MILESTONES

Ballistic missile operations

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THE 1991 GULF WAR BROUGHT THE WORD 'SCUD' INTO THE EVERYDAY MEDIA AND THE PUBLIC LEXICON. Arguably, this is a sad reflection on our times, that in the public consciousness the sustained bombardment of Britain by A-4/V-2 ballistic missiles in the later months of World War II was all but forgotten. That the R11/8K11/SS-1 Scud is a direct linear descendent of the A-4/V-2 ballistic missile is another basic reality that has eluded those who define public perceptions of world developments.

The technical aspects of the evolution of the A-4 missile, known by its propaganda name V-2, have been studied extensively and a vast amount of literature exists detailing this program, including some excellent W3 references. What has been studied much less is the operational side of A-4 and how this progenitor of today's Inter-Continental, Intermediate Range and Tactical Ballistic Missiles set the pattern for the operational use of such weapons, a pattern which persists to this day. For better or for worse, many operational realities remain unchanged as long a basic technology remains unchanged.

The principal designer of the A-4 was Dr Wernher von Braun of NASA fame, a patrician of Prussian aristocratic descent who pursued a career in rocket physics rather than the family tradition of politics. The 'Aggregat-4' was the evolution of a series of earlier designs (A-1 through A-3) flown between 1932 and 1937. Germany's Nazi regime took an early interest in the ballistic missile research effort, which was not covered by the Versailles Treaty, and recruited Dr Walter Dornberger to lead an Army Test Centre program at the Peenemunde site in northern Germany. The A-4 itself was conceived as early as 1936, intended to deliver a 1,000 kg warhead to a distance of 250 kilometres (~135 NMI).

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A recently restored example of the A-4 on the Meillerwagen TEL, both owned by the US Air Force museum. Splinter camouflage was typical for operational weapons, using a range of patterns and colours.

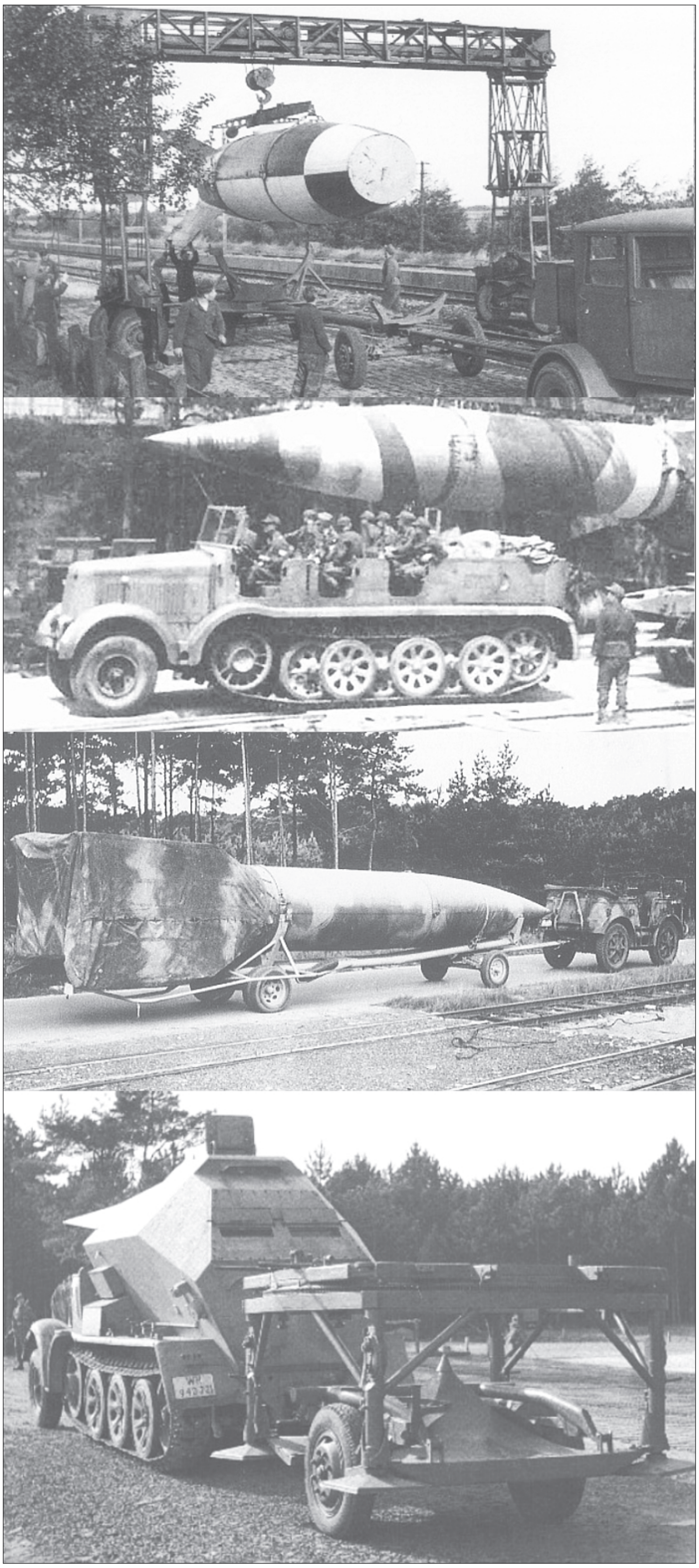
The A-4's rocket motor, designed for 25 tonnes of thrust, did not achieve a sustained burn until March 1940. The missile itself proved far more challenging than the powerplant. While funding for development of an operational weapon was approved in late 1941, a successful prototype flight did not occur until October 1942. Early developmental launches resulted in frequent failures involving launch pad explosions, in flight explosions, and repeated instances of loss of control. 1943 proved a critical year for the A-4 program. As development continued, the design was progressively refined, simplified and matured, and arrangements were made for operational deployment and mass production in an underground factory. The RAF attacked the Peenemunde test centre in August 1943 using 600 heavy bombers in an attempt to delay deployment by killing as many technical and scientific staff as possible, an aim partly achieved but at a very high cost in aircraft and aircrew losses. Von Braun lost his engine designer Walter Thiel during this raid.

