535

~~(S)~~Table 8.5-1 Weight Summary For Composite Materials Study: Aluminum Airplanes (U)

(pounds)

Gross Weight (lb)	Item	AR-3 W/S 45	AR-3 W/S 50	AR-3 W/S 55	AR-3 W/S 60	AR-4 W/S 45	AR-4 W/S 50	AR-4 W/S 55	AR-4 W/S 60	AR-5 W/S 45	AR-5 W/S 50	AR-5 W/S 55	AR-5 W/S 60	AR-6 W/S 45	AR-6 W/S 50	AR-6 W/S 55	AR-6 W/S 60
15,600	FUSELAGE	2476	2476	2482	2485	2503	2507	2507	2510	2532	2533	2533	2533	2552	2553	2553	2551
	HORIZ. TAIL	372	352	334	316	360	340	324	308	348	326	310	294	340	320	304	288
	VERT. TAIL	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292
	LAND'G GEAR	595	595	595	595	595	595	595	595	595	595	595	595	595	595	595	595
	WING	1740	1626	1527	1443	2218	2073	1950	1845	2817	2546	2493	2361	3535	3318	3132	2965
	TOTAL STRUCTURE	5475	5343	5230	5133	5970	5807	5670	5550	6584	6352	6223	6075	7314	7078	6878	6691
	PROPULSION	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459
	SYSTEMS & EQUIP.	2830	2776	2734	2699	2876	2811	2765	2728	2896	2826	2792	2753	2920	2862	2813	2773
	USEFUL LOAD	395	395	395	395	395	395	395	395	395	395	395	395	395	395	395	395
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,792	12,606	12,451	12,319	13,333	13,105	12,922	12,763	13,967	13,717	13,502	13,315	14,721	14,427	14,178	13,951
	FUEL	2808	2994	3149	3281	2267	2495	2678	2835	1633	1883	2098	2285	879	1173	1422	1649
	GROSS WEIGHT	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
16,800	FUSELAGE	2562	2565	2570	2572	2596	2596	2599	2601	2626	2626	2626	2626	2647	2648	2648	2646
	HORIZ. TAIL	610	384	367	346	396	370	350	334	380	356	336	322	372	348	328	314
	VERT. TAIL	316	316	316	316	316	316	316	316	316	316	316	316	316	316	316	316
	LAND'G GEAR	616	616	616	616	616	616	616	616	616	615	616	616	616	616	616	616
	WING	1899	1774	1670	1576	2413	2257	2125	2011	3091	2878	2715	2560	3837	3603	3404	3229
	TOTAL STRUCTURE	5803	5655	5534	5426	6335	6155	6006	5878	7007	6792	6605	6448	7788	7531	7312	7121
	PROPULSION	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530
	SYSTEMS & EQUIP.	2891	2835	2789	2751	2929	2872	2826	2781	2960	2900	2851	2804	2986	2926	2874	2832
	USEFUL LOAD	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	13,257	13,053	12,886	12,740	13,831	13,590	13,393	13,222	14,530	14,255	14,019	13,819	15,337	15,020	14,749	14,516
	FUEL	3543	3747	3914	4060	2969	3210	3407	3578	2270	2545	2781	2981	1463	1780	2051	2284
	GROSS WEIGHT	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
18,000	FUSELAGE	2654	2657	2663	2665	2691	2692	2695	2697	2723	2724	2724	2724	2747	2747	2760	2745
	HORIZ. TAIL	430	422	400	382	434	408	386	366	420	390	370	356	406	382	362	344
	VERT. TAIL	344	344	344	344	344	344	344	344	344	344	344	344	344	344	344	344
	LAND'G GEAR	636	636	636	636	636	636	636	636	636	636	636	636	636	636	636	636
	WING	2063	1945	1833	1736	2622	2455	2311	2185	3332	3136	2963	2789	4179	3906	3691	3503
	TOTAL STRUCTURE	6149	6004	5856	5744	6727	6535	6372	6230	7655	7218	7019	6847	8312	8017	7781	7576
	PROPULSION	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603
	SYSTEMS & EQUIP.	2954	2895	2846	2806	2935	2923	2881	2838	3027	2964	2911	2865	3056	2997	2935	2888
	USEFUL LOAD	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	433
	ZERO FUEL WEIGHT	13,744	13,540	13,343	13,189	14,363	14,109	13,894	13,709	15,123	14,823	14,571	14,353	16,007	15,649	15,357	15,103
	FUEL	4256	4460	4657	4811	3637	3891	4106	4291	2877	3177	3429	3647	1993	2351	2643	2897
	GROSS WEIGHT	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000

SECRET

536

~~(S)~~ Table 8.5-2 Weight Summary for Composite Material Study: All-Composite Airplanes (U)

(pounds)

Gross Weight (lb)	Item	AR-3 W/S 45	AR-3 W/S 50	AR-3 W/S 55	AR-3 W/S 60	AR-4 W/S 45	AR-4 W/S 50	AR-4 W/S 55	AR-4 W/S 60
15,600	FUSELAGE	1987	1987	1989	1990	2008	2009	2009	2009
	HORIZ. TAIL	288	273	259	247	279	264	251	239
	VERT. TAIL	234	234	234	234	234	234	234	234
	LAND'G GEAR	595	595	595	595	595	595	595	595
	WING	1354	1267	1192	1127	1681	1572	1482	1403
	TOTAL STRUCTURE	4458	4356	4269	4193	4797	4674	4571	4480
	PROPULSION	3397	3397	3397	3397	3397	3397	3397	3397
	SYSTEMS & EQUIP.	2830	2776	2734	2695	2876	2811	2765	2728
	USEFUL LOAD	395	395	395	395	395	395	395	395
	PAYLOAD	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	11,713	11,557	11,428	11,313	12,098	11,910	11,761	11,633
	FUEL	3887	4043	4172	4287	3502	3690	3839	3967
	GROSS WEIGHT	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
16,800	FUSELAGE	2047	2049	2052	2052	2073	2072	2074	2075
	HORIZ. TAIL	314	294	277	265	303	283	268	255
	VERT. TAIL	253	253	253	253	253	253	253	253
	LAND'G GEAR	616	616	616	616	616	616	616	616
	WING	1479	1383	1303	1231	1829	1712	1614	1529
	TOTAL STRUCTURE	4709	4595	4501	4417	5074	4936	4825	4728
	PROPULSION	3462	3462	3462	3462	3462	3462	3462	3462
	SYSTEMS & EQUIP.	2891	2835	2789	2749	2929	2872	2824	2781
	USEFUL LOAD	400	400	400	400	400	400	400	400
	PAYLOAD	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,095	11,925	11,785	11,661	12,498	12,303	12,144	12,004
	FUEL	4705	4875	5015	5139	4302	4497	4656	4796
	GROSS WEIGHT	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
18,000	FUSELAGE	2113	2116	2117	2115	2141	2141	2142	2143
	HORIZ. TAIL	344	324	307	293	333	313	296	282
	VERT. TAIL	275	275	275	275	275	275	275	275
	LAND'G GEAR	636	636	636	636	636	636	636	636
	WING	1605	1501	1415	1339	1985	1861	1756	1662
	TOTAL STRUCTURE	4973	4850	4750	4662	5370	5226	5105	4998
	PROPULSION	3530	3530	3530	3530	3530	3530	3530	3530
	SYSTEMS & EQUIP.	2954	2895	2846	2804	2995	2933	2881	2838
	USEFUL LOAD	405	405	405	405	405	405	405	405
	PAYLOAD	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,497	12,323	12,164	12,034	12,933	12,727	12,554	12,404
	FUEL	5503	5687	5836	5966	5067	5273	5446	5596
	GROSS WEIGHT	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000

Gross Weight (lb)	Item	AR-5 W/S 45	AR-5 W/S 50	AR-5 W/S 55	AR-5 W/S 60	AR-6 W/S 45	AR-6 W/S 50	AR-6 W/S 55	AR-6 W/S 60
15,600	FUSELAGE	2029	2028	2026	2027	2044	2044	2042	2041
	HORIZ. TAIL	270	253	241	228	264	248	236	224
	VERT. TAIL	234	234	234	234	234	234	234	234
	LAND'G GEAR	595	595	595	595	595	595	595	595
	WING	2053	1931	1823	1731	2482	2335	2209	2094
	TOTAL STRUCTURE	5181	5041	4921	4815	5619	5456	5316	5188
	PROPULSION	3397	3397	3397	3397	3397	3397	3397	3397
	SYSTEMS & EQUIP.	2896	2838	2792	2753	2920	2862	2823	2773
	USEFUL LOAD	395	395	395	395	395	395	395	395
	PAYLOAD	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,504	12,304	12,138	11,993	12,964	12,743	12,554	12,386
	FUEL	3096	3296	3462	3607	2636	2857	3046	3214
	GROSS WEIGHT	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
16,800	FUSELAGE	2095	2095	2095	2094	2113	2113	2112	2109
	HORIZ. TAIL	291	272	255	246	285	268	251	240
	VERT. TAIL	253	253	253	253	253	253	253	253
	LAND'G GEAR	616	616	616	616	616	616	616	616
	WING	2237	2094	1983	1880	2693	2505	2373	2256
	TOTAL STRUCTURE	5492	5334	5202	5089	5960	5753	5605	5476
	PROPULSION	3462	3462	3462	3462	3462	3462	3462	3462
	SYSTEMS & EQUIP.	2960	2900	2851	2808	2986	2926	2874	2832
	USEFUL LOAD	400	400	400	400	400	400	400	400
	PAYLOAD	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,947	12,729	12,548	12,392	13,441	13,174	12,974	12,801
	FUEL	3853	4071	4252	4408	3359	3626	3826	3999
	GROSS WEIGHT	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
18,000	FUSELAGE	2155	2165	2164	2163	2184	2183	2183	2180
	HORIZ. TAIL	322	299	284	272	312	293	278	266
	VERT. TAIL	275	275	275	275	275	275	275	275
	LAND'G GEAR	636	636	636	636	636	636	636	636
	WING	2423	2277	2150	2039	2893	2714	2571	2444
	TOTAL STRUCTURE	5811	5652	5509	5385	6300	6101	5943	5801
	PROPULSION	3530	3530	3530	3530	3530	3530	3530	3530
	SYSTEMS & EQUIP.	3027	2964	2911	2865	3054	2991	2935	2888
	USEFUL LOAD	405	405	405	405	405	405	405	405
	PAYLOAD	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	13,406	13,184	12,988	12,818	13,922	13,660	13,446	13,257
	FUEL	4594	4816	5012	5182	4078	4340	4554	4743
	GROSS WEIGHT	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000

SECRET

SECRET

(S) Table 8.5-3 Weight Summary For Composite Material Study: Composite- Wing-Only Airplanes (U) (pounds)

