

FOCUS ON RESPIRATORS: THE US ARMY M-9 FAMILY

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The observation that imitation is an ingenious form of flattery appears to apply to all areas of technology research and development, including that of NBC respirator design. The fact that a particular respirator has spawned a 'family' of identical or closely similar copies around the world is strongly suggestive of its having achieved status as an archetype standard by which succeeding developments in the object-specific milieu might be compared.

[Note: Whether that bellwether status is *deserved* from a purely functional status or not is often another matter altogether, best demonstrated in a suitably equipped laboratory setting.]

Such is the case with the US military M-9 respirator. As an archetype of design, the US Army early 1950s M-9 NBC respirator unmistakably served as an inspiration for many of the previous post-war generation of NBC protective masks. Over the past 40+ years it fostered at least seven other NBC respirators that were directly patterned after it (in European and Asian military service) and set trends that persist strongly today.

Bearing a superficial resemblance to its WWII predecessors in US military service (specifically the M-5 'Assault Gas Mask' of 1945, from which it was developed), the M-9 is basically a refinement of pioneering facial ergonomic concepts established in respirator research of the 1930s and 1940s, in cooperative studies done by the US Army and MIT. Principal differences between the M-9 and earlier US masks consist principally of improvements in filter canister components and incorporation of an improved inner oro-nasal cup to enhance demisting and air-flow control characteristics. Introduction of *nuclear weapons* contamination concerns in this period resulted in the M-9 mask being the first true 'NBC' mask (vice 'CBW' only).

Although the side-mounted filter idea originated in an earlier mask (the M-5), the cheek-mounted filter approach would increasingly gain favor over the front-mounted filter convention of previous decades and set the precedent for succeeding generations of respirators and for a number of reasons that would include ease of use in sighting and firing individual soldier infantry weapons and provision of enhanced fields of vision.



Figure 1: US M-4 facepiece (WWII), an ancestor of the M-9 NBC respirator

The controversial M-17 series mask with its awkward *integral* filter elements was introduced in the 1960s as a replacement for the M-9. However, because of certain design advantages over the M-17 (not least being the difficulty changing spent filters while exposed to continuing chemical attack), the M-9 retained its popularity. In fact, the M-9 continued to be used in special US Army applications even as the equally controversial (silicone facepiece) M-40 mask came into mass production as a replacement for the M-17. By the time the M-9 mask was finally fully retired, it would be difficult to overlook the 40+ years of very adequate service the M-9 design provided since its inception at the end of the WWII era.

In conjunction with efforts to produce a new 4th generation respirator, a major European national defense research establishment carried out comparative studies of what were the latest military respirators in the mid-1980s. The studies used a license-made Scandinavian copy of the US M-9 as a standard reference for comparison (i.e. the *Skyddsmaske-51*). These test results showed the M-9 based mask to have a significantly high level of protection even in competition with respirators using the latest advances in technical methodologies and materials. This further underscores the substantial effectiveness of the original M-9 design and (by extension) the *offspring* relatives it has inspired in a number of other nations.

During the 1980s *Iran-Iraq War* (and also in the 1991 Gulf War), the Serbian (formerly Yugoslavian) M-1 mask, which is virtually an identical version of the US Army M-9, saw considerable battlefield service with various Arab and Middle Eastern states. The protective functionality of the Serbian M-1 against a range of formidable CBW agents makes the M-1 one of the very few NBC respirator designs to have been actually *tested and proven* in battlefield CBW situations in the past 40 years. Considering that Iraq used both nerve agents and penetrating agents (such as mustard), the protective qualities of the basic M-9 design were well demonstrated.

There are two distinct groups of respirators which are directly or indirectly related to the original US M-9 design. For the most part, masks in the first group are virtually identical clones of the US M-9, differing only in minor details such as mask suspension attachment hardware, carrying cases, etc. The latter category consists of substantially modified (evolved) designs, or M-9 type masks with added features and/or significant enhancements. One such 'modified' design of Serb (Yugoslavian) origin is an "inter-generational improvement of the M-9 ancestor designated the *Serbian Model M-2*. Compared to the Serbian M-1 in a side-by-side comparison, the small but significant differences become more apparent. In the case of the Serb M-2, one such obvious difference is the inclusion of a reversed peripheral seal on the inner face-seal area of the mask (vice none on the either the Serb M-1 or its American relative, the M-9). Today all NBC protective respirators incorporate a reversed peripheral face-seal in one form or another.

