-10°C/+55°C). These temperatures ensure helmet protection across the range of extreme hot and cold conditions in which bomb technicians must operate. The standard also includes a multi-temperature spine protector test methodology, developed specifically for bomb suits (as opposed to motorcycle test standards, sometimes used by bomb suit manufacturers), with appropriate pass/fail thresholds. This type of test addresses the critical need for blunt impact protection over the spine if a technician were to be propelled by the force of a blast.

The NIJ standard includes flame resistance tests for the suit outer shell materials and the helmet shell, based on ASTM D6413-99. The pass/fail requirements are customized for EOD applications, ensuring protection against the flash heat threat from IEDs.

Human Factors

While the bomb suit's primary objective is to protect from the main blast threats, EOD ensembles must also minimize hindrance to bomb disposal operations. As such, the NIJ standard includes stringent field of view requirements. The static field of view test (Figure 4) is conducted with a headform and a laser system, ensuring objective measurements with thresholds determined based on actual bomb technician requirements (e.g. downward field of view when manipulating devices, horizontal field of view for peripheral vision). The dynamic field of view tests (Figure 5) evaluate the appropriate integration of the helmet with the suit and protective plates. These tests ensure that the visual field is not blocked by suit components, such as the collar or frontal plates. Visor optics tests evaluating the level of distortion, light transmission, refractive power, and haze resistance, are also carefully conducted to ensure clear visibility and prohibit visual distractions. Finally, an end-user dressed in the EOD suit walks on a treadmill in order to assess the particular helmet system's ability to prevent visor fogging in accordance with the stipulations of NIJ 0117.01.

The NIJ 0117.01 includes additional requirements related to ergonomics whereby certified bomb technicians go through exercises relevant to EOD operations. For instance, an obstacle course involving the handling of a disruptor is included, as well as other tests like "lie on back and standup" and "kneel and rise". Such tests ensure that users can readily perform the critical motions required for their work.

The number of sizes, maximum weight and label legibility, are also explicitly prescribed. Certification to the NIJ standard thus provides a clear independent evaluation of a bomb suit against a wide range of test methods relevant to EOD. All tests

Figure 3: **Helmet drop tower testing relevant to traumatic brain injury. 72 drops conducted at 3 temperatures**

Figure 4: **NIJ Static FOV apparatus – helmet fitted on headform and tested at various angles**

Figure 5: **NIJ Dynamic FOV test – Head and Body motion with volunteer**

are conducted under the auspices of NIJ, overseen by an accredited standards organization in qualified third party and accredited laboratories. End-users and their procurement agencies, therefore, are no longer obliged to exclusively rely on supplier credibility and claims, or diverse test reports from disparate laboratories and test methods.

Beyond the NIJ Standard

While a critical step forward for the EOD community, the NIJ 0117.01 remains a “minimum standard”, as its requirements do not address all the possible protection and functional requirements end-users may require. Procurement agencies must thus also take other requirements into account when selecting bomb suits. Quantitative blast overpressure measurements based on statistically meaningful data samples should be required, involving head acceleration, ear and chest overpressure. Other suit features, not necessarily directly related to protection, should also be seriously considered, or mandated. For instance, bomb technicians may need to communicate remotely (voice, data, images) in a safe manner. All electronics within the suit and helmet must meet the more relevant and highly stringent military standards for electromagnetic compliance (emissions and susceptibility according to MIL-STD and DEF-STAN), as opposed to the less stringent industrial standards (EN, FCC). EOD ensembles must provide proper lighting to work in dark areas, and they must fit a wide range of body sizes and shapes (recommended 5th percentile female to 95th percentile male). In addition, there may be a need for personal cooling or ventilation, when operating in hot environments. Ergonomics must also be evaluated beyond the NIJ requirements, which only ensure basic functionality in simulated scenarios.

In addition, purchasing agencies should ensure that bomb suit manufacturers provide long-lasting, high quality and reliable products, with strong customer support. The NIJ manufacturing facility audit plays an important role for this aspect. Other accreditations of the product, such as CE markings, RoHS compliance and some regional standards may also apply for bomb suits to be procured and used in certain countries. Finally, the NIJ standard for bomb suits requires regular re-certification after a period of time has elapsed, or a number of bomb suits have been manufactured, thereby ensuring constant vigilance and oversight of the quality and performance.

Conclusion

Bomb suit certification to the NIJ 0117.01 standard is a way to ensure fully independent, comprehensive and reliable validation of bomb suit performance against relevant EOD threats, built as per documented manufacturing processes and regularly audited independently, by an officially appointed and accredited organization. Self-certification to NIJ 0117.01 or unsupported claims about “meeting NIJ” are not permitted.

End-users should also ensure that beyond getting an officially certified suit, they specify any additional features of a bomb suit that may be important to them which may not be explicitly called out in the NIJ standard.

About the authors:

Dr. Aris Makris holds a Ph.D. in Mechanical Engineering with over 30 years of expertise in the fields of shock waves, detonation, and associated protection technologies. Since joining Med-Eng in 1994, Dr. Makris has led numerous R&D programs, including the development of several generations of highly advanced personal protective equipment for Explosive Ordnance Disposal (EOD). He has also participated in the development of industry standards and NATO working groups.

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