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## **BK117: SURVIVING IN A DESPERATE MARKET PLACE**

F.Musman  
W.Reinl  
Messerschmitt-Boelkow-Blom GmbH  
Ottobrunn, West Germany

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# BK 117: SURVIVING IN A DESPERATE MARKET PLACE

by

F. Musman and W. Reinl

Messerschmitt-Bölkow-Blohm GmbH, Munich, Germany

## Abstract

Today's helicopter programmes need 8 - 10 years from the initial marketing analysis to final market introduction. The last decade has shown market predictions to be not very reliable for a period exceeding 2 to 3 years. As a consequence the development teams have to face a constant change in requirements. Low cost, fast changes, for flight envelope extensions and new optional equipments are the engineering challenges.

The presentation deals with the agitated programme time of the BK 117 from first certification till today. The comparably good sales numbers are the result of dedicated cooperation between engineering and sales.

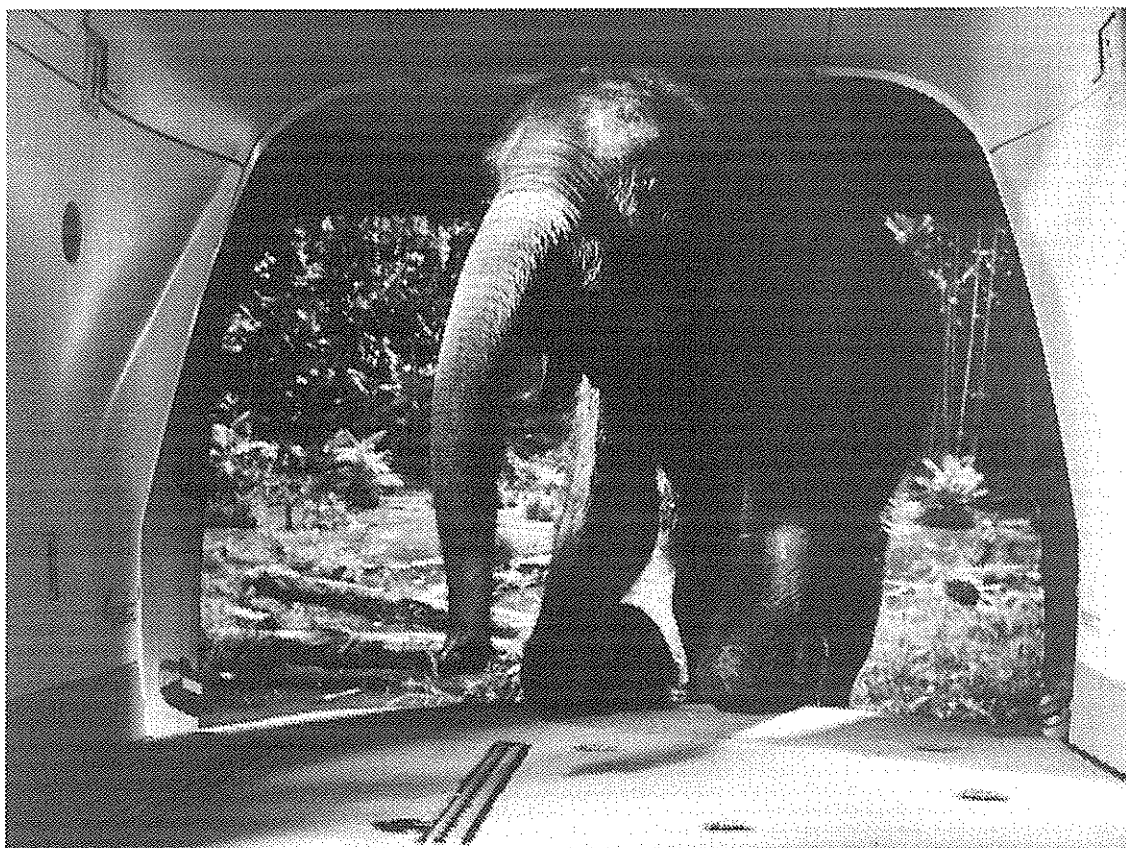


FIG. 1

The market recession raised the necessity for market segments, which had not been specified at the time of development go ahead

## Development Time versus Market Forecast

Any company deciding the development of a new helicopter type for the civilian market, needs to live with highly unreliable assumptions concerning market requirements and cost development, since a period as far as 15 or even 20 years ahead will have to be considered.

Approximately 8 years are required from a go ahead for development until market introduction, which can be considered somewhere between the 50th and 100th helicopter at the customer.

Even under fairly good circumstances a 7 year period will be required to reach a break-even point, depending on how honestly this is being defined.

Looking to a typical helicopter programme plan, we see, that a considerable overlap of development and production is necessary, if deliveries should begin within a reasonable time after reaching type certification.

LLTI need to be ordered and tool design and fabrication needs to be initiated a time, when the engineering group is fighting vibration, stability problems, excessive temperatures or unacceptable service life of some components. A riskless sequencing of development, serialisation and production would extend the programme plan by at least 3 years, a nightmare for those releasing the funding for development (FIG. 2).