Gross Weight (lb)	Item	AR=3 W/S 45	AR=3 W/S 50	AR=3 W/S 55	AR=3 W/S 60	AR=4 W/S 45	AR=4 W/S 50	AR=4 W/S 55	AR=4 W/S 60	AR=5 W/S 45	AR=5 W/S 50	AR=5 W/S 55	AR=5 W/S 60	AR=6 W/S 45	AR=6 W/S 50	AR=6 W/S 55	AR=6 W/S 60
15,600	FUSELAGE	2476	2478	2482	2485	2505	2507	2509	2510	2532	2533	2533	2533	2552	2553	2555	2552
	HORIZ. TAIL	372	352	334	318	360	340	324	308	348	326	310	294	340	320	304	288
	VERT. TAIL	292	292	292	292	292	292	292	292	292	292	292	292	252	292	292	292
	LAND'G GEAR	595	595	595	595	595	595	595	595	595	595	595	595	595	593	595	595
	WING	1354	1267	1192	1127	1681	1572	1682	1603	2055	1931	1823	1731	2482	2335	2209	2094
	TOTAL STRUCTURE	5289	4984	4895	4817	5433	5306	5202	5108	5820	5677	5553	5445	6261	6095	5935	5821
	PROPULSION	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459	3459
	SYSTEMS & EQUIP.	2830	2776	2734	2693	2876	2811	2765	2726	2896	2838	2792	2753	2920	2862	2813	2773
	USEFUL LOAD	395	395	395	395	395	395	395	395	395	395	395	395	395	395	395	395
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,406	12,247	12,116	11,999	12,796	12,604	12,456	12,323	13,203	13,002	12,832	12,685	13,668	13,444	13,255	13,081
	FUEL	3194	3353	3484	3601	2804	2996	3146	3277	2397	2598	2768	2915	1932	2156	2345	2519
	GROSS WEIGHT	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
16,800	FUSELAGE	2561	2565	2570	2572	2594	2596	2599	2601	2624	2626	2626	2626	2647	2648	2646	2646
	HORIZ. TAIL	410	384	362	346	396	370	350	334	380	356	334	322	372	348	328	314
	VERT. TAIL	316	316	316	316	316	316	316	316	316	316	316	316	316	316	316	316
	LAND'G GEAR	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616
	WING	1475	1383	1301	1231	1829	1732	1614	1529	2237	2098	1983	1880	2693	2505	2373	2256
	TOTAL STRUCTURE	5383	5264	5167	5081	5753	5610	5495	5396	6173	6012	5875	5760	6644	6433	6281	6148
	PROPULSION	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530
	SYSTEMS & EQUIP.	2891	2835	2789	2749	2929	2872	2824	2781	2960	2900	2851	2808	2986	2926	2874	2832
	USEFUL LOAD	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,837	12,662	12,519	12,393	13,265	13,045	12,882	12,740	13,696	13,475	13,289	13,131	14,193	13,922	13,718	13,543
	FUEL	3963	4138	4281	4407	3535	3755	3918	4060	3104	3325	3511	3686	2607	2878	3082	3257
	GROSS WEIGHT	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
18,000	FUSELAGE	2634	2657	2663	2666	2691	2692	2695	2697	2723	2726	2724	2724	2747	2747	2748	2745
	HORIZ. TAIL	450	422	400	382	434	408	386	368	420	390	370	354	406	383	362	346
	VERT. TAIL	344	344	344	344	344	344	344	344	344	344	344	344	344	344	344	344
	LAND'G GEAR	636	616	636	636	636	636	636	636	636	636	636	636	636	636	636	636
	WING	1606	1501	1415	1339	1985	1861	1756	1662	2423	2277	2150	2039	2893	2716	2571	2444
	TOTAL STRUCTURE	5689	5560	5458	5367	6090	5941	5817	5707	6546	6371	6226	6097	7026	6823	6661	6515
	PROPULSION	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603	3603
	SYSTEMS & EQUIP.	2954	2895	2846	2804	2995	2933	2851	2838	3027	2964	2911	2865	3054	2991	2935	2868
	USEFUL LOAD	405	405	405	405	403	405	403	405	405	405	405	405	405	405	405	405
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	13,284	13,096	12,945	12,812	13,726	13,515	13,339	13,186	14,214	13,976	13,776	13,603	14,721	14,455	14,237	14,044
	FUEL	4716	4904	5055	5188	4274	4485	4661	4814	3786	4024	4224	4397	3279	3545	3763	3956
	GROSS WEIGHT	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000

SECRET

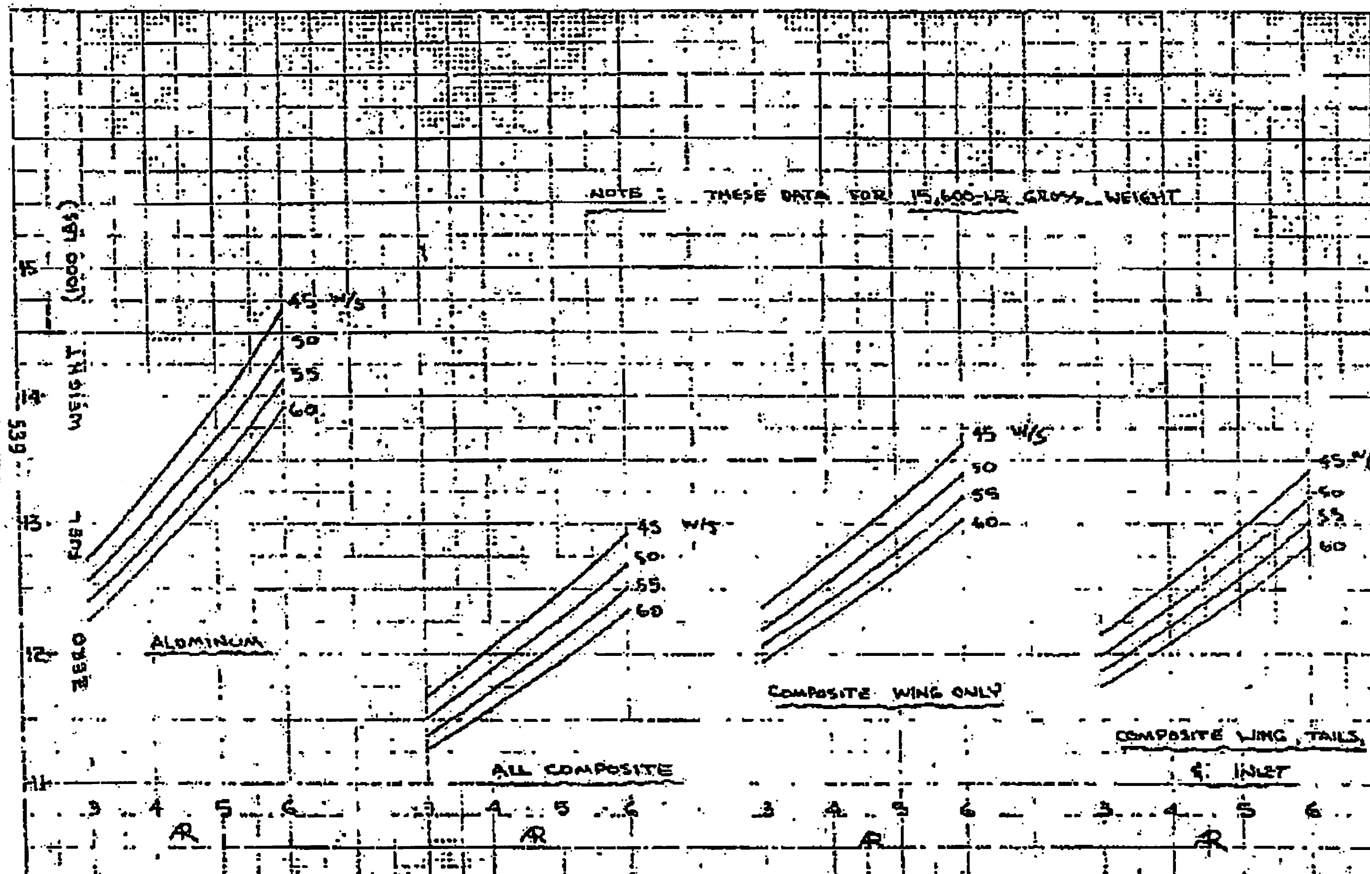
(S) Table 8.5-4 Weight Summary For Composite Material Study: Composite-Wing, -Tails -Inlet Duct Airplanes(U)

(pounds)

Gross Weight (lb)	Item	AR=3				AR=4				AR=5				AR=6			
		W/S 45	50	55	60	W/S 45	50	55	60	W/S 45	50	55	60	W/S 45	50	55	60
15,600	FUSELAGE	2476	2478	2482	2483	2500	2507	2509	2510	2532	2533	2533	2533	2552	2553	2553	2551
	HORIZ. TAIL	268	273	259	247	275	264	251	239	270	253	241	228	264	260	256	224
	VERT. TAIL	234	234	234	234	234	234	234	234	234	234	234	234	234	234	234	234
	LAND'G GEAR	595	595	595	595	595	595	595	595	595	595	595	595	595	595	595	595
	WING	1374	1267	1192	1129	1681	1572	1482	1403	2053	1931	1823	1731	2402	2335	2209	2094
	TOTAL STRUCTURE	4947	4847	4762	4688	5294	5172	5071	4981	5684	5546	5426	5321	6127	5963	5829	5698
	PROPULSION	3397	3397	3397	3397	3397	3397	3397	3397	3397	3397	3397	3397	3397	3397	3397	3397
	SYSTEMS & EQUIP.	2830	2776	2734	2695	2876	2811	2765	2728	2896	2838	2792	2753	2920	2862	2813	2773
	USEFUL LOAD	395	395	395	395	395	395	395	395	395	395	395	395	395	395	395	395
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,202	12,048	11,921	11,808	12,595	12,408	12,261	12,134	13,005	12,809	12,643	12,499	13,472	13,252	13,067	12,896
	FUEL	3398	3552	3679	3792	3005	3192	3340	3466	2595	2791	2957	3101	2128	2348	2533	2704
	GROSS WEIGHT	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
16,800	FUSELAGE	2562	2565	2570	2572	2596	2596	2599	2601	2624	2626	2626	2626	2647	2648	2648	2646
	HORIZ. TAIL	314	296	277	265	303	283	268	255	291	272	255	246	265	266	251	240
	VERT. TAIL	253	253	253	253	253	253	253	253	253	253	253	253	253	253	253	253
	LAND'G GEAR	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616
	WING	1479	1383	1303	1231	1829	1712	1614	1529	2237	2098	1983	1880	2493	2505	2373	2256
	TOTAL STRUCTURE	5224	5113	5019	4937	5597	5460	5350	5254	6021	5865	5733	5621	6494	6288	6141	6011
	PROPULSION	3462	3462	3462	3462	3462	3462	3462	3462	3462	3462	3462	3462	3462	3462	3462	3462
	SYSTEMS & EQUIP.	2891	2835	2789	2749	2929	2872	2824	2781	2960	2900	2851	2808	2986	2926	2874	2832
	USEFUL LOAD	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	12,610	12,441	12,303	12,181	13,021	12,827	12,649	12,530	13,476	13,260	13,079	12,924	13,975	13,709	13,510	13,338
	FUEL	4190	4359	4497	4619	3779	3973	4151	4270	3324	3540	3721	3876	2825	3091	3290	3462
	GROSS WEIGHT	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
18,000	FUSELAGE	2654	2657	2663	2666	2691	2692	2695	2697	2723	2724	2724	2724	2747	2747	2748	2745
	HORIZ. TAIL	346	324	307	293	333	313	296	282	322	299	284	272	312	293	278	266
	VERT. TAIL	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
	LAND'G GEAR	636	636	636	636	636	636	636	636	636	636	636	636	636	636	636	636
	WING	1605	1501	1415	1339	1985	1861	1756	1662	2423	2277	2150	2039	2893	2714	2571	2444
	TOTAL STRUCTURE	5516	5393	5296	5209	5920	5777	5658	5552	6379	6211	6069	5946	6863	6665	6508	6366
	PROPULSION	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530	3530
	SYSTEMS & EQUIP.	2954	2895	2866	2804	2995	2933	2881	2838	3027	2964	2911	2865	3054	2991	2935	2890
	USEFUL LOAD	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405
	PAYLOAD	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633	633
	ZERO FUEL WEIGHT	13,038	12,856	12,730	12,581	13,483	13,278	13,107	12,958	13,974	13,743	13,548	13,379	14,485	14,224	14,011	13,824
	FUEL	4962	5144	5270	5419	4517	4722	4893	5042	4026	4257	4452	4621	3515	3776	3989	4176
	GROSS WEIGHT	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000

