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SUBSONIC CAPABILITY OF PRATT AND WHITNEY TURBOJET POWER PLANTS

H. E. Nicoll
AIRCRAFT APPLICATIONS UNIT

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March 23, 1960

GENERAL ELECTRIC
ATOMIC PRODUCTS DIVISION
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The major characteristics of three Pratt & Whitney power plant configurations are given in XDCL 60-3-18, "Summary of Pratt & Whitney Application Studies," by W. J. Tripp, Product Planning. Although the performance data presented is incomplete there is, none the less, sufficient information provided with which to perform preliminary application studies.

Included in the tabulation of results are the weights, characteristics and performance of both penetrating and non-penetrating, three engine, P140 turbojet applications. These serve as a basis for comparison between the ANPD and Pratt & Whitney nuclear propulsion systems. It is to be noted that both P140 and nuclear J58 applications presented in Tables 1 and 2 are the results of an aircraft design optimization technique described in DC 59-11-93, "ANPD 704 [illegible] Computer Program No. 426, Combined Aircraft Program". Hence the aircraft presented are on a comparative basis.

All three Pratt & Whitney configurations involve two reactors which power either four or six nuclear J-58 turbojets. The four engine applications incorporate two PWAR-11 reactors at 200 MW each. For the six engine applications there are two reactor systems. One system incorporates two PWAR-11 reactors and the other involves two 300 MW reactors. The weights of these two reactor systems (including crew shield) differ by less than 2%. The difference in thrust output however at [illegible], sea level is appreciable with the PWAR-11 reactor associated with the lower value. Therefore, the six engine application with sea level penetration capability is powered by the two 300 MW system while the non-penetrating application incorporates the two PWAR-11 reactor system.

The weight breakdown, aircraft characteristics and performance for two non-penetrating applications are given in Table 1. The four engine, two PWAR-11, aircraft is designed for maximum cruise speed at 35,000 feet. The six engine application with the same reactor system is designed for maximum flight speed at 40,000 feet. This application also provides a flight speed of M 0.9 at 35,000 feet. The four engine application when designed for 40,000 feet exhibited a maximum flight Mach number less than M 0.8 and therefore was no longer investigated at that altitude.

Both PWAR-11 and 300 MW reactor systems provide a flight speed of M 0.86 at 40,000 feet for the six engine application. However, the PWAR-11 configuration is somewhat lighter and was therefore selected for the non-penetrating mission.

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Emergency cruise performance data (reactor out, 5,000 feet, AFHD) is not available for any of the Pratt & Whitney power plant configurations. However, previous experience with aircraft of comparable weight, design and $(L/D)_{max}$ values, indicates that the emergency cruise requirement can be met. The excellent normal cruise capabilities associated with these applications are also indicative of adequate emergency performance.

The weight breakdown, aircraft characteristics and performance for the penetrating aircraft are given in Table 2. The four engine application is powered by two PWAR-11 reactors at 200 MW each, while the six engine application is powered by two 300 MW reactors. The aircraft are designed for maximum flight speed at sea level and although the gross weights differ appreciably the differences in thrust available have a compensating effect. As a result the sea level maximum flight speed of both applications is approximately M 0.9 to M 0.95. Because of these high subsonic flight speeds the aircraft characteristics are effected to the extent that the values of $(L/D)_{max}$ associated with the penetrating aircraft are relatively low. As a result it appears doubtful that emergency cruise capability exists for either of these applications. However, no definite statement can be made in this regard until adequate performance data is available.

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TABLE 1

WEIGHT SUMMARY, CHARACTERISTICS AND PERFORMANCE
OF NUCLEAR J-58 AND P140 POWERED AIRCRAFT
NON-PENETRATING MISSION

Reactor Configuration	Four J-58 PWAR-11	Six J-58 PWAR-11	Three P140 With Two J-75 Auxiliary Engines
Total Maximum Reactor Power - MW	400	400	426
Weight Breakdown			
Wing	51,130	64,090	48,190
Fuselage	27,270	30,860	35,220
Empennage	9,737	13,200	11,950
Landing Gear	15,540	19,250	18,020
Propulsion System			
Nuclear Power Plant, Nacelles and Crew Shield	183,200	234,200	217,300
Auxiliary Power Plants	---	---	20,000
Equipment	30,363	33,521	30,290
Empty Weight	317,240	395,121	380,970
Fuel	37,650	56,500	40,000
Oil	3,200	4,000	2,400
Crew	900	900	900
Payload	50,000	50,000	50,000
Gross Weight	409,000	506,500	474,270
Aircraft Characteristics			
Wing Area - Sq Ft	4,000	4,900	4,600
Aspect Ratio	5.5	5.5	6.5
Thickness Ratio	0.075	0.075	0.09
Wing Sweep - .25c, Degrees	39	36	18
Performance			
$(L/D)_{max}$, With Payload	18.08	18.33	19.37
Ground Run, SL Std Day	6,600	5,000	5,000
Critical Field Length, SL Std Day	8,100	5,700	6,600
Maximum M_{Cruise} and Corresponding Altitude	0.88 / 35,000 ft	.9 / 35,000 ft / .88 / 40,000 ft	0.8 / 32,500 ft

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TABLE 2

WEIGHT SUMMARY, CHARACTERISTICS AND PERFORMANCE
OF NUCLEAR J-58 AND P140 POWERED AIRCRAFT
PENETRATING MISSION

Reactor Configuration	Four J-58 PWAR-11	Six J-58 300 MW	Three P140 With Two J-75 Auxiliary Power Plants
Total Maximum Reactor Power - MW	400	400	426
Weight Breakdown			
Wing	19,240	23,970	39,400
Fuselage	32,700	37,600	43,550
Empennage	6,387	8,172	9,070
Landing Gear	14,320	17,800	17,880
Propulsion System			
Nuclear Power Plant, Nacelles and Crew Shield	183,200	237,000	217,300
Auxiliary Power Plants	---	---	20,000
Equipment	29,521	32,473	30,000
Empty Weight	285,378	357,015	377,200
Fuel	37,650	56,500	40,000
Oil	3,200	4,000	2,400
Crew	900	900	900
Payload	50,000	50,000	50,000
Gross Weight	377,100	468,400	470,500
Aircraft Characteristics			
Wing Area - Sq Ft	2,800	3,300	3,800
Aspect Ratio	2.5	2.5	5.0
Thickness Ratio	0.06	0.06	0.09
Wing Sweep - .25c, Degrees	21	15	15
Performance			
$(L/D)_{max}$, With Payload	11.50	11.66	16.5
Ground Run, SL Std Day	6,900	5,500	5,000
Critical Field Length, SL Std Day	8,600	6,400	6,600
Maximum Sea Level Mach Number	0.90-0.95	0.90-0.95	.83

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