Planning for operational deployment of a production A-4 commenced as early as mid-1943 when Albert Speer authorised funding for the construction of a large launch bunker at St Omer in Calais, France. This artifact, now called La Coupole, today houses a war museum but was intended to allow the assembly, fuelling and launch of around 40 A-4 missiles per day, resupply with reloads and fuel permitting.

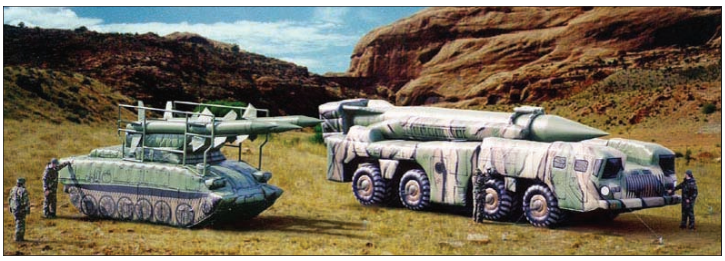
The focus of German planning was however for highly mobile launch batteries, to be manned by Wehrmacht and Waffen SS troops. The first units were formed in mid 1943, these being Wehrmacht (Artillery Units Motorised) Art.Abt. 482, 485, 836, Technical Artillery Units (Motorised) 91, 953 and SS Artillery Unit (Motorised) Art.Abt. 500, for a total of twelve 'FernRakete-Batterie' (long range missile batteries). These fell under Artillery Command 191/LXV.

Each missile battery had three launchers and a pair of ready-to-fire missiles, an intelligence unit for targeting, a launcher unit, an assigned Army Flak (AAA) air defence unit, a fuel supply train and a troop of firefighters, should accidents occur refuelling or launching the missiles.

To appreciate the battery structure, it is necessary to explore the A-4's demands in propellants and pre-launch servicing. The missile's engine burned an ethanol-water / B-Stoff fuel with a liquid oxygen (LOX) / A-Stoff oxidiser, each round requiring 3.8



Battery support equipment for the A-4, top to bottom: Strabo mobile gantry crane for transloading, Sd.Kfz.8 12 tonne halftrack tow tractor, Vidalwagen transloader trailer, Feuerleitpanzer launch control centre towing the launching pad.



The Russian R11 Scud is a direct descendant of the A-4, and uses much the same deployment model.

tonnes of ethanol/water fuel and 4.9 tonnes of cryogenic LOX. The fuel doubled up as a coolant for the combustion chamber and exhaust nozzle. The engine pumps, which drove the fuel and oxidiser into the engine, were powered by high pressure steam produced from an internal tank of hydrogen peroxide / T-Stoff using a manganese catalyst.