In the first group of respirators closely patterned after the M-9 are five that are virtually identical in every detail. These are the archetypal US M-9A1 design, the Serb (ex-Yugoslavian) M-1, the Swedish *Skyddsmaske-51*, the Finnish M-61 and the South Korean KM-9A1. These masks have a finely patterned inner face-seal contact area, except for the Swedish *Skyddsmaske-51* (that has a smooth face-seal contact area). All of these masks use the original American 60mm filter attachment thread (a feature shared with the very different and *no-longer-in-service* Canadian C-3 mask).

M-9 type masks in the second category (those incorporating significant improvements or enhancements to the original M-9 design) include the Norwegian NM-16 and the Finnish M-76 mask. In the former (NM-16) the facepiece is molded to take the now standard NATO 4155 STANAG thread filter (40mm x 1/7") but is otherwise similar to the M-9. The Finnish M-76 mask has had the previously mentioned reverse peripheral seal lip added to the face contact area and additionally incorporates a modified exhalation valve combined with a mechanical voicemitter (the Finnish M-76 mask retains the original 60mm filter thread size, although all the older 60mm thread equipped masks may use a screw-in adaptor manufactured in Canada to permit use with NATO 40mm thread filters).

A further modification to the Finnish M-76 mask relates to the suspension harness points, that do not penetrate the face-blank as the case of the US M-9, the Serbian M-1 and Korean KM9A1; instead of rivets that penetrate from the outside of the strap through the facepiece (a potential weak area for penetrating agents), the mask attachment straps are extensions of the same material the faceblank has been molded from (the head straps then attach to these extensions). Both of these improvements appear to be thoughtful and functional enhancements to the basic M-9 design which should theoretically result in better face-seal characteristics. The Norwegian Model NM-16 respirator, while virtually identical to the Swedish Skyddsmask-51 in most of its features, incorporates a modern NATO 4155 (40mm x 1/7") standard canister connection thread, enabling it to use a wide range of current, modern filter canisters (US C2A1, Canadian C-7, etc., just to name several current types). By contrast, the other masks in the first group all use the old style US 50s-era M-11 filter (60mm) compatible canister connector thread.

The Finnish Model M-76, which features several distinctly different details, additionally uses a reconfigured inner oronasal cup of more modern style than the original US M-9 type. In combination with its other quality features, it appears to be somewhat more developed than its peers in the first M-9 group. However, in the absence of *actual laboratory comparative testing* for resistance to penetration and sealing qualities, whether or not the M-76 actually provides a higher overall protection factor than the original M-9 group masks is open to question. That said, a highly 'educated' guess would be that it does.

Natural rubber is used for the manufacture of the face-blank of all of these M-9 patterned respirators. Of the 6 identified in Fig. 1 above, only the Korean KM9A1 was still being currently produced as of 1993. Fresh stocks of the Serbian M-1 mask were available as late as 1995, even though the others have been out of production for many years. All of these masks are roughly comparable in overall quality of manufacture, but the face-seal enhancements of the Swedish, Norwegian and Finnish masks would suggest they provide a slightly better degree of protection.

During the 1991 Gulf war 1, the Serb M-1 mask was marketed by Serbia's Industry *Miloje Zakic* (Krusevac) as part of a civil defense kit that included the M-1 mask, the LPD-M1 personal decontamination kit, a non-permeable (Polyurethane) plastic protective overcoat and a first aid kit. This particular mask is still kept in reserve for emergency use in some Arab countries (as civilian defense stock) and provides reasonable protection with substantial cost effectiveness as long as storage conditions are appropriate (cool, dry).

Most of the masks in Fig. 1 were carried in a fabric sack based on or patterned after the original US M-11 satchel of olive green canvas. The Korean KM9A1 came in a proofed-nylon satchel similar to the US M-11 bag and the Finnish M-76 was supplied in a spacious, light

OD cotton duck bag with a bit more room for spare canisters, accessories, etc. The design of carrying satchels is relative to use and intent, as may well be understood, but the best are made from proofed material that provide some degree of protection from environmental degradations (such as oil, heat and chemical effects).

None of the seven M-9 copies feature drinking tube attachments, making them unsuited for modern first line military use; however, such a component could conceivably be retrofitted with only minor tooling changes, although the task would involve expensive machining and production support. Given the relatively wide range of more modern masks already designed and produced with drink componentry, the cost would not be justified.