88th ABW/IPI
FOIA (b)(1)
~~E.O.13526 SEC. 3.3.~~
(b)(4)
1.4. (a)(g)

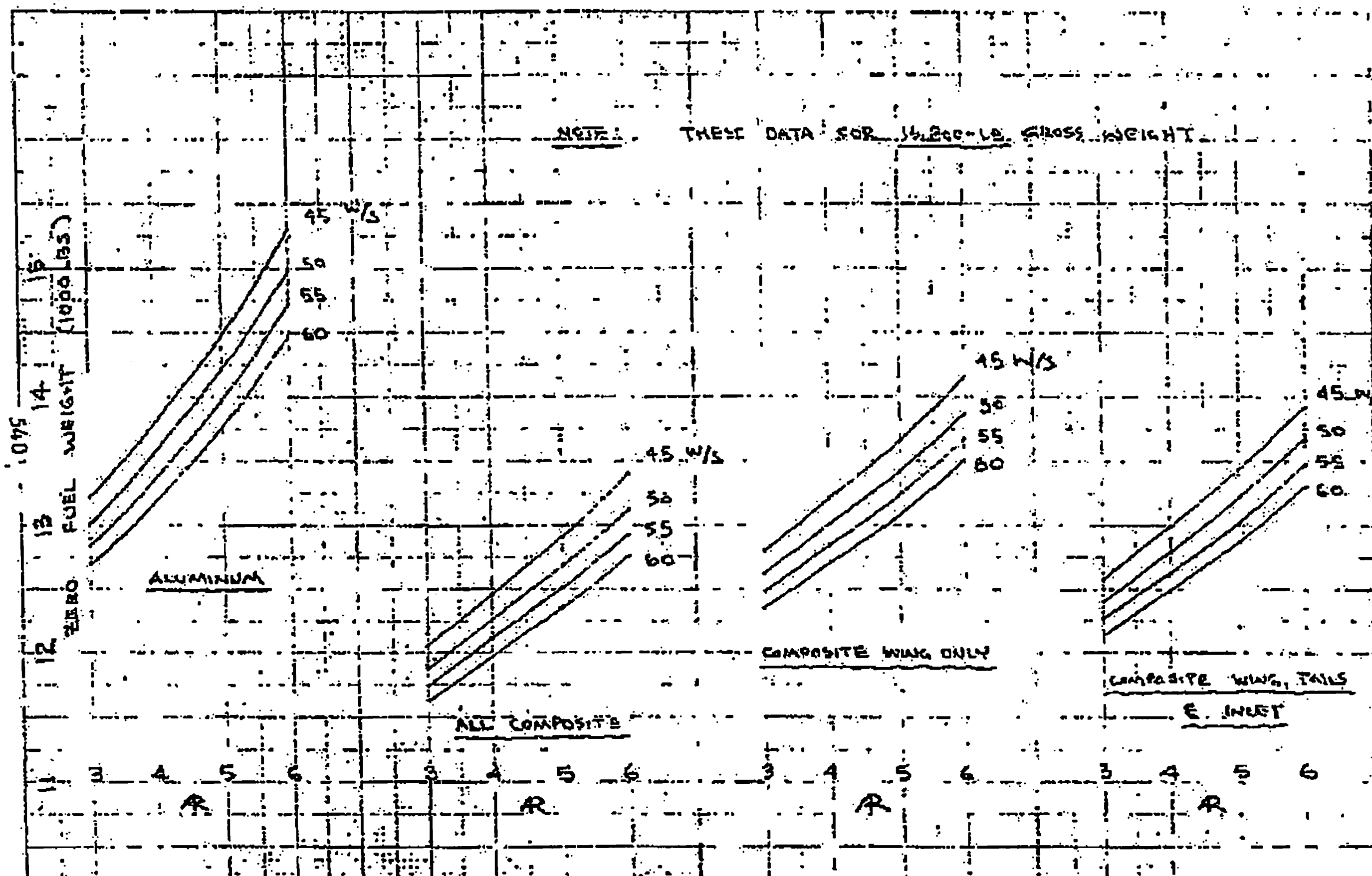
~~SECRET~~



(S) Figure 8.5-1 Composite Study: Zero Fuel Weight vs Aspect Ratio at 15,600-lb Gross Weight (U)

~~SECRET~~

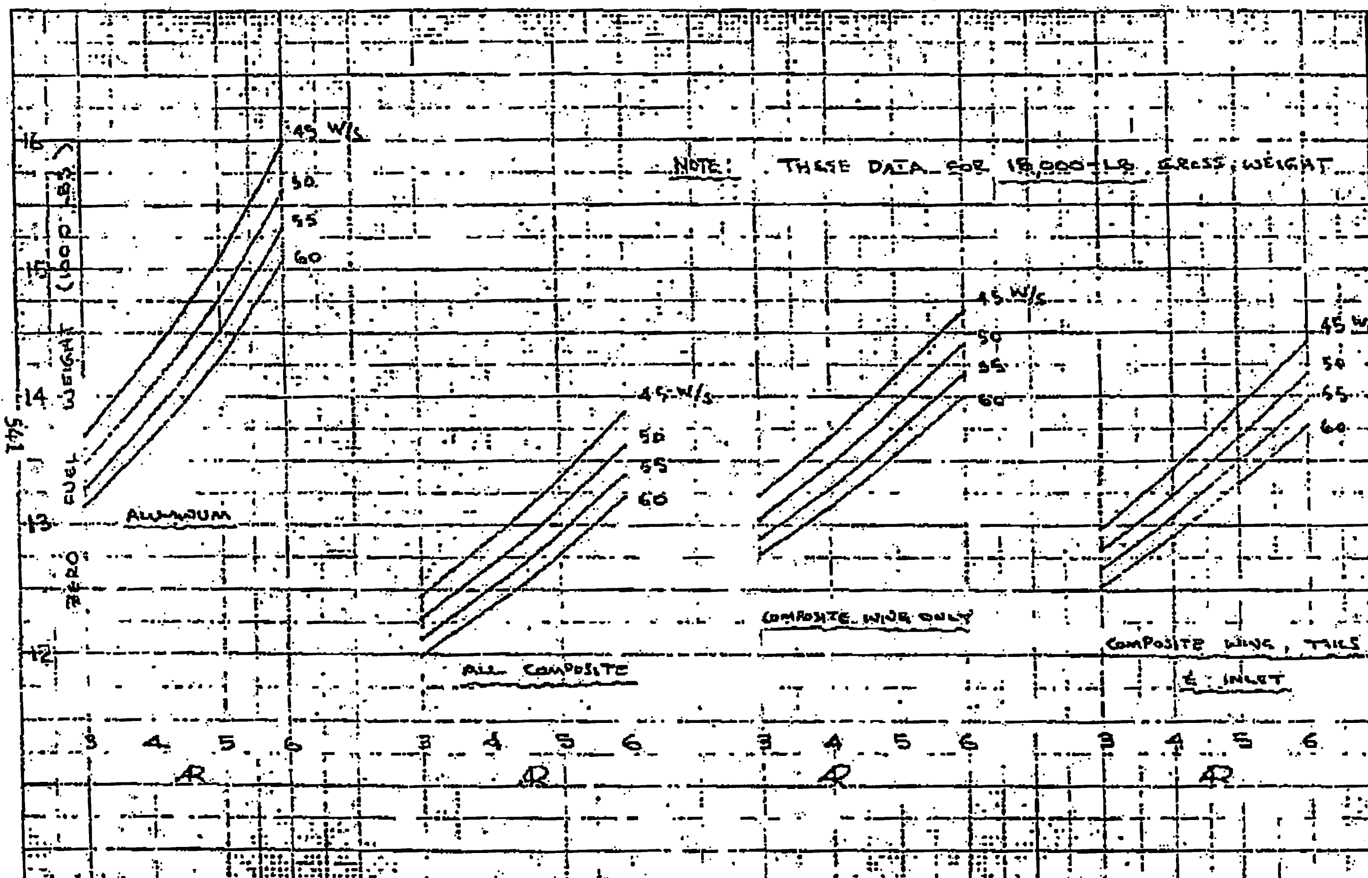
SECRET



SECRET

~~(S)~~ Figure 8.5-2 Composite Study: Zero Fuel Weight vs Aspect Ratio at 16,800-lb Gross Weight (U)

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC.
3.3.(b)(4)
1.4. (a)(g)



(S) Figure 8.5-3 Composite Study: Zero Fuel Weight vs Aspect Ratio at 18,000-lb Gross Weight (U)

SECRET

SECTION 9

INLET TRADE STUDY ON 401B

(U) Four inlet designs were evaluated during the study to assess the payoff and penalties associated with inlet sophistication. Specifically, the effects of inlet design Mach number and inlet variable geometry were evaluated. The Configuration 401B/F100-PW-100 inlet was used as the baseline configuration for the study. Inlet and duct lines were generated in sufficient detail to determine aircraft cross-sectional and wetted-area changes, structural and control system weights (as applicable), inlet pressure recoveries, and inlet drags.

9.1 INLET TYPES SELECTED

~~(C)~~ The four inlet types selected and evaluated were as follows:

Inlet	Design Mach	Capture Area, A_i ($in.^2$)	Variable Geometry	Bypass
1. Open-Nose (401B baseline)	1.6	740	No	No
2. Half-Axisymmetric, fixed-spike	2.0	1020	No	Yes
3. Half-axisymmetric, variable-diameter, double-cone spike	2.2	890	Yes	No
4. Two-dimensional variable ramp	2.2	841	Yes	No

(U) Inlet 1, the baseline inlet, is described in Subsection 3.6.2.

(U) Layouts for Inlets 2, 3, and 4 are shown in Figures 9.1-1, 9.1-2, and 9.1-3, respectively. The lines for each inlet are compared with the baseline open-nose inlet in Figures 9.1-4, 9.1-5, and 9.1-6. Basically, the groundrule was to incorporate the alternate inlet configurations on

