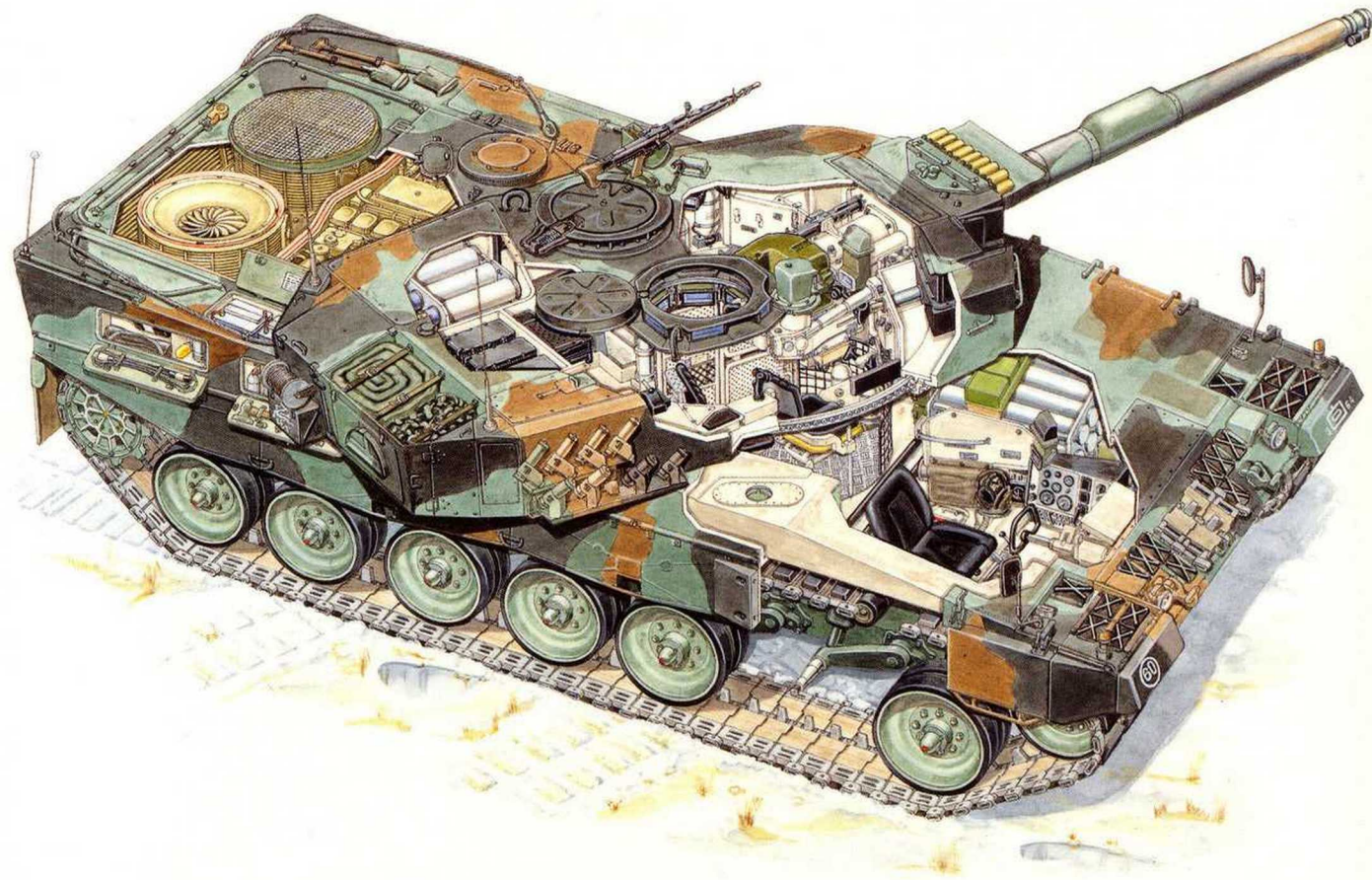


New Vanguard

OSPREY
PUBLISHING

Leopard 2 Main Battle Tank 1979–1998



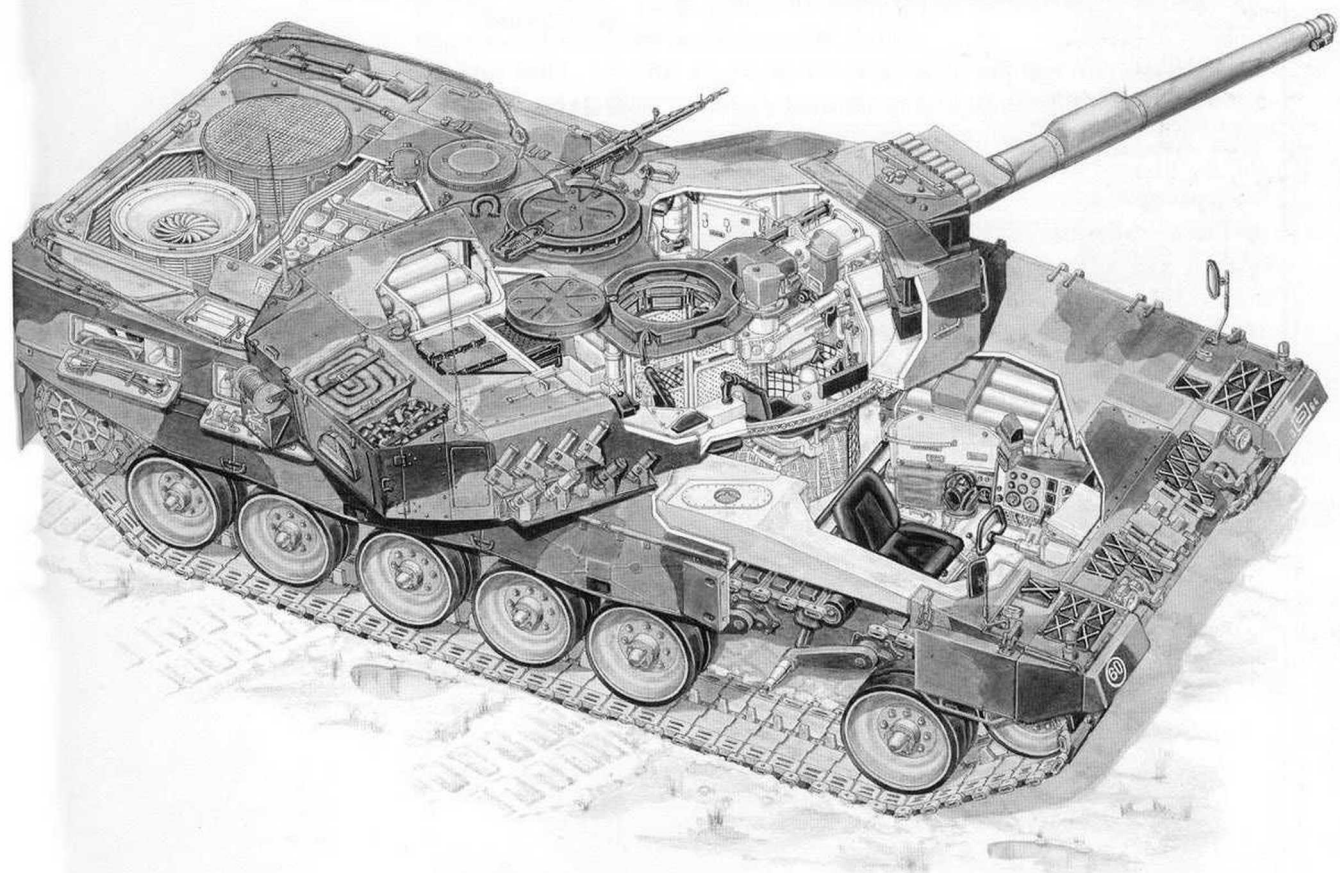
M Jerchel & U Schnellbacher • Illustrated by M Badrocke

MICHAEL JERCHEL was born in 1956 and is interested mainly in Western and former Soviet military equipment, an interest reflected in his work as a freelance journalist and author. He is a recognized authority on modern German armour, having previously published *New Vanguard 16: Leopard 1965-95*.

UWE SCHNELLBACHER was born in 1962 and has a lifelong interest in military matters, especially tanks. During the eighties he served as an officer with the Signal Corps of the Bundeswehr.

MIKE BADROCKE is one of Osprey's most highly respected and accomplished illustrators, notably in the field of precision 'cutaway' artwork, as exemplified in this volume. Over the years, he has produced quality artwork for numerous books, magazines and industry publications throughout the world, not only in the field of militaria, but also in the intricate and technically demanding sphere of aviation publishing.

Leopard 2 Main Battle Tank 1979–1998



First published in Great Britain in 1998 by Osprey Publishing,
Midland House, West Way, Botley, Oxford OX2 0PH, UK
443 Park Avenue South, New York, NY 10016, USA
Email: info@ospreypublishing.com

© Copyright 1998 Osprey Publishing Ltd.
Reprinted 2005

All rights reserved. Apart from any fair dealing for the purpose of private study, research, criticism or review, as permitted under the Copyright, Designs and Patents Act, 1988, no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means electronic, electrical, chemical, mechanical, optical, photocopying, recording or otherwise, without the prior written permission of the copyright owner. Enquiries should be addressed to the Publishers.

CIP Data for this publication is available from the British Library

ISBN 1 85532 691 4

Editor: Iain MacGregor
Design: The Black Spot

Filmset in Singapore by Pica Ltd
Printed in China through World Print Ltd.

FOR A CATALOGUE OF ALL BOOKS PUBLISHED BY OSPREY MILITARY AND
AVIATION PLEASE CONTACT:

NORTH AMERICA
Osprey Direct, 2427 Bond Street,
University Park, IL 60466, USA
E-mail: info@ospreydirectusa.com

ALL OTHER REGIONS
Osprey Direct UK, P.O. Box 140, Wellingborough,
Northants, NN8 2FA, UK
E-mail: info@ospreydirect.co.uk

www.ospreypublishing.com

Acknowledgments

The authors would like to thank the following individuals and companies for their invaluable help and assistance during the preparation of this book: Frau Baumgart of MaK Systemgesellschaft mbH for providing detailed information and additional photographs, and Sabine Rotter, Christopher Foss, Andreas Kirchhoff, Gerd Schwiens, Carl Schulze, Holger Veh of the Motor-Technica-Museum, Major Harald Kuhl, Hauptmann Armster and Hauptmann Zeletzki of the Panzertruppenschule. Special thanks are due to Herr Zickwolff of Krauss-Maffei GmbH for providing some excellent photographs and back-up information.

Artist's Note

Readers may care to note the original paintings from which the colour plates in this book were prepared are available for private sale. All reproduction copyright whatsoever is retained by the publisher. All enquiries should be addressed to:

37 Prospect Road, Southborough, Tunbridge Wells, Kent, TN4 0EN

The publishers regret that they can enter into no correspondence upon this matter.

Editor's note

Readers may wish to read this title in conjunction with the following Osprey titles:

New Vanguard 2 M1 Abrams
New Vanguard 10 Warrior
New Vanguard 13 Scorpion
New Vanguard 16 Leopard 1
New Vanguard 23 Challenger
Elite 45 Armies of the Gulf War
Elite 16 NATO Armies Today

LEOPARD 2 MAIN BATTLE TANK 1979-1998

DESIGN AND DEVELOPMENT

The Main Battle Tank/Kampfpanzer-70

The development history of the Leopard 2 – which in spite of its name is not simply a new version of the well-known Leopard 1 – began in 1963, when the Federal Republic of Germany and the United States of America signed an agreement to develop a common highly sophisticated tank, known as the Main Battle Tank/Kampfpanzer-70. The MBT/KPz-70 was planned to be the best tank in the world by a design and development group made up of General Motors on the US and the Deutsche Entwicklungs-Gesellschaft mbH (DEG) consortium on the German side. DEG included companies such as MaK, Rheinstahl-Henschel, Lutherwerke and Krauss-Maffei.

The MBT/KPz-70, which was intended to replace the M48A2G in German service, was to have a combat weight of around 50 tonnes and was designed to have a hydro-pneumatic suspension and an automatic loader for the 152 mm XM150E5 main gun, which was to have the ability to fire the Shillelagh anti-tank missile as well as conventional ammunition. A total of 50 rounds of various types of ammunition would be carried, 26 of them in an automatic loading system. The fire control system was to include a laser rangefinder and an infrared observation system. The tank was to be operated by a crew of three, all (including the driver!) seated in the turret. The German version would have a 7.62 mm MG 3 machine gun mounted co-axially to the main gun and a 20 mm

The Main Battle Tank/
Kampfpanzer 70 was a joint
US-German development and
designed to be the best tank
in the world. Seen here is a
German example, with the
20 mm anti-aircraft automatic
cannon deployed for operation.
The development programme
was stopped in 1970.
(FMZ/Panzertruppenschule)





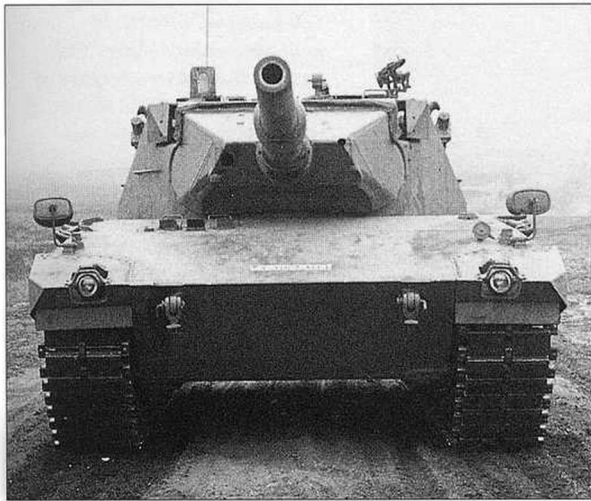
The early prototypes of the Leopard 2 resembled at first glance the Leopard 1 A4. The one shown here is equipped with the Rheinmetall 105 mm smooth bore main gun. (Michael Jerchel)

retractable automatic cannon, installed in a cupola to the left on the turret roof, primarily for air defence purposes. The first US-built test chassis was ready in June 1966, followed by the first German chassis in September 1966. The first bilateral tests conducted in October 1966 showed the superiority of the German hydro-pneumatic suspension system, although this did not mean that it would have automatically been selected for series production.

In February 1967 the liquid-cooled MTU MB 873 Ka 500 engine, with an output of 1500 PS, was ready, its competitor being the US-built air-cooled Teledyne-Continental engine with 1475 PS. In May 1967 construction drawings of the nationally developed components were exchanged and in early 1968 it was agreed that only six prototypes instead of the eight originally planned would be built by each country. The costs of the vehicle somehow exploded, and in 1968 the amount for



Seen here is Prototype 14 with one of the seven prototype turrets, presumably turret 17, equipped with the Rheinmetall 120 mm smooth bore main gun, during tests at Kampftruppenschule 2 (German Armour School) in Münster in 1974. (FMZ/Panzertruppenschule)



This view of PT 14 clearly shows the EMES 12 stereoscopic rangefinder with its protecting screens slid open. The shape of the turret had been chosen to meet the military demand at that time to allow the fire control system being developed for the Leopard 2 to be adopted for the Leopard 1 at a later stage. The eventual dropping of this requirement opened the way to the Leopard 2 AV. (FMZ/Panzertruppenschule)

one MBT/KPz-70 was more than double that of a Leopard 1.

However, in 1969 three component trial vehicles, four vehicles with the Continental engine and three with the MTU engine, were available for trials. It became obvious that the highly sophisticated vehicle had become too heavy and the next step in development would be to reduce its weight, but no agreement could be reached between the USA and Germany. The programme was finally stopped in January 1970, after DM 830 million had been spent, and both nations carried on to develop their own main battle tanks. While the USA continued with an austere version of the MBT 70 (also known as the XM803) and subsequently developed the M1 Abrams (see New

Vanguard 2, *M1 Abrams*), Germany went on to develop a new main battle tank, using components already developed for the MBT/KPz-70, which was to become the Leopard 2.

The 'Keiler' and the 'Eber'

While Germany and the United States were developing the MBT/KPz-70 their agreement did not allow a parallel national tank development programme, but when the Leopard 1 MBT (see New Vanguard 16) was introduced into service in 1965 Porsche was awarded a contract to develop improved components to increase its combat effectiveness to the standard demanded for the MBT/KPz-70. This programme lasted until 1967, when the contract expired, and became known as 'Vergoldeter Leopard' (Gilded Leopard).

When the first cracks appeared in 1967 in the German/American cooperation for joint development of the MBT/KPz 70, the German Ministry of Defence decided to continue and to increase the development programme for the 'Vergoldeter Leopard', which later became known as 'Keiler' (Wild Boar). Krauss Maffei in Munich was chosen as the main contractor, with Porsche involved in the development of the chassis and Wegmann in that of the turret. In 1969 and 1970 two prototypes (ET 01 and ET 02), both powered by the 10-cylinder MB 872 engine, were built for further evaluation.

In late 1969, with the end of the development programme for the German-American tank at hand, the German Office for Defence Technology and Procurement (BWB) initiated a study to save at least the majority of the MBT/KPz-70 development programme. This was an attempt to combine parts of the abandoned MBT/KPz-70 with components of the experimental tank, and became known as 'Eber' (Boar) but never reached prototype status.

