



Dose Reconstruction for F-104 Starfighter Maintenance Personnel



T.P. Kuipers, A.S. de Koning



Netherlands Ministry of Defence

Support Command, Health Care Agency Group, Military Health Care Expertise Co-ordination Centre, Health Physics, Hilversum, The Netherlands

tp.kuipers.01@mindef.nl

1

Introduction

The F-104 Starfighter was in active duty and maintenance at the Royal Netherlands Air Force in the period 1963-1983. The compressor casing alloy of the F-104 Starfighter J79 jet engine contains between 2 and 4 percent thorium and inherent daughter isotopes. During maintenance technical personnel was exposed to an unknown radiation dose. We performed a dose reconstruction for external exposure and internal contamination.

2

Objective

- I reconstruct external effective dose for maintenance personnel exposed to radiation during maintenance work on the J79 jet engine
- II reconstruct internal effective dose for maintenance personnel

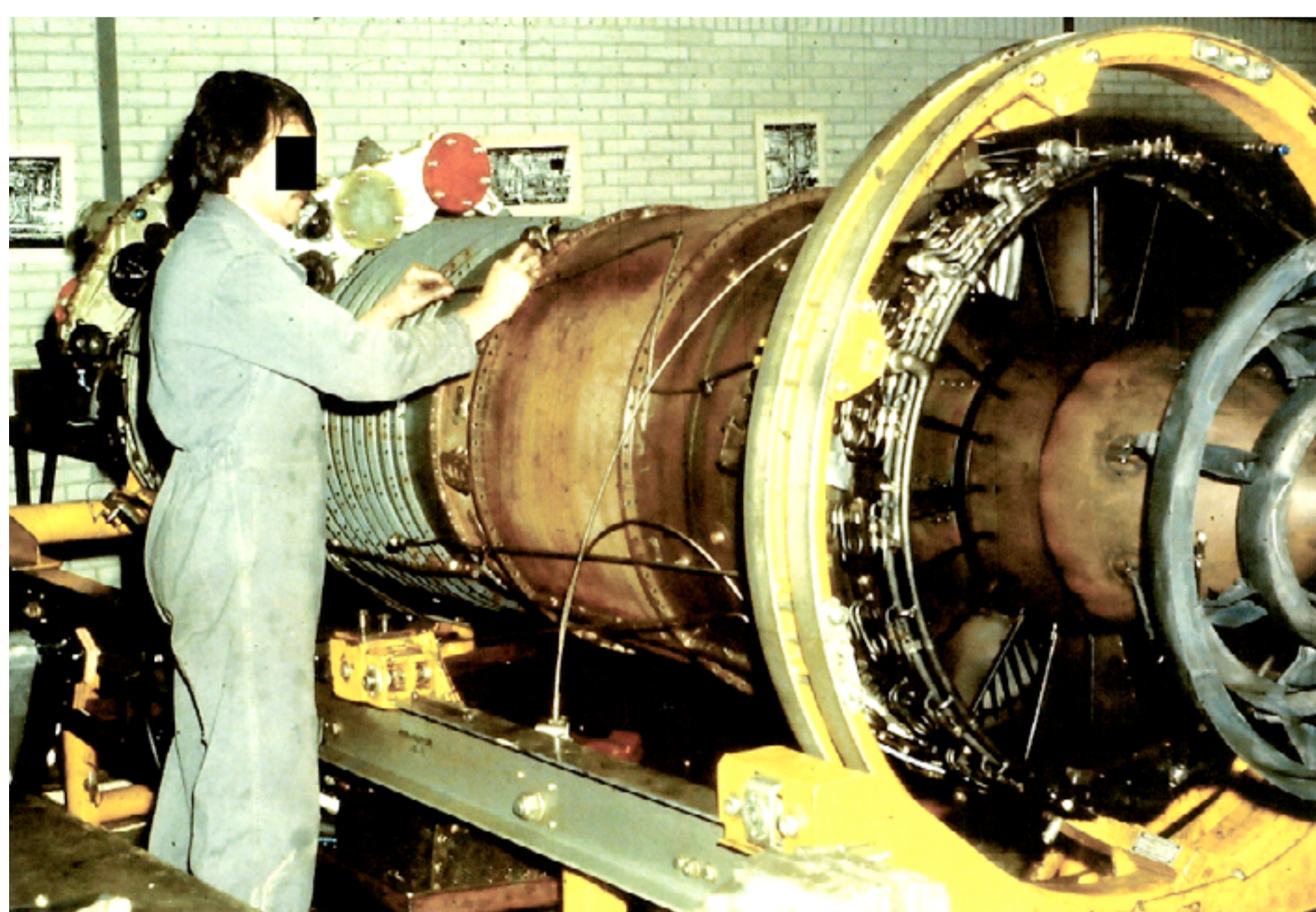


Figure 2 Maintenance personnel working on the General Electric J79 jet engine.

3

Methods

I External dose

The quantification of the external effective dose is based on the combination of two main parameters:

- 1) the yearly duration of exposure per category maintenance personnel working near the compressor casing (Table 2)
- 2) a 2-dimensional effective dose profile of the compressor casing (Figure 3).

The information of the yearly duration of exposure was extracted from in depth interviews with maintenance personnel and inspectors. The type of maintenance activities (eq. welding, drilling, open wheel grinding) and the use of protective measures to diminish internal contamination (eq. suction of welding fumes) were also derived from these interviews.

The 2-dimensional dose profile was constructed by interpolating data from active and passive effective dose measurements. The active dose measurements were performed using a GM probe in the horizontal plane relative to the central axis of the compressor casing. For determining the component of alpha and beta particles to the total measured effective dose a perspex slice was used for shielding purpose. The passive dose measurements were performed using standard TLD's attached to a human phantom during one month. The TLD's were located on multiple locations in the same horizontal plane. The yearly effective dose and the yearly equivalent dose for hand and eye lenses were derived from these measurements.

II Internal dose

The quantification of the internal effective dose is based on the combination of the yearly duration of exposure and four parameters for internal exposure:

- 1) compressor casing wipe tests analyzed using gamma spectrometry and LSC
- 2) radon and thoron emanation estimates using emanation factors for concrete
- 3) welding fumes
- 4) machining dust particle distribution estimates

