



University of Dayton  
Research Institute

# Probability Of Failure (PROF)



## Overview

The USAF has developed and used a structural risk analysis program, entitled Probability Of Failure (PROF), that synthesizes the hazard rate and probability of fatigue failure as a function of flight hours based on data largely available from the USAF Aircraft Structural Integrity Program (ASIP).

A basic run of PROF estimates the single flight probability of failure and probability of failure between inspections as a function of flight hours for a population of critical locations as defined by the unique damage tolerance analysis (DTA) for the location. There are three major aspects of the process: a) estimating the crack size distribution as a function of flight hours, b) estimating the distribution of time to reach a pre-defined crack size, and, c) calculating the probability that a stress will exceed residual strength during a flight.

## Capabilities

PROF comprises a comprehensive graphical user interface (GUI), a data management system, and computation modules. The following is a brief listing of the key GUI/data management features:

- A tree for saving, recalling and organizing information related to control points and analysis.
- Wizards that provide step-by-step procedures for entering and updating information.
- A standards library for quick recall of crack size distribution and inspection capability information with drop-and-drag data entry for analyses.

- Data organization by user-defined groups of analyses, such as Model/Design/Series (MDS).
- Grouping of control point information by user-defined classes.
- Storage of descriptive information concerning input and analysis results in an Access database.
- Provisions for exporting results to Excel for user specific analyses.

A basic PROF analysis run calculates the probability of failure as a function of flight hours due to the growth of fatigue cracks at a population of locations that is defined by a single damage tolerance analysis – say, a control point. Failure is defined in terms of the Irwin fracture criteria. In particular, for the control point, PROF calculates tables and plots of:

- The SFPOF as a function of flight hours for the combination of all similar control points (see Figure 1).
- The probability of failure as a function of flight hours for the combination of all similar control points (see Figure 2).
- The expected percentage of sites at which cracks will be found at each inspection.
- The predicted distribution of crack sizes immediately before each inspection (see Figure 3).
- The predicted distribution of crack sizes immediately after each inspection (see Figure 3).
- The predicted distribution of crack sizes that are missed at each inspection.
- The predicted distribution of crack sizes that are found at each inspection.

- The probability of failure as a function of crack size.

The results of an analysis can be exported to an Excel file for further use.

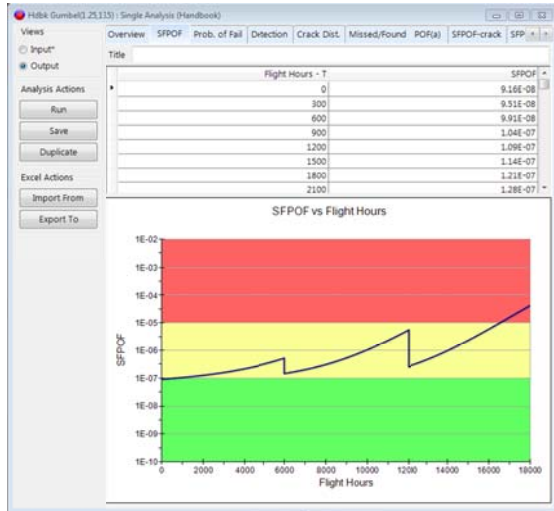


Figure 1 – Single flight probability of failure

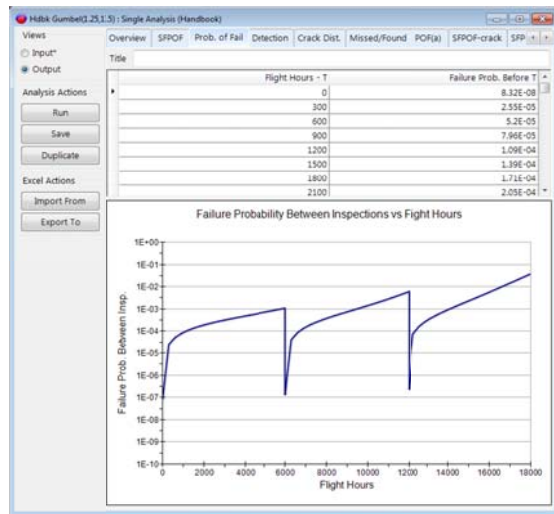


Figure 2 – Failure probability between inspections

The SFPOF and probability of failure results from a basic PROF run can be combined in post-processing phases to describe failure risks for more-complex structural configurations and to calculate fleet summaries. In particular:

- Facilitates such calculations by providing the ability to perform multiple analyses and export the results from the multiple analyses to an Excel file.

- Combines SFPOFs from independent (non-interacting) control points to obtain failure probabilities for the combination.
- Calculates the expected number of fleet failures at selected combinations of control points as a function of calendar time from the projected number of flight hours for calendar periods of the individual aircraft in a fleet.

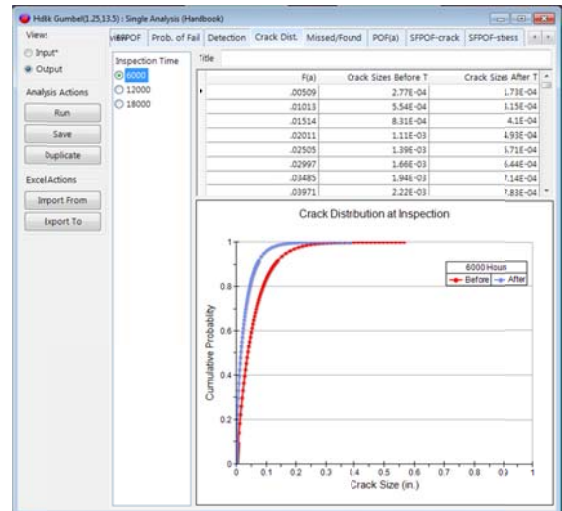


Figure 3 – Crack distribution at inspection – before/after

## Contact

PROF is proprietary to the University of Dayton but is freely available for United States government applications. For applications not directly related to the United States government, a license for the use of PROF can be arranged. Please contact:

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