### Typical Helicopter Program Milestones

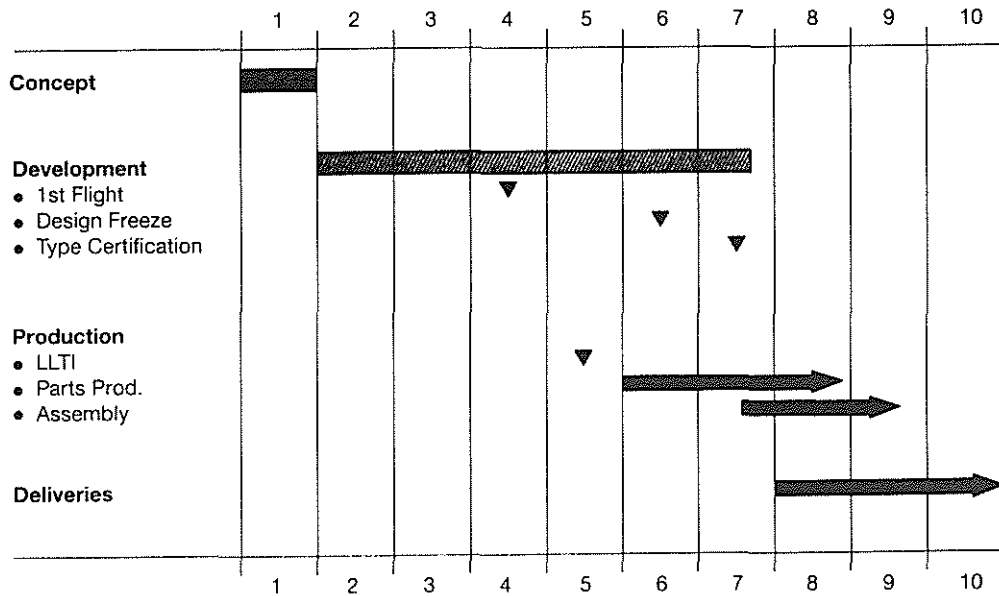


FIG. 2

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With an early release of manufacturing we accept, that the pretty new helicopters are affected by a high number of retrofits, even before leaving the assembly line (FIG. 3).

The retrofits origine from the following sources:

- component and flight test
- certification process
- manufacturing of first serial helicopters
- the general trend of generating better design
- the influence of the product support department

In the case of the BK 117 three maintenance studies have been conducted by the product support team. Those gentlemen revealed to be splendid good authors, producing volumes of change requests within shortest time.

The design group didn't like the big papers; nor did production like the pile of new drawings. It did, however, a lot of good to the maintainability and the operation of the BK 117.

### Production Retrofits Prior Delivery (Result From Development/Production Overlap)

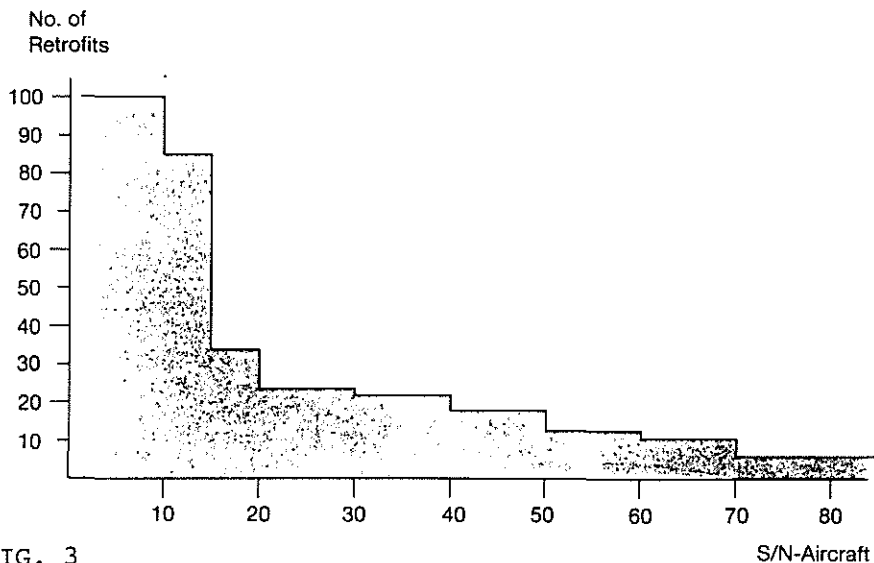


FIG. 3

The development time, required for the BK 117, was very similar to other helicopters of that category. Both the time from go ahead to first flight and from first flight to type certification, are comparable. Of course the exact date for a go ahead is not known as clearly as dates of first flight and of certification, which every company is proud to publish (FIG. 4).

It is remarkable, that helicopters need twice the time of fixed wing between first flight and certification. The further evolution of the four helicopters, compared here, was much different. The BK 117 shows the highest number of new models, issued within a short period.