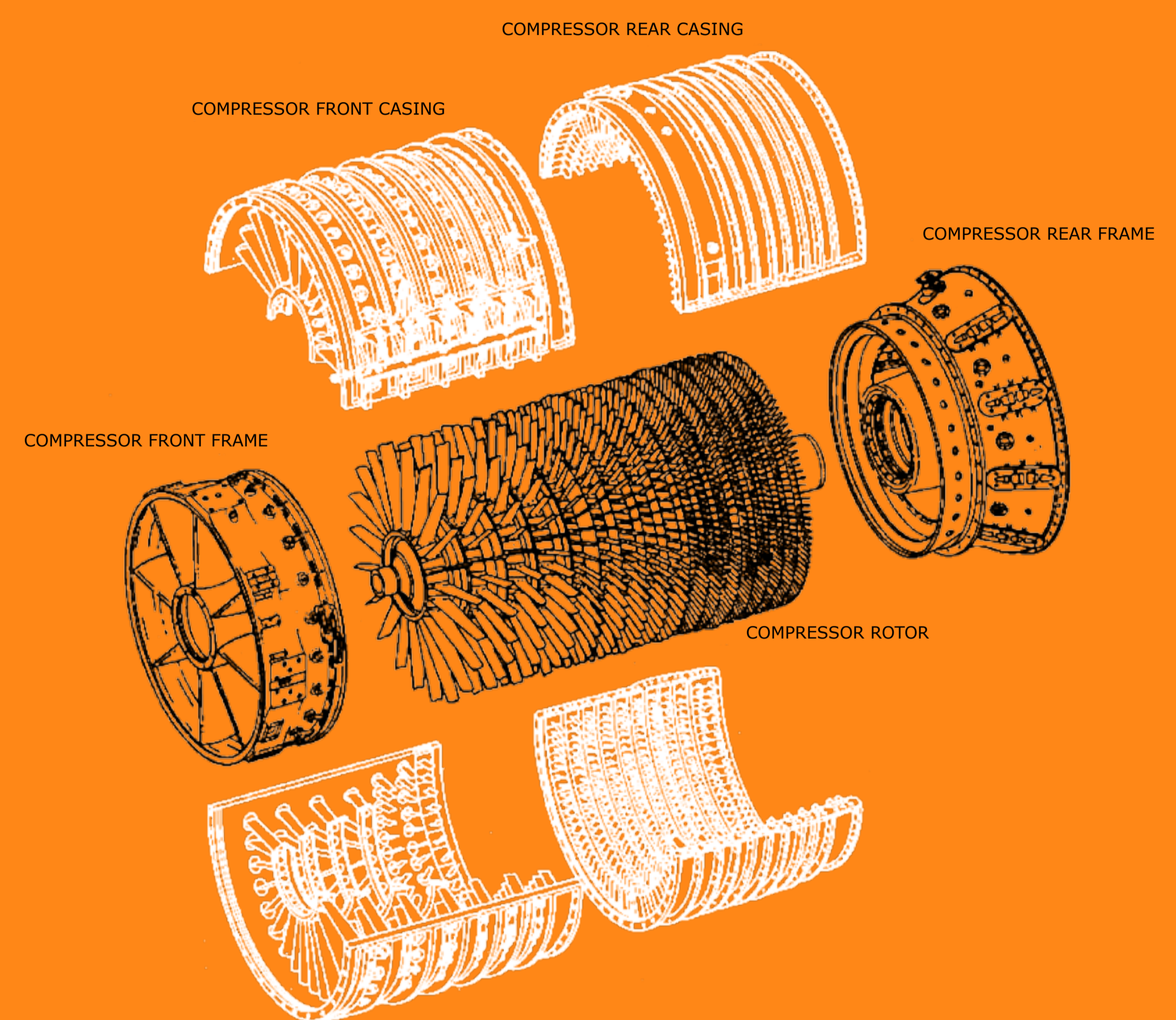


Figure 1 Parts of the compressor casing of a General Electric J79 jet engine. The white parts contain between 2 and 4 mass percent thorium.