Leopard 2 Prototypes 01 to 17

In early 1970 Helmut Schmidt, then German Defence Minister, recommended continued development of the 'Vergoldeter Leopard', with the adoption of the MTU engine developed for the MBT/KPz-70 to use the further experience with it that had been acquired. Another seven vehicles were ordered in addition to the ten prototypes already planned, and Krauss-Maffei was again chosen as the main contractor. Altogether



The Leopard 2 AV PT 19 underwent comparative trials against the XM1 prototypes of Chrysler and General Motors in the USA. Its armament was changed from the 105 mm to the Rheinmetall 120 mm smooth bore gun while still in the USA after these tests. The Leopard 2 AV is seen here after its return to Germany. (Krauss-Maffei-Werkfoto)

16 prototype chassis (PT 1 to PT 11 and PT 13 to PT 17) and 17 turrets were built between 1972 and 1974. The prototypes looked at first glance very much like the Leopard 1 A4, but had a wedge-shaped bow and an exhaust grille moved to the rear plate. The road wheels and tracks came from the MBT/KPz-70 and the return rollers from the Leopard 1. The prototypes varied in certain components and fire control systems. For example, PT 11 and PT 17 had a hydro-pneumatic suspension invented for the MBT/KPz-70 programme, with 6 road wheels per side – just to find out that the torsion bar suspension with integrated friction dampers was the better solution – and PT 11 had a remote-controlled 20 mm automatic cannon mounted on the turret roof. With the exception of PT 07, PT 09, PT 15 and PT 17, which received a slightly modified engine, the prototypes had the engine developed for the MBT/KPz -70. This 12 cylinder MTU MB-873 Ka-500 water-cooled multi-fuel four-stroke engine, together with its 20 kW generator, gearbox, air filters, and the cooling and braking systems, formed one compact group which could be easily replaced within 15 minutes. The engine had two superchargers operated by the exhaust fumes, which gave it an output of 1500 PS at 2600 rpm. The Renk HSWL-354/3 gearbox had four speeds, both forward and reverse; it allowed a change of direction (left and right) in the two lower gears without reducing engine speed. Ten of the 17 turrets built were fitted with a 105 mm smooth bore gun while the remaining seven had a 120 mm smooth bore gun, both designed and produced by Rheinmetall. These prototypes were known as the Leopard 2 K (K = Kanone, i.e. gun) because in 1970 the German Ministry of Defence and the BWB were still hoping to save at least some major components of the MBT/KPz-70, especially the 152 mm main gun and Shillelagh missile, and had initiated a study under the designation Leopard 2 FK (FK = Flugkörper, missile). At the beginning of development, therefore, military demands basically called for a common chassis to accept both turrets. The Leopard 2 FK programme was stopped in 1971 for practical and economical reasons and it was decided to concentrate on the Leopard 2 K (the suffix K was

later deleted). However, further military demands required the weight of Leopard 2 to be in MLC 50 (Military Loading Class 50) and the fire control system under development, including the combined optical and laser rangefinder, was to be compatible with the turret of Leopard 1. The engineering tests of the prototypes were conducted at various proving grounds, such as Münster and Meppen, between 1972 and 1974 and were followed by troop tests. Four tanks were sent to Shilo in Canada to carry out cold weather trials between 14 February and 19 March 1975 at temperatures down to -30 degrees, followed by high-temperature tests at up to +45 degrees at Yuma, Arizona, in April and May 1975. However, the weight of the prototypes was 1.5 tonnes above the required MLC 50. A new and lighter turret, which became known as 'Spitzmaus-Turm' (Shrew-turret), was designed by Wegmann to be fitted with an optronic co-relation rangefinder known as EMES 13. This was developed by Leitz and AEG-Telefunken and had a base length of only 350 mm. The small size of EMES 13 would have allowed its installation in the turret front. At the same time the first analysis of the Yom Kippur War of 1973 became available and made it clear that increased armour protection would be a decisive factor in the future. The outcome was a decision to accept MLC 60 for the Leopard 2, which would allow increased armour, and to modify one of the turrets with a new multi-layer type of armour. This resulted in turret number 14 mod. (T 14 mod.), which was a breakthrough in the Leopard 2 development programme and the first step towards the Leopard 2 AV.

THE LEOPARD 2 AV

During 1973, negotiations began between the USA and Germany to standardise certain components of both nations' main battle tank for the eighties. This culminated in a Memorandum of Understanding (MoU), which was signed on 11 December 1974 with an amendment signed in



After their return to Germany from comparative tests in the USA against the XM1 prototypes, the Leopard 2 AVs were used for the German evaluation programme. Seen here is Leopard 2 AV PT 20 during live firing tests at Bergen-Hohne ranges. (FMZ/Panzertruppenschule)

July 1976. One chassis, prototype PT 07, had already been sold and delivered to the USA in February 1973 and was tested by the US Army at Aberdeen Proving Ground. Part of the MoU was a comparative test between a Leopard 2 prototype and the competing XM1 prototypes built by Chrysler and General Motors in the United States. It was agreed to study how Leopard 2 could be modified with minimum change to its design to meet US performance and cost



constraints, and Krauss-Maffei were given the requested performance characteristics of the XM1 including ballistic protection. All these specifications were the result of the trials carried out by the US Army in the United States with Leopard 2 prototype PT 07. However, 15 of the 17 early Leopard 2 prototypes had already been built, with the remaining two nearing completion, when the MoU was signed. Based on the altered German and the US military demands, Porsche, Krauss-Maffei and Wegmann designed and built the Leopard 2 AV (Austere Version). Modifications included the new spaced armour on the hull and a new turret based on experience with turret T 14 (mod.), which had a less sophisticated fire control system. Two chassis were built, designated PT 19 and PT 20, plus three turrets designated T 19, T 20 and T 21, and were ready in 1976. Leopard 2 AV PT 19 mounted turret T 19 with a fire control system, including the gunner's sight and controls, built by Hughes. For the tests in the USA, because the XM1 was armed with the L7A3 105 mm main gun, PT 19/T 19 was equipped with the same gun, though there were provisions which allowed a quick adoption of the 120 mm smooth bore main gun. Turret T 20 had a German fire control system, including the EMES 13, and was to be used for the German test programme. The additional turret T 21 was equipped like turret T 20, but had the Rheinmetall 120 mm smooth bore gun installed from the beginning.

The Leopard 2 AV was originally intended to be tested at the same time as the XM1, but the German modification programme took longer than expected. The US Army therefore proceeded with the evaluation of the XM1 prototypes built by Chrysler and General Motors, and ultimately requested authorisation to launch full-scale development of the Chrysler XM1 design without awaiting the availability of the Leopard 2 AV. However, at the end of August 1976, PT 19/T 19 and PT 20 with extra weight to simulate that of a turret, plus one hull and one turret for live firing tests, were transported to the United States by a C-5A Galaxy.

The comparative tests, known as Development Test (DT) and Operational Test (OT), were conducted at Aberdeen Proving Ground following the programme that had already been passed earlier by the XM1 prototypes and lasted until December 1976. The US Army reported that the

Three pre-series vehicles and two pre-series turrets were delivered in 1978 to the German Armour School in Münster. Shown here is the third pre-series chassis with the second pre-series turret and fake tactical markings. (Krauss-Maffei-Werkfoto)



The tank thermal sight was not ready for production when series production began. 200 of the first batch vehicles were therefore fitted with the PZB 200 low light TV system, installed on the gun mantlet. (Krauss-Maffei-Werkfoto)

Leopard 2 AV and XM1 were comparable in firepower and field mobility but that the XM1 was superior in armour protection, and the XM1 was selected. With a touch of bitterness, the German companies responsible for Leopard 2 AV development realised that their prototype PT 07 had served as a source of technology in the development of the XM1 prototypes.

After the comparative tests PT 19 and PT 20 returned to Germany for further evaluation whilst turret T 19 remained in the US until early 1977 and was adapted to the PT 07 chassis. Its armament was changed from



The first Leopard 2s were delivered to the German Armour School in Münster, provisionally equipped with the PZB 200 seen here on the gun mantlet. (FMZ/Panzertruppenschule)



The modified first batch was designated the Leopard 2 A2, and the one seen here of Panzerbataillon (mixed) 31 enters range 5B in Bergen in 1988. (Michael Jerchel)

the 105 mm to the new Rheinmetall 120 mm main gun in very little time and with only minor changes to its fire control system and electronics. Germany had selected this calibre for series production of the Leopard 2, and the US Army proposed to incorporate this gun into later batches of the XM1. After intensive live firing tests carried out by US personnel, turret T 19 was brought back to Germany, and was modified to the same standard as turret T 21 and mounted on chassis PT 19 to be used in the evaluation programme for series production. PT 20, turret T 20, and turret T 14 (mod.), which was brought up to the standard of turret T 20, were also available for the evaluation programme. In September 1977 the German MoD formally decided to go ahead with plans for production of 1,800 Leopard 2s, which were to be delivered in five batches. From the original group of companies bidding

for the contract (Krauss-Maffei, Maschinenfabrik Kiel (MaK) and Thyssen-Henschel) Krauss-Maffei was chosen as the main contractor and systems manager. MaK became sub-contractor and production was to be shared between the two companies on the basis of 55% for Krauss-Maffei and 45% for MaK. Wegmann as turret integrator received full responsibility for coordinating the integration of the EMES 15 fire control system, which was selected in preference to the EMES 13(L) for series production and was developed by Hughes in cooperation with Krupp Atlas Elektronik, with the 120 mm smooth bore high-performance main gun supplied by Rheinmetall with the turret. All in all, an estimated 25,000 components of the Leopard 2 were subcontracted.

SERIES PRODUCTION

Pre-series Vehicles

On 20 January 1977 three pre-series chassis and two pre-series turrets were ordered, with the first delivered on 11 October 1978. The first chassis built was fitted with turret T 21 and carried out troop trials until early 1979 at the German Armour School (Kampftruppenschule 2) in Münster. The other two vehicles were used in acceptance trials and final tests in early

A Leopard 2 A4 (first batch) of PzBtl. 84 conducting a live firing exercise in Bergen in winter 1993. (Michael Jerchel)



1979. The pre-series Leopard 2 could be recognised by having a collimator attached to the top of the barrel end, which was deleted in the series vehicles. The next vehicle on the assembly line, the fourth built, was officially handed over to the German Armour School on 25 October 1979 – the Bundeswehr had received its first Leopard 2 series tank.

The first batch

A total of 380 Leopard 2's were built in the first batch: 209 by Krauss-Maffei (Fahrgestell-Nr. 10001 to 10210) and 171 by MaK (Fahrgestell-Nr. 20001 to 20172), with the first six vehicles delivered in 1979 to Kampftruppenschule 2 in Münster. 100 were delivered in 1980 and 220 in 1981, replacing the M48A2G in units among I (GE) Corps. The first Leopard 2s went to Panzerbataillons 31, 33 and 34 of 1 Panzerdivision, with partially parallel delivery to Panzerbataillons 81, 83 and 84 of 3



Leopard 2 A4 (third batch) of PzBtl. 203 during CAT 89, the prestigious NATO tank gunnery competition. The first six places were taken by platoons equipped with the Leopard 2, with the best M1A1 team in seventh place. (Michael Jerchel)

An MaK-built Leopard 2 A4 (fourth batch) of PzBtl. 363 during a field training exercise, marked with red crosses denoting OPFOR (OPosing FORces). (Michael Jerchel)



Panzerdivision. The Leopard 1s then in service were passed on to the Panzerbataillions of the Panzergrenadier divisions, where they replaced the M48A2G. By 1982 production was running at 300 a year, with the last first-batch Leopard 2 delivered in March that year.

The combat weight of the Leopard 2 is 55,000 kg, empty weight being 52,000 kg, and its hull has spaced multi-layer armour. The running gear consists of seven dual rubber-tyred road wheels and four return rollers per side, with the idler wheel at the front and drive sprocket at the rear. Torsion bar suspension is employed, with advanced friction dampers provided at the 1st, 2nd, 3rd, 6th and 7th road wheel stations. The Diehl 570F tracks, with rubber-bushed end connectors, have removable rubber pads and use 82 links for each track. For use on icy ground up to 18 rubber pads can be replaced with the same number of grousers, which are stored on the vehicle's bow when not in use. The four first sections of the

side skirts are heavily armoured and must be raised for transport by railway. The remaining three sections are made of the standard rubber and metal fabric and are hinged to swing upward if necessary.

The driver's station is located at the front, offset to the right of the vehicle's centre line. A large, pintle-mounted, lift-and-swing-type single-piece hatch is provided for the driver and opens to the right. There are two observation periscopes in the driver's

This view of a Leopard 2 A4 (second batch) of PzBtl. 23 in 1987 shows the old-style engine grilles still in use. (Uwe Schnellbacher)





The divisional reconnaissance battalions were also equipped with the Leopard 2 A4. This fifth-batch vehicle of PzAufklBtl. 2 shows the collimator at the right side of the barrel's end, fitted in 1994. (Michael Jerchel)

hatch, plus one to the left of his station, for use when driving closed down. The central periscope (in the hatch) can be exchanged for a passive IR-sight for night operations. 27 rounds of 120 mm ammunition are stored in a special magazine in the forward section of the hull, to the left of the driver's station. An escape hatch is provided under the driver's seat.

The turret, incorporating multi-layer armour, is mounted in the centre of the hull and is manned by the commander and gunner in the right half, with the gunner seated below and in front of the commander, and the loader in the left half. The commander and the loader each have a circular hatch, opening to the rear, and six periscopes provide all-round vision for the commander. Both hatches have ring mounts for the 7.62 mm MG 3 air-defence machine gun, though it is normally fitted to the loader's hatch. 15 additional rounds for the 120 mm Rheinmetall smooth bore main gun, making a total of 42, are carried in the left side of the turret bustle and separated by an electrically operated door from the fighting compartment. Should the ammunition in the bustle be hit, blow-off panels in the turret roof would direct any explosion upwards.

The 120 mm main gun is fully stabilised in both azimuth and elevation, and the WNA-H22 electro-hydraulic gun control system is fitted. The gun fires two types of ammunition, both developed by Rheinmetall: APFSDS-T, known as DM-33 KE (Kinetische Energie = kinetic energy), and HEAT-MP-T, known as DM-12 MZ (Mehrzweck = multi-purpose), both types having combustible cases. A co-axial 7.62 mm MG 3 is mounted to the left of the main gun and 4,750 rounds of machine gun ammunition are carried.

The thermal sight for the gunner's EMES 15 primary sight was not ready during production of the first batch, though all vehicles were prepared to be so equipped at a later stage. To provide an improvised night-fighting capability for first-batch vehicles, the Panzer-Ziel-und-Beobachtungsgerät (PZB) 200 low light level TV system (LLLTV) was temporarily fitted to 200 Leopard 2. The EMES 15/FLT-2 fire control system consists of:

- (1) gunner's primary sight with mirror stabilised in azimuth and elevation
- (2) laser transmitter and receiver
- (3) thermal imaging system (not ready for the first-batch vehicles) and eye piece assembly
- (4) commander's and gunner's control units
- (5) commander's display unit
- (6) computer control unit
- (7) commander's joy-stick hand control
- (8) the digital ballistic computer, which calculates the relevant data for a firing solution
- (9) crosswind velocity sensor (only the first-batch vehicles had a crosswind velocity sensor installed on the turret roof above the turret bustle)
- (10) gun elevation sensor
- (11) laser electronics box
- (12) cant angle sensor
- (13) interconnecting cable set.

The gunner also has an auxiliary telescope FERO-Z18 with a magnification of x8, mounted co-axially to the right of the main gun. An independent and fully stabilised PERI R-17 primary panoramic sight, made by Carl Zeiss and with magnifications of x2 and x8, is installed at the front of the commander's station. This sight can be traversed through 360 degrees and allows the commander to override the gunner's control if necessary. An ammunition supply hatch, opening outward, is provided in the left side of the turret. Two groups of four 76 mm Wegmann smoke mortars are mounted on either side of the turret and can be electrically fired either as single rounds or in salvos of four. Two SEM 25/SEM 35 radios are fitted behind the commander in the rear right of the turret bustle. These operate in the 26 – 70 MHz band and have maximum ranges of 25 and 12 km respectively. The radio antennae are mounted to the left and right behind the crew stations.

The engine compartment is at the rear, separated from the fighting compartment by a fireproof bulkhead. The MTU MB 873 Ka-501 liquid-cooled 47.6 litre V 12-cylinder 4-stroke exhaust turbo-charged diesel engine develops 1,104 kW (1,500 PS) at 2,600 rpm. It is started by eight 12-volt/125



Up to 18 grousers can be fitted to the tracks in place of rubber pads for use on soft ground or snow, as seen here on a Leopard 2 A4 (sixth batch) on exercise at the CMTC in Hohenfels. (Carl Schulze)



Late sixth-batch vehicles introduced new forward sections for the side skirts, as seen here at a demonstration exercise in Münster during 1992. (Michael Jerchel)

Ah batteries and has a 24-volt electrical system. The Leopard 2's maximum road speed is 68 km/h, though it is limited to 50 km/h during peacetime, and top speed in reverse is 31 km/h. Fuel consumption is estimated at around 300 litres per 100 km on roads and 500 litres per 100 km across country. The four fuel tanks have a total capacity of approx. 1,160 litres, giving a maximum road range of about 500 km. The Renk HSWL 354 hydro-kinetic planetary gearbox with integral service brake is coupled to the engine, forming a compact power pack which can be exchanged within 15 minutes. Four forward and two reverse gears are available through a torque converter, enabling the Leopard 2 to turn on the spot if required. The transmission automatically changes gear within the range preselected by the driver. The cooling air outlet grille is very prominent across the upper section of the rear plate, and was reinforced after the 28th vehicle built. Exhaust grilles with vertical bars are located to the left and right of the de-airation vents. A Rechnergestütztes Panzer-Prüfsystem (RPP), i.e. fault detection system, detects any technical malfunctions.

