

THE CIVIL CERTIFICATION PROCESS OF THE MTR390 TURBOSHAFT ENGINE

Dipl. Ing. P. Schinzl, MTU Motoren- und Turbinen-Union München GmbH
Dr. K. Hoier, Luftfahrt-Bundesamt, Braunschweig

Abstract

The MTR390 engine specification is based on two main airworthiness regulations - BCAR Section C issue 13 (equivalent to JAR-E change 6) and MIL-E-8593A. After successful completion of the Airworthiness related qualification requirements, the Military type certificate (Musterzulassung) was granted by the German Military Airworthiness Authorities on 09 May 1996 and followed by the German Civil Type Certificate on 19 June 1997.

Abbreviations:

BCAR	British Civil Airworthiness Requirements
CRI	Certification Review Item
DFHB	Deutsch-Französisches Hubschrauber-Büro (contractual customer)
DOA	Design Organization Approval
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FMECA	Failure Mode Effect and Criticality Analysis
FTB	Flying Test Bed
JAA	Joint Aviation Authorities
JAR	Joint Aviation Regulations
JAR-E	Joint Aviation Regulations - Engines
LBA	Luftfahrt-Bundesamt (German Aviation Authority)
LuftBauO	German rule
LuftGerPO	Approval of Aeronautical Products Order (German rules)
OEI	One Engine Inoperative Rating
WTD61	German Military Airworthiness Authorities (Wehrtechnische Dienststelle für Luftfahrzeuge - Musterprüfwesen für Luftfahrgerät der Bundeswehr)

1. Introduction

The programme of the MTR390 turboshaft engine for the Tiger helicopter started officially with the signature of the main engine development contract followed by the first engine run in December 1989.

From the very beginning of the development programme, a civil application of the MTR390 was intended and therefore the MTR390 engine specification is based on two main airworthiness regulations,

- British Civil Airworthiness Requirements (BCAR) Section C, issue 13, which is equivalent to JAR-E change 6
- Military Specification MIL-E-8593A

and additional French and German national requirements taking into account the military operation of the Tiger helicopter.

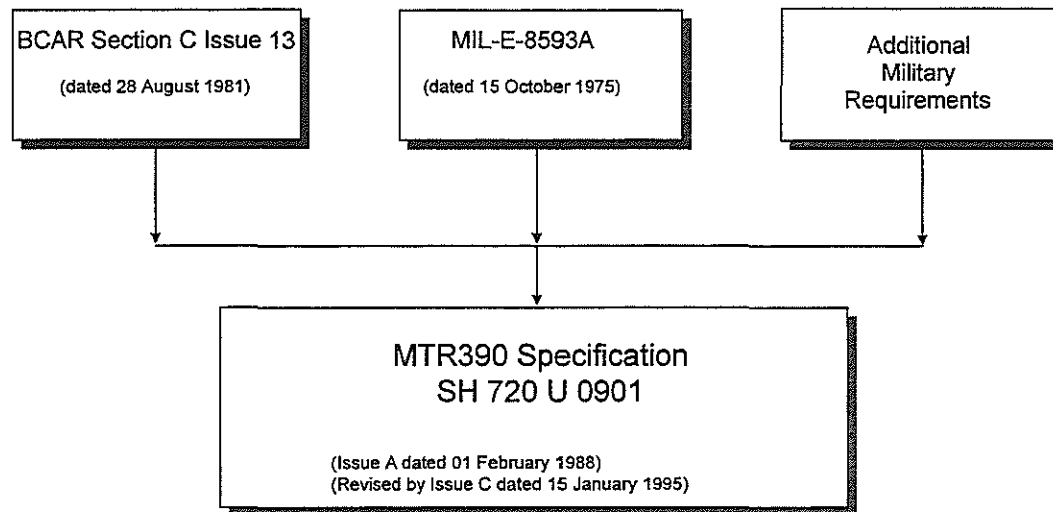


Figure 1.1: Composition of the MTR390 specification

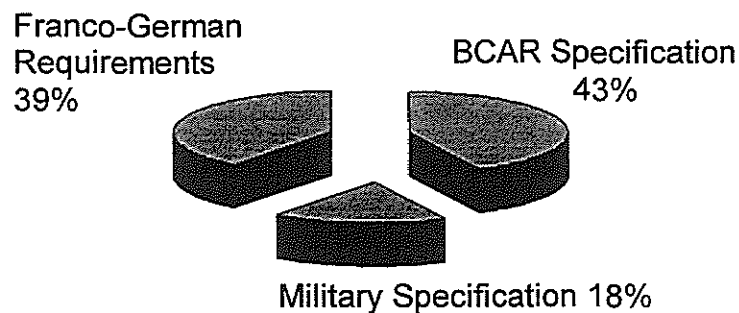


Figure 1.2: Share of specific specification requirements

2. Military Certification

The military qualification programme of the MTR390 turboshaft engine is divided into three major qualification milestones:

Qualification A

The first development phase – Qualification A – covered the clearance of the MTR390 engine for the FTB (flying test bed) and prototype Tiger testing. In accordance with the qualification procedure laid down in the engine development contract, the minimum qualification tests were defined. These tests were agreed with the German and French Military Authorities as their requirements to release for development flight operation:

- 60 hrs endurance run (10 cycles each of six hours duration, derived from the 150 hrs endurance run)

- Vibration investigation
- Engine overspeed tests
- Software integration
- Power turbine overspeed test (cut shaft)
- Oil and fuel system performance tests
- Rig overspeed tests for turbine discs (disc burst)
- Oil flow interruption test in order to clear negative g flights
- Equipment vibration and fire tests.

The successful demonstration of these qualification requirements with the MTR390 engine resulted in the first FTB flight on 14 February 1991 (Panther helicopter) and the first prototype flight on 27 April 1991 (Tiger helicopter) both equipped with two MTR390 engines.

Qualification B & C

The primary intention of Qualification B (Military Type Certificate) was to show compliance with the Airworthiness requirements as laid down in the MTR390 engine specification.

With respect to the contractual requirements, i.e. performance improvement, specific fuel consumption and optimisation of control parameters, the engine standard was slightly modified and the mechanical integrity was successfully demonstrated by the qualification tests listed below.

- Rain Ingestion Test (→ JAR-E 790)
- Snow Ingestion Test (Crushed Ice) (→ JAR-E 790)
- 150 hrs Endurance Run (→ JAR-E 740)
- Overspeed Tests (→ JAR-E 830)
- Vibration Surveys (→ JAR-E 650)
- Oil/Fuel Clearance runs
- Icing Conditions (→ JAR-E 780)
- Starting tests (Sea level, ATF) etc. (→ JAR-E 750, JAR-E 770)

Based on the engine qualification evidence (engine tests, analyses, FMECAs, etc.) this was achieved with this engine standard. The **Military Type Certificate** (Musterzulassung) was issued by the Military German Airworthiness Authorities (WTD61) on the **09 May 1996**.

After this important certification milestone, the military certification (qualification C phase, which is still in progress) was concentrated on the specific military requirements, such as

- Sand ingestion test with helicopter sandfilter
- Sand ingestion test without helicopter sandfilter
- Demonstration of the engine modular concept
- Corrosion test demonstrating the operation in salt containing atmosphere
- 30-Second OEI rating
- Full compliance with specification requirements.

3. Civil Certification

In November 1992, MTR contacted the LBA in order to discuss possible ways of obtaining the Civil Type Certificate for the MTR390 turboshaft engine. As result of these discussions two variants were investigated more detailed:

- Investigation and Approval according to the JAA procedures,
- Investigation and Approval according to German National Procedures

Within the member countries of the JAA only the German law allows a validation of a Military Type Certificate (i.e. German Military Certificate) in the frame of a Simplified Type Investigation according to §4 LuftGerPO. Therefore the company consortium MTR (MTU TURBOMECA ROLLS-ROYCE) decided in November 1994 to apply for a German Type Certification officially.

The reason for selecting this way was that the company preferred to use the advantage of the German Procedures to avoid additional costs potentially resulting in a repetition of the majority of certification activities which would have resulted when using the Joint European Procedures.

This route was possible because the Military Certification Basis was JAR-E, change 6. Therefore MTR complies with the German regulations that require the same level of safety in the case that the LBA validates a German Military Type Certificate.