As it was unsafe to transport a fuelled A-4, the missiles had to be deployed empty to a launch area and then fuelled up just before launch. Once set up and fuelled, the battery command post would launch the missile, which then flew to its target under gyroscopic autopilot control. While Von Braun invented the rotating reticle infrared seeker (of AIM-9 Sidewinder fame) as a terminal guidance system for the A-4, it is not believed that this innovation ever entered service.

A complex train of vehicles was used to deploy the weapon to a launch site, and fuel the round. A 'Vidalwagen' transloader trailer, usually towed by a Hanomag SS-100 wheeled tractor, transported the missiles by road from a railroad to a transloading site in the vicinity of several intended launch sites. A Fries / Strabo 15 tonne portable Gantry Crane, in service with Wehrmacht tank units, trans-loaded the A-4 round from the Vidalwagen to the 'Meilerwagen' Transporter Erector Launcher (TEL) trailer, itself usually towed by a 12 tonne Daimler-Benz Sd.Kfz.8 Zugkraftwagen or 18 tonne FAMO Sd.Kfz.9 schwerer Zugkraftwagen half-track heavy artillery tow tractor, or the Hanomag SS-100. An Sd.Kfz.7/3 Feuerleitpanzer half track was used as a launch control centre (LCC) for the battery. With an armoured crew cabin retrofitted, the LCC vehicle was usually used to tow the Abschussplattform launch pad trailer.

The battery's TEL and command post would be accompanied by a train of tankers. The A-Stoff (LOX) was carried in a cryogenic tanker trailer, usually towed by the SS-100, the Sd.Kfz.8 or the Sd.Kfz.9 in more complex terrain. Opel Blitz S 3 tonne tanker trucks were used to deploy the T-Stoff (pump propellant) and B-Stoff (fuel), with several required to fuel the battery's pair of A-4 rounds (towed B-Stoff cisterns were also used). Additional support vehicles, usually Opel Blitz S trucks, were used as the radio van, battery command post, spare parts carrier, and radio uplink vehicles, where used. A Steyr 2000 generator truck usually powered the battery systems. Additional trailers including LOX pumps, LOX tank pressurisation compressors, cable spools, and telescoping ladders, were towed to the launch site by the support vehicles.

An operational battery would have to deploy this menagerie of support vehicles from the transloading site to a launch site, evading watchful Allied fighter patrols, and on site deploy camouflage netting while the TEL elevated the A-4 round on to the launch pad, upon which the weapon could be fuelled up and checked out for launch. Once ready, the tankers and TEL would be moved to a safe distance, with the LCC sited within 150 metres of the missile.

Once the A-4 was fired, the battery crew would disassemble the site in 30 minutes and move to another, arguably the first application of the 'shoot and scoot' tactic.

The highly secret Lorenz Leitstrahl-(LS)-facheranlage Viktoria midcourse guidance package for a modified A-4 was introduced during the final months of operations. Using a ground-based VHF band antenna arrangement, the Leitstrahl system would appear to be an equivalent to much later beam-riding guidance systems used in air defence missiles. The A-4 battery would launch from a site which was somewhere along the line between the target and the Leitstrahl transmitter, and antennas on the missile's tail would be used to centre the missile's early flightpath while under power along the boresight of the radio beam. The A-4 used graphite thrust-deflecting paddles mechanically coupled to trailing edge aerodynamic controls for flightpath control. The achievable and achieved accuracy of the Leitstrahl guided A-4 is unclear, without access to more detailed technical data – the guidance system was only effective while the missile was under power, compensating for gyro drift and crosswind during its climb.

The first A-4 battery to go operational in September 1944 was Art. Abt.444 – to bombard Paris. In total, 76 rounds were fired at French targets, including Paris, Lille, Tourcoing, Arras and Cambrai. Batteries deployed to Holland soon commenced launches against targets in the UK, with 1360 rounds credited, all but 44 fired at London. As the Allied ground forces advanced up the coast, the A-4 batteries retreated and shifted their fire against more operationally relevant targets, especially in Belgium. Antwerp, a key transportation hub for the resupply of the invasion force, was attacked with no less than 1610 rounds, or around half of the war stock to reach its target. An additional 54 rounds hit other targets in Belgium, 19 in Holland, and 11 rounds were fired against the Allied bridgehead at the critical Remagen bridge on the Rhein.

