Nyaben Flight Dynamics

Validation Data for Flight Models

FAA Level 5 and EASA FNPT II FSTD Qualification for Large Passenger Jet Airplanes

- Report for A320. Normal and Direct Law -

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4th Edition

Preface

The present document provides information and data which can be used as reference for the qualification of the flight dynamics model of FNPT II devices according to EASA CS-FSTD(A) or Level 5 devices according to FAA 14 CRF Part 60.

Unless stated otherwise, the estimation of the data in this document is based on the International Standard Atmosphere (ISA). This report version does not cover the test cases with operating stability augmentation or flight envelope protection systems.

The reference data are calculated by means of equations in most cases. For some dynamic maneuvers however the flight simulation software NYASIM has been used. Please visit **https://youtu.be/4yNFgwNE5rY** for more information about this tool. That means no flight data are contained directly in the reference data package provided with this report.

Prior to the estimation, a data base has been created. This data base consists amongst others of the drag polar coefficients, the stability and control derivatives as well as some parameters pertaining to the installed engines of selected large jet airplanes. This engineering data set is mostly derived from flight testing or is measured in wind tunnel. The sources of these data are technical books or technical reports. For the A320NFD however the engineering data set is calculated by means of the semi-empirical Roskam's method implemented in NYASIM. The Roskam's method yields a flight model, which fulfills the level 1 or 2 requirements as defined by the Cooper-Harper Rating Scale. Where necessary, the panel-based method XFOIL has also been used as virtual wind tunnel. The use of this engineering data set and the appropriate formulas enables the determination of the flight performance as well as of the flying and handling qualities.

DISCLAIMER This report is based on research, knowledge and understanding, and to the best of the author's ability the material is current and valid. While the author has made reasonable efforts to ensure the accuracy of the information contained herein, he cannot be held responsible for any errors found in the present document. The Author, Dr. Danyck Nguewo, does not guarantee the acceptance (by the aviation authority for example) of the information contained in this report as validation data for the qualification of any flight simulation and training device (FSTD).

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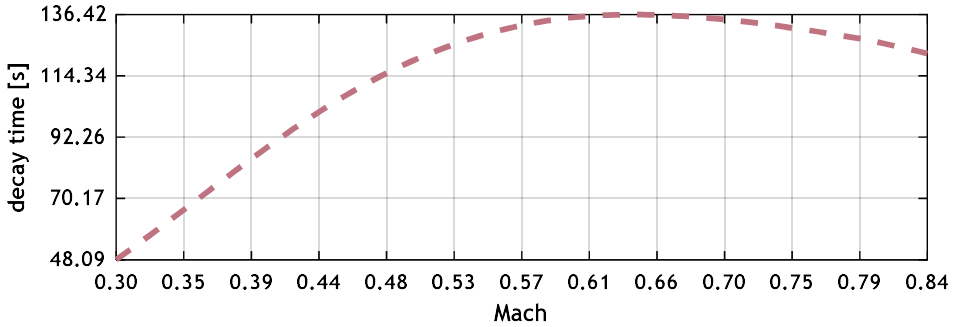
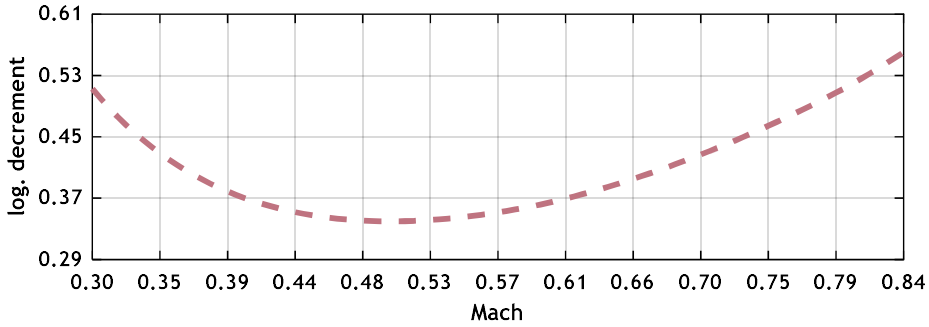
1.2 List of Selected Large Jet Airplanes