Four 9 kg Halon fire extinguisher bottles are installed on the right behind the driver's station. The bottles are connected to pipes and hoses



The eighth batch introduced new rear sections for the side skirts and slightly reshaped mounts for the smoke mortars. The collimator of the muzzle reference system is not yet fitted. (Krauss-Maffei-Werkfoto)

The ammo hatch was deleted entirely during production of the sixth-batch vehicles, and also on a few of the late fifth batch. (Michael Jerchel)



and are activated automatically by the fire detection system, when temperatures rise above 180°F inside the fighting or engine compartment, or manually via a control panel in the driver's compartment. An extra 2.5 kg Halon fire extinguisher (HAL 2.5) is stored on the floor beneath the main gun. The Leopard 2 has a self-contained NBC protection system, which produces up to 4 mbar (0.004 kp/cm²) overpressure inside the vehicle. This is installed in the hull to the left of the turret, with access through the forward hatch in the left hull side for changing the NBC filter. Storage of most engineer tools and various equipment is integrated into the hull, with one compartment in the left side and two in the right side of the hull accessible by hatches.

The Leopard 2 is able to ford water obstacles 1.20 m deep (wading) without any special preparation or loss of combat effectiveness. Before fording at a depth of 2.25 m (deep wading) special preparation is required to activate the built-in hydraulic and pneumatic seals, and the folding snorkel, carried on the turret rear, is fitted to the commander's cupola. About 15 minutes' preparation is required to ready the tank for crossing water obstacles at a depth of 4 m (underwater driving), including the fitting of a special three-piece snorkel to the commander's cupola.

The second batch

Production of the second batch began in March 1982 and ended in November 1983. Of the 450 vehicles built, 248 were built by Krauss-Maffei (Fahrgestell-Nr. 10211 to 10458) and 202 by MaK (Fahrgestell-Nr. 20173 to 20347). The most significant changes were the deletion of the crosswind velocity sensor, and that the protection over the optical blocks at the commander's station was now faceted shape. The tank thermal sight, based on the common modules provided by Texas Instruments and built by Carl Zeiss, was now fitted to the gunner's EMES 15 primary sight during its construction and the gun control system was included in the fault detection system. The fuel fillers were repositioned from the engine deck to the left and right niche tanks, considerably reducing the time required for refuelling. An external head-set connection for the crew's intercom system was added to the left rear of the turret side. The racks of the ammunition stowage were identical to those that were to be

fitted to the M1A1 Abrams. Two foot boards were attached to the power pack, thus avoiding damage to the steering system and the electrical wiring and plugs during maintenance with the engine deck removed. The tow cable clamps on the rear deck were repositioned and the cables, now 5 m long, were crossed over on the rear plate. Due to these numerous changes this version was designated the Leopard 2 A1.

The third batch

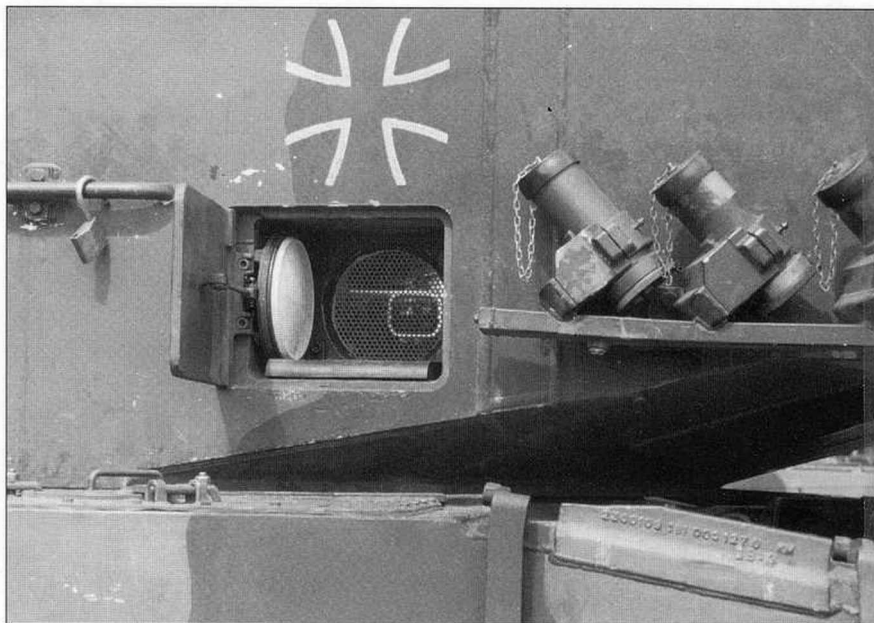
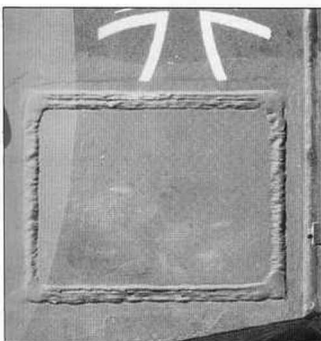
The 300 Leopard 2's of the third batch were built between November 1983 and November 1984, 165 by Krauss-Maffei (Fahrstell-Nr. 10459 to 10623) and the remaining 135 by MaK (Fahrstell-Nr. 20375 to 20509). The most notable changes were the addition of a deflector, which raised the position of the commander's PERI R-17 primary panoramic sight by 50 mm, and a larger cover plate fitted on top of the NBC protection system. These modifications were subsequently also carried out to the second-batch vehicles. The third-batch vehicles were also designated Leopard 2 A1.

The modernised first batch

When the tank thermal sight for the EMES 15 fire control system became available, it was decided to modernise the vehicles of the first batch to a similar standard as those of the second and third batches. Modernisation of the first vehicle started in 1984 and the last modified vehicle returned to its unit in 1987, which means that this programme was carried out parallel to the production of the third, fourth and fifth batches. Besides the installation of the tank thermal sight and removal of the PZB 200 (which was then used with the Leopard 1 programme, see Vanguard No. 16), it included the installation of filler openings and caps in the forward niche tanks, raising the PERI R-17 by 50mm and adding a deflector, the fitting of the large cover plate to the NBC protection system, and the repositioning of the new 5 m tow cables. Furthermore, the crosswind velocity sensor was deleted and its base mount was covered by a circular

RIGHT The ammunition supply hatch in the left turret side, seen here open, was installed in turrets of the first five batches. (Michael Jerchel)

The ammunition hatch was later welded shut to improve NBC protection. (Michael Jerchel)





This Leopard 2 A4 (second batch) was used to test a pair of mufflers, already a common sight on the Swiss Panzer 87. (Uwe Schnellbacher)

plate giving a distinctive recognition feature for vehicles of this batch, together with the circular protection ring over the optical blocks at the commander's station which remained unchanged. The modified first-batch vehicles became known as the Leopard 2 A2.

The fourth batch

The fourth batch was built between December 1984 and December 1985. Of the 300 vehicles delivered, 165 were built by Krauss-Maffei (Fahrgestell-Nr. 10624 to 10788) and 135 by MaK (Fahrgestell-Nr. 20510 to 20644). The most significant changes were the installation of new digital SEM 80/90 VHF radios, together with shorter antennae, and revised exhaust grilles with circular bars. An adjustable chest support was installed at the gunner's station, allowing him to lean on it when observing or aiming while the tank is on the move. On delivery, all vehicles of this batch sported new camouflage colours, consisting of bronze green (RAL6031), leather brown (RAL 8027) and tar black (RAL 9021). Tests had shown a possibility that the ammunition supply hatch in the left side of the turret could leak after a hit on the turret, which would mean big trouble for the crew concerning NBC protection, i.e. the loss of the overpressure provided inside the vehicle by the built-in NBC protection system. The ammunition supply hatches were therefore welded shut. The vehicles of this batch were designated the Leopard 2 A3.

The fifth batch

370 vehicles were delivered between December 1985 and March 1987, of which 190 were built by Krauss-Maffei (Fahrgestell-Nr. 10789 to 10979) and 180 by MaK (Fahrgestell-Nr. 20645 to 20825). The fire control computer of this batch was fitted with a digital core to facilitate the use of new ammunition, and to improve the crew's survivability a fire and explosion suppression system developed by Deugra was installed. Beginning with Fahrgestell-Nr. 10968 and 20788, the second and third return rollers were repositioned. The second return roller was moved from a position between the second and third road wheel stations to one between the third and fourth stations, while the third return roller was moved from a position between the fourth and fifth stations to one between the fifth and sixth road wheels. There are indications that the

This sixth-batch chassis, photographed at the WTD 41 proving grounds in Trier during 1995, was among those used as test vehicles for the Leopard 2 improvement programme. (Michael Jerchel)



ammunition supply hatch in the left turret side was deleted from very late Krauss-Maffei built vehicles. The vehicles of this batch are designated Leopard 2 A4. The final MaK built vehicle (Fahrgestell-Nr. 20825) served as the "Komponentenversuchsträger" (KVT) component trial vehicle for the Leopard 2 improvement programme.

The sixth batch

Although only five batches were originally intended to be built, an order for a sixth batch of 150 vehicles was placed in June 1987, and 83 were built by Krauss-Maffei (Fahrgestell-Nr. 10980 to 11062) and 67 by MaK (Fahrgestell-Nr. 20826 to 20892) between January 1988 and May 1989. New features of this batch were the installation of maintenance-free batteries, the introduction of Diehl 570FT tracks, and the use of zinc chromate-free paint. The central warning light was now installed in a small housing on the hull, in front of the driver's station, for better observation by the driver when driving head-out. New box-shaped



A Leopard 2 driver training tank showing its paces at the German Armour School in Münster in 1988. (Uwe Schnellbacher)



The driver training tank is basically a regular Leopard 2 MBT with a glasshouse cabin, extra weight and dummy gun instead of the regular turret. The licence plate number is quite interesting, as it denotes that this vehicle came off the assembly line at MaK immediately before the TVM II. (Gerd Schwiers)

forward sections of the side skirts were introduced with Fahrgestell-Nr. 11033 and 20869. The ammunition supply hatch in the left turret side was deleted. The vehicles of this batch are also known as Leopard 2 A4.

The seventh batch

Production of 100 seventh-batch vehicles began in May 1989 and ended in April 1990, with 55 built by Krauss-Maffei (Fahrgestell-Nr. 11063 to 11117) and 45 by MaK (Fahrgestell-Nr. 20893 to 20937). The vehicles of this batch were identical to the late sixth-batch vehicles and were also designated Leopard 2 A4.

The eighth batch

Between January 1991 and March 1992 75 vehicles were delivered, with 41 built by Krauss-Maffei (Fahrgestell-Nr. 11118 to 11158) and 34 by MaK (Fahrgestell-Nr. 20938 to 20971). Their changes included slight modification of the base mounts for the smoke mortars. The rear sections of the side skirts were now divided into six parts and of a different design and material, but they were not fitted on delivery of early models of this batch. Later on a collimator for the muzzle reference system was fitted to the right side of the 120 mm main gun, near the barrel's end, and was subsequently retrofitted to the vehicles of the previous batches. The muzzle reference system allows a quick check for the gunner of the distortion of the gun barrel in relation to the sight optics. In conjunction with the modernisation programme for the Leopard 2, two vehicles were built by Krauss-Maffei as troop trial vehicles (Truppenversuchsmuster, TVM), Fahrgestell-Nr. 11156 as TVM max. and 11157 as TVM min. The final Leopard 2 A4 (11158) of the eighth batch was handed over on 19 March 1992 to the Gebirgs-Panzerbataillon 8 (Mountain Tank Battalion) in an official ceremony in Munich.



The component trial vehicle, KVT, was taken from the fifth batch (MaK) and used for the improvement programme. The KVT was later converted to the instrument trial vehicle, IVT, seen here in 1991. (Krauss-Maffei-Werkfoto)



The TVM max. was a converted eighth-batch vehicle and was also known as TVM I. It was later used for comparative trials in Sweden. (Krauss-Maffei-Werkfoto)

Modernisation

The subsequent modernisation of the first-to-fourth batch vehicles included the installation of SEM 80/90 radios, the use of the newer Diehl 570 FT tracks, the use of maintenance-free batteries and the APFSDS-T DM-23 KE introduced in 1983, and later on the newer APFSDS-T DM-33 KE round with a new monobloc tungsten penetrator. These modifications led to a redesignation, and the modified vehicles are also designated Leopard 2 A4 despite the fact that vehicles beginning with the fifth batch have a fire suppression system, whereas those of the first four batches only have a fire extinguishing system. The modernised first-batch vehicles could also be distinguished from later batches by still having a circular cover plate over the socket for the disused crosswind velocity sensor, and also by the circular protection ring over the optical blocks at the commander's station.

After delivery of the last eighth-batch vehicle there were 2,125 Leopard 2 A4 in service with the Bundeswehr. The Leopard 2 was designed to meet the requirements of modern mobile combat to counter the Soviet threat to Central Europe. It uses advanced technologies to achieve enhanced performance, with optimal results in the combination of armour protection, firepower and mobility which place it among the leaders in modern tank design.

INSIDE THE LEOPARD 2A4

Engaging a target

To steer the tank, the driver simply turns the control lever left or right. Four forward gears are available; the slowest speed forward in first gear is 4 km/h and the maximum speed in first gear is 15 km/h, in second 31 km/h, in third 45 km/h and in fourth 68 km/h. In automatic mode, which includes all four gears, the maximum speed is also 68 km/h. Acceleration from 0 – 32 km/h is achieved within six seconds. In the first reverse gear maximum speed is 15 km/h, and in the second 31 km/h. When turning on the spot is required, the direction pre-selector of the



The TVM 2 was built to the 'Mannheim Configuration' and was less sophisticated than the TVM 1. It is seen here during tri-national troop trials in Münster in October 1993. (Jerchel/Krauss-Maffei 93278)

gearbox is switched to the desired direction – i.e. left or right – and the engine is accelerated to 1500 rpm before the driver simply fully turns the control lever in the desired direction. Turning on the spot is carried out within 10 seconds. For driving forward the pre-selector is switched upwards and for reversing it is switched downwards.

In combat the loader takes one of the 15 120 mm rounds stored in a special magazine, with an electrically driven sliding door, in the turret bustle and loads the gun. Depending on the target to be engaged, this could either be a APFSDS-T DM-23 KE (Kinetische Energie) round, with a monobloc tungsten penetrator, or a HEAT-MP-T DM-12 MZ (Mehrzweck) round. The total combat load is 42 rounds. The breech of the 120 mm L/44 Rheinmetall smooth bore main gun is semi-automatic, opening after each round is fired. Both types of round have semi-combustible cartridge cases, and after firing the remaining base stub is ejected into an attached bag. The breech has a guard to protect the crew.

The Krupp Atlas Elektronik fire control system (FCS) of the Leopard 2 A4 enables the crew to engage moving or stationary targets in day and night operations. When the commander has identified a target with his PERI-R 17, the gunner takes over to engage as soon as the commander has slewed the turret to the target's azimuth. The gunner identifies the target through the HZF sighting channel of the EMES-15, which has a x12 magnification and a 5 degree field of view. Relevant target range data and system information are superimposed by the FCS on the lower part of the sight image. The tank thermal sight is used for identification and tracking of camouflaged targets and at night or in poor visibility. Target markers are superimposed on the image, which is injected into the ray path of the daylight channel. The mirror of the EMES 15 is stabilised in azimuth and elevation. The sighting channel is located to the right in the EMES 15 housing and an integrated Nd:YAG laser rangefinder is installed to the left. The daylight channel, laser transmitter, laser receiver and tank thermal imaging channel are all routed via the same mirror to ensure exact alignment. The tank commander can also use the tank thermal sight, as the picture can also be transmitted to his fully stabilised PERI-R 17 primary panoramic sight.

The digital ballistic computer calculates the angle of sight and lateral

The first new Leopard 2 A5's were handed over to the Panzertruppenschule in Münster. The one shown here comes from the sixth batch and was originally built by MaK. (Michael Jerchel)



The first armoured battalion to receive the new version in December 1995 was PzBtl. 33. This sixth-batch vehicle, built by Krauss-Maffei, has the early version of the TIM PERI-R 17A2 commander's sight without armour fitted. This sight was eventually replaced by the latest standard issue. (Detmar Modes/BMVg)

angle lead for the 120 mm main gun, taking into account the target range, the Leopard 2's cant angle, the direction of motion with regard to the target, crosswind velocity and direction (automatically measured with the original first batch, but manual input is required with the later and the modernised first batches), and the ballistic data of the selected ammunition (data for up to seven different ammunition types are carried). The calculated firing solution is then transferred to the weapon control and stabilisation system, which lays the main gun to the line of sight of either the gunner's or commander's sight as required. When the target is identified, its range is measured by the Nd:YAG laser





A recently completed Leopard 2 A5 on the test course at MaK in Kiel, where it was converted from a seventh-batch vehicle. The new components have not yet been painted in the proper camouflage colours. (Michael Jerchel)

rangefinder, which has a maximum range of up to 9,990 m. The gunner then keeps the sight on the target using his hand controller. The fire control system includes aids for aiming and range correction, such as the gunner's dynamic lead, commander's automatic tracking integrator, automatic range correction when approaching the target, and tracking action of the line of sight to compensate for the Leopard 2's own motion. The collected target information is automatically presented to the ballistic computer with the other relevant data listed above. The fire control system

continuously computes the main armament's settings in both elevation and azimuth. Once locked on the target, the 120 mm smooth bore main gun may be fired. If the EMES 15 malfunctions, the gunner can use a monocular Turmzielfernrohr (TZF) FERRO-Z 18 telescope, built by Leitz, with a magnification of x8 and a 10 degree field of view. Manual controls allow the turret to be turned manually, and the gun to be elevated and depressed, if the hydraulic system is inoperable.