## Development and Product Improvement

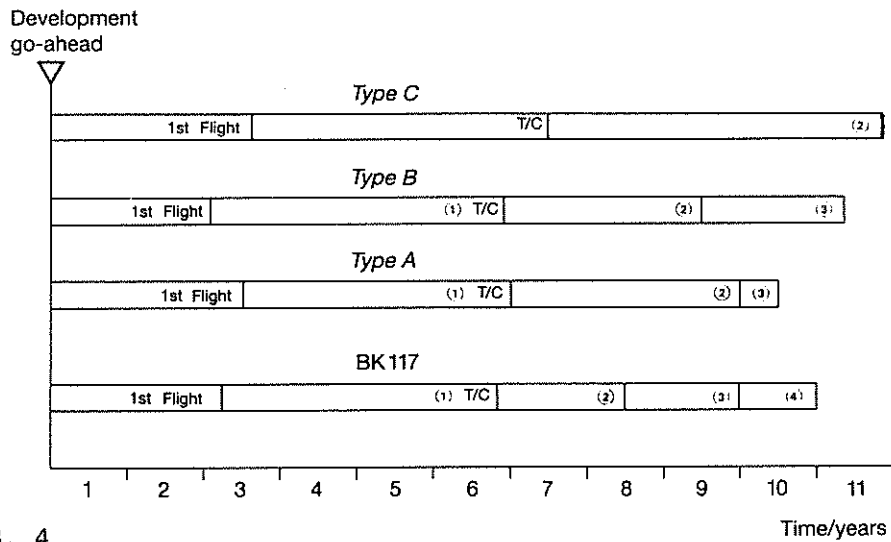


FIG. 4

The trend of the early deliveries is as different as the model policy, if we compare the curves, shown in figure 5. We must remind, however that the four helicopters have been brought to the market at a much different time.

## Market Introduction

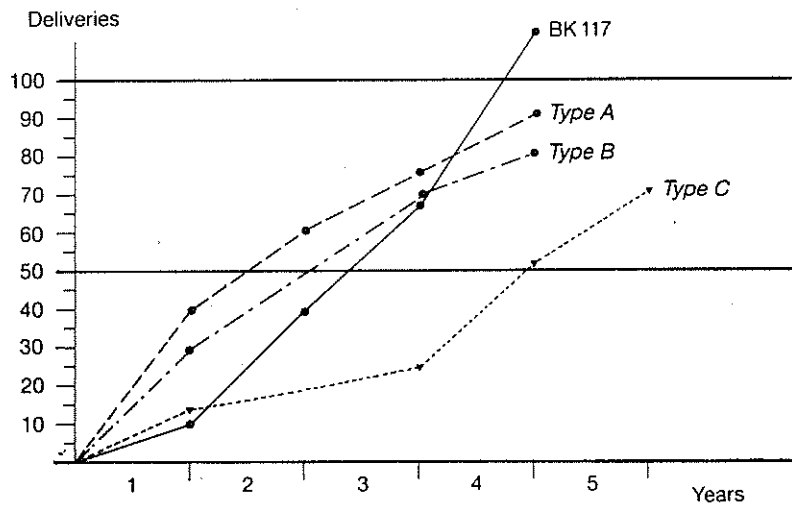


FIG. 5

The BK 117, as the more recent model, started its deliveries, when the civilian helicopter market went into its deep recession. In the early 80ties, not much was left of the optimistic sales forecasts published, when Kawasaki of Japan and MBB decided to go ahead with the development of the BK 117 (FIG. 6).

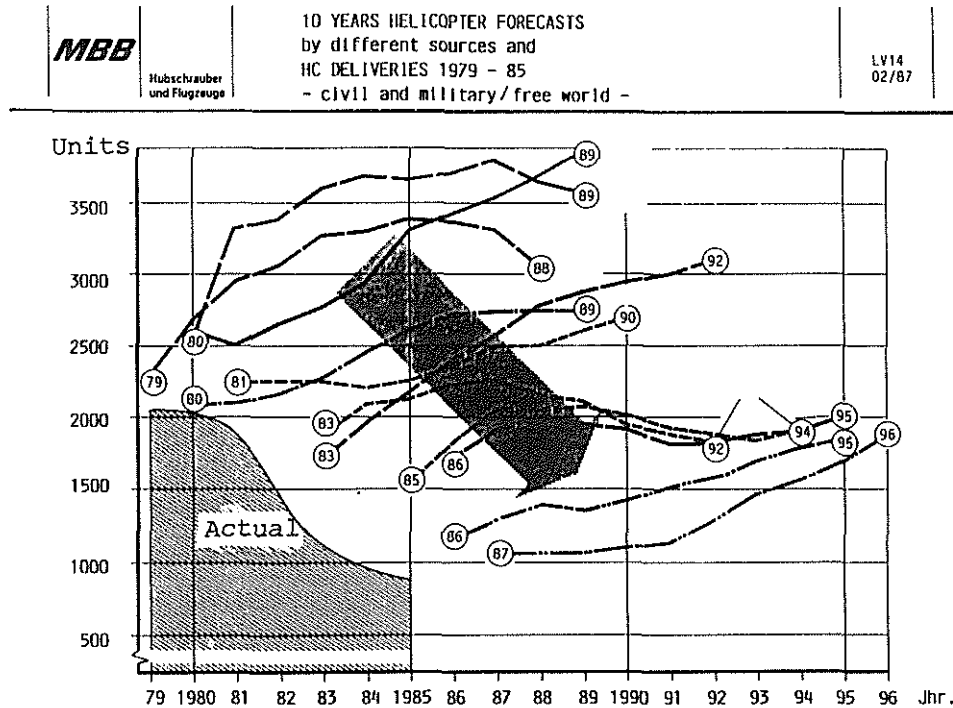


FIG. 6 Declining numbers in sales forecasts

The BK 117 applications today show up much different from the estimates, drafted back in 1975, as can ben seen from the following table:

	1975 FORECAST	MID 1987 ACTUAL
EXECUTIVE	30 %	24 %
OFFSHORE	28 %	6 %
LAW ENFORCEMENT	20 %	8 %
UTILITY	14 %	9 %
AMBULANCE RESCUE	8 %	48 %
ENVIRONMENTAL PROT.	----	5 %

The market recession raised the necessity to reach for market segments, which had not been specified at the time of development go ahead. This, at the same time, opens new competitions.

Competing against a bigger helicopter, requires improved performances. Resisting the competition from smaller helicopters, requires to keep production and development cost down. A real challenging task for the development group.

In the case of the BK 117, the effort can be split into the following categories:

- development of new models, offering increased performance
- extended temperature and altitude range
- increased offer of optional equipment
- product improvement of parts and components
- T.B.O. improvement and extended life for time change items

### New Models

A considerable increase of the BK 117 mission performances has been achieved since the first certification. They are summarized in the following table.

MODEL	MODEL-IMPROVEMENT	T/C	EFFECT.	AVAILAB. (STAND.-HC)	HARDWARE-CHANGES	
					MINIMUM ("MUST"-CHANGES)	ADDITIONAL MODIFICATIONS
(A-1)	BASIC	12/82 (LBA) 3/83 (FAA)	7001	3/83	-	-
(A-1D)	DOT-VERSION	3/85 (DOT)	-	6/85	DOT-KIT 117-800171	-
(A-3)	MAX. GROSS WEIGHT 3,2 T	3/85 (LBA) 9/85 (FAA) 7/85 (DOT)	7055	6/85	<ul style="list-style-type: none"> <li>● T/R-HEAD/TWISTED BLADES</li> <li>● M/R-HEAD/BUSHING</li> <li>● M/R-BLADE/TRACKING SHEET</li> <li>● M/R-SYSTEM/BEARING BLOCK</li> </ul>	SPAS: (IMPROVED LONGITUDINAL STABILITY)  YAW CSAS: (OPTIONAL FOR 7001-7101 BASIC SALES CONFIGURATION SINCE 1985/-7060)
(A-3D)		12/85 (LBA)	7102	10/86		
(A-3D)		12/85 (LBA)	7102			
(A-4)	83% TORQUE (5MIN, TOP)	7/86 (LBA) 4/87 (FAA) 7/87* (DOT)	7122	4/87	<ul style="list-style-type: none"> <li>● ELT. TORQUE INDIC. SYSTEM</li> <li>● YAW CSAS (FOR HC RETROFITTED A-1 → A-3 → A-4)</li> <li>● SPAS (FOR HC RETROFITTED A-1 → A-3 → A-4)</li> </ul>	
(A-4D)						
(B-1)	ENGINES, IMPROVED PERFORMANCE (HOT/HIGH)	10/87* (LBA) 11/87* (FAA) 2/88* (DOT)	7140	10/87*	<ul style="list-style-type: none"> <li>● ENGINES LYCOMING LTS101-750 (FLAT RATED LIKE-650)</li> <li>● IMPROVED TAKE OFF-/LANDING CAPABILITY FROM 12000 FT. TO 14000 FT.</li> <li>● COMING WITH SCOOPS</li> <li>● HGT MARKING</li> <li>● STARTER-GENERATOR MOD</li> <li>● ADD. ENGINE CHIP DET.</li> <li>● BLEED AIR SYSTEM CHECK VALVE</li> <li>● ENGINE ANTI-ICING DELETED</li> </ul>	
(B-1D)						

BK 117 - A3 350 kg more payload!

The design gross weight of the BK 117 was deliberately kept very low, in order to achieve a low weight empty. The initial certification was conducted for a maximum take-off-weight of 2 850 kg. It was called the A1.

MBB and KHI had agreed to increase the gross weight in a 2nd step. At the same time, a tail rotor, with a twisted blade, slightly increased diameter and chord, was developed and introduced to production from S/N 55 up by June 85.

This new version of the BK 117, the A3, offered a gross weight of 3 200 kg, the increase being a total benefit to payload.

A retrofit of earlier BK 117, from A1 to A3, is possible by merely exchanging the tail rotor and some minor parts of the t/r control system.

BK 117 - A4 improved take-off and hover performance

In a next step, the gearbox limit was lifted from 2 x 424 SHP to 2 x 493 SHP.