Finally, the sole member of the second category of M-9 related respirator designs is the much evolved M-9 relative, the Serbian Model NBC M-2, produced by *Industry Miloje Zakic* (Krusevac) in Serbia. This interesting development serves to demonstrate how a successful 'inter-generational' design may evolve from a proven predecessor. Although the Serbian M-2 benefits from a thoughtful and skillful up-dating of the overall M-9 design base, it is altogether a new mask design bearing only a superficial resemblance to respirators in the first category. The first M-2 (1980s) model mask appeared with the now standard inward-turned peripheral face seal (an important enhancement) and a simple expiration valve located on the face blank, similar to that found on the M-9, but it also lacked a drinking tube. A later and modified version of the M-2 mask incorporates a Draeger style drinking tube port on the right side of the facepiece's exterior (as found on the Draeger Karet-M model and the Israeli military grade M-15A1); it uses a combined exhalation valve and mechanical voicemitter similar in intent and function to that found on the Finnish M-76 mask. Both the early and late production Serbian masks feature slightly improved semi-triangular eyepieces that enhance field of vision capabilities over the original US M-9 design and are clearly influenced by more modern Draeger twin-lens designs. The M-2 mask suspension is made in the conventional multi-strap manner and the faceblank material is molded from light olive green colored polymer material that has excellent resistance to penetrating agents (like mustard agent).

Overall, and considered against the latest and most modern NBC respirators of advanced (late 1990s/early 2000s) design, the late issue Serbian M-2 NBC respirator remains an excellent general purpose NBC protective mask. Further refinements that were never attempted could have consisted of an exchangeable left sided auxiliary voicemitter for use with telecommunications equipment. Most importantly, the M-2 mask benefitted from use of the German DIN 3182 (40mm) standard filter screw-thread, enabling it to be used with any NATO interchangeable STANAG NBC filter. Although now figuratively obsolesced by the latest generation of NBC masks, the Serbian M-2 mask remains an excellent protective NBC respirator for general use at fairly low cost.

Undoubtedly, there are several M-9 respirator clones or one-off upgrades that have been overlooked and not been included in this paper, but they all follow (meet or match) standards set originally by the US Army M-9 NBC respirator of the early 1950s. Even today the M-9 series of protective masks cannot be fully dismissed as merely 'old technology', as long as they are well-preserved specimens with all components intact and functional. As studies have shown, respirators of this type can still provide reasonably good defense against chemical and biological war agents, despite all the recent advances in materials technology and computerized design software. Although efforts to ban chemical and biological agents as weapons of war have been largely successful in recent decades, the

principal threat today comes not from national armies, but from individual terrorist (theoretically state-less) organisations. Cost effective protective masks such as those comprising the US M-9 family may help many developing nations bridge the gap from armament to disarmament while remaining fully protected.

One last note concerns the sale of protective masks of this generational family on the open market for individual protection against NBC agents. Today, old 'gas masks' of just about every type, manufacture, date and or specification may be found offered for sale by individuals or commercial groups claiming to be authoritatively knowledgeable about NBC respirator technology. Given the fact that there is little effective policing or regulating of these commercial activities, anyone considering the purchase of any older respirator for personal use against CBW agents should make every effort to do as much homework as possible on the subject first.

Several facts remain salient, regardless of what is being offered and what sort of protective claims are being made by the seller of a mask or NBC filter. Chief among these is the fact that all respirator materials age significantly with increased exposure to degrading elements. Another is that the very latest and most modern NBC filters meet higher standards of particulate filtration efficiency (i.e. P100, etc.) that did not exist when the M-9 generation masks were in current use. Further, all masks and filters have definite and specific 'shelf life' and expiration dates. Additionally, small polymeric components like one-way valves, seals, and such can and do fail if degraded significantly by antagonistic effects of exposure to air, dirt, dust, heat, sunlight (UV) and chemicals (petroleum and other complex aromatic hydrocarbons).

Although a mask like the Finnish M-76 or Serbian M-2 respirator that has been stored under ideal conditions (cool, dry, sealed) may well be capable of providing protection against an NBC threat far beyond its formal shelf or service life, masks available from commercial sellers are not guaranteed to have come from stocks kept under those perfect storage conditions and masks in many cases are from lots of obsolesced, *beyond-storage-date-limit*, surplus inventory released by military or civilian defense agencies that have deemed them either unsafe or of questionable value.