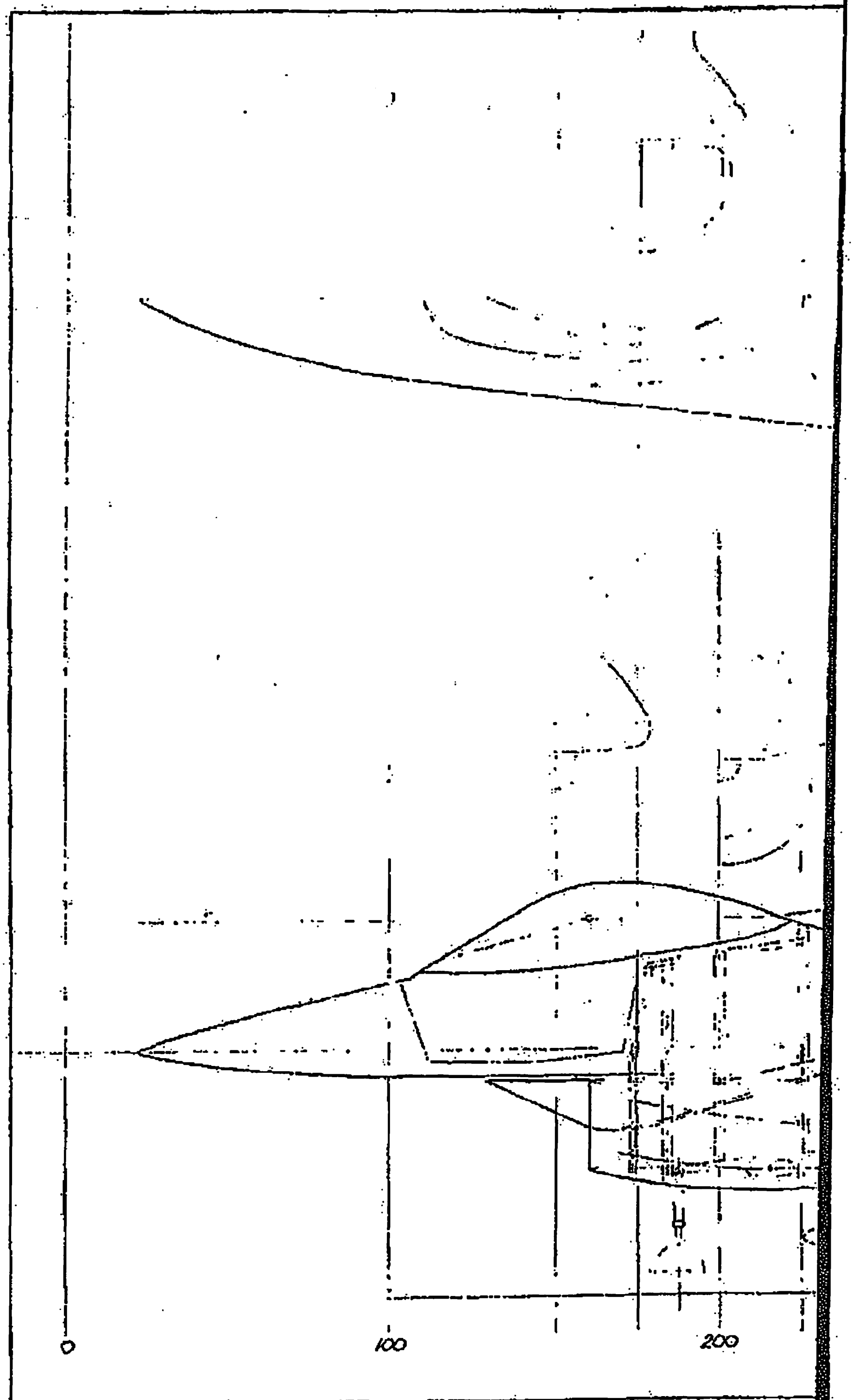
Configuration 401B with minimum change. Some refinement of lines and area distributions might be possible with each configuration, but it is not expected to change the result significantly.

(C) Inlet 2, is a half-axisymmetric fixed-geometry inlet incorporating a 22.5-degree half-angle conical centerbody (spike) for supersonic compression. The inlet is designed for a terminal-shock Mach number of about 1.5 at Mach 2.0 flight, a critical mass flow ratio of 0.96, and a throat area of 710 sq in. The same throat-sizing criteria were used for this inlet as for the open-nose baseline configuration since the maximum throat area is set by the maximum subsonic engine airflow. These throat-sizing criteria result in an inlet capture area of 1020 sq in. for this inlet, which is oversized for the Mach 2.0 flight condition and requires a bypass to avoid highly subcritical (and probably unstable) operation of the inlet.

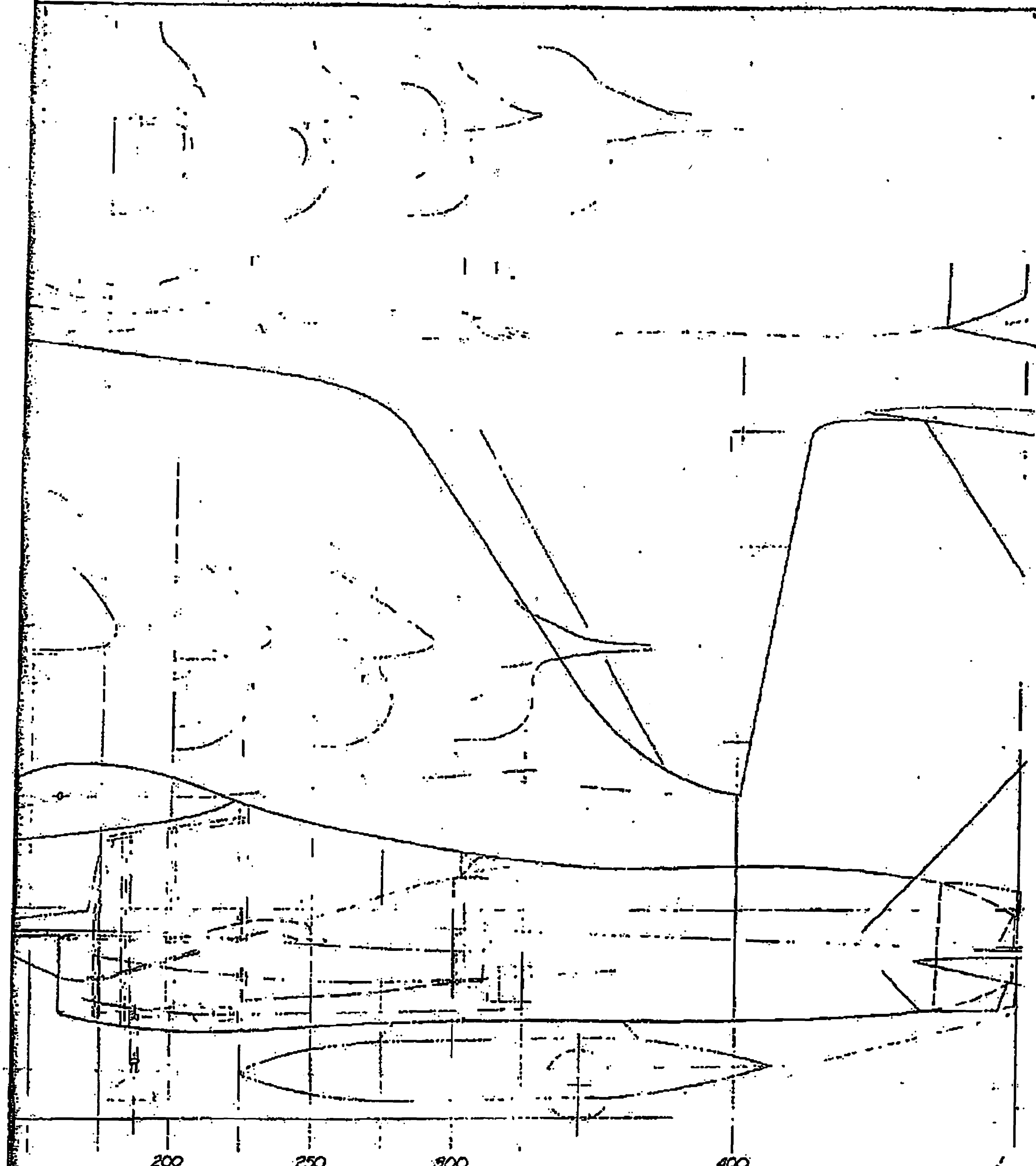
(C) Inlet 3 is a half-axisymmetric inlet with a double-cone centerbody for supersonic compression. The centerbody second-cone angle and centerbody maximum diameter are variable for inlet/engine airflow matching. The design-point (Mach 2.2) first-cone and second-cone half angles are 15 and 27 degrees, respectively. The second-cone angle is variable to about 12 degrees for maximum throat-area increase. The inlet is designed for a terminal shock Mach number of about 1.5 at Mach 2.2 flight and a critical mass flow ratio of 0.94; it is sized at Mach 2.2 for a corrected airflow of 160 lbm/sec.

(C) Inlet 4 is a two-dimensional double-compression-ramp configuration with the second-ramp angle variable. A subsonic duct ramp is slaved to the second compression ramp to achieve throat-area variation. Inlet/engine airflow matching is achieved by second-ramp angle and throat-area variation. The design-point (Mach 2.2) first-ramp and second-ramp angles are 2.5 and 18.5 degrees, respectively, with the second ramp variable to about 6 degrees for maximum throat-area increase. The design-point ramp angles produce a terminal shock Mach number of about 1.5 at Mach 2.2 flight. The inlet size used is based on a corrected airflow of 160 lbm/sec and a critical mass flow ratio of about 0.99 at Mach 2.2.