For hover out of ground effect, this allows at 5 000 ft ISA additional 200 kg of payload. Respectively at 3 000 kg, it allows to increase the hover capability from 5 000 ft to 8 000 ft.

It must be noted, that the increase was possible, without any change of the gear box itself.

A retrofit of earlier helicopters is possible. However, in order to keep the number of different models within reasonable limits, 3 improvements, which were introduced to production at the time of launching, must be retrofitted. These are:

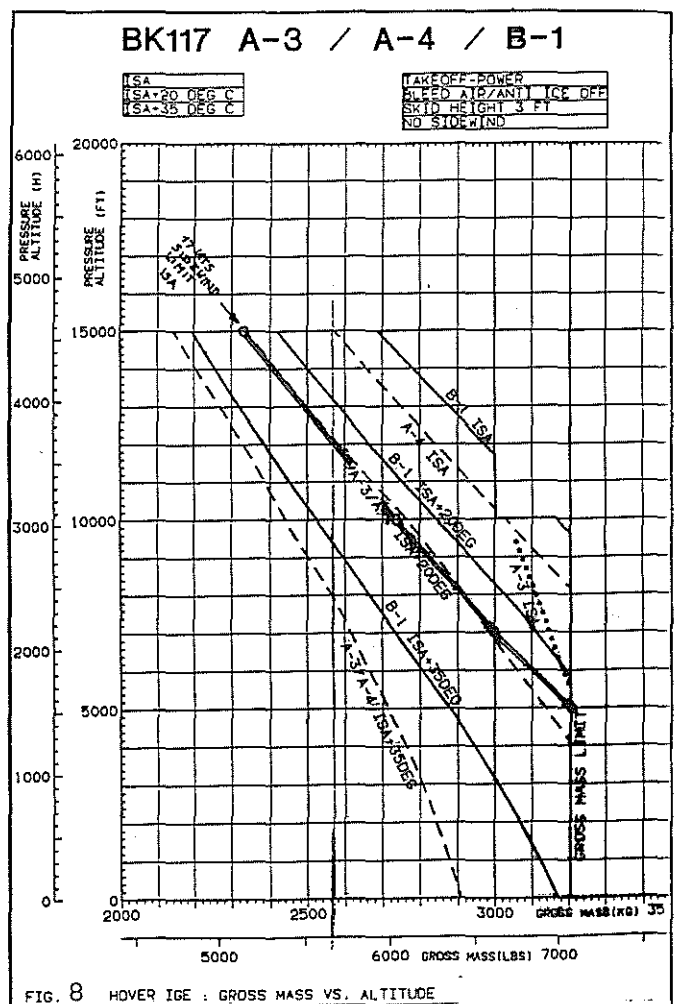
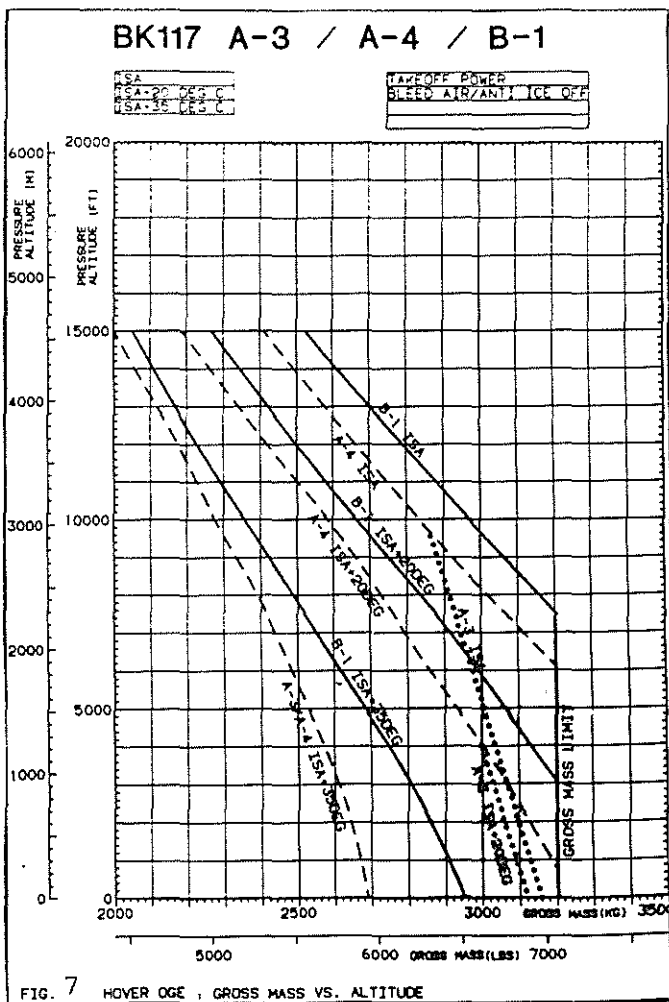
- o electrical torque indication system
- o yaw CSAS, now standard for the BK 117
- o Stick Position Augmentation System, which allows an increased VNE at low temperatures

The A4 has been introduced to production in 1987, starting from S/N 122 up.