The only absolutely satisfactory NBS respiratory protective mask and filter must come from a licensed, regulated and professional commercial organisation and consist of *fresh stock* that has not exceeded shelf-life and/or specified storage conditions. While true for all respirators, these criteria are doubly crucial for NBC filters. Old NBC filters are simply not worth risking your survival on (particularly those manufactured back in the 50s, 60s and 70s that are by now long-expired). Military organisations have specific programs and use highly trained personnel to monitor and maintain the serviceability of the protective gear their troops depend upon against chemical, biological and nuclear threats; in the civilian (private) sector, such expertise seldom exists or is poorly regulated. One further caveat: anyone surfing the internet for information on protective defense against NBC threats will quickly determine that as much as 40% of everything that one comes across in terms of information, advice and/or *materiel* offered by 'private' parties or small businesses is either false, misleading, inaccurate, or dangerously wrong. "*Buyer beware*" remains the watch phrase, always. The amount of blatant misinformation on NBC defense to be found on the internet is utterly stupefying!

It is also important to realize that if and when an actual terrorist threat from chemical or biological agents ever occurs, it will very likely be far too quick and deadly to reply on having much time to put self-protection measures into use. The Japanese cult 'Aum Shinrikyo' attacks using nerve agents (*Sarin*) against civilians in 1995 was a bellwether event in terms of pointedly illustrating potential for wide-spread and chaotic public disruption that CBW agent use carried with it. Thus, such basic measures as masks, filters and protective gear are only as functional or effective as the margin of time one is allowed between the actual surprise onset of CBW agent use and widely disseminated public awareness of the event itself.

'Survivalists' and others of the sublime 'end of the world' mind-set are sadly mistaken if they think that possession of some surplus protective gear will enable them to survive the greater tragedies of a large, well-coordinated and broad-based NBC attack against civilians, since the devastatingly adverse impact of such an attack would result in conditions so horrid that hardly anyone would *want* to survive in them. At best, protective gear for civilians should thus be considered much as one would a *Band-Aid*...temporary and marginal protection under the most optimal conditions that may well be rendered completely *ineffective*, given the irrational psychology of public panic, misinformation, impaired communications, uncertainties and extreme fear that typically accompanies an unannounced terrorist attack with NBC agents.

APPENDIX 1: Some of the principal M-9 NBC respirator family masks

Model Designation	National Origin	Manufacturer	Facepiece color	Date/time frame
1) M-1	Serb Republic	Industry Miloje Zakic/Krusevac	Medium OD	1970s
2) M-2 & M2A	Serb Republic	As above	Medium OD	1980s
3) M-9A1	USA	Several (defense related co.)	Olive Green	1950s
4) KM9A1	South Korea	Samgong Ind. Co / Seoul	Black	1980s
5) M-61	Finland	Kemira Oy/Nokia	Light Gray	1960s
6) M-76	Finland	Kemira Oy/Nokia	Light Gray	1970s
7) NM-16	Norway	Forsheda AB/Sweden	Black	1970s
8) Skyddsmaske-51	Sweden	Forsheda AB/Sweden	Olive Green	1950s

[Note: This article, one of a series on NBC respirators, originally appeared in the *ASA Bulletin*, issue 93-1, 1993. It has been updated accordingly for this subsequently revised version of the original.]

APPENDIX: Images



Figure 2: US Army M-5 'Assault Gas Mask', used on D-Day (1944) and the direct ancestor of the post-war M-9 NBC mask.



Figure 3: US Army M-9 CBW mask (early 1950s), the archetype for all subsequent M-9 based masks.



Figure 4: Serb M-1 CBW mask, used by Iraq in 1991 'Gulf War 1'



Figure 5: Iraqi (Serb) M-1 (also known as the M-59) CBW mask. Gulf War 1, 1991.



Figure 6: Serb M-2 (early model without voicemitter), mid 1980s.



Figure 7: Serb M-2A (late model with voicemitter), late 1980s.



Figure 8: One of the rarer M-9 copies, this one from Bulgaria (found in Iraq, during Gulf War 1, 1991).



Figure 9: The Finnish M-61 NBC respirator (1961).



Figure 10: Finnish M-76 NBC respirator (note combined exhalation valve and voicemitter unit) 1976.

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