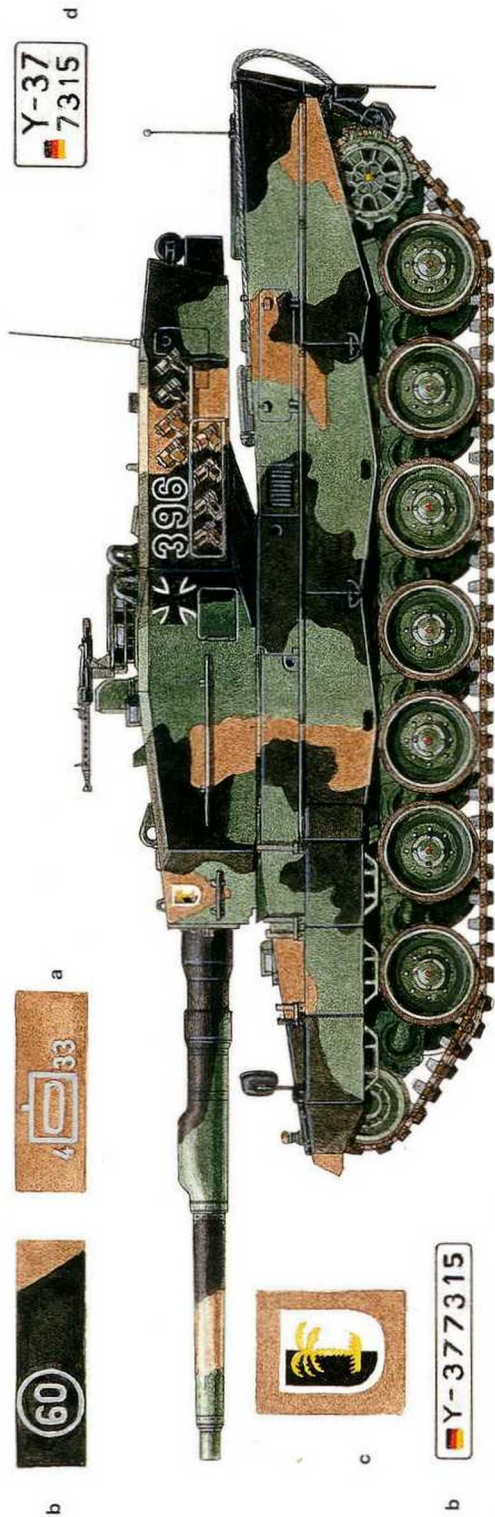
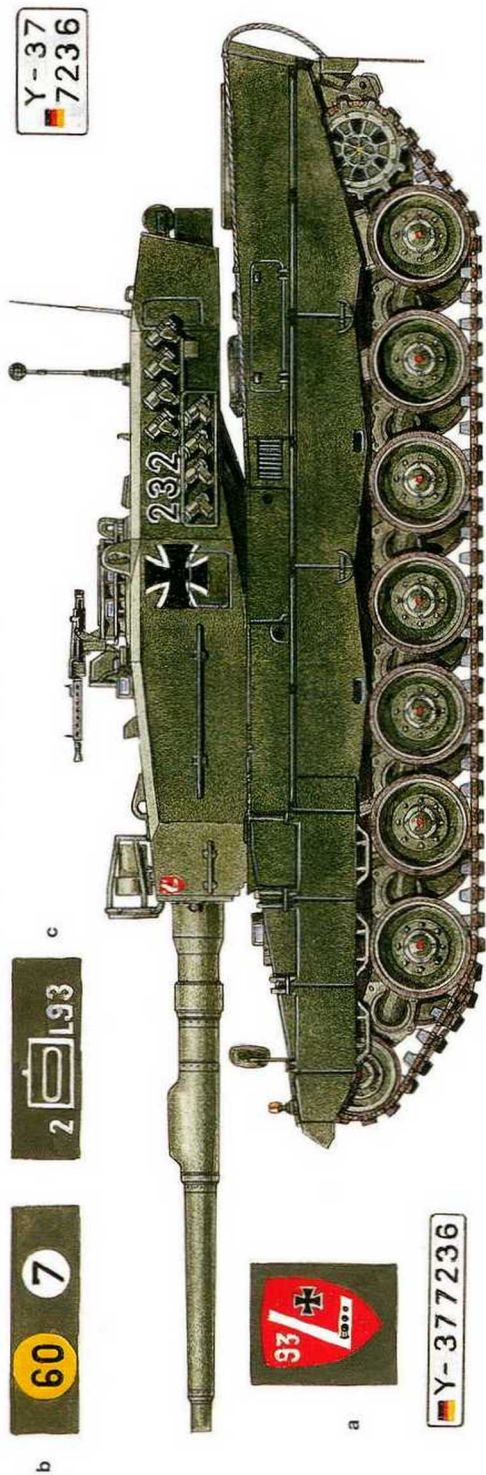
This Krauss-Maffei built Leopard 2 A5 (seventh batch) was converted by MaK in 1996 and serves with PzBtl. 214 in Augustdorf. (Sabine Rotter)

THE IMPROVED LEOPARD 2

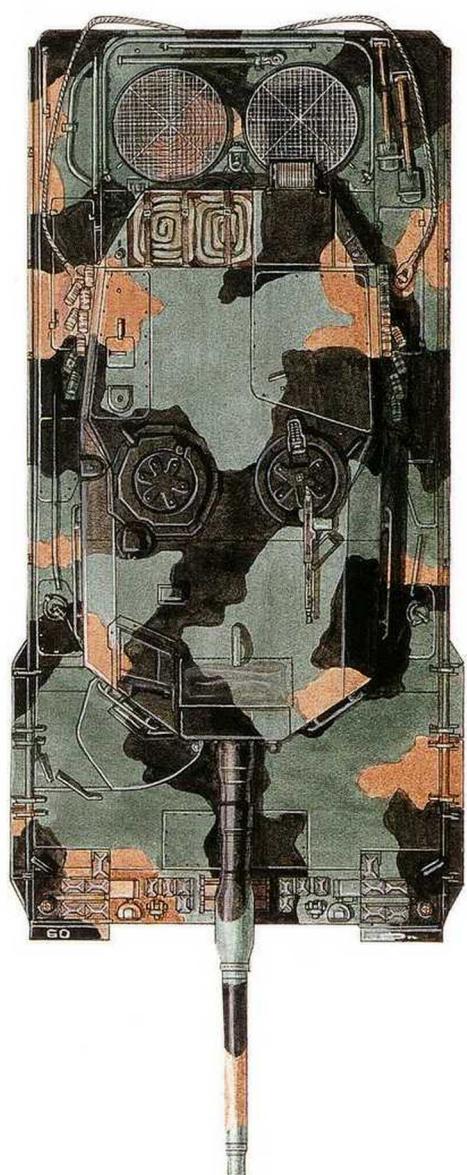
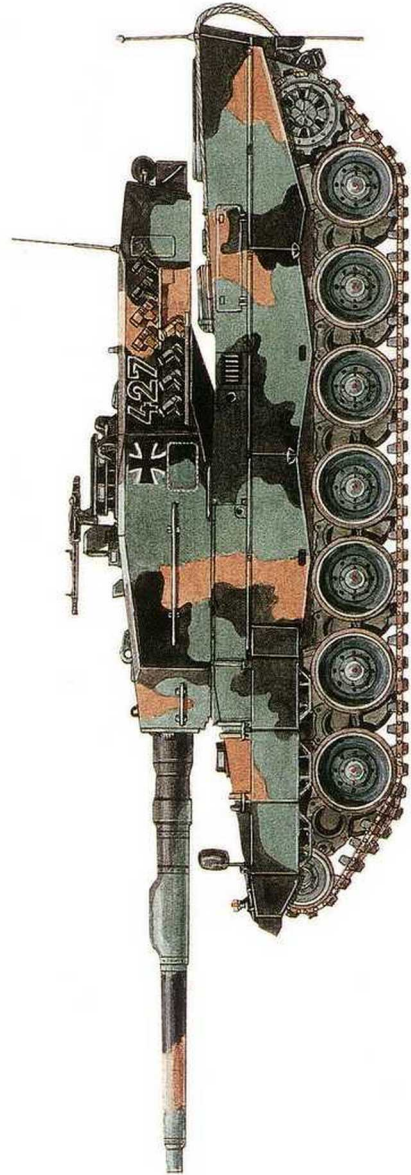
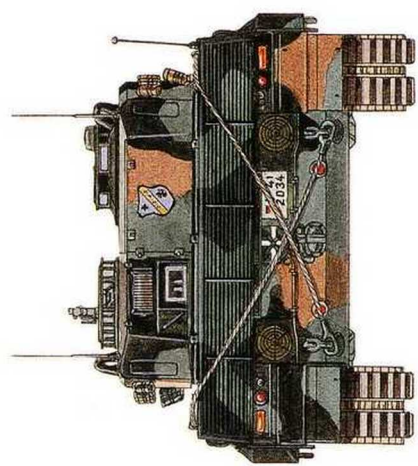
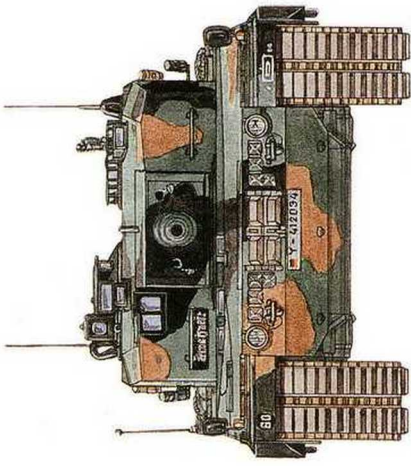
Leopard 2 A5

In a modern world the pressure for modernisation is a matter of course, but in the field of military technology it is a bitter necessity. With the appearance of modern and capable Soviet tanks such as the T-64 B and T-80 B, equipped with a high-performance 125 mm smoothbore gun capable of firing guided missiles, the development of an even better Leopard 2 was demanded. However, cooperation between nations over their tank industries sometimes seems to be difficult. After the cancellation of a joint French-German tank development project in November

1: Leopard 2 with PZB 200 (first batch), Panzerlehrbataillon 93, Panzerlehrbrigade 9, Munster 1980

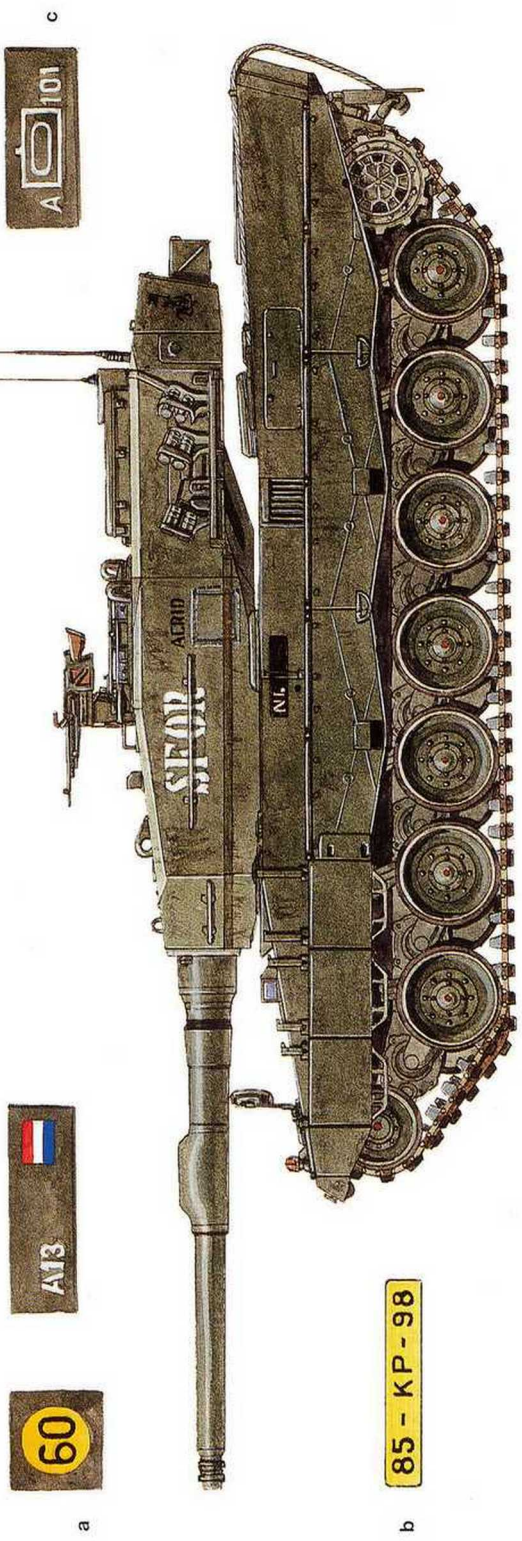


2: Leopard 2 A2 (modified first batch), 4th Company, Panzerbataillon 33, 1st Panzerdivision, Luttmersen 1988



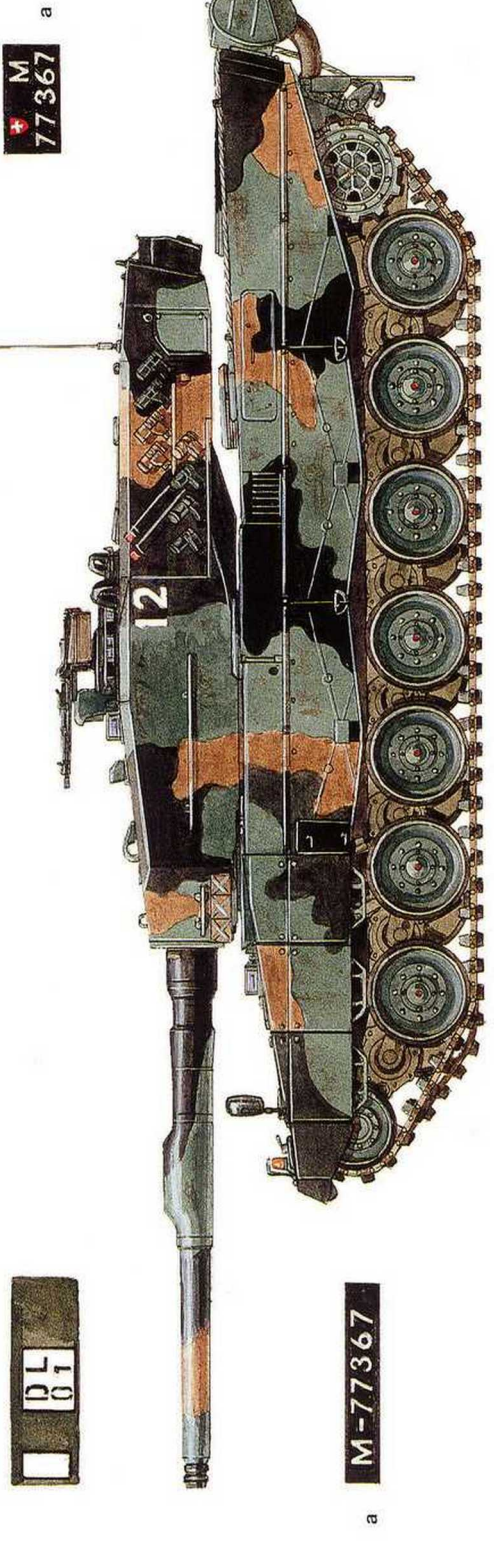
Leopard 2 A4 (second batch), 4th Company, Panzerbataillon 24, 1st Panzerdivision, Braunschweig 1991

1: Leopard 2 NL, A Sqdn, 101 Mechanised Battalion RHPA, NLCONSFOR, Multi-National Division (South West), Novi-Travnik, Bosnia and Herzegovina, April 1997



85 - KP - 98

2: Panzer 87 Leopard 2, Panzertruppenschule, Thun 1993



M-77367

LEOPARD 2 A4 (fifth batch)

3RD COMPANY, PANZERBATAILLON 64, MDC IV/5TH
PANZERDIVISION, SCHWARZENBORN 1996

SPECIFICATIONS

Crew: Four (Tank commander, driver, gunner, loader)

Combat weight: 55,000 kg (Max. weight: 55,150 kg)

Ground pressure: 8.3 N/cm²

Power-to-weight ratio: 27 PS/t

Hull length: 7.72m

Overall length: 9.67m

Width: 3.75m

Height to turret roof: 2.48m (2.87m to top of PERI-R 17) Turning radius, turret @ 6 o'clock: 9.5m (turret @ 12 o'clock 11.5m)

NBC protection system: Dräger-Piller compact system, working on up to 4 mbar overpressure)

Engine: MTU MB 873 Ka-501, liquid cooled V-12 cylinder 47.6 litre 4-stroke exhaust turbo-charged diesel engine, developing 1500 PS (1104 kW) @ 2,600 rpm

Transmission: Renk HSWL 354 hydro-kinetic planetary gear shift, 4 forward and 2 reverse gears