BK 117 - B1 improved hot-day-performance

Presently, MBB/KHI are finishing the certification of the B1-version, which, by installation of Lycoming LTS 101-750 engine instead of the earlier LTS 101-650, will make the BK 117 even more competitive to some bigger helicopters. At ISA + 35°, the payload for hover, in and out of ground effort, is increased by 260 kg! (FIG. 7, 8).





### Extended Temperature and Altitude Range

Extensive testing at high and low temperatures and high altitude went along with the certification of forementioned models.

During the 1986 Forum in London, Adam Teleki has reported details on this subject.

Just for completeness of the activity picture, the different explorations should be mentioned here:

- Oct. 82 Samedan, Switzerland (A1)
- April 83 Leadville, Colorado (A1)
- Aug. 83 Sudan (A1)
- Oct. 83 Samedan, Switzerland (A3)
- Jan. - March 84 Yellowknife, Canada (A3)
- May 84 Samedan, Switzerland (A3)
- Aug. 86 Colorado (B1)

The temperature/altitude ranges for the most recent B1-tests are shown in the next figure (FIG. 9).

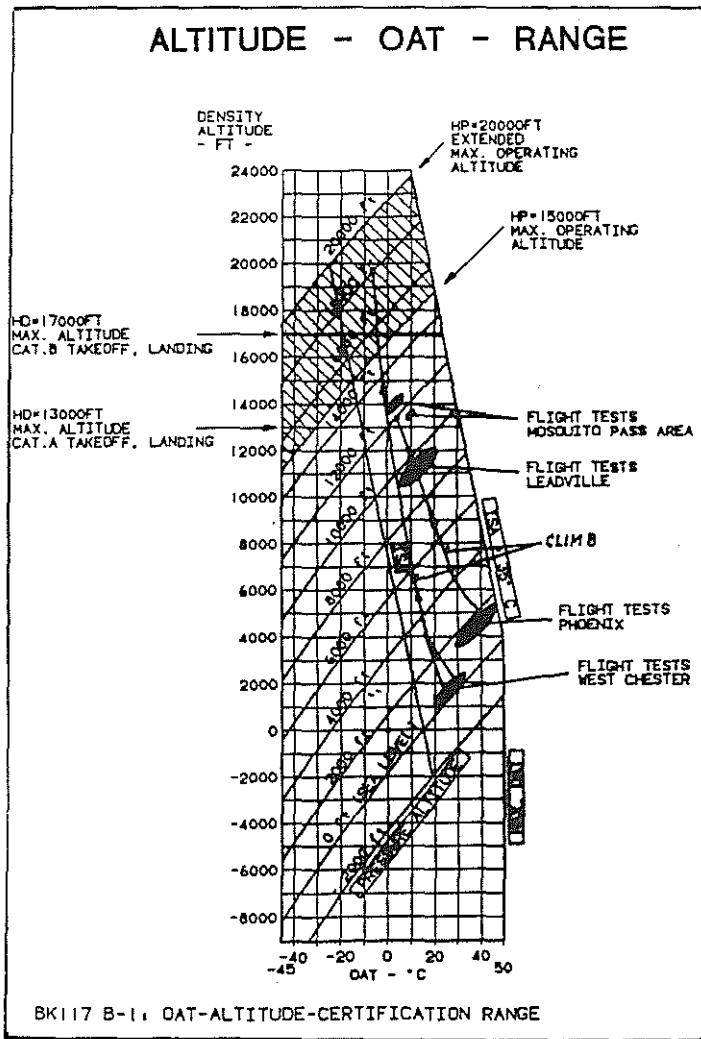



FIG. 9



FIG. 10 Cold weather tests in Yellowknife

## Optional Equipment

In order to cover the requirements of the variant missions, 50 different packages of optional equipment have been developed, avionics not included.

 Helicopter and Military Aircraft Group		Optional Equipment	BK 117
<b>Cabin &amp; Cargo Compartment</b>	High Density Seats Litter Adapter Rails Sound Insulating Wall Special Painting Custom Sound Proofing Kit	<b>Special Equipment</b>	Engine Compressor Washing Device External Loudspeaker System Self-Sealing Feeder Tanks Search Light SX 16 (Nightsun) Ambulance/Rescue Equipment VIP-Equipment Packages Flash Lights Multi Purpose Pylon Command and Stability Augmentation System (CSAS) Sandfilter
<b>Heating and Ventilation</b>	Bleed Air Heating System Air Conditioning System (Freon Type) Air Conditioning System (Heated & Refrigerated Air)	<b>Customer Request Items</b>	Tie-down and Covering Kit Tail Flood Light Radar Radome with Battery Relocation Battery Relocation Avionic Rack Avionic Rack with Ventilation Emergency Locator/Transmitter Cockpit Storage Kit Rear Clam Shell Door Windows Camera Window Cockpit Camera Window Cabin, LH/RH Tinted Passenger Compartment Windows Siren System for External Loudspeaker System Extended Interior Panelling
<b>Main Rotor System</b>	Main Rotor Blade Folding Kit		
<b>Landing Gear</b>	Emergency Floats Snow Skids Settling Protectors		
<b>Mission Equipment</b>	Service Hour Meter Dual Control Covering Dual Pilot Operation Kit Long Range Fuel Tank System Increased Basic Fuel Capacity Fuel Dump Valve Rescue Winch External Load Hook Load Hook, Sighting Mirror Head Rests Cabin Speakers 2nd Landing Light, fixed Landing and Search Light Flare System		