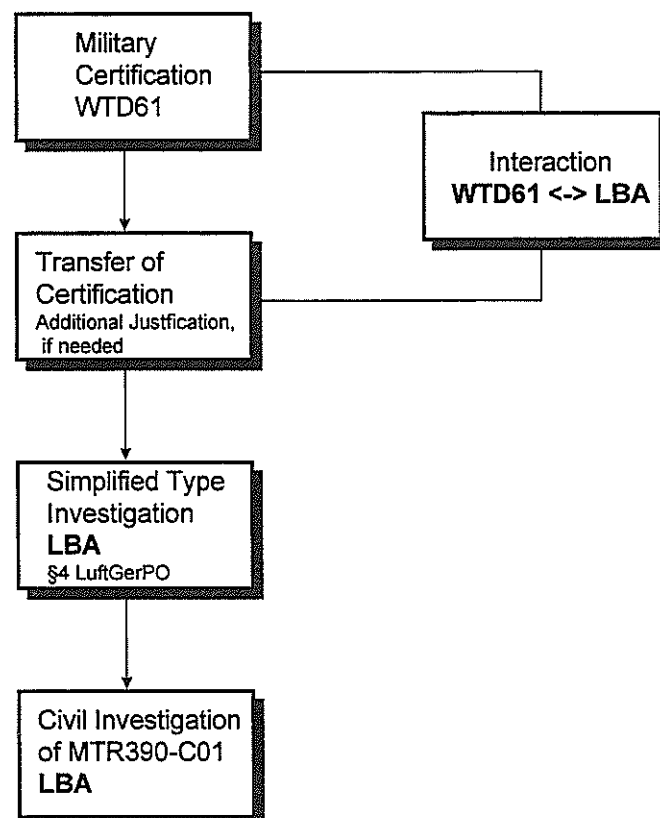


Figure 3.1 Simplified Type Investigation

From the industrial perspective our experience gained during the investigation process, may result in the JAA considering such procedures (i.e. Civil validation of Military Type Certificates) in the future when amending the JAR-21.

Certification Basis

As stated before, the formal application date for Military Certification was in November 1989. At this time in the "Civil World" the Airworthiness Requirements JAR-E change 7 including Amendment E/89/1 were effective.

Since the basis of the Military Spec. was JAR-E change 6 (resulting from an earlier start of the definition phase) and at the time of our application for Civil Certification (November 1994) we had exceeded the 'Three Years Rule' according to JAR-21.17 (c) and German LuftBauO, the company had to revise the Basis for Civil Certification.

Therefore MTR and LBA performed a detailed comparison between the latest Airworthiness Requirements (JAR-E change 9) and the Military Spec. for the MTR390 engine.

The result of this comparison was that the requirements of our Specification and the JAR-E change 9 requirements define the same level of safety and are identical for most of the paragraphs for helicopter engines. Therefore it was not necessary to define any Exemptions or Equivalent Safety Findings.

In order to have a reliable and reproducible Compliance Record, MTR prepared a set of so-called Means of Compliance Lists based on JAR-E change 9. These lists were discussed and agreed by both, the German Military Authorities and the LBA.

JAR-E Change 9	Spec. Reference		Spec. Deviation	Means of Compliance									Compliance Sheet No.	Issue No.	Status		Remarks
	QS	Spec. Para.		1	2	3	4	5	6	7	8	9			open	closed	
E10		2.2	covered	x										-			
E20		2.2.1	covered	x	x	x								1		x	
E30				x										1		x	
E40			identical											1		x	N/A, Heading
E40 (a)-(b)(2)	4	2.4.1	covered	x										1		x	N/A
E40 (b)(3)	4	2.4.1	covered	x					x					1		x	
E40 (c)	4	2.4.1	covered	x										1		x	
E50	40	2.16.1	identical											1		x	N/A, Heading
E50 (a)(1)	40	2.16.1.1 (a)	identical	x										1		x	
E50 (a)(2)	40	2.16.1.1 (b)	identical		x				x					1		x	
E50 (a)(3)	40	2.16.1.1 (c)	identical		x				x					1		x	
E50 (a)(4)	40	2.16.1.1 (d)	identical		x				x					1		x	
E50 (a)(5)	40	2.16.1.1 (e)	identical		x		x							1		x	
E50 (a)(6)	40	2.16.1.1 (f)	identical		x		x		x					1		x	
E50 (b)	40	2.16.1.2	identical		x							x		1		x	
E50 (c)	40	2.16.1.3	identical		x		x							1		x	
E50 (d)	41	2.16.1.4	identical	x	x									1		x	

Figure 3.2: Means of Compliance Table (Extract)

This Compliance List contains all requirements in detail, i.e. tests, analysis, design statements etc., derived from the JAR-E requirements. These tables formed the basis for Certification Compliance Sheets (CCS) and ensured that each applicable JAR-E paragraph had been adequately addressed. In these sheets the content of the relevant JAR-E para. was interpreted and the necessary compliance method identified.