In strategic terms the A-4 was a failure. The total weight of fire delivered, given the accuracy of the weapon, was uncompetitive against aerial bombs delivered by aircraft. However, given Germany's loss of air superiority over Europe in mid 1944, the A-4 was the only system available to deliver any sustained fire beyond the range of artillery. The weapon's technical success, however, set the pattern for numerous post war developments.

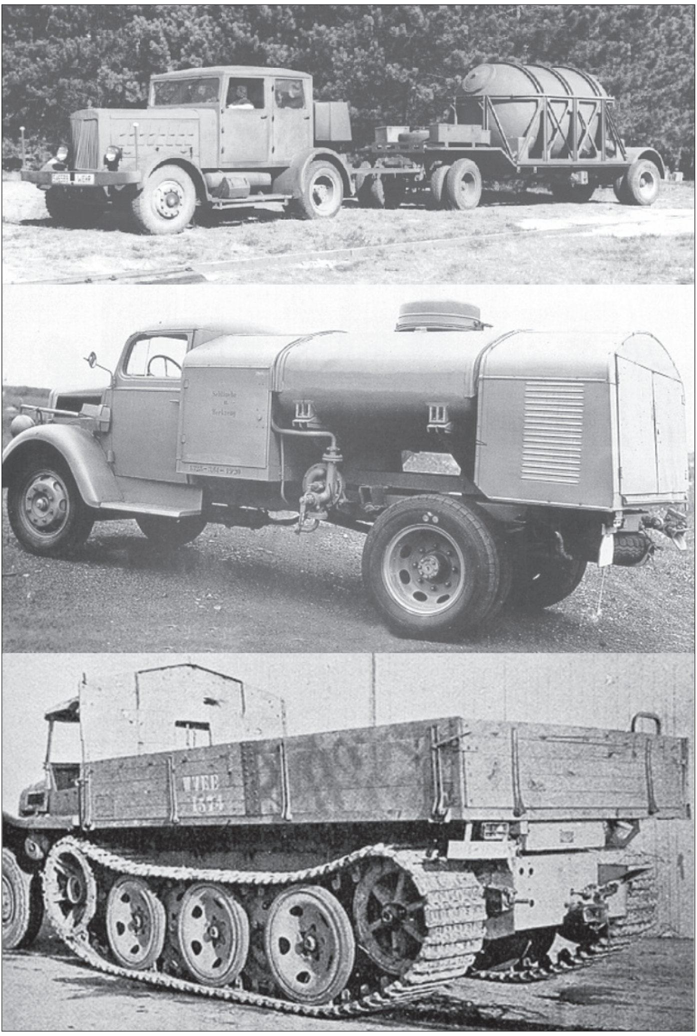
Both the US and Soviets cloned the A-4 for their initial trials with TBM technology. The Scud became the most widely used descendant of the A-4 family of weapons, with the derivative Wasserfall Surface to Air Missile becoming the progenitor of the numerous Soviet air defence missiles deployed over the subsequent decade and a half. In an interesting twist, the Scud family of missiles adopted the storable oxidiser originally developed for the Wasserfall, with LOX becoming the oxidiser of choice for most space launchers. On the other hand, the US Redstone TBM, designed by von Braun, retained the propellant mix of the A-4, and is also considered a direct descendent of the A-4. Australia's Wresat (Weapons Research Establishment Satellite) was launched on a Redstone vehicle in 1967.

In operational terms, the big innovation the Soviets brought to the TBM game was the MAZ-543 series 8x8 TEL vehicle, capable of good road speed, yet also good off-road mobility. The Soviets perfected the 'shoot and scoot' model for TBM deployment, and have since then developed IRBM and ICBM mobile launchers following this model.

Saddam's Scud bombardment campaign against Israel and Saudi Arabia in 1991 was notable for its lack of useful combat effect but also for the survivability of the Al Husayn and Scud batteries using 'shoot and scoot' tactics pioneered in 1944. For the forseeable future this operational model developed for mobile TBM batteries will remain the method of choice for land-based ballistic missile operations.

Further Reading:

By far the best online reference is http://www.v2rocket.com/; Joachim Engelmann's 'V2 Dawn of the Rocket Age', Schiffer, 1990, contains excellent imagery.



Battery fuel train for the A-4, top to bottom: LOX tanker towed by Hanomag tractor, Opel Blitz S tanker truck, used for fuel and hydrogen peroxide supply, FAMO Sd.Kfz.9 18 tonne halftrack tow tractor used in difficult terrain.