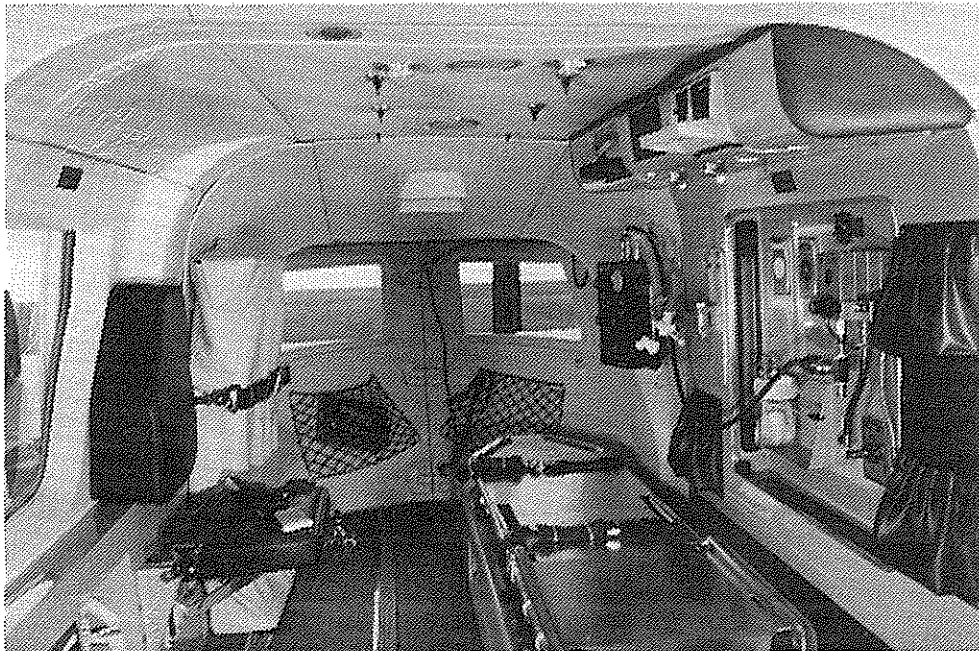


FIG. 11

The best-selling equipment at this time, is the ambulance/rescue package. The BK 117, with its outstanding loading capability and its well sized cabin, is especially suitable for this kind of mission.



FIG. 12 Just now, the exterior sling capability of the BK 117 is being extended to 1 200 kg.

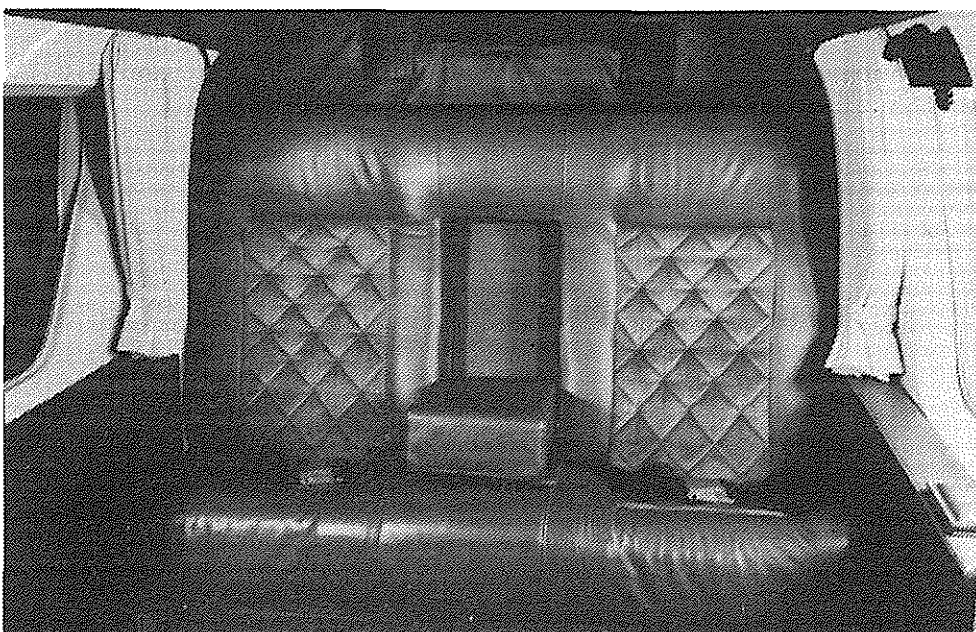


FIG. 13 Different interiors range from high density to V.I.P.-equipment.