PRECEDING PAGE BLANK-NOT FILMED

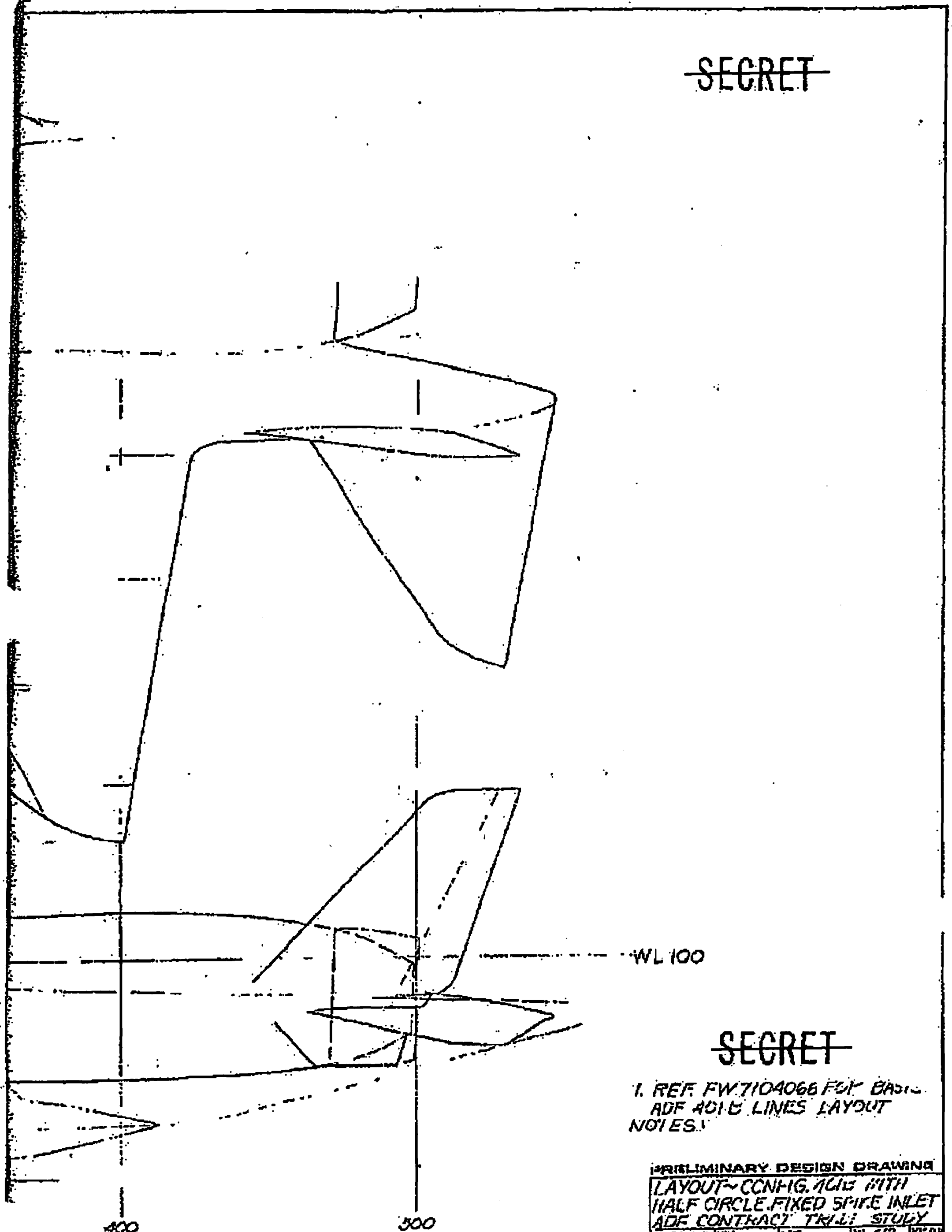


PRECEDING PAGE BLANK-NOT FILMED



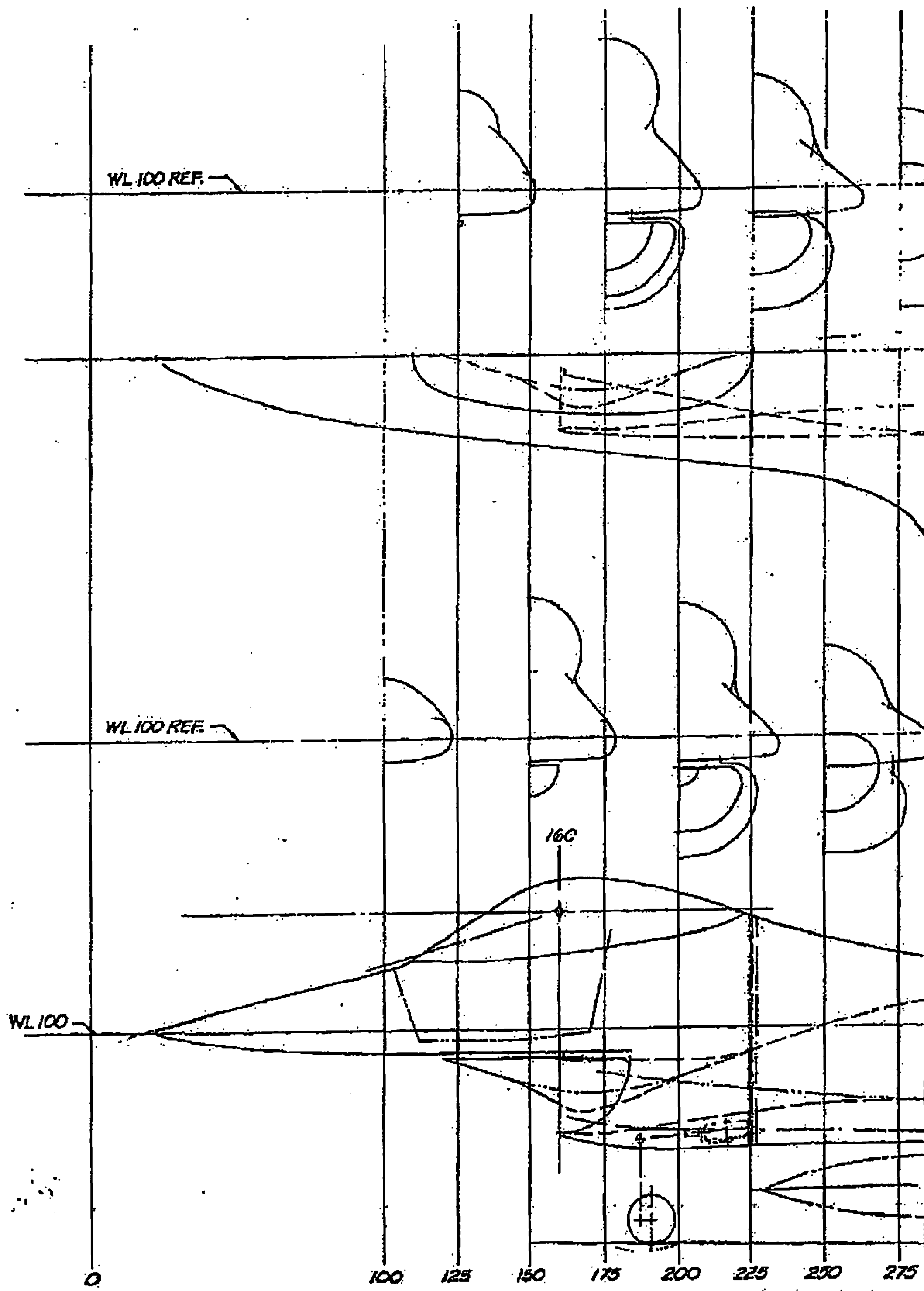
~~(C)~~ Figure 9.1-1 Configuration 401B with Half-Axisymmetric F...

PRECEDING PAGE BLANK-NOT FILMED



...ion 401B with Half-Axisymmetric Fixed-Spike Inlet (U)

3



~~(S)~~ Figure 9.1-2 Configurat

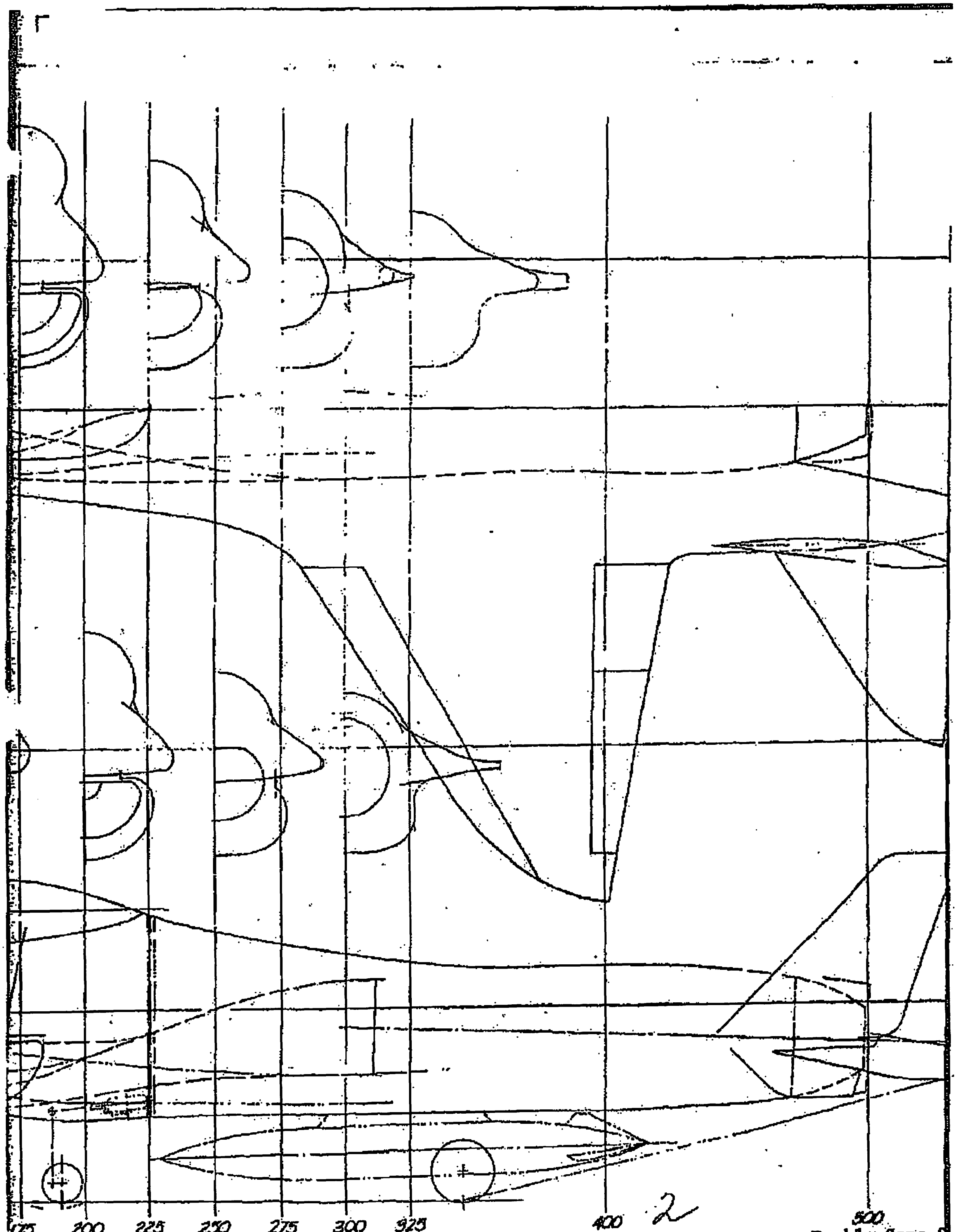
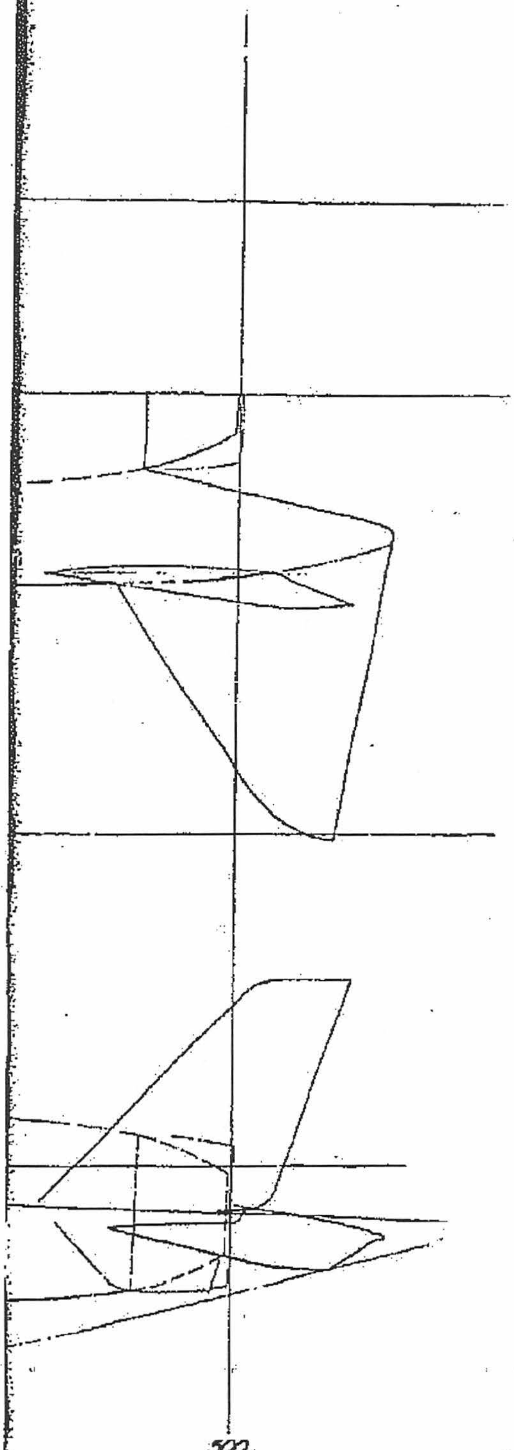


Figure 9.1-2 Configuration 401B with Half-Axisymmetric Variable-Diameter Double-Cone-S

SECRET



SECRET

NOTES :