Fuel capacity: Approx. 1,160 litres

Max. speed (road): 68 km/h

Max. speed in 2nd reverse gear: 31 km/h

Fording depth: 1.2m

Deep wading depth: 2.25m

Underwater drive: 4m

Slope: 60° gradient, 30% side slope

Obstacle: 1.10m vertical, 3m trench

Main gun: Rheinmetall 120mm L/44 smoothbore

Stowed maingun ammunition: 42 rounds

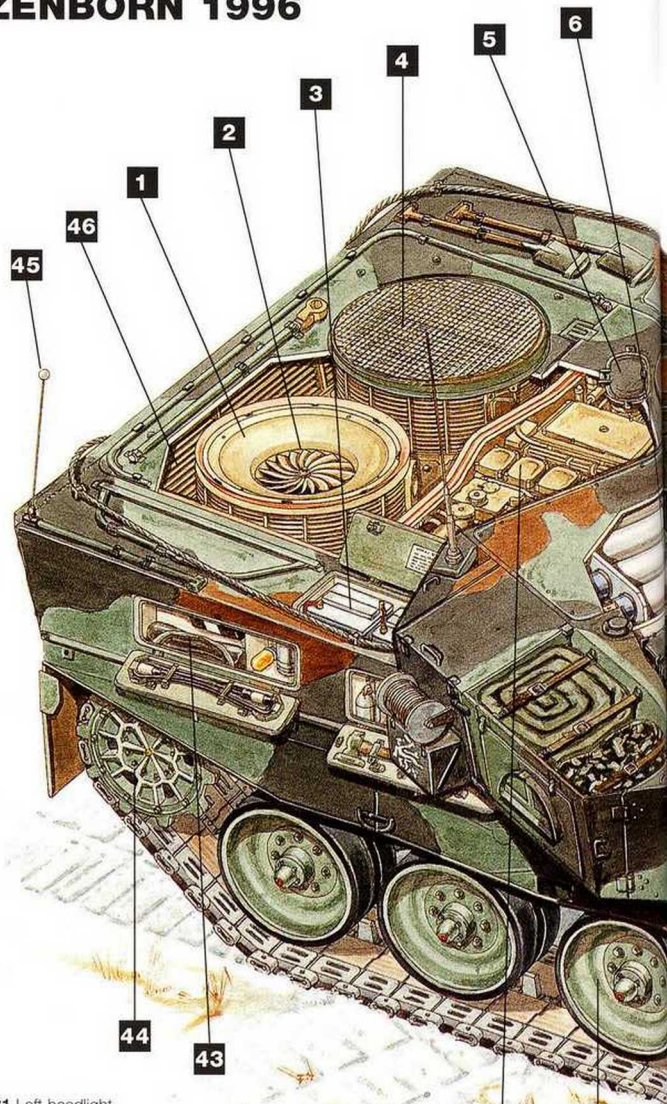
Gun depression/elevation: -9 to +20°

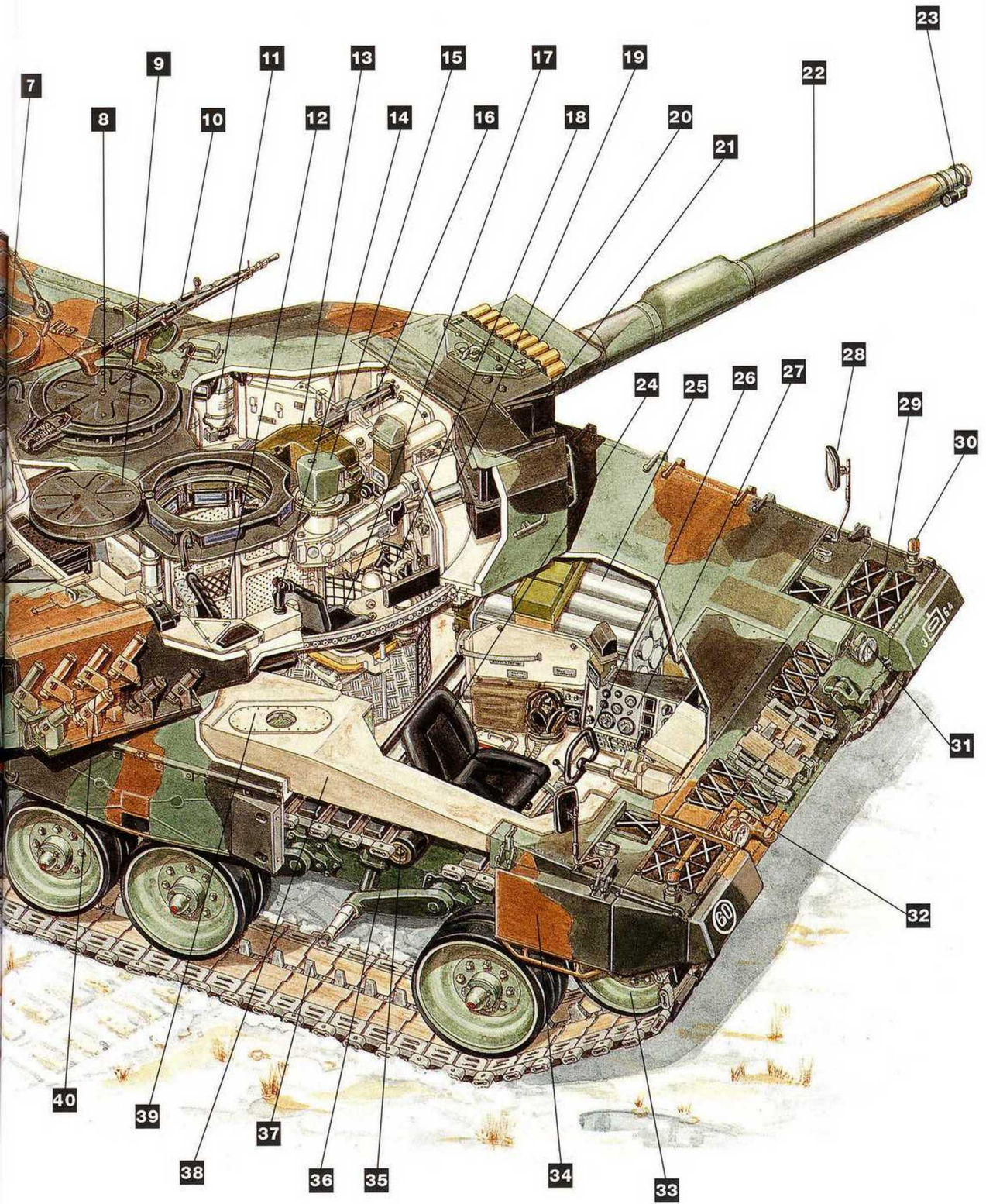
Secondary armament: One co-axial 7.62mm MG 3 A1, one air-defence 7.62mm MG 3 A1

Smoke dischargers: 16 Wegmann 76mm smoke mortars, firing DM 35 smoke mortars either in single rounds or in groups of four, with the ability to also fire fragmentation grenades (not yet in service)

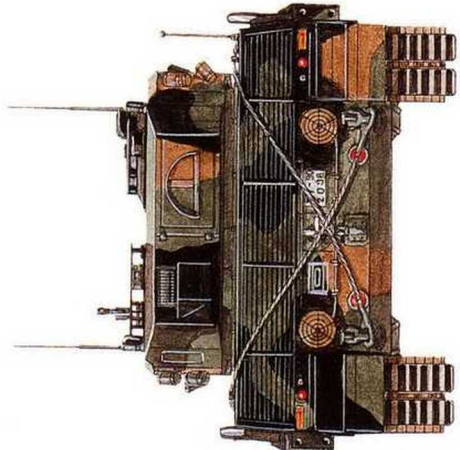
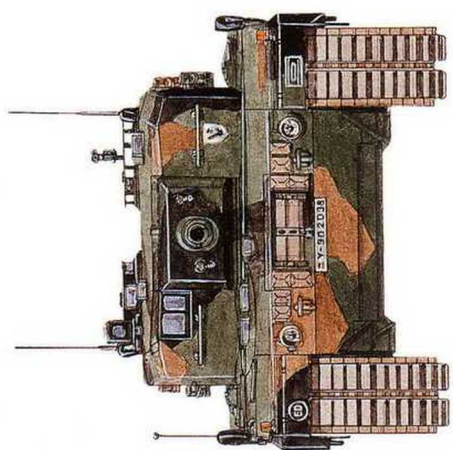
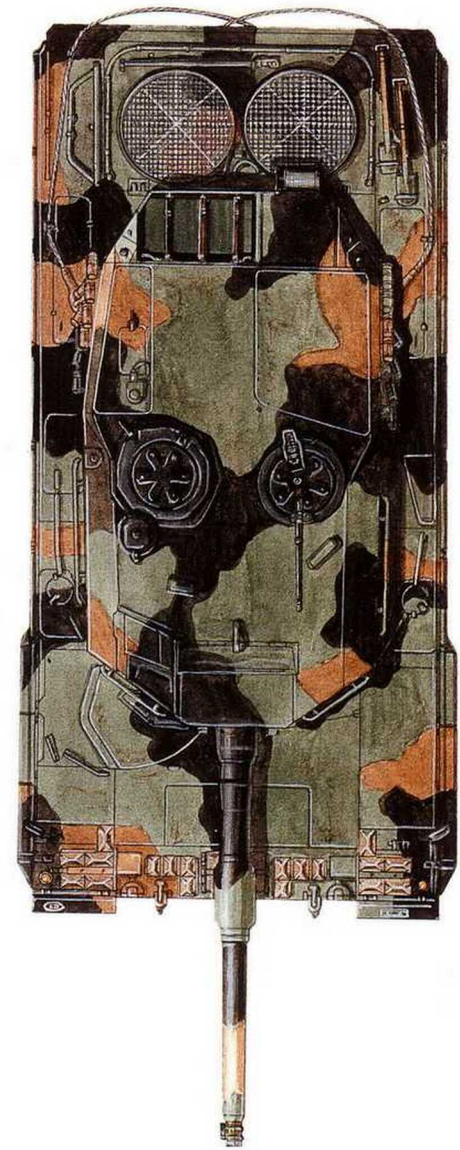
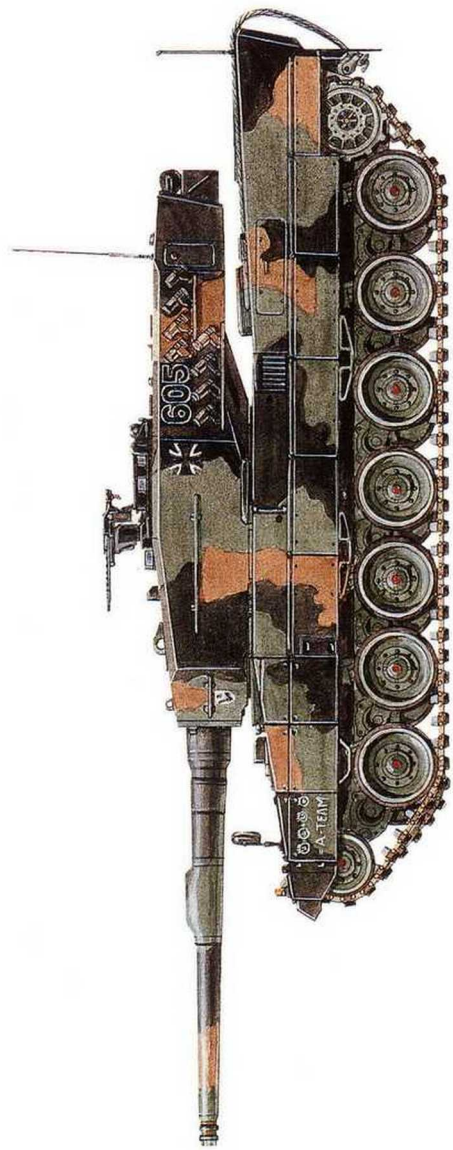
KEY

- | | | |
|---|---|---|
| 1 Ring type radiator | 16 Co-axial 7.62mm MG 3 A1 machine gun | 31 Left headlight |
| 2 Coolant fan assembly | 17 Gunner's station | 32 Towing shackle |
| 3 12-Volt/ 125 Ah battery in right hand side battery compartment | 18 Gunner's controls | 33 Idler wheel |
| 4 Cooling air intake grill | 19 Sighting channel of EMES 15 gunner's primary sight | 34 Section of heavy armoured skirts |
| 5 Maintenance hatch for engine and transmission oils (lubricants) | 20 Gun-fire simulator | 35 Return roller |
| 6 Turret bustle ammunition stowage | 21 EMES 15 housing | 36 Suspension arm and road wheel station |
| 7 Combustion air intake | 22 Rheinmetall 120mm L/44 smoothbore main-gun | 37 Track guide horn |
| 8 Loader's hatch | 23 Muzzle reference system | 38 Right niche fuel tank |
| 9 Commander's hatch | 24 Driver's station | 39 Filler opening |
| 10 MG 3 air defence machine-gun | 25 Hull ammunition syowage rack | 40 Wegmann 76mm smoke mortar |
| 11 Fire extinguisher | 26 Driver's steering column | 41 Road wheel |
| 12 Commander's station | 27 Driver's instrument panel | 42 MTU MB 873 Ka-50 powerpack |
| 13 Gun breech of 120mm main gun | 28 Leftside rear-view mirror | 43 Rear right tool compartment |
| 14 Commander's control handle | 29 Groucers | 44 Drive sprocket |
| 15 Commander's PERI-R 17 primary panoramic sight | 30 Left position light/ indicator | 45 Length indicator aid for the commander |
| | | 46 Coolant air outlet grill |

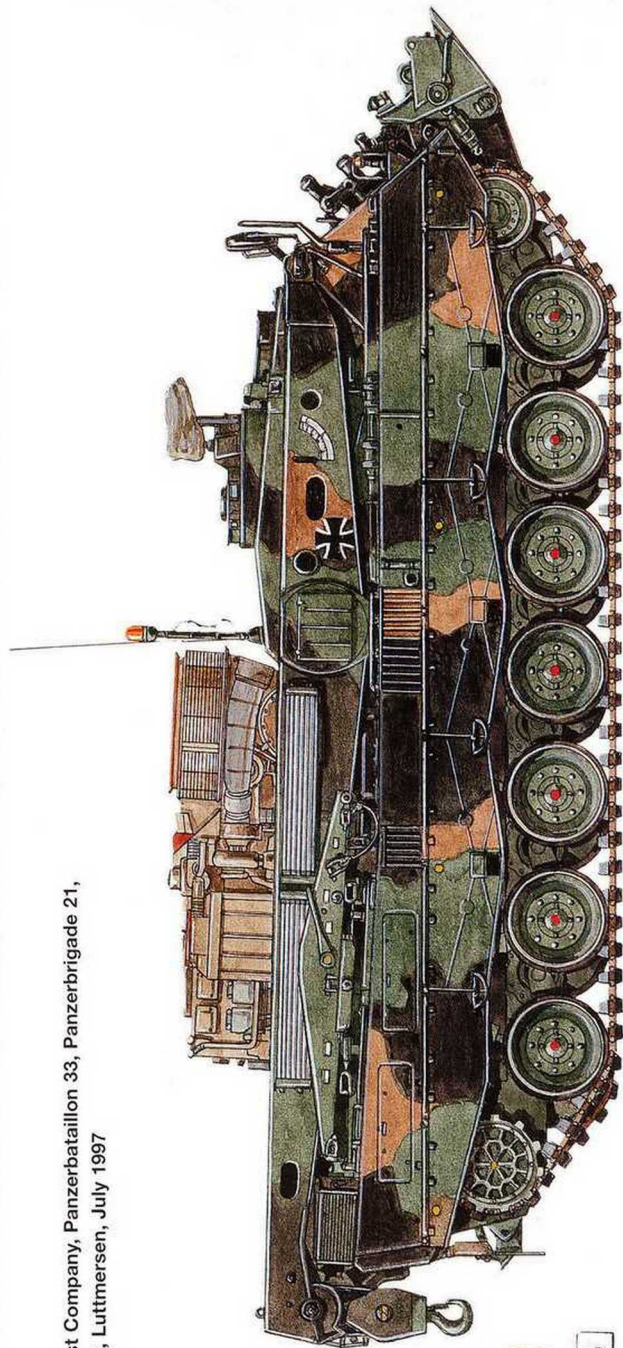





Leopard 2 A4 (eighth batch), Panzertruppenschule, Münster 1992



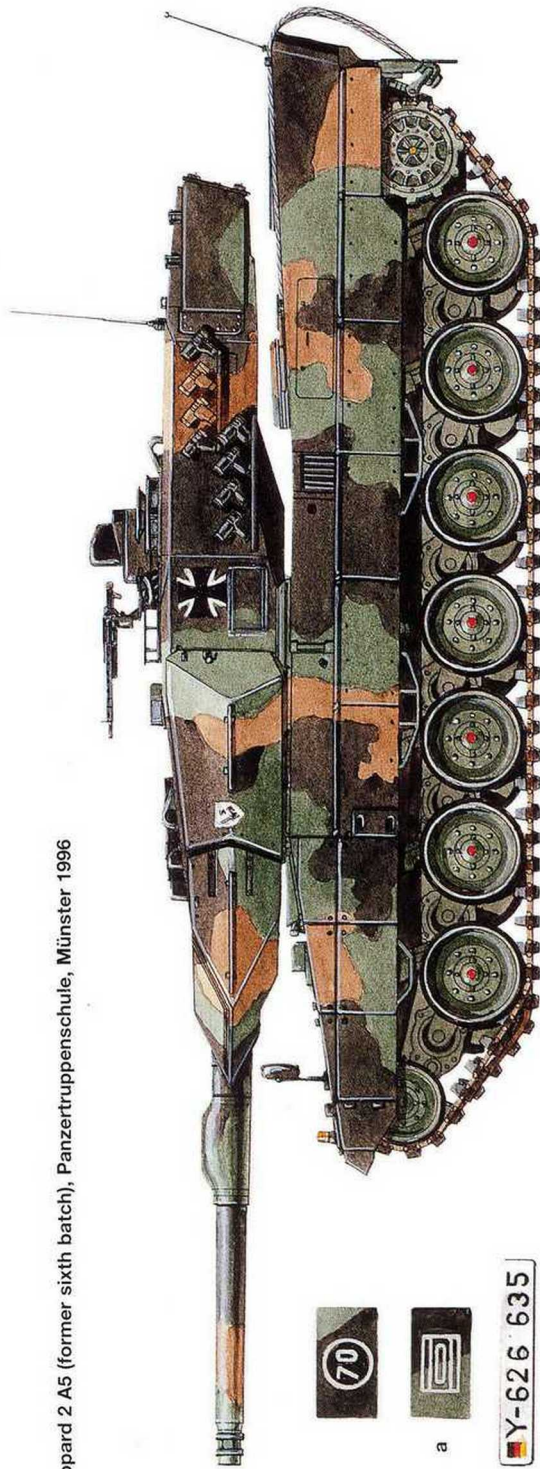
1: Bergepanzer 3 Büffel, 1st Company, Panzerbataillon 33, Panzerbrigade 21, MDC III/7th Panzerdivision, Luttmersen, July 1997