During this process MTR benefited from the fact that most of the Civil Certification tests (see Military Certification) were successfully passed during the Military Certification. These Certification Compliance Sheets were harmonized with both German Airworthiness Authorities.

Since the use of the Tiger helicopter requires a Super Emergency rating for 30 seconds (30 sec. OEI rating) which is not yet covered in JAR-1 (definitions) and therefore not considered by JAR-E directly, the Civil Certification basis was amended by a Certification Review Item according to JAR-21.16 (a)(1) which contains eleven Special Conditions to show compliance with the Airworthiness requirements concerning this new rating.

For example, one of these Special Conditions requires an engine test demonstrating 'Eight Shots' at the 30-Second OEI Rating within a defined two hours cycle.

Because the Military requirements required 'four shots' only, MTR had to harmonize the relevant schedules with the military customer (DFHB). This underpins the mechanical integrity of the engine.

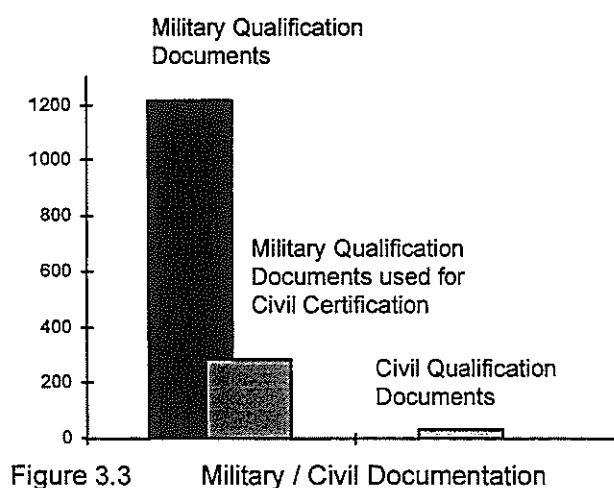
Furthermore MTR decided to perform additional Overtemperature Test (four minutes at maximum, permissible power-on speed with turbine entry temperature at least 19°C higher than the 30-Second OEI Rating temperature limit. This test was derived from the FAR Part 33 regulation and could be helpful in the case of a civil FAA application.

All tests related to the Special conditions and the FAR-33 requirements were successfully completed and the mechanical condition of the engine was in excellent condition considering the severe test requirements.

Evidence of Compliance

After the harmonisation of the 'Means of Compliance' sheets and 'Special Conditions', MTR summarised the evidence covering the defined tasks in the 'Evidence of Compliance'.

Approximately 1200 reports were prepared for the full qualification of the MTR390 turboshaft engine and have been reviewed as justification for the 'Evidence of Compliance' sheets. As stated before the Military Certification Basis and the JAR-E change 9 requirements are at the same level of safety. This resulted in MTR only having to prepare 30 reports to cover the additional Civil requirements. This small quantity of additional documentation, further confirmed that the MTR390 specification fulfils nearly all civil requirements.



At the beginning of June 1997 the final civil documentation was submitted and accepted by the German Civil Airworthiness Authorities supported by the German Military Authorities. Based on the evidence given to both Airworthiness Authorities, the **Civil Type Certificate** was granted by LBA on **19 June 1997**.

4. Future Prospect

FAA Type Certificate

In order to enter the international engine market, it will be necessary to receive FAA Type Certification for the MTR390 engine. The FAR civil requirements are comparable to the JAR-E regulations except for a few published differences which will have to be harmonised and discussed with FAA and LBA.

Based on the Bilateral Agreement between the United States of America and the Federal Republic of Germany, MTR will apply for FAA Type Certification in the future.

Continued Airworthiness

It is obvious that the operation of the engine will be different between Military and Civil Customers. For the military applications the procedures for continued airworthiness are defined by quality assurance documentation. In the 'Civil World' this requires the approval of the Design Organization by the German civil authorities. Therefore MTU decided to apply for a DOA in 1996. The investigation process is still ongoing and is planned to be finished by the end of this year.

Depending on the future effectiveness of JAR-21 in Germany it is intended to apply for JAR-21 DOA in the future.