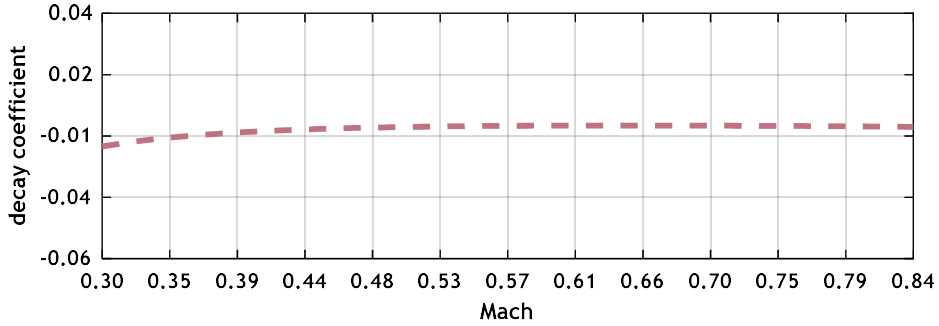
Name	Engine	MTOM [kg]	Mass [kg]	Wing Area [m²]	Wingspan [m]	Max. Thrust [N]	No. Engine
Data Base - for the analysis of the flight performance or handling qualities -							
A319	CFM International CFM56-5B	75500	59000	124	35.8	120100	2
A320	CFM International CFM56-5B	78000	70000	124	35.8	120100	2
A321	CFM International CFM56-5B	93500	81000	128	35.8	120100	2
A300	General Electric CF6-50A	165000	130000	260	44.8	230000	2
B737-400	CFM International CFM56-3	68039	52000	91.04	28.88	98000	2
B737-700	CFM International CFM56-7B	70080	63000	124.6	34.32	101000	2
B737-800	CFM International CFM56-7B	79016	71000	124.6	34.32	108000	2
B737-900	CFM International CFM56-7B	85124	76000	124.6	34.32	108000	2
B707	Pratt & Whitney JT3D	117000	100000	268	43.4	76000	4
B727	Pratt & Whitney JT8D	76700	70000	123	32.92	96500	3
B767	General Electric CF6-80C2B7F	204120	130000	383.3	47.6	283000	2
CV880M	General Electric CJ805-3	87730	70307	185.8	36.58	51820	4
DC8	Pratt & Whitney JT3D	123800	104326	241.54	43.4	76000	4
NYASIM Flight Simulation - for the analysis of the flight performance or handling qualities -							
A320NFD	CFM International CFM56-5B	78000	70000	124	35.8	120100	2
Heavy Airplanes – for comparison purposes -							
B747-100	General Electric CF6CF6-50	333400	318757	511	59.6	240000	4
B747-8I	General Electric GEnx-2B67B	447696	447696	554	68.4	296000	4
Light Airplane – for comparison purposes -							
Do328JET	Pratt & Whitney Canada PW306B	15200	10500	40	20.98	26900	2

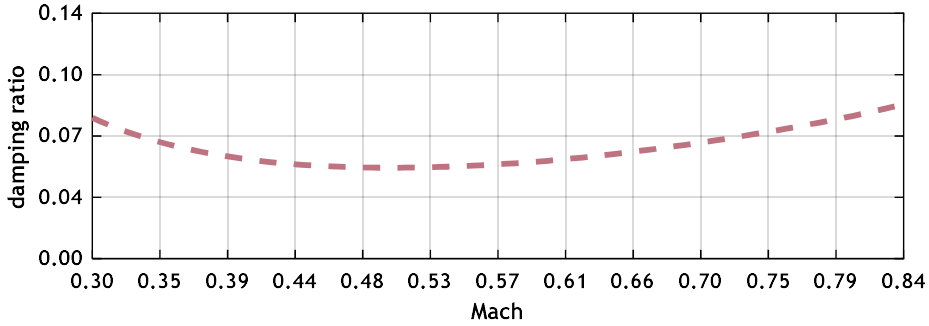
4. Dynamic Characteristics over Mach Number for the A320NFD

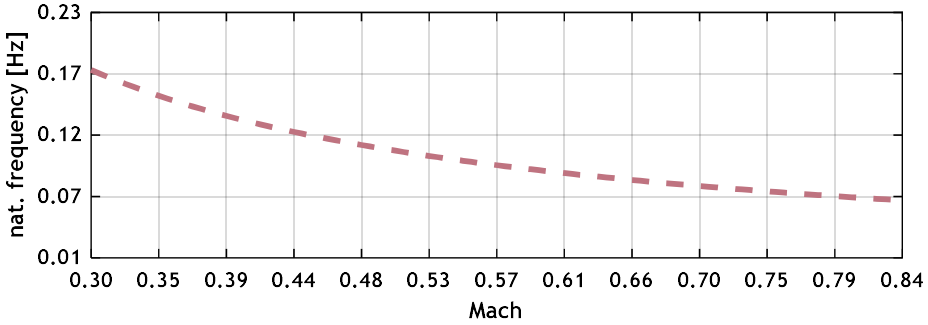
II. Phugoid Dynamics

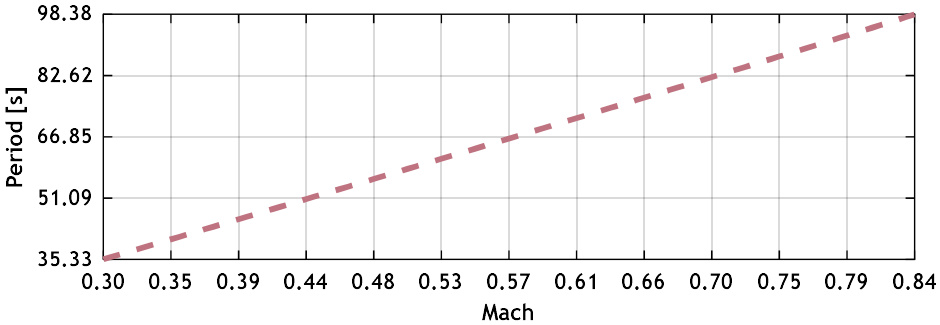












5. Appendix A: Plots of the QTG Test Results

See enclosed documents.

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