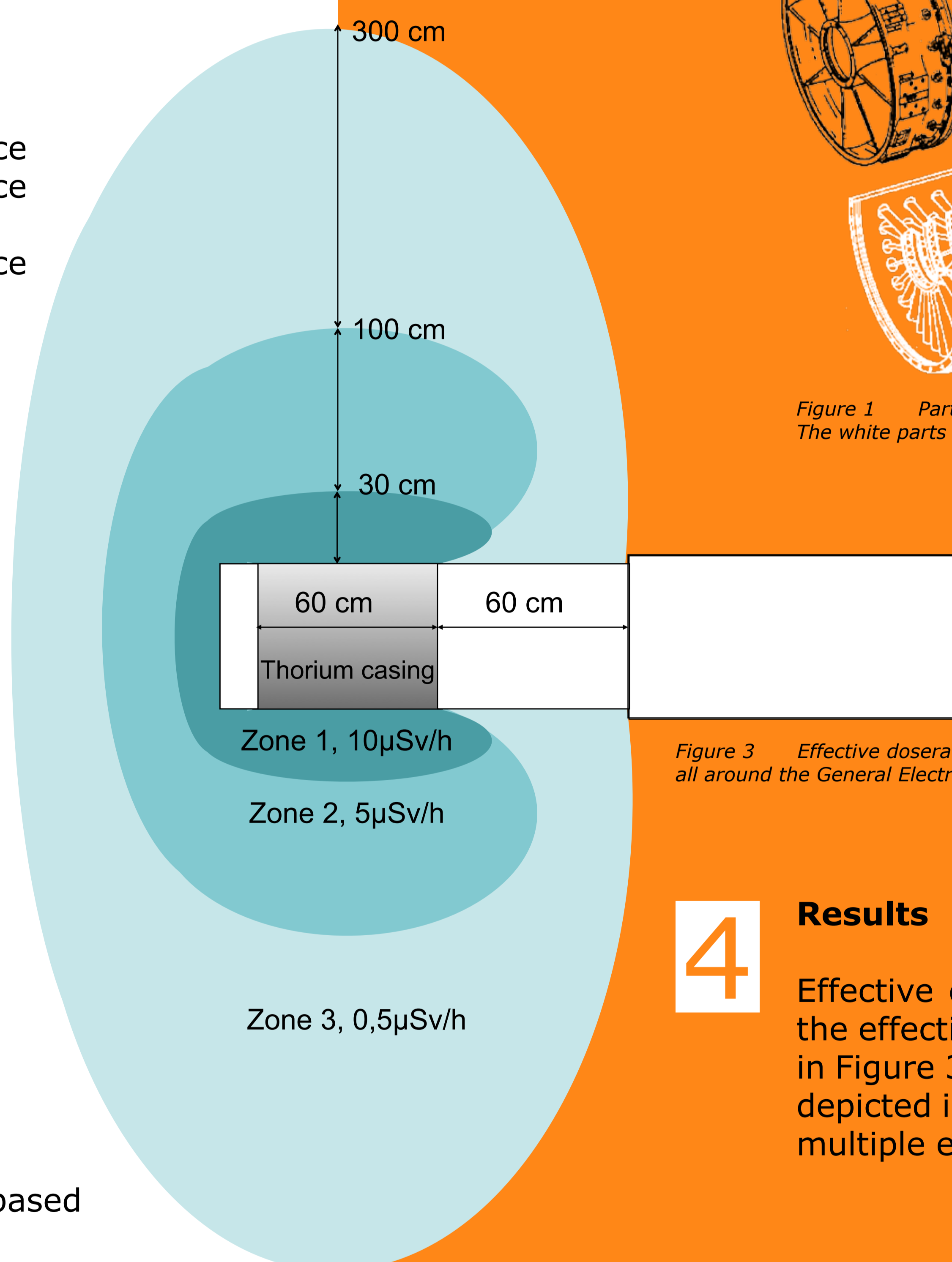


Figure 3 Effective dose rate zones (maxima) all around the General Electric J79 jet engine.

4

Results

Effective dose rate zones were created based on the effective dose measurements and represented in Figure 3. Equivalent skin and eye lens doses are depicted in Table 1. The effective dose per year for multiple employee categories are listed in Table 2.

Table 1 Equivalent Skin Dose and Equivalent Eye Lens Dose

	Equivalent skin dose $H_s(0.07)$ [mSv]	Equivalent eye lens dose $H_e(3)$ [mSv]
mechanics	36	10.5
group Compression	72	21
inspectors	0	0

Table 2 Effective Dose Per Year Per Category Employees

Zone	Effective dose rate [µSv/hour]	Duration of exposure mechanics [hours/year]	Duration of exposure group Compression [hours/year]	Duration of exposure inspectors [hours/year]	Effective dose mechanics [mSv/year]	Effective dose group Compression [mSv/year]	Effective dose inspectors [mSv/year]
1	10	750	1500	0	7.5	15	0
2	5	0	500	500	0	2.5	2.5
3	0.5	500	0	0	0.25	0	0
Total					7.75	17.5	2.5

5 Conclusion

The reconstructed worst case total effective dose for maintenance personnel is 17.5 mSv per year.

The yearly duration of exposure is the most influential parameter in reconstructing the yearly effective dose but also the most sensitive to recall bias.

The reconstructed committed effective dose due to grinding and radon/thoron inhalation is 79 µSv per year. Due to removal by suction of welding fumes the averted committed effective dose is 3.5 mSv per year.