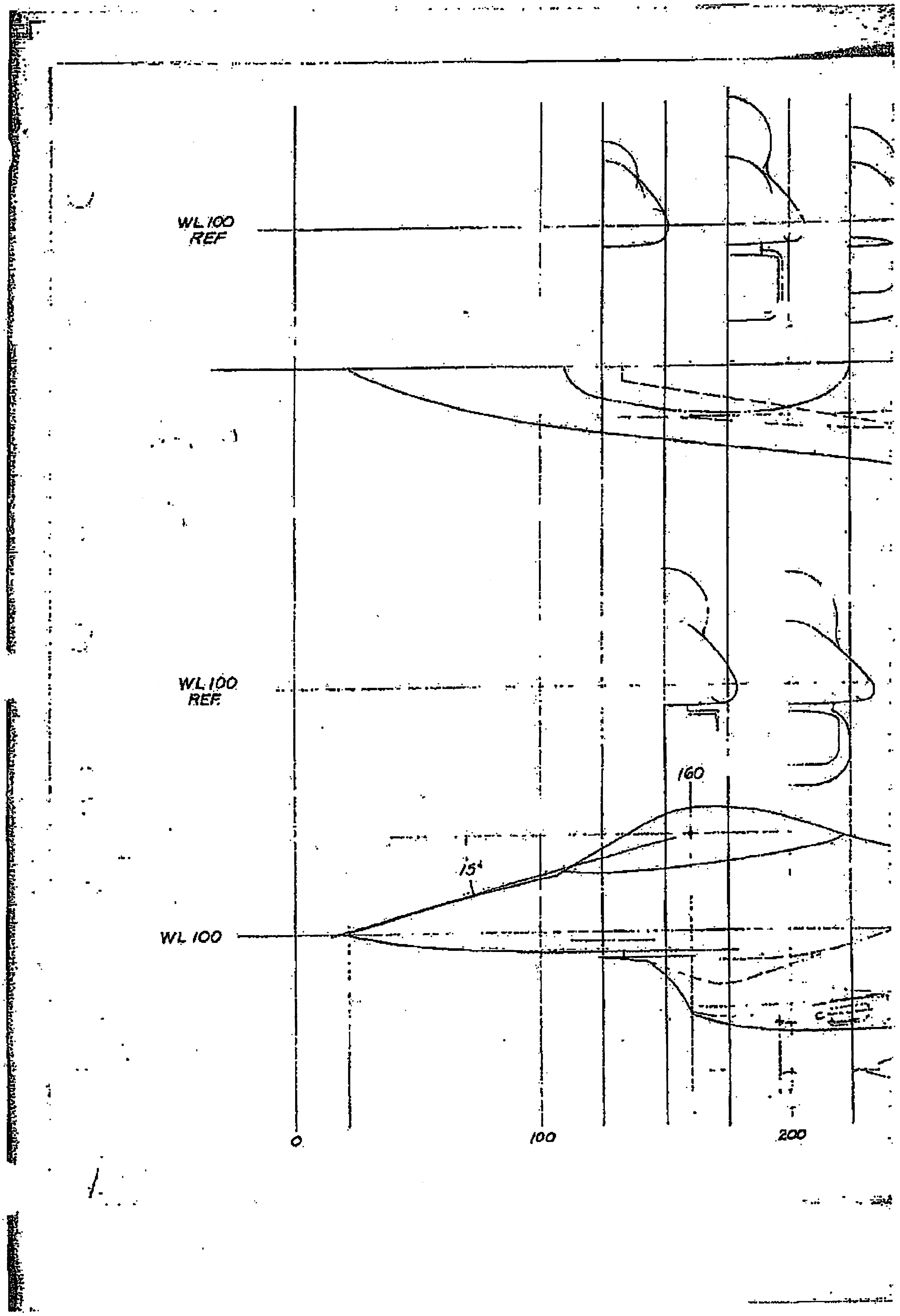
1. REF FW7104066 FOR BASIC ADF 401B LINES LAYOUT.

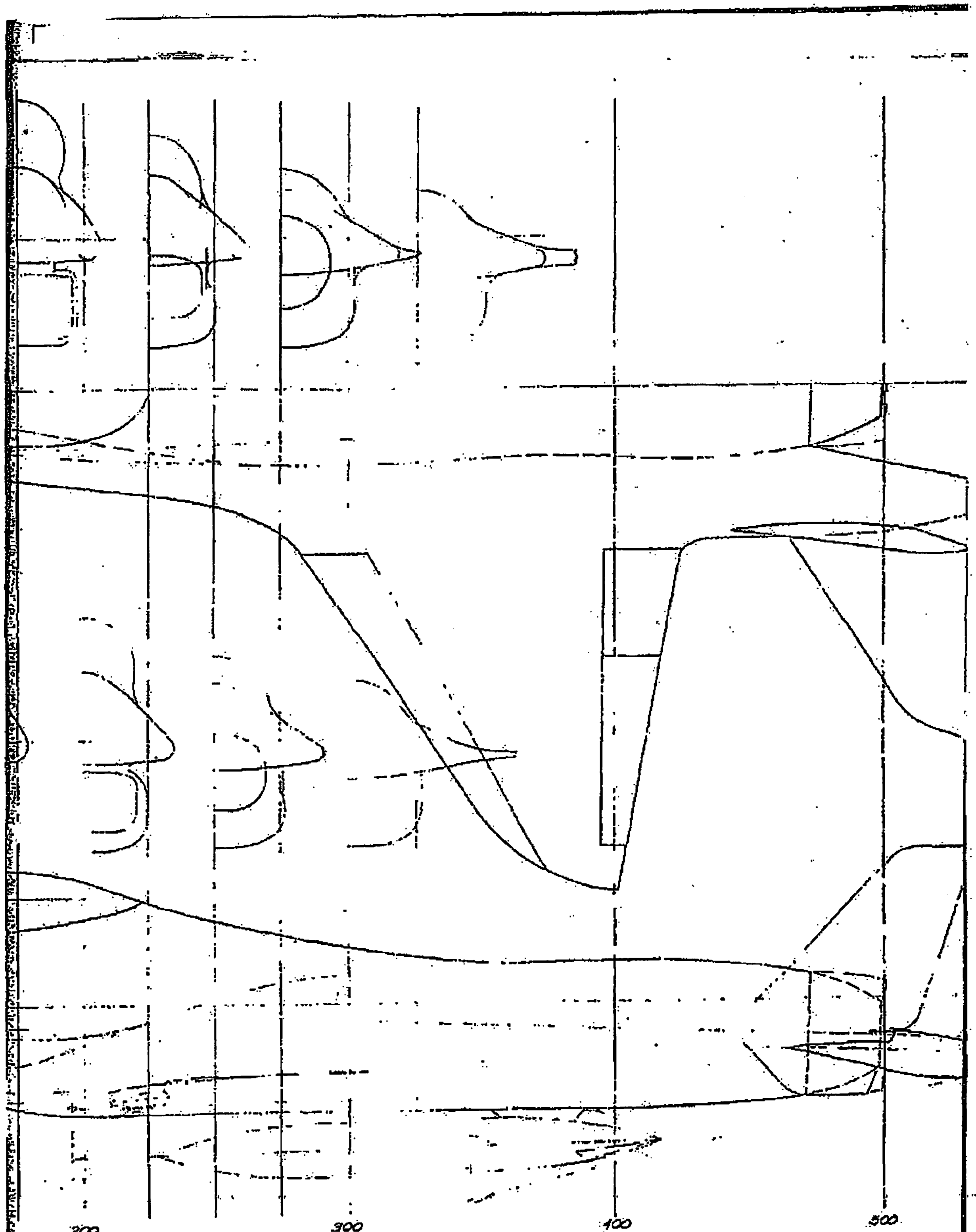
PRELIMINARY DESIGN DRAWING

LAYOUT~CONFIG 401B WITH HALF CIRCLE, VARIABLE SPIKE INLET AVFFX CONTRACT TRADE STUDY	
W.B.I.CSASZAR / APPROVED	SCALE 1/20 / DATE 6-24-71
GENERAL DYNAMICS Convair Aerospace Division Fort Worth Operation	FW7104080

3

e-Diameter Double-Cone-Spike Inlet (U)

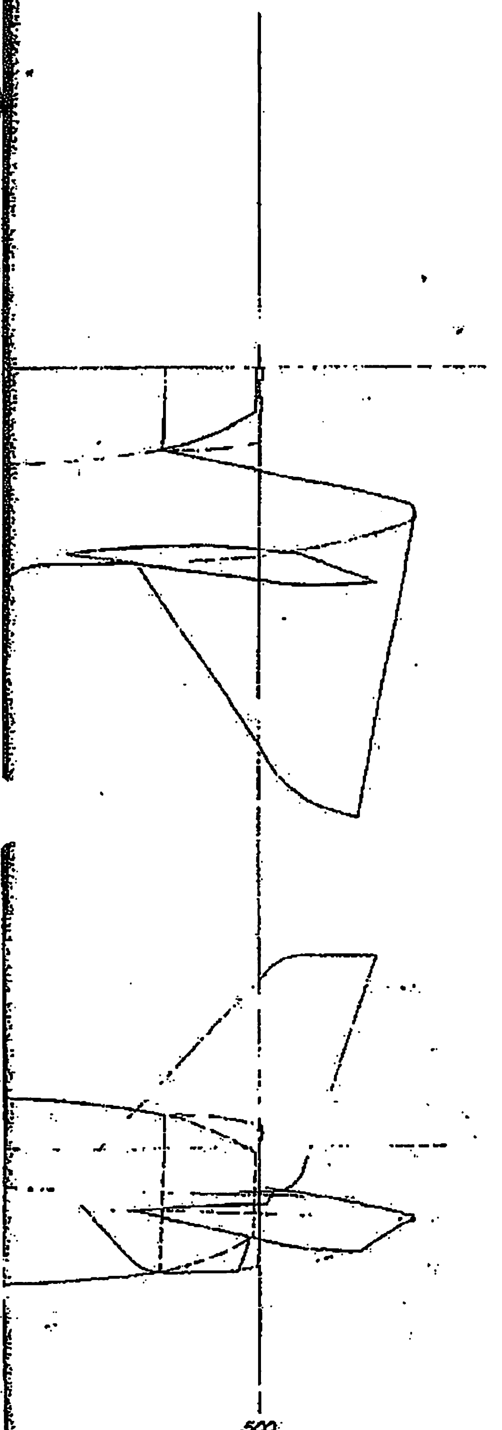

WL 100
REF
WL 100
REF
160
15°
WL 100
0
100
200



~~(S)~~ Figure 9.1-3 Configu

2

~~SECRET~~



~~SECRET~~

1. REF. DWG. FW7104C66 FOR BASIC AVFFX 401B LINES LAYOUT

NOTES:

PRELIMINARY DESIGN DRAWING

LAYOUT - CONFIG. 401B WITH 2-D VARIABLE RAMP INLET AVFFX CONTRACT TRADE STUDY

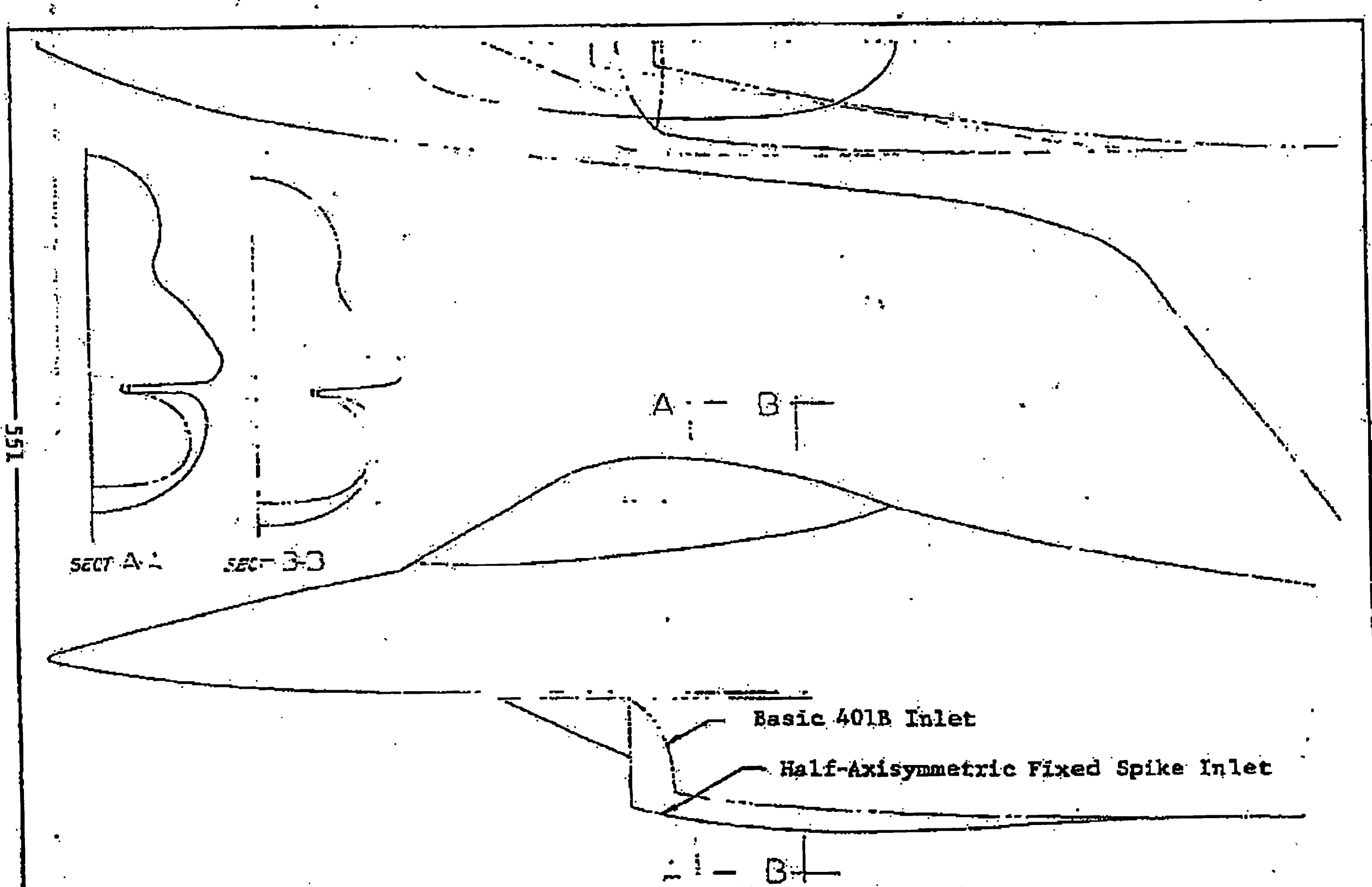
DR. E.J. CSASZAR | APPROVED | SCALE 1/20 | DATE 8-7-71

GENERAL DYNAMICS Convair Aerospace Division Fort Worth Operation | FW71C4111

SHEET OF

~~(S)~~ Figure 9.1-3 Configuration 401B with Two-Dimensional Variable-Ramp Inlet (U)

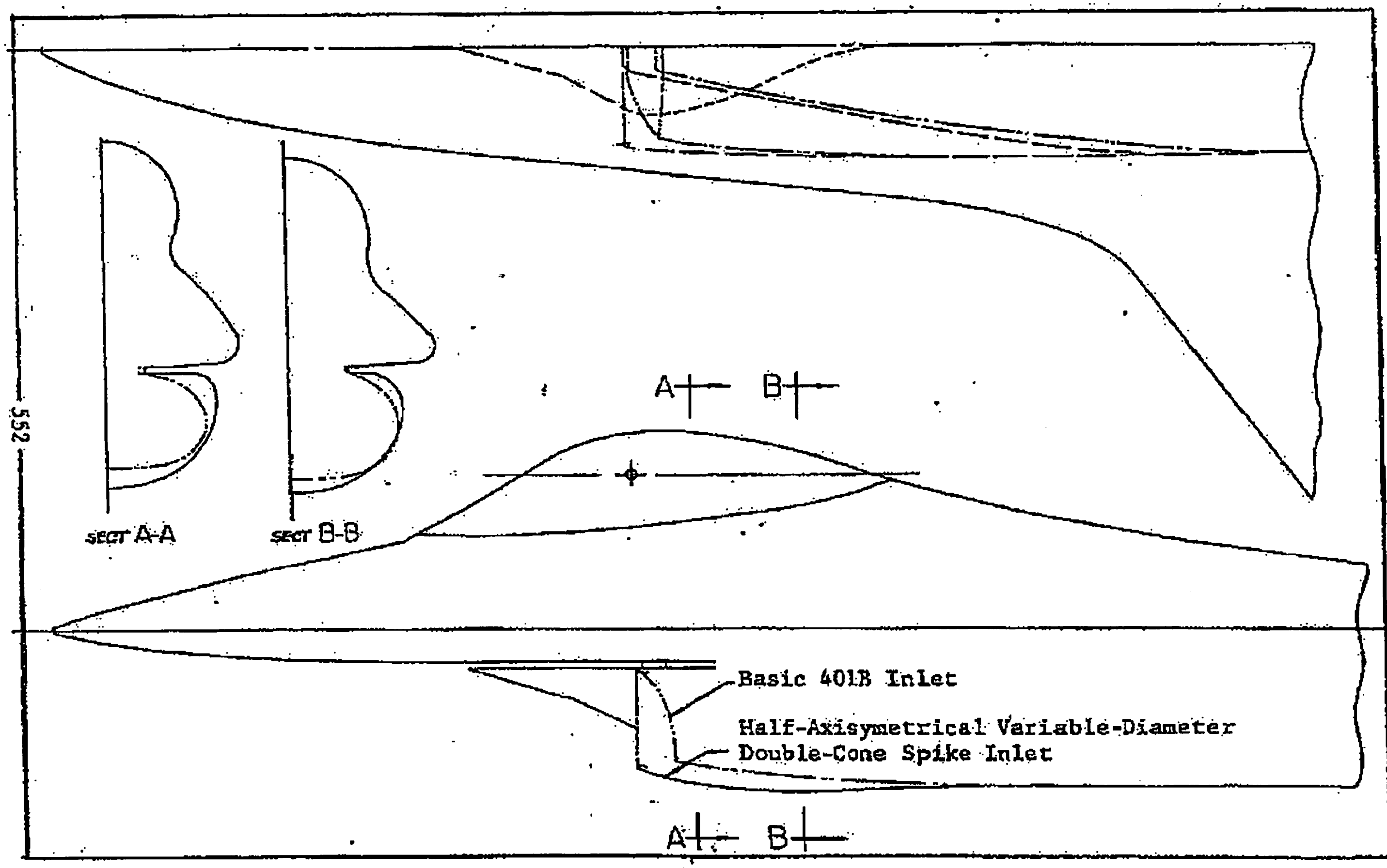
SECRET



~~(S)~~ Figure 9.1-4 Half-Axisymmetric Fixed-Spike Inlet Lines Comparison (U)

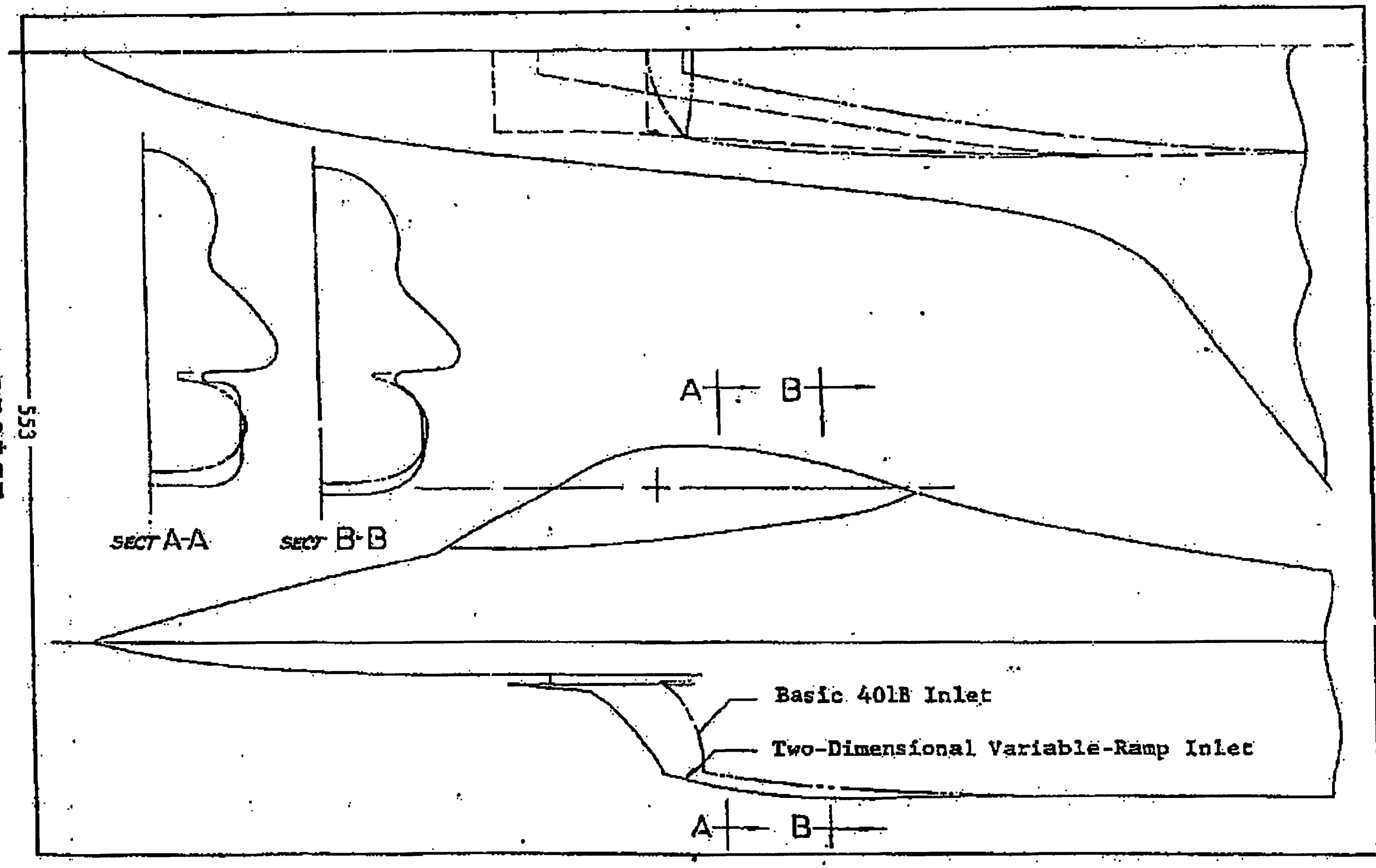
SECRET

SECRET



~~(S)~~ Figure 9.1-5 Half-Axisymmetric Variable-Diameter Double-Cone-Spike Inlet Lines Comparison

SECRET



~~(S)~~ Figure 9.1-6 Two-Dimensional Variable-Ramp Inlet Lines Comparison (U)

9.2 AIRPLANE PERFORMANCE WITH SELECTED INLET TYPES

~~(S)~~ The performance capabilities of Configuration 401B equipped with alternate inlets is compared in Figure 9.2-1 with the performance obtained with the basic open-nose inlet. The comparison is made at the mission weight (i.e., full-up weight without external tanks) required for the 750-n.mi LRASM radius. The maneuver capability is compared in terms of energy rate (P_s) and absolute ceiling as well as of the mission performance on the Long-Range-Air Superiority Mission.

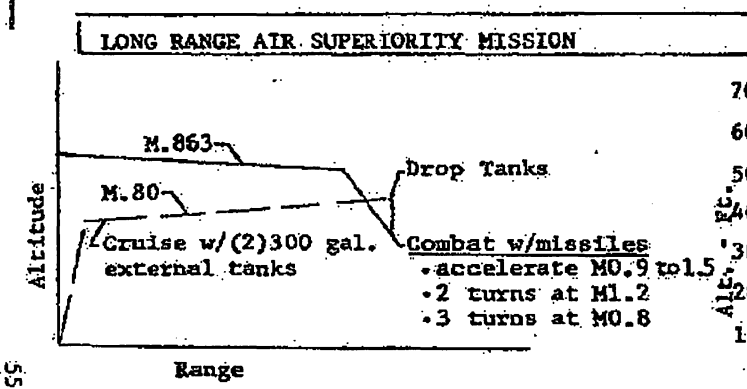
~~(S)~~ The P_s and ceiling comparison show the variable-geometry inlets to have greater performance capabilities than the fixed inlets at speeds of Mach 1.6 and higher. This is as expected. The mission performance comparison also shows the expected results, namely, that at speeds of less than Mach 1.2 the aircraft with the basic open-nose inlet has maneuver capabilities as good as or slightly better than aircraft with any of the alternate designs. Also, the aircraft accomplishes the mission at a smaller size. Thus, improved performance capabilities at Mach 1.6 and above, which is outside the expected combat region, will be at the cost of increased aircraft size for a given mission radius. The aircraft sizes required to make the desired 750-n.mi LRASM radius are compared below.