a **WOTAN**


 **Y-820 743**

2: Leopard 2 A5 (former sixth batch), Panzertruppenschule, Münster 1996

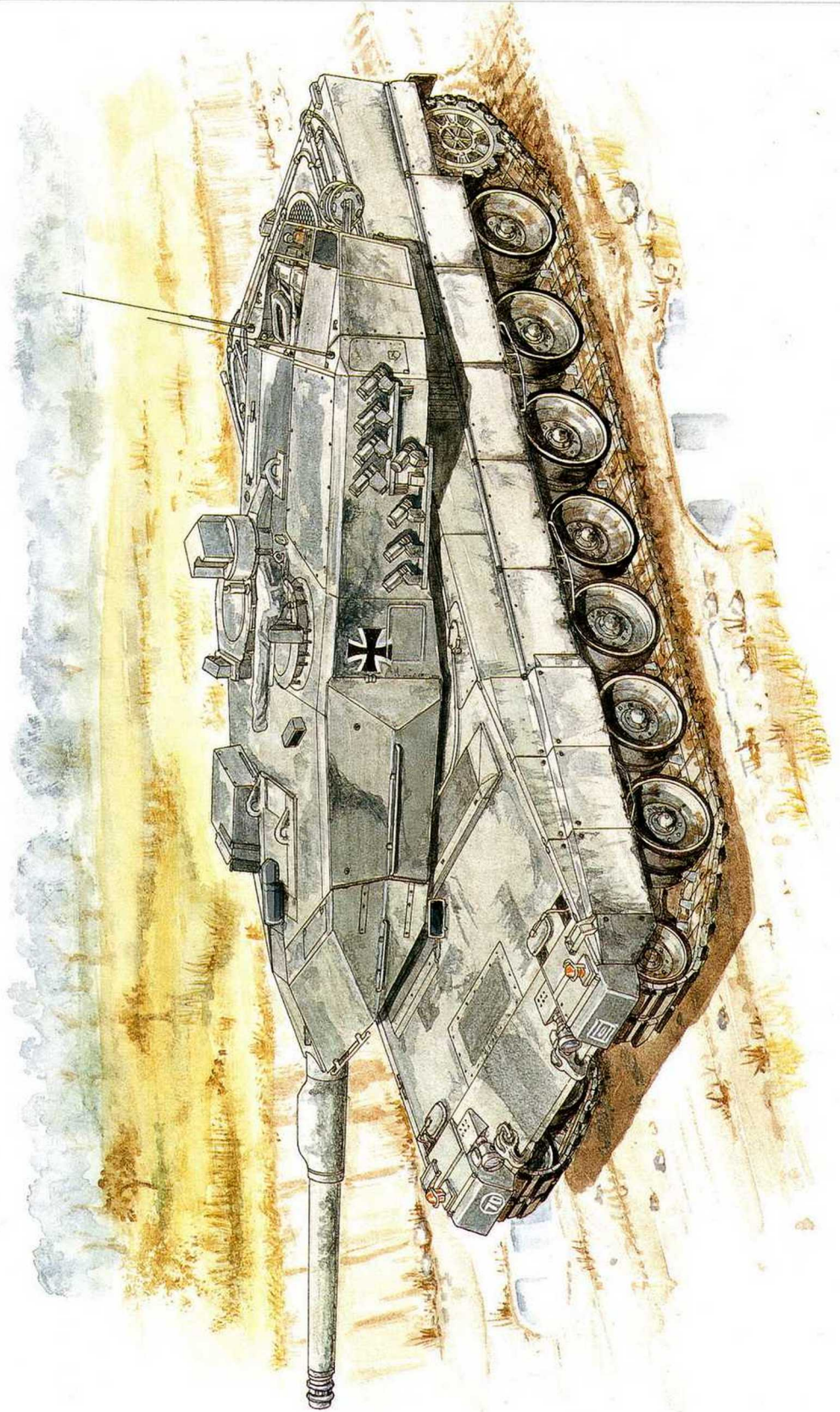


 70

a 

 **Y-626 635**

Truppenversuchsmuster II, Truppenversuchskommando KWS II, Panzertruppenschule/ATV-Stab, Münster 1993



1982, Germany extended the concept phase for a Leopard 3 in March 1983 to last until 1996. Several alternatives had to be examined, including production of additional Leopard 2s, improvement of the Leopard 2, development of a new turret on the Leopard 2 hull with a crew of either four or of three with an automatic loader, or development of a new hull and a new turret.

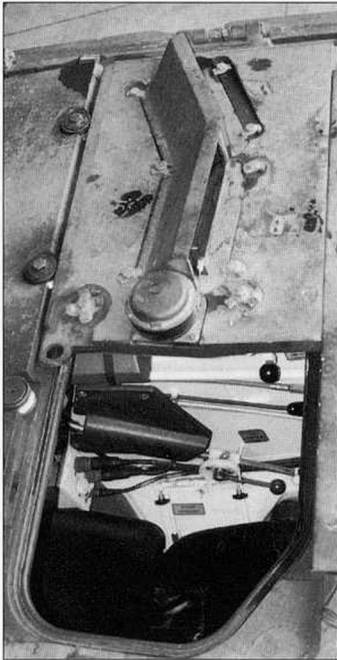
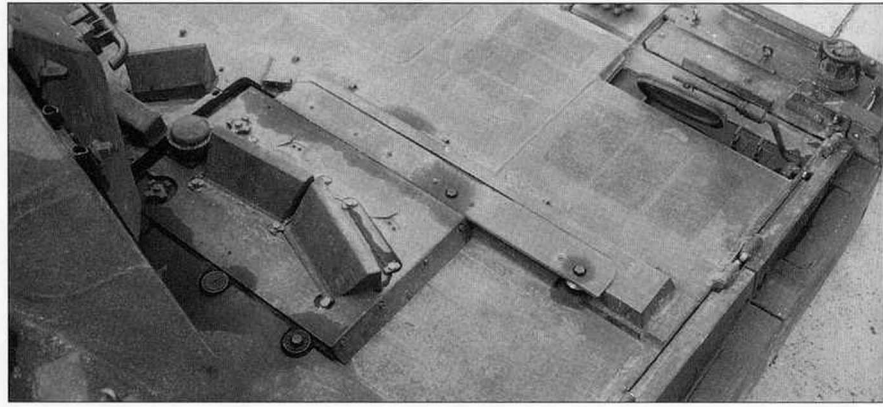
The development of improved components for the Leopard 2 was finally favoured, and in 1989 the Leopard 2 KVT (Komponentenversuchsträger, i.e. component trial vehicle) was built and tested. The final MaK-built fifth-batch vehicle, Fahrgestell-Nr. 20825 with licence plates Y582 391, was fitted with additional armour, spall liners in the fighting compartment, a new type of electrically driven sliding hatch for the driver, rearranged hatches for the commander and loader, and increased passive and reactive armour on the turret roof. The EMES 15 was raised and given an armoured housing and the PERI-R 17, now including an independent thermal sight channel, was relocated to the left rear of the commander's station. This vehicle had a total weight of about 60,500 kg. After the trials this vehicle was converted into the IVT (Instrumenten-Versuchsträger, i.e. experimental vehicle for instruments) and joined the IFIS (integrated command and information system) development programme carried out between 1988 and 1992, which researched in cooperation with the USA the more efficient management and use of gathered information.

Also involved in this programme were two rather unusual-looking Versuchsträger-2000's (VT, experimental vehicle), based on the Leopard 2 chassis and used to evaluate a concept for a 2 x 2 man crew. However, after evaluation of the development tests with the KVT, two Truppenversuchsmuster (TVM, troop trial vehicles) were built in 1991 by Krauss-Maffei for the improvement programme, known as KWS. Taken from the eighth batch, these vehicles became known as the TVM max. (Y-907 792/Fahrgest.-Nr. 11156) and TVM min. (Y-907 793/Fahrgest.-Nr. 11157) and were intensively tested by a specially



This view of the same PzBtl. 214 tank shows the racks on the turret rear for chocks and spare end connectors. The driver's rear-view camera can be seen above the coolant air outlet grille, in an armoured box. An attached sighting device allows the commander to judge the vehicle's rear end when manoeuvring. (Michael Jerchel)

The most significant change to the hull of the Leopard 2 A5 is the new electrically driven sliding hatch for the driver, seen here closed. (Michael Jerchel)



The driver's sliding hatch in the open position. (Michael Jerchel)

formed unit (Truppenversuchskommando) from December 1991 to April 1992. A number of shortcomings on the technical side were mostly eventually solved at the Technical School in Aachen.

The overwhelming political changes within the Eastern Bloc, and the resulting decreasing defence budgets, dramatically influenced the improvement programme. Between 1990 and 1993 the Panzertruppe had to defend itself against philosophies that regarded light airmobile forces as being more suitable to a modern battlefield. Due to the constantly decreasing defence budget, plans to convert 699 vehicles to the Leopard 2 improved standard achieved by the TVM max had to be dropped. An alternative improvement programme was initiated, divided into three stages and known as KWS I, KWS II and KWS III (the Roman numerals do not denote chronological order). KWS I combined the fitting of a longer L/55 120 mm main gun and the use of improved ammunition, having an increased muzzle velocity of 1,800 m/s; KWS II was the development of increased armour protection for the crew and improved command and control system capabilities; KWS III was intended to mount a 140 mm main gun.

On 29 October 1991, Switzerland, the Netherlands and Germany signed an MoU for cooperation in the development programme for KWS II. A contract was signed on 30 March 1992 by the three nations, following agreement about the configuration of KWS II at a conference held in Mannheim, known as the 'Mannheim Conference'. A TVM 2 (converted from the MaK-built fifth-batch vehicle Y-567 056/Fahrgest. Nr. 20823) was built to the 'Mannheim configuration' and intensively tested, with several detail modifications, between 1993 and 1994. A contract was finally signed on 29 December 1993 between the German MoD and Krauss-Maffei, which had been selected as prime contractor for this programme, to convert 225 Leopard 2 A4's to the new Leopard 2 A5 standard, with an option for a further 125 vehicles. The Netherlands signed a contract for the conversion of 330 vehicles, and Switzerland will follow in the next century. The first Leopard 2 A5's were officially handed over to the German Armour School on 30 November 1995. The Leopard 2 A5 will equip the four Panzerbattalions (33, 214, 393 and 104) of the German Crisis Reaction Forces (KRK), with PzBtl. 33 being the first unit to receive Leopard 2 A5's in December 1995. Chassis of the sixth, seventh and eighth batches are used for the conversion programme and will receive reworked and modernised turrets taken from tanks of the first four batches. Modernisation of the chassis

is carried out by Krauss-Maffei and MaK while Wegmann and Rheinmetall are responsible for the turrets.

The most significant change to the hull of the Leopard 2 A5 is the new driver's hatch, which is now electrically operated and slides to the right to open. A deflector is mounted to the left of the driver's station, with stowage brackets for camouflage support poles. A camera mounted above the rear cooling air outlet is connected to a monitor on the driver's dashboard to enable him to reverse at high speed, without needing direction by the commander. The road wheel hubs are now made of steel, replacing those made of aluminium.

The turret front and sides are fitted with wedge-shaped add-on armour in sections, which can easily be replaced by field workshops if hit or be replaced at a later stage by even more advanced armour. The side panels of this extra armour are hinged to swing forward, necessary when the engine is to be replaced. The gun mantlet is completely redesigned and additional stowage boxes are fitted to the turret rear and sides. The interior of the turret is now fitted with a spall liner for improved protection against splinters. The electro-hydraulic gun control and stabilisation system was replaced by an all-electric system. The optical head assembly of the FERRO Z-18 auxiliary telescope was relocated to a position on top of the gun mantlet, and the commander's PERI-R 17 panoramic sight has been moved to the left rear of the commander's station. The commander's improved independent sight, designated the PERI-R17A2/TIM, now includes a thermal channel whose image is displayed on a monitor at the commander's station. This can also display the gunner's day-or night-vision image to the commander, while he can see his own day-vision image through his eyepieces. The laser range data processor was modified, and now accepts both the first and second echoes of range measurement as valid. With the Leopard 2 A4 only the second and more distant echo is accepted as valid. This acceptance of the first echo now enables the Leopard 2 A5 to engage helicopter targets with APFSDS-T



Two Leopard 2 A5's were used for troop trials with the longer 120 mm L/55 smooth bore gun at the German Armour School in 1997, with both crews coming from PzBtl. 33. The vehicle shown here has just finished a deep wading operation and the three-piece snorkel is attached to the commander's station. (Michael Jerchel)



A Leopard 2 NL of 41st Tank Bataljon, with the unit crest applied to its turret sides, is seen here during exercise 'Free Lion' in September 1988. The FN MAG machine gun, Dutch smoke mortars and antenna base are shown to good advantage. (Michael Jerchel)

a long-barrelled 120 mm L/55 main gun developed by Rheinmetall. Troop trials were conducted during 1997 at the Münster Armour School, and the new gun is ready to enter service.

Hybrid Leopard 2

As a result of the Leopard 2 A5 improvement programme a number of chassis of the first to fourth batches, whose turrets were required for the Leopard 2 A5, were fitted with the turrets of the sixth to eighth batches, whose chassis were also required for the Leopard 2 A5. The warning light was repositioned from the driver's dashboard on to the hull, in front of the driver's hatch. The slightly modified bases for the smoke mortars on the turret sides, introduced with the eighth batch, are now used.

THE LEOPARD 2 IN FOREIGN SERVICE

The Netherlands

The Netherlands showed very early interest in the Leopard 2 as it was looking for a replacement tank for its ageing fleet of 369 Centurion MBTs and 130 AMX-13 light tanks, to add to the modern fleet of Leopard 1 NL that were delivered between 1969 and 1972. The Netherlands examined the results of the tests between the XM1 and the Leopard 2 AV very carefully, and decided to purchase the better tank. Therefore the Netherlands placed an order on 2 March 1979 for 445 Leopard 2's, with delivery to begin in 1982. It was agreed that Dutch industry would participate in the production of components and parts to approximately 60 per cent of the value, which was based on the price of German vehicles being DM 3.2 million in 1980 for each Leopard 2. The first four Leopard 2 NL's were completed in July 1981, and the main contract delivery began in July 1982. The delivery rate of 10 vehicles a month was achieved in November 1982, and the last Leopard 2 NL was delivered in July 1986. Of the 445 Leopard 2 NL's, derived from the second and third German production batches, 278 were built by Krauss-Maffei (Fahrge-Nr. 12001 to 12278) and 167 by MaK (Fahrge-Nr. 22001 to 22167). The 41 Tankbataljon of 41 Armoured Brigade/4 (NL) Infantry Division, then stationed in Germany with Headquarters in Seedorf (NL), was the first unit

ammunition. A GPS vehicle navigation system is built in, with the GPS antenna installed at the rear right on the turret roof. The additional armour has increased combat weight to 59,500 kg, which has not affected mobility as the tank was originally designed to accept such an increase.

Two Leopard 2 A5's of the seventh batch (Fahrge-Nr. 11108 and 11110) have been fitted for the KWS I programme with

The Dutch contingent in Bosnia, deployed in 1996 as part of the Implementation Force (IFOR), included a squadron of Leopard 2 NL's. (Carl Schulze)



to receive the new tank in 1983. The Leopard 2 NL differs from its German counterpart in having a Dutch-designed smoke mortar system with six barrels on each side, a Dutch-built passive night periscope for the driver, a 7.62 mm FN MAG machine gun installed co-axially to the main gun and one further MAG for air defence, and Philips-built radios with US-style radio antenna bases. Like their German counterparts, the Dutch Leopard 2s received modifications such as the welding shut of the ammunition supply hatch in the left turret side and the fitting of a collimator for the muzzle reference system at the barrel's end. Additionally, a fleet of 20 Leopard 2 driver training tanks are currently in operation with the Royal Netherlands Army (RNLA) and 25 Bergingstank 600 kN Büffel ARVs provide maintenance support to units equipped with the Leopard 2 NL. However, in January 1993 the RNLA announced plans to phase out 115 of its 445 Leopard 2 NL's, which were sold to Austria, and to upgrade the remaining 330 vehicles to the standard of the German Leopard 2 A5. The first unit so equipped was 42 Tankbataljon, now stationed in Havelte (NL) as part of 41 Lichte Brigade, with the first improved Leopard 2 NL delivered in May 1997. The vehicles sport the camouflage scheme invented by Germany and adopted by most NATO countries, but retain the Dutch radios, antenna bases, FN MAG machine guns and smoke

A Leopard 2 NL of 41 Tankbataljon, seen during exercise 'Light Viper' in 1993. Camouflage netting is draped around the turret to break up the vehicle's silhouette. (Michael Jerchel)



mortars. It is expected that the Netherlands will adopt the longer Rheinmetall 120 mm L/55 main gun for their fleet of Leopard 2 A5 NL's at a later stage.