## Product Improvement of Parts and Components

Every month, a special team is reviewing the change requests, addressed to the configuration control group. The team consists of:

- programme management, incl. programme finance manager
- configuration control
- product support
- manufacturing
- design engineering
- stress department
- quality assurance
- certification office

The change requests result from:

- operational problems/customer critics
- manufacturing
- material review board
- sales promotion

The difficult task of the team is, to find the golden mean between technical value and cost.

As of today, a total of 1 374 change requests have been scrutinized. 968 have led to smaller or bigger changes of the helicopter or the equipment.

The reputation of high quality of the MBB-products is mainly a result of the dedicated work, continuously put to product improvement.

## T.B.O. and Life Time Improvement

Along with the forementioned quality improvement continuous effort is put into reduction of direct operating cost through higher T.B.O and life time.

The table hereafter shows the comparison between T.B.O. and T.C.I. values at the time of introduction of the BK 117 and today.

Improvement of Time Change Items  
and T.B.O. BK 117

### 1. Time Change Items

#### Lifting System

Bearing block	300 h	} replaced by new parts now on condition
Bolt	300 h	
Drive Rod Bolt	300 h	
Slider Guide	1 200 h	new part available now on condition
Clutch	300 h	new part available now on condition

#### Tail Unit

T/R Shaft Assembly	1 200 h	now 8 100 h
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#### Control System

Control Ring	16 400 h	now 39 300 h
Shuttle Valve	1 200 h	replaced by new part now on condition

#### Power Plant Install.

Vibration Isolator	800 h	now 1 200 h
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### 2. T.B.O.

Main XMSN	1 200 h	now 1 800 h
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Further Development

- New Engine

As mentioned before, the re-engined BK 117-B1 is approaching its certification and will be delivered by end of this year.

- Single Pilot IFR

A single pilot IFR equipped BK 117 will start flight test by mid of september. Availability is foreseen for mid 88. For this programme, MBB has selected Sperry as supplier for the autopilot system (FIG 14).

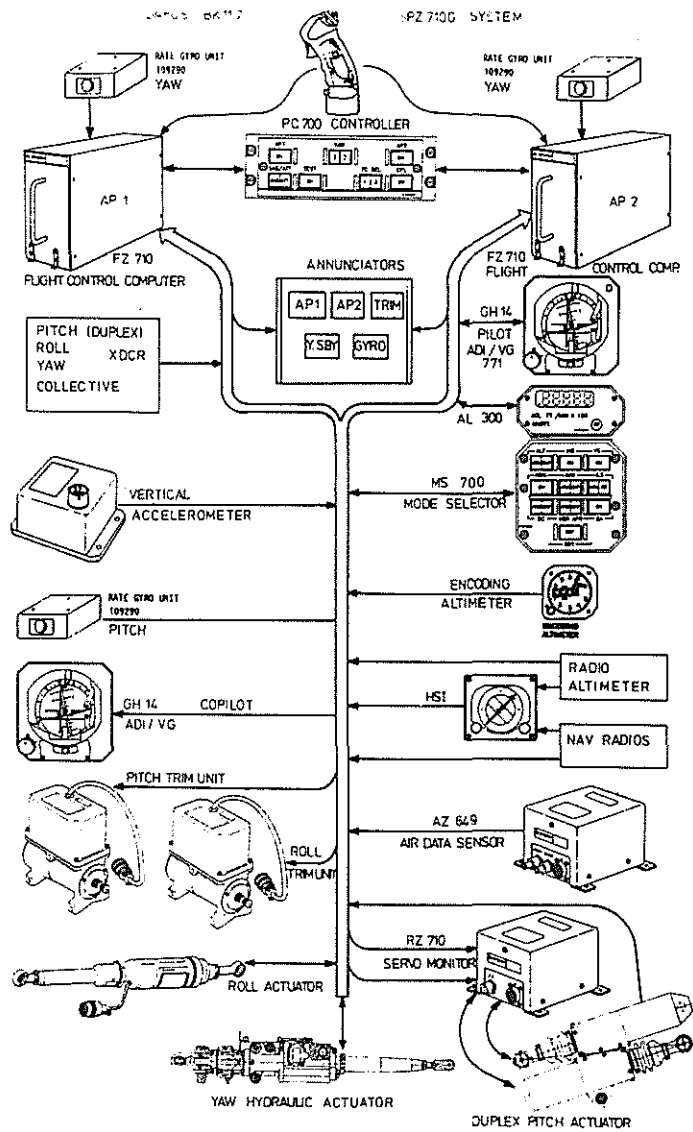


FIG. 14 BK 117 Autopilot schematic

- Military BK 117

The first phase of development for the BK 117 M has been successfully completed. The helicopter has been flown with many different external stores, including guided and unguided rockets.

The compatibility of the engine inlet, with different sights, has been proofed.

A higher landing gear for flight, with gun turrets, has been developed.

This first phase of the trials has shown, that the weapon systems can be installed to the BK 117, without any negative influence to the flying qualities of the helicopter.

Before end of the year, the first series of actual shooting with the BK 117 will be completed.

For any helicopter manufacturer, it is important, to complement the civil programme by military sales. At MBB we see a growing chance to penetrate the market with a military version in the very near future.



FIG. 15 BK 117 M Flight test with unguided rockets