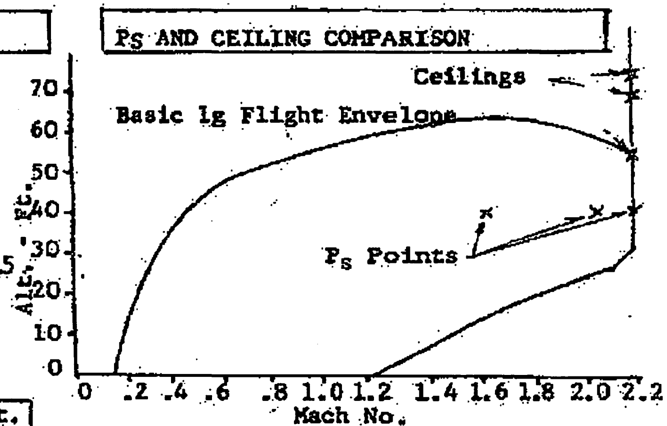
Inlet Type	Mission Wt. (lb)	LRASM Radius, n.mi (16,800-lb A/P)
Open-nose (401B baseline)	17,115	686
Half-axisymmetric fixed-spike	17,910	529
Half-axisymmetric variable-diameter, double-cone spike	17,880	530
Two-dimensional variable-ramp	17,790	550

(U) The two-dimensional variable-ramp inlet is the best choice of the alternate designs in terms of trading mission radius for supersonic P_s. Its energy rate and ceiling are competitive among the alternate designs, and the aircraft size increase is the least of any of the alternate concepts.

SECRET

555





Inlet	Mission Weight -lb.	Combat at 30,000 Ft.		
		$\dot{\theta}$M1.2 deg/sec	$\dot{\theta}$M1.2 deg/sec	Accel Time deg/sec
Basic	17115	9.8	8.1	35.5
Fixed Spike	17910	9.7	7.7	39.8
Variable Spike	17880	9.7	8.0	37.7
2-D Variable Ramp	17790	9.7	8.2	36.9

Inlet	Ps @40,000 ft-fps			M2.2 Ceiling
	M1.6	M2.0	M2.2	
Basic	657	526	283	53,500
Fixed Spike	667	917	847	65,800
Variable Spike	735	1094	1288	70,600
2-D Variable Ramp	760	1113	1259	70,300

~~(S)~~ Figure 9.2-1 Airplane Performance Comparison Summary for the Inlet Trade Study on Configuration 401B (U)

SECRET

(U) The performance analysis is for standard-day conditions and is based on:

1. Aerodynamic data presented in Section 3.3, with corrections presented in Section 9.4 for incremental drag differences caused by the alternate inlets.

2. Weight data presented in Section 3.5, with corrections presented in Section 9.5

3. Propulsion data presented in Section 3.6, with corrections presented in Section 9.6.

9.3 DESIGN DATA

(U) The configuration design data and inlet geometry generated to support the structures, aerodynamic, and performance analyses of each alternate inlet configuration are presented in Figures 9.3-1 through 9.3-12. The data presented for each alternate configuration are (1) basic description data, (2) friction drag data, (3) normal area distribution, and (4) inlet geometry. Similar data for the baseline configuration may be found in the following respective figures: (1) Figure 3.1-18, (2) Figure 3.1-21, and (3) Figure 3.1-23.

BASIC DESCRIPTIONS

PROJECT: AVFFX PROGRAM

G.W. = 16,800 lbs.
W/S = 60 lbs./ft²
T/W = 1.397 (uninstalled)
Eng = P&WA JTF 22A-27

CONFIGURATION: 401B WITH HALF CIRCLE, FIXED SPIKE INLET
DATE: 1 July 71
REF. DWG. FW7104046

BODIES

	LENGTH (IN.)	X (IN.)	Y (IN.)	Z (IN.)
FUSELAGE CENTERBODY	*178	0	0	0
FUSELAGE OUTERBODY	422	102	±40	0
CANOPY+	135.5	85	0	[illegible]

* INCLUDES NOZZLE LENGTH (OPEN)
\+ FOR K-35 PROGRAM ONLY

WING REF. AREA (IN²)

SURFACES

	[illegible] WING [illegible]	[illegible] HORIZ. TAIL	[illegible] VERT. TAIL	[illegible] VENTRAL FIN
AREA (FT²)	280	125.96	22.12	[illegible]
AR - ASPECT RATIO	3.0	3.416	1.3265	0.47[illegible]
λ - TAPER RATIO	0.2	0.1369	0.4	0.5[illegible]74
E_1	7.55°	7.55°	7.15°	7.15°
E_2	+10°41'	+10°41'	-19°22'	+19°22'
a - CUTOUT				
C_R - ROOT CHORD (IN.)	194.22	126.84	70	45
C_T - TIP CHORD (IN.)	38.64	17.37	25	23
b - SPAN (IN.)	347.79	246.31	65	19
AIRFOIL	4% Biconvex	Exp Root - 6% Biconvex, Tip - 4% Biconvex, Exp Root @ HL 51.5	Root - 6% Biconvex, Tip - 4% Biconvex	6% Biconvex
d (IN.)	51	51.5	0	0
x (IN.)	257.5	440.0	419.5	42[illegible]
Y (IN.)	0	0	±51.4 [illegible]	51.0
Z (IN.)	0	[illegible] 14.1	-3	-19

d = Average buried semi-span
x = Distance aft from fuselage nose to body nose or surface fuselage intersection point,
y = Distance outbd from fuselage ref. line to body ref. line or vertical surface chord line,
z = Distance up (+) or down (-) from fuselage ref. line WL 92.0 to body or surface ref line,

~~(S)~~ Figure 9.3-1 Basic Description Data Sheet for Half-Axisymmetric Fixed-Spike Inlet Configuration (U)

SECRET

2.

FRICTION DRAG DATA

G.W. = 16,800 lbs.
W/S = 60 lbs./ft²
T/W = 1.397 (uninstalled)
[illegible] JTF 22A-27

PROJECT AVFFX PROGRAM
CONFIGURATION 431E WITH HALF [illegible] FIXED SPIKE INLET
DATE 25 MAY 72
[illegible]

BODIES

BODY	WETTED AREA (FT^2)		LENGTH (IN)	MAX WIDTH (IN)	MAX HEIGHT (IN)
* [illegible]		410.4	*476.2	56	70.5
[illegible]		259.0	421	28	18
Canopy (Centering)		40.7	143	40	27.0
Nozzle ([illegible])		20.5	27.2	43.5 [illegible]	
Nozzle (Ov.)	26.7		28.6	43.5 [illegible]	
Spike [illegible]		2.9			

10-7.1

BODY TOTAL 740.9 (743.7)

* length [illegible] does not [illegible])

SURFACES

SURFACE	WETTED AREA (FT^2)		EXPOSED MAC LENGTH (IN)	MAX. THICKNESS SWEEP (DEG.)	AIRFOIL
Wing		522.2	102.23	14°30'	[illegible]
Hor. Tail		98.0	56.09	14°30'	[illegible]
Vert. Tails		88.5	51.93	34°15'	[illegible]
Ventral Fins		14.6	39.33	17°45'	[illegible]

SURFACE TOTAL 507.3

AIRPLANE TOTAL 1248.2 (1251)

BASIC WING GEOMETRY:

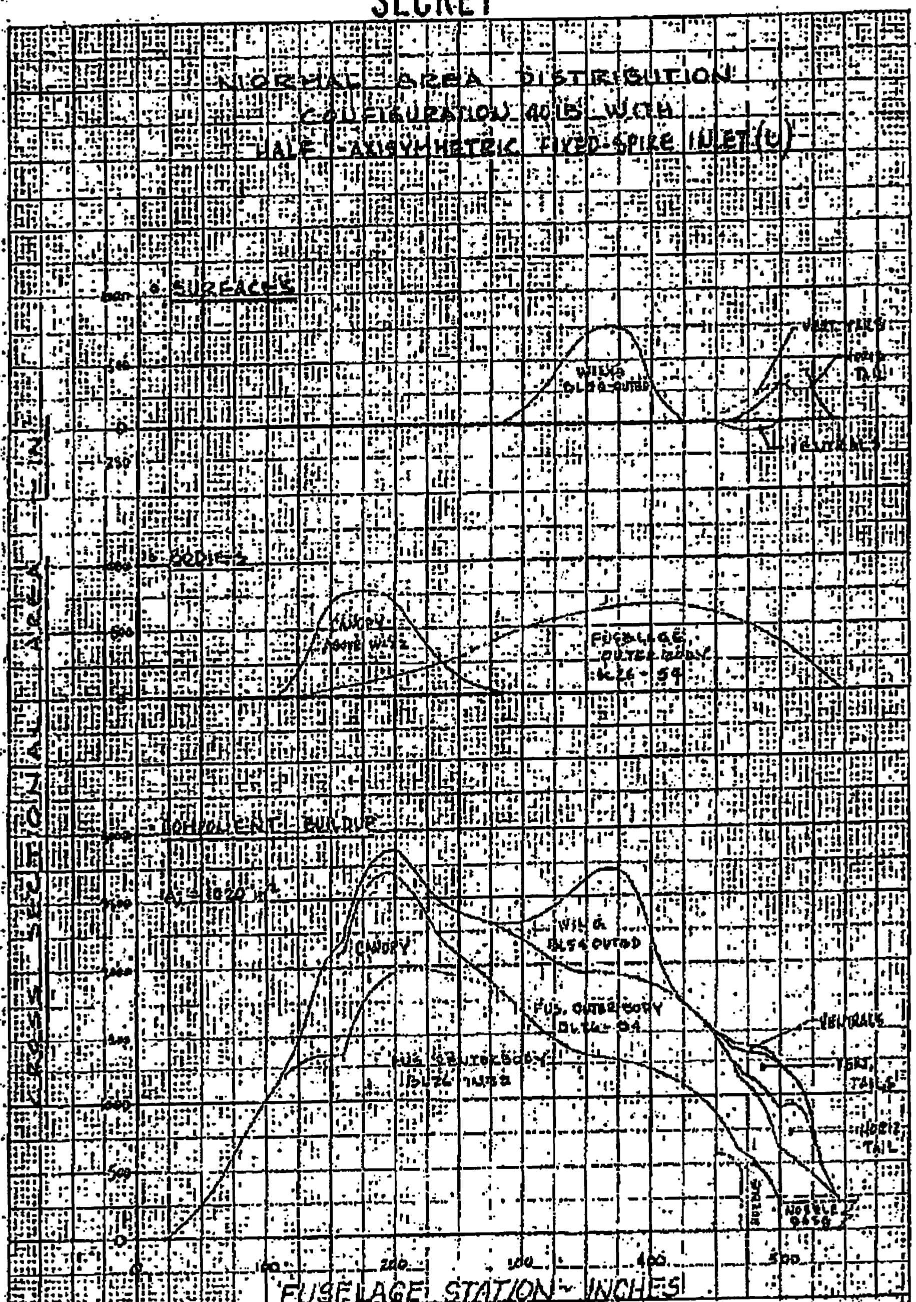
	Trap. Wing	Trapezoidal Reference Wing
AREA (FT^2)	280	285.53
ASPECT RATIO	3.0	2.2
TAPER RATIO	0.2	0.1689
LEADING EDGE SWEEP (DEG.)	35	35

[illegible]

~~(S)~~ Figure 9.3-2 Friction Drag Data Sheet for Half-Axisymmetric Fixed-Spike Inlet Configuration (U)