Swiss Panzer 87 Leopard 2

After the decision to stop the development programme for the Neuer Kampfpanzer (NKPz) in December 1979 due to overwhelming costs, the Swiss government decided instead to go for the option



When the IFOR mandate ended in December 1996 it was immediately followed by the Stabilization Force (SFOR) mandate. This Leopard 2 NL of A Squadron, 101st Tank Bataljon bears the new SFOR markings on its turret while on patrol in April 1997 in Novi Travnik, Bosnia. (Michael Jerchel)

to either purchase or licence-produce M1 Abrams or Leopard 2's. A total of 420 vehicles was originally planned to be ordered to replace the Centurion MBT and, in part, the Kampfpfanzter 61. A decision was to be made after comparative tests of both contenders on Swiss soil. Intensive tests were carried out with two vehicles of each type between August 1981 and June 1982 and the Leopard 2 was finally selected on 24 August 1983 for Swiss service, with funding granted by the Swiss government in December 1984.

Thirty-five of the 380 vehicles ordered were delivered by Krauss-Maffei (Fahrgestell-Nr.13001 to 13035) in March and June 1987 and the remaining 345 vehicles were produced under licence at the Federal Construction Works in Thun (Eidgenössische Konstruktionswerkstätte Thun, KWT). The prime contractor for licence production was Contraves, which started production in December 1987 of Fahrgestell-Nr. 13036 to 13380 at a rate of six vehicles a month. The last Panzer 87 Leopard 2, as the vehicle is officially known in Swiss service, was delivered in March 1993.

The Pz 87 Leopard 2 differs from its German counterpart in having a slightly altered turret rear, with a slope at the rear left side, and an additional stowage box for the camouflage net on the right turret rear. On the left turret rear is a box containing the external head-set connection for the crew's intercom. Swiss-made WF Bern 7.5 mm MG 87 machine guns are installed, one mounted co-axially to the main gun and one fitted to the loader's station on a Swiss-built MG mount for air defence. AN/VCR 12 radios of US design, also produced under licence, are installed. On the left and right sides of the turret, next to the 76 mm Nebelwerfer 87 smoke mortars, are two tubular cases for interim storage of hot exchanged machine gun barrels. Three grousers are stowed on the left turret side and a further seven on the right, which with the 18 carried on the bow brings the total to 28 grousers available for use on

A licence-produced Swiss Panzer 87, with the new side skirt forward sections, standing ready during an exercise at the Swiss Armour School in Thun in 1993. Note also the extra grousers on the left turret front. (Andreas Kirchhoff)





Switzerland was the first country to adopt extra noise-reducing mufflers with their Pz 87 as seen here on a vehicle of the Armour School in Thun. (Andreas Kirchhoff)

soft or snowy ground instead of the same number of rubber track pads. Additional width indicator lights, required to meet official Swiss traffic regulations, have been fitted. The new side skirt forward sections, introduced with the German sixth production batch, were adopted beginning with Fahrgestell-Nr. 13156. All Pz 87 Leopard 2's are fitted with the Deugra fire and explosion suppression system. As the first European buyer, Switzerland introduced extra noise-reducing exhaust mufflers, attached to the vehicle's rear in pairs, for its entire fleet of KPz 87's. These mufflers were demanded by the Swiss population as most of the Swiss training areas are very close to, or even located inside, towns.

All Pz 87 carry the regular camouflage scheme of bronze green (RAL 6031), leather brown (RAL 8027) and tar black (RAL 9021) and are fitted with the collimator at the barrel's end for the muzzle reference system. In 1992 a new 140 mm main gun, developed by the Federal Construction Works in Thun, was proposed as an upgrade package for the Swiss Army Panzer 87 Leopard 2. Switzerland participated in the tri-lateral KWS II improvement programme, which led to the Leopard 2 A5, and will upgrade its Pz 87 in the next century.

SWEDISH LEOPARD 2

The Stridsvagn 122

In 1984 Sweden launched a study, which lasted until 1987, under the working name MBT 2000 to either upgrade the Centurion and S-Tank MBTs, purchase and/or licence produce a foreign MBT, or manufacture a nationally developed MBT. To evaluate the operational capacity of foreign-built MBTs in Sweden, the Swedish Army leased a Leopard 2 and an M1A1 Abrams for a short period in 1989. This test led to the Swedish Army's decision to finally replace with a foreign product its rather unconventional S-Tank (Stridsvagn 103) main battle tank, which was built in 1966 following more the assault gun concept than that of a main battle tank. The contenders were the GIAT Leclerc, General Dynamics M1A2 Abrams, and the Krauss-Maffei Leopard 2 TVM max.. Intensive tests were carried out from January to June 1994, including mobility and live firing tests conducted by Swedish crews. According to Swedish

The Swedish Stridsvagn 122 is the most sophisticated version of the Leopard 2 in service. It closely resembles the TVM I, but has the GALIX vehicle protection system fitted to the turret sides. (Andreas Kirchhoff)



sources, during the comparative tests the Leclerc travelled 3,000 km with a total fuel consumption of 41,400 litres and the M1A2 Abrams 3,820 km with a consumption of 56,488 litres, while the Leopard 2 TVM max travelled 3,730 km with a fuel consumption of only 26,874 litres – figures that speak for themselves. However, reports on the tests carried out to Swedish military demands quote the achievement by the Leclerc at 63 per cent, the M1A2 Abrams at 86 per cent, and the Leopard 2 TVM max. at 90 per cent. The Swedish Defence Materiel Administration (FMV) signed a contract with Krauss-Maffei GmbH on 20 June 1994 in Stockholm for the manufacture and delivery of 120 Leopard 2-S, officially designated the Stridsvagn 122 by the Swedish Army. The contract also includes the supply of training, maintenance, spare parts, documentation, simulators, and an option to purchase 90 additional Strv 122, Büffel ARVs as well as interfaces for equipment already used by the Swedish Army. While Krauss-Maffei is the prime contractor, the chassis was sub-contracted to Hägglunds in Sweden. Wegmann, the prime contractor for the turret, sub-contracted the work to Bofors, and work for the fire control system was sub-contracted from STN Atlas Elektronik (formerly Krupp Atlas Elektronik, KAE) to Celsius Tech Systems AB in Sweden. Bofors will also manufacture 50 per cent of the 120 mm main



This photograph shows the Strv 122 on its delivery by Krauss-Maffei, with spare end connectors, spare tracks and grousers attached to the turret rear. (Andreas Kirchhoff)



This rather unusual looking VT-2000 (Versuchsträger experimental vehicle) was intensively tested at the Armour School as part of the IFIS programme. (FMZ/Panzertruppenschule)

guns, while Rheinmetall will produce the other half. The first Strv 122 was officially handed over on 19 December 1996 and the delivery of the first Swedish-assembled vehicle is expected in spring 1998, while the final vehicle of this batch is expected to be delivered in 2001.

The Stridsvagn 122 is the most sophisticated version of the Leopard 2 in current service. The hull front and glacis are fitted with additional armour plates, and the inside of the driver's station has additional spill liners to reduce the effects of being hit by projectiles, hollow charges or fragments. For night driving the driver uses the same type of passive night sight as used with the CV 90 Infantry Fighting Vehicle. Due to the heavier combat weight of 62,000 kg, compared to the 59,500 kg of the German Leopard 2 A5, stronger torsion bars (derived from the ones used with the Panzerhaubitze 2000) are installed and reinforced brake discs are provided. All fuel tanks have a special additional explosion-suppressing filling liquid. The engine compartment is constantly cooled to reduce the IR signature, and heat sensors installed in the engine compartment would automatically cut off fan and air intake operation if the Strv 122 should come under attack with napalm. The road wheels are fitted with armoured wheel hubs.

The turret front and sides have the same wedge-shaped add-on armour as the Leopard 2 A5 but, unlike the latter, the turret roof and the commander's and loader's hatches are also up armoured. Due to the extra weight, both turret hatches are of the electrically driven sliding type. The commander's periscope has an electrically operated protective flap, which would fold up to protect the optic when desired and rests in front of it when not in use. The digital fire control computer carries data for up to 12 different rounds, including APFSDS-T, HEAT-MP-T, HEAT-GP, smoke, anti-helicopter and training ammunition. It also allows the use of the BT 46 gunnery simulator. The laser rangefinder integrated in the EMES 15 uses the eye-safe Raman-shifted laser. The Strv 122 is the first MBT in Europe equipped with the advanced tank command and control system (TCCS), which includes for example map functions with various selectable scales, position display, and a decision support and handling system. The built-in RPP fault detection system sends information to the TCCS via a MIL-BUS 1553B connection which is then shown on the TCCS



A Bergepanzer 3 Büffel of PzBtl. 33, with a spare power pack on the special rack attached to its engine deck, during an exercise in 1994. The power pack weighs about 6100 kg. (Michael Jerchel)

monitor. On the left and right sides of the turret the GIAT Industries GALIX vehicle protection system with 80 mm calibre mortars is installed, able to launch smoke, decoy, flare and fragmentation rounds. 16 grousers are stored on the turret rear, for use on soft ground instead of the same number of rubber track pads. The Stridsvagn 122 is painted in a disruptive camouflage scheme of green, light green and black colours.

The Stridsvagn 121

In 1994 and 1995 a total of 160 Leopard 2 A4's of the first five batches, taken from German stocks, were delivered to the Swedish Army. Officially designated the Stridsvagn 121, the first vehicle arrived in Sweden in February 1994. There were no noticeable changes or modifications carried out to these vehicles, which are in use with Swedish mechanised brigades.

Spanish Leopard 2

On 5 June 1995 a Memorandum of Understanding (MoU) was signed in Brussels between Spain and Germany, under which Spain will licence-produce 200 improved Leopard 2 for the Spanish Army. Delivery of the first vehicle is expected in 1998, and the rate of production is expected to be 40 vehicles a year. The Spanish content of the licence manufactured Leopard 2 is estimated to be around 65 per cent. Spain has leased 108 Leopard 2 A4, which were delivered between November 1995 and June 1996, from the German Army for a period of five years for training purposes.

Austrian Leopard 2

In 1997 Austria purchased 115 Leopard 2's formerly used by and phased out by the Royal Netherlands Army.

Danish Leopard 2

In July 1997 a contract was signed between Danish officials and Krauss-Maffei GmbH for the delivery of 52 Leopard 2 A4's from German stocks. These are expected to be delivered in early 1998. The vehicles will be upgraded to Leopard 2 A5 standard in a modernisation programme starting in 1999.

VARIANTS

The driver training tank

In addition to theoretical education and simulator driving, the Bundeswehr uses 31 Leopard 2 driver training tanks, which were

delivered in two batches. The first batch of 22 vehicles, of which eight were built by Krauss-Maffei and 14 by MaK (Fahrgestell-Nr. 19001 to 19022), was delivered between February and September 1986. The chassis were taken from current production and are therefore equivalent to those of the fifth batch. The second batch of nine vehicles, of which five were built by Krauss-Maffei and four by MaK (Fahrgestell-Nr. 19023 to 19031), were delivered between January and April 1989; their chassis are equivalent to the sixth batch with the new side skirt forward sections. The driver training tank is essentially a regular Leopard 2 MBT with its turret replaced by a special observation cabin, with a dummy gun and extra weight to simulate that of an MBT turret. The instructor, with appropriate devices to override the trainee driver seated in the hull, sits in the front seat of the observation cabin. Two additional seats in the "glasshouse" provide space for pupils to observe. The Netherlands have 20 driver training tanks in operation and Switzerland uses three.

The Bergepanzer 3 Büffel ARV

The first component studies for a new armoured recovery vehicle (ARV), planned to provide the maintenance support for the new Leopard 2 which was soon to enter service, began in 1977. On the introduction of the Leopard 2 MBT it soon became apparent that the Bergepanzer 2 A2 armoured recovery vehicle (ARV), which was based on the Leopard 1 chassis (see Vanguard No. 16) and delivered in 1978, would be not powerful enough to provide round the clock maintenance support under 24-hour combat conditions (statistics had shown that over 50 per cent of immobilized tanks could be repaired and sent back into battle – if only they could be recovered). Consequently a development programme for a new armoured recovery vehicle was launched, and first concept studies in 1982 for an ARV capable of recovering MLC 60 loads were supplemented by a final definition phase contract in 1984, with the Netherlands joining the development programme.

The first experimental vehicle (Versuchsträger) with a similar layout to the Bergepanzer 2 A2, and a wooden mock-up for an alternative internal layout, were ready in 1986. Two prototypes were ordered in 1987 and the experimental vehicle was rebuilt to the prototype standard. The three prototypes were delivered in 1988 and underwent intensive tests, and in 1990 an order was placed for 75 Bergepanzer 3 Büffel's (Buffalo) for the Bundeswehr and 25 Bergingstank 600 kN Büffel's for the Royal Netherlands Army (RNLA). MaK Systemgesellschaft mbH in Kiel was selected as the main contractor. Production was shared between MaK, with 55 vehicles built, and Krauss-Maffei with 45 built. The first three Büffel ARV's were handed over in August 1992, with two for the RNLA and one for the Bundeswehr. The Bergepanzer 3 Büffel armoured recovery vehicle is based on the

A quick-recovery device fitted to the dozer blade enables the crew of the Bergepanzer 3 to recover a broken-down tank under full armoured cover. (Uwe Schnellbacher)





The first unit to receive the Bergingstank 600 kN Büffel was Verkenning Bataljon (reconnaissance battalion) 104, which is seen here during exercise 'Light Viper' in 1993. (Michael Jerchel)

chassis of the Leopard 2. The driver sits in the superstructure front with the commander behind him. Three large doors provide access to the inside of the vehicle. A fire extinguishing and suppression system, an NBC protection system and deep fording equipment with bilge pumps are provided. For night driving the driver can replace one of his periscopes with a passive night sight. During peacetime, the Büffel is operated by a crew of two, although space for a third crew member is provided. The engine compartment is at the rear, and the Büffel uses the same type of powerpack as the Leopard 2.

A large crane, with a lifting capacity of 30,000 kg, is installed at the right forward side of the vehicle; the jib can be traversed 270 degrees. The crane has an electronic momentum limiter, which constantly calculates jib elevation, vehicle tilt and load mass to prevent overloading. When not in use the crane is lowered and rests along the right side of the Büffel, pointing rearward. A Rotzler Treibmatic TR 650/3 winch is installed in the vehicle's forward section with an effective cable length of 180 m (33 mm in diameter) and the capacity to pull up to 35,000 kg, which can be doubled by using a pulley tackle. The maximum constant cable speed is 16 m per minute. The opening with the cable roller guides in the hull plate is protected by a hinged armoured cover, opening upwards for operation. The cable runs in grooves on the capstan, preventing friction and wear. A secondary winch is provided, designated Rotzler HZ 010/1-8, with a cable 280 m long and 7 mm in diameter.

A complete power pack can be carried in a special cradle on the engine deck. The large dozer/support blade at the front is lowered as a support to stabilise the ARV during winching or crane operation. The blade, 3,420 mm wide and 880 mm high, can also be used for obstacle clearance or dozing operations. The Büffel is equipped with a suspension lockout system. Electrical cutting and welding equipment is also provided. Further equipment includes various couplings and towbars, rapid connect and disconnect couplings for towing, and a self-recovery system. A rapid recovery bar (Schnellbergeeinrichtung) can be attached to the dozer/support blade and there are provisions to refuel and/or defuel other tanks. Armament consists of a 7.62 mm MG3 machine gun,

primarily used for air defence, and 16 76 mm smoke grenade mortars, with eight fitted in two groups of four at the front and eight in a row at the rear of the vehicle.

Combat weight is 54,300 kg and the Büffel has a towing capacity of 62,000 kg (MLC 70). Maximum achievable speed is 68 km/h, and 30 km/h in 2nd reverse gear. With a fuel capacity of 1,620 litres, the Büffel ARV has a maximum range of 650 km on roads and 325 km across country. There are provisions for deep wading operations up to a depth of 4 metres. The Dutch version, known officially as the Bergingstank 600 kN Büffel, differs only slightly from its German counterpart in using a Dutch FN MAG machine gun, additional stowage boxes on top of the crane jib, Dutch-made Philips radios with the appropriate US-style antenna mount, and the obligatory Dutch smoke mortars installed in a group of six on the bow. The Büffel is able to exchange the powerpack of a Leopard 2 A4 in about 25 minutes, and with the Leopard 2 A5 about 35 minutes are required. Some recovery components of the Bergepanzer 3 Büffel are used on the Korean K-1 ARV and the Leclerc ARV prototype.

The future?

The necessity to be "up to date" doesn't correspond with decreasing defence budgets, and many important projects had therefore to be abandoned. Nevertheless, the design and development of advanced armour and fighting vehicles seems to be a demanding task for the future. Many of these projects and reports of their testing must be kept secret, such as the twin-barrelled main battle tank project of the seventies and eighties known as the Kasemattpanzer, or the Erprobungsträger Gesamtschutz (EGS, or integrated protection experimental vehicle), built by Krauss-Maffei in the early nineties. At first glance just another test vehicle based on the chassis of the Leopard 2, it is in fact a totally new design. The EGS introduces modifications such as a two-man crew seated side by side in the hull, a decoupled running gear with rubber seals at the connection points to the hull, and road wheels measuring 810 mm in diameter. The end-connector tracks are about 635 mm wide and the drive sprocket seizes into the track. These features are part of a noise reduction concept. The lower hull was designed to maximise mine protection and the upper hull for infra-red signature reduction. No turret is installed so far, only a special cover to protect the instruments installed inside. However, the Leopard 2 is a product of the true German engineering spirit and will serve well into the next century as a reliable weapon system.

THE PLATES

A1 LEOPARD 2 WITH PZB 200 (FIRST BATCH), PANZERLEHRBATAILLON 93, PANZERLEHRBRIGADE 9, MÜNSTER 1980

The tank thermal sight for the EMES 15 fire control system (FCS) was not ready for production when series production of the Leopard 2 commenced. To provide at least some night fighting capability the PZB 200 low light level TV system was therefore temporarily installed on 200 of the 380 vehicles of the first batch, with the camera attached on top of the gun mantlet. As usual, the first vehicles so equipped were delivered in 1980 to the Armour School to train the NCOs and officers of the next units to receive the new weapon system. Panzerlehrbataillon 93 (abbreviated PzBtl. L 93) and PzBtl. L 94, both part of Panzerlehrbrigade 9, were among the first units to receive the new main battle tank. Both units were stationed in Münster and provided support to the German Armour School, then known as Kampftruppenschule 2. The Leopard 2 of that time sported the then standard colour olive (RAL 6014) overall. The old-style large cross was applied on the turret, with standard tactical numbers in black and white. The number 232 is read from right to left to denote the second vehicle of the third platoon in the second company.

A The battalion crest, shown in the inset, was carried on the left front of the turret. **B** The black 60 on a yellow circle denotes the military loading class (MLC), and **(C)** the tactical markings in white applied on the front left fender and to the left on the rear plate denote the company and battalion.

A2 LEOPARD 2 A2 (MODIFIED FIRST BATCH), 4TH COMPANY, PANZERBATAILLON 33, 1ST PANZERDIVISION, LUTTMERSEN 1988

The tank thermal sight for the EMES 15 FCS was built in from the start of second-batch series production of the Leopard 2, but the 380 first-batch vehicles already delivered had to be brought up to the same standard. These vehicles were modernised in a programme between 1984 and 1987 and designated the Leopard 2 A2. Panzerbataillon 33, then stationed in Luttmersen near Hannover as part of 1st Panzerdivision, was amongst the first battalions equipped with the Leopard 2 and was therefore solely equipped with first-batch vehicles. The tank is painted in the standard camouflage scheme introduced on the fourth batch in 1984, consisting of the colours bronze green (RAL 6031), leather brown (RAL 8027) and tar black (RAL 9021). This German-developed scheme was later adopted in similar form by many other nations, including the US Army, which first used it for its M1A1 delivered in 1986. **A** With the new camouflage scheme smaller size crosses were applied, along with smaller tactical markings in grey (RAL 7000). **B** The MLC marking was now also in grey, on a tar black circle. **C** The inset shows the battalion crest carried on the left turret front. **D** The licence plates were carried on the bow and on the rear plate.

B LEOPARD 2 A4 (SECOND BATCH), 4TH COMPANY, PANZERBATAILLON 24, 1ST PANZERDIVISION, BRAUNSCHWEIG 1991

The tank shown here is an upgraded vehicle with the ammunition supply hatch in the left turret side welded shut, and



The squadron of Dutch Leopard 2 NL's in Bosnia is supported by a single Bergingstank Büffel, seen here in 1996 with IFOR markings. (Carl Schulze)

was originally delivered as a Leopard 2 A1 of the second batch. This battalion, stationed in Braunschweig, was solely equipped with second batch vehicles and is still part of the 1st Panzerdivision. Apart from the standard camouflage scheme and tactical markings applied, this Leopard 2 A4 carries the name of its commander on the right turret front. The meaning of the tactical numbers on the turret sides, now with grey outlines, is coded. The licence plates are carried in the regular positions. Also to be seen is the battalion crest carried on the turret rear along with a tactical mark, invented at battalion level, denoting the vehicle's position within a certain company.

C1 LEOPARD 2 NL, A SQDN, 101 MECHANISED BATALJON RHPA, NLCONSFOR, MULTI-NATIONAL DIVISION (SOUTH WEST), NOVI-TRAVNIK, BOSNIA AND HERZEGOVINA, APRIL 1997

A squadron of 14 Leopard 2 NL's is stationed in Novi-Travnik as part of the Dutch contingent of the Stabilisation Force (SFOR). The Dutch forces are responsible for the eastern sector of the Multi-National Division South-West (MND-SW), which is under British command. In April 1997 the crews of the Leopard 2 NL were from A Squadron of the 101st Mechanised Bataljon Royal Huzaren Prins Alexander. Stationed in Bosnia since December 1996 with the beginning of the SFOR mandate, they were just about to finish their tour of duty in May 1997. The vehicle is painted in olive drab, with the letters SFOR in white on the turret standing out well. The name ACRID in low-visibility black, also on the turret, denotes a vehicle of A Squadron. A hussar, also in black, is applied to the left turret side. **A** The MLC marking is on a yellow disc. **B** Licence plates are carried on the bow and the rear, as are **(C)** white tactical markings.

C2 PANZER 87 LEOPARD 2, PANZERTRUPPENSCHULE, THUN 1993

The Panzer 87 came into Swiss service in 1988, and soon received noise-reducing extra mufflers on the rear plate. These mufflers were introduced at the demand of the Swiss public, concerned about noise nuisance as most Swiss training areas are located close to towns. Unique features are



A Leopard 2 A5 NL of 42nd Tank Bataljon, the first unit so equipped, which received its first improved Leopard 2 in May 1997. The Dutch-built smoke mortars are clearly seen on the turret side. (Michael Jerchel)

the two tubular containers on each turret side, seen to the right of the white tactical turret number, that are used as interim stowage for hot machine gun barrels. This vehicle was built in Switzerland under licence and has the late-style forward side skirt sections. **A** Licence plates are carried on the bow and rear.

D LEOPARD 2 A4 (FIFTH BATCH), 3RD COMPANY, PANZERBATAILLON 64, MDC IV/5TH PANZERDIVISION, SCHWARZENBORN 1996

This Leopard 2 A4 was originally built as a fifth-batch vehicle (Fahrgestell-Nr. 10820) by Krauss-Maffei GmbH. It serves with 3. Kompanie/Panzerbataillon 64, which after the restructuring is under command of Military District Command IV, 5th Panzerdivision, commanded by II German-US Corps in Ulm as part of the Main Defence Forces. The unit adopted an emblem applied in pink to the right turret front and the left turret rear, showing a ghost brandishing a sword and standing on speeding tracks. It bears a close resemblance to



This rear view of the EGS trial vehicle reveals the large mufflers carried at the rear. Although bearing a close resemblance to the Leopard 2, it is in fact a new chassis with larger road wheels and has a lower hull that is optimised for mine protection. (Michael Jerchel)

the one used by the 11th Panzer Division (Gespenster-division) during World War II.

E LEOPARD 2 A4 (EIGHTH BATCH), PANZERTRUPPENSCHULE, MÜNSTER 1992

Leopard 2 A4 of the eighth batch are relatively rare with only 73 vehicles built to this configuration. The majority of this batch is in service with Gebirgs-Panzerbataillon 8 (1st Mountain Division), others are used by the German Armour School (Panzertruppenschule, PzTrS) in Münster, and a few have already been converted to Leopard 2 A5. The vehicle seen here, built by MaK and used to train crews at the PzTrS in 1992, shows off the new rear sections of the side skirts. A cartoon has been applied with chalk to the forward section of the heavy side skirts introduced during production of the sixth batch.

F1 BERGEPANZER 3 BÜFFEL, 1ST COMPANY, PANZERBATAILLON 33, PANZERBRIGADE 21, MDC III/7TH PANZERDIVISION, LUTTMERSEN, JULY 1997

This Bergepanzer 3 Büffel was built by MaK and is in service as one of four with 1st Company/Panzerbataillon 33 in Luttmersen, fully equipped with the Leopard 2 A5. Due to the Armed Forces reorganisation this battalion came under command of Panzerbrigade 21 as part of the Crisis Reaction Forces (KRK) and the military district command III/7th Panzerdivision, headquartered in Düsseldorf. **A** The vehicle bears the name 'WOTAN' on the superstructure along with the battalion crest. A spare engine is carried on the special mount on the engine deck. The engine weighs approx. 6,100 kg (wet), an easy task for the vehicle's crane, which can lift up to 30,000 kg.

PLATE F2 LEOPARD 2 A5 (FORMER SIXTH BATCH), PANZERTRUPPENSCHULE, MÜNSTER 1996

Originally built as a sixth-batch vehicle (Fahrgestell-Nr. 20877) by MaK, this Leopard 2 A5 was among the first delivered to the Bundeswehr and, in April 1996, was used to train crews of Panzerbataillon 214, which was soon due to receive this version. It has the early-style commander's PERI-R17A2/TIM primary sight, still lacking the additional armour. The position lights near the bow have additional protection left off later vehicles. **A** The tactical markings and the badge on the turret are those of the armour school.

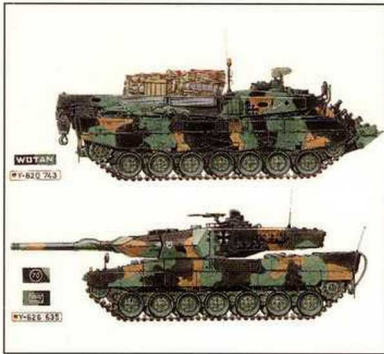
G TRUPPENVERSUCHSMUSTER II, TRUPPENVERSUCHSKOMMANDO KWS II, PANZERTRUPPENSCHULE/ATV-STAB, MÜNSTER 1993

After the German MoD's rejection as too costly of the two vehicles of the highly sophisticated TVM I programme, a simplified version known as the TVM II was built. TVM (or Truppenversuchsmuster) stands for troop trial sample, which is developed and paid entirely by industry. The TVM II, based on a fifth-batch vehicle originally built by MaK but converted by Krauss-Maffei, underwent intensive trials carried out by a technical detachment of the Panzertruppenschule. It is depicted here during evaluation trials at Münster training area in autumn 1993, which finally led to the Leopard 2 A5. The camouflage scheme is almost entirely obscured by mud.

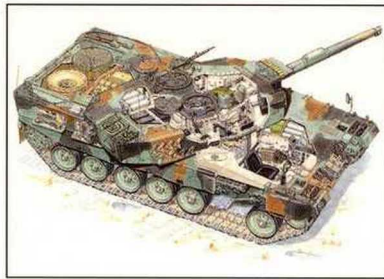
INDEX

- AEG-Telefunken 7
AMX-13 light tank 36
AN/VCR 12 radio 38
APFSDS-T (DM-23 KE) ammunition 21, 22, 35, 41
APFSDS-T (DM-33 KE) ammunition 13, 21
Austria: Leopard 2 42
- Bergepanzer 2 A2 ARV 43
Bergepanzer 3 Büffel ARV 42, 43-5, 43, 47, **F1**
Bergingstank 600 kN Büffel AVR 43, 44
Bofors 40
- camouflage 18, 39
cannons: 20mm retractable automatic 3-4
Carl Zeiss 14, 16
Celsius Tech Systems AB 40
Centurion MBT 36, 38
Chrysler 8
Contraves 38
Crisis Reaction Forces (KRC) 34
- Denmark: Leopard 2 42
Deugra 18
Deugra fire and explosion suppression system 39
Deutsche Entwicklungs-Gesellschaft mbH (DEG) 3
Diehl 570F track 12
Diehl 570FT track 19, 21
- 'Eber' Leopard 5
EMES 13 rangefinder 7
EMES 15 fire control system 10, 13-14, 16, 17, 22, 33, 41
Erprobungsträger Gesamtschutz (EGS) 45, 47
- Federal Construction Works 38, 39
FERO-Z18 telescope 14, 24, 35
fire extinguishers 15-16, 21
- GALIX vehicle protection system 42
General Motors 3, 8
German Armour School 10, 11, 34
GIAT Leclerc 39, 40
GPS vehicle navigation system 36
- Hägglunds 40
HEAT-MP-T (DM-12 MZ) ammunition 13, 22, 41
- Kasemattpanzer 45
'Keiler' Leopard 5
Krauss-Maffei 5, 8, 10, 11, 16, 17, 18, 19, 20, 34, 35, 36, 38, 39, 40, 43, 45
Krupp Atlas Elektronik 10
Krupp Atlas Elektronik fire control system 22
KWS I 34, 36
KWS II 34, 39
KWS III 34
- L7A3 105mm gun 8
- Leitz 7
Leopard 1 MBT 5
Leopard 2
1st batch 11-16, 46, **A1**
1st batch (modernised) 17-18
2nd batch 16-17
3rd batch 17
4th batch 18
5th batch 18-19
6th batch 19-20
7th batch 20
8th batch 20
ammo hatch 14, 16, 17
component trial vehicle (KVT) 19
driver training tanks 19, 20, 42-3
in foreign service 36-42
hybrids 36
instrument trial vehicle (IVT) 20
modernisation 20
Prototype 14 4, 5
Prototypes 01 to 17 5-7, 8
specifications 12-16
wading capabilities 16
- Leopard 2 A1 16-17
Leopard 2 A2 10, 17-18, 46, **A2**
Leopard 2 A3 18
Leopard 2 A4
1st batch 11
2nd batch 12, 18, 46, **B**
3rd batch 11
4th batch 12
5th batch 13, 47, **D**
6th batch 14, 15, 19
8th batch 15, 47, **E**
armaments 22
fire control system 22-4
speed 21-2
- Leopard 2 A5
6th batch 23, 47, **F2**
7th batch 24
armour 35
development 24, 33-4
driver's hatch 34, 35
main gun 35, 36
navigation system 36
snorkel 35
- Leopard 2 AV
development 8-10
Prototype 19 6
Prototype 20 7
- Leopard 2 FK 6
Leopard 2 K 6
Leopard 2 KVT 33
Leopard 2 NL 36-7, 36, 37, 38, 46, 46, 47, **C1**
- M1 Abrams 5, 38
M1A2 Abrams 39, 40
MAG 7.62mm machine gun 37
Main Battle Tank/Kampfpfänger-70 3-5, 3
'Mannheim Conference' 34
Maschinenfabrik Kiel (MaK) 10, 11, 16, 17, 18, 19, 20, 35, 36, 43
MG 3 7.62mm machine gun 3
Military Loading Class 7
- MTU MB-873 Ka-500 engine 4-5, 6
MTU MB-873 Ka-501 engine 14-15
- NBC protection system 16, 17, 18, 44
Nd:YAG laser rangefinder 22, 23
Nebelwerfer 87 76mm smoke mortar 38
Netherlands: Leopard 2 NL 36-7, 36, 37, 38, 46, 46, 47, **C1**
Neuer Kampfpfänger (NKPz) 37
- Office for Defence Technology and Procurement (BWB) 5
- Panzer 87 Leopard 2 37-9, 38, 39, 46-7, **C2**
PERI-R 17 primary panoramic sight 14, 17, 22, 33, 35
PERI-R 17A2 primary panoramic sight 35
Porsche 5, 8
PZB 200 thermal sights 9, 13, 17
- Renk HSWL-354/3 gearbox 6, 15
Rheinmetall 6, 35, 36, 41
Rheinmetall 120mm main gun 10, 13, 22, 37
Rotzler Treibmatic TR 650/3 winch 44
Royal Netherlands Army (RNLA) 37
RPP fault detection system 15, 41
- Schmidt, Helmut 5
SEM 25/35 radio 14
SEM 80/90 radio 18, 21
Shillelagh anti-tank missile 3, 6
Spain: Leopard 2 42
'Spitzmaus-Turm' 7
STN Atlas Elektronik 40
Sweden
Stridsvagn 121 42
Stridsvagn 122 39-42, 40
- Switzerland: Panzer 87 Leopard 2 37-9, 38, 39, 46-7, **C2**
- T-64 B (Soviet tank) 24
T-80 B (Soviet tank) 24
tank command and control system (TCCS) 41-2
Teledyne-Continental engine 4, 5
Texas Instruments 16
Thyssen-Henschel 10
TVM II 47, **G**
TVM 2 22
TVM max 20, 21, 33-4, 39, 40
TVM min 33-4
- 'Vergoldeter Leopard' 5
Versuchsträger-2000 33, 41
- Wegmann 5, 7, 8, 10, 35, 40
WF Bern 7.5mm MG 87 machine gun 38
WNA-H22 electro-hydraulic gun control system 13
- XM150E5 152mm gun 3, 6
Yom Kippur War (1973) 7

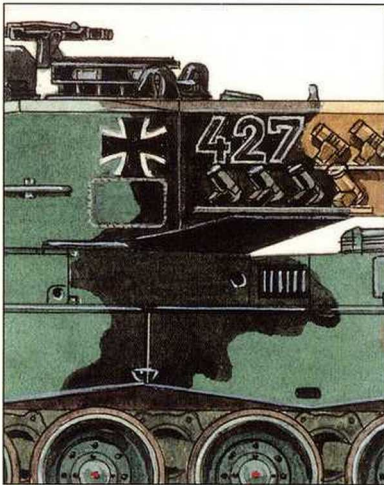
The design, development, operation and history of the machinery of warfare through the ages



Full colour artwork



Cutaway artwork



Unrivalled detail



Photographs

Leopard 2 Main Battle Tank 1979–1998

In 1963, West Germany and the United States signed an agreement to develop the best tank in the world – the MBT/KPz-70. Though by 1970 this project was stopped, West Germany used the components created for the MBT/KPz-70 to develop a new main battle tank – the Leopard 2. Since 1979, when the first Leopard 2 rolled off the production line, this tank has undergone various modifications and has been exported to numerous European countries. Enhanced by Osprey's signature colour plates and cutaway artwork, this book examines the development of the Leopard 2 from the first batch to its evolution into the improved Leopard 2 A5, detailing its features and variants.

OSPREY
PUBLISHING

www.ospreypublishing.com

ISBN 1-85532-691-4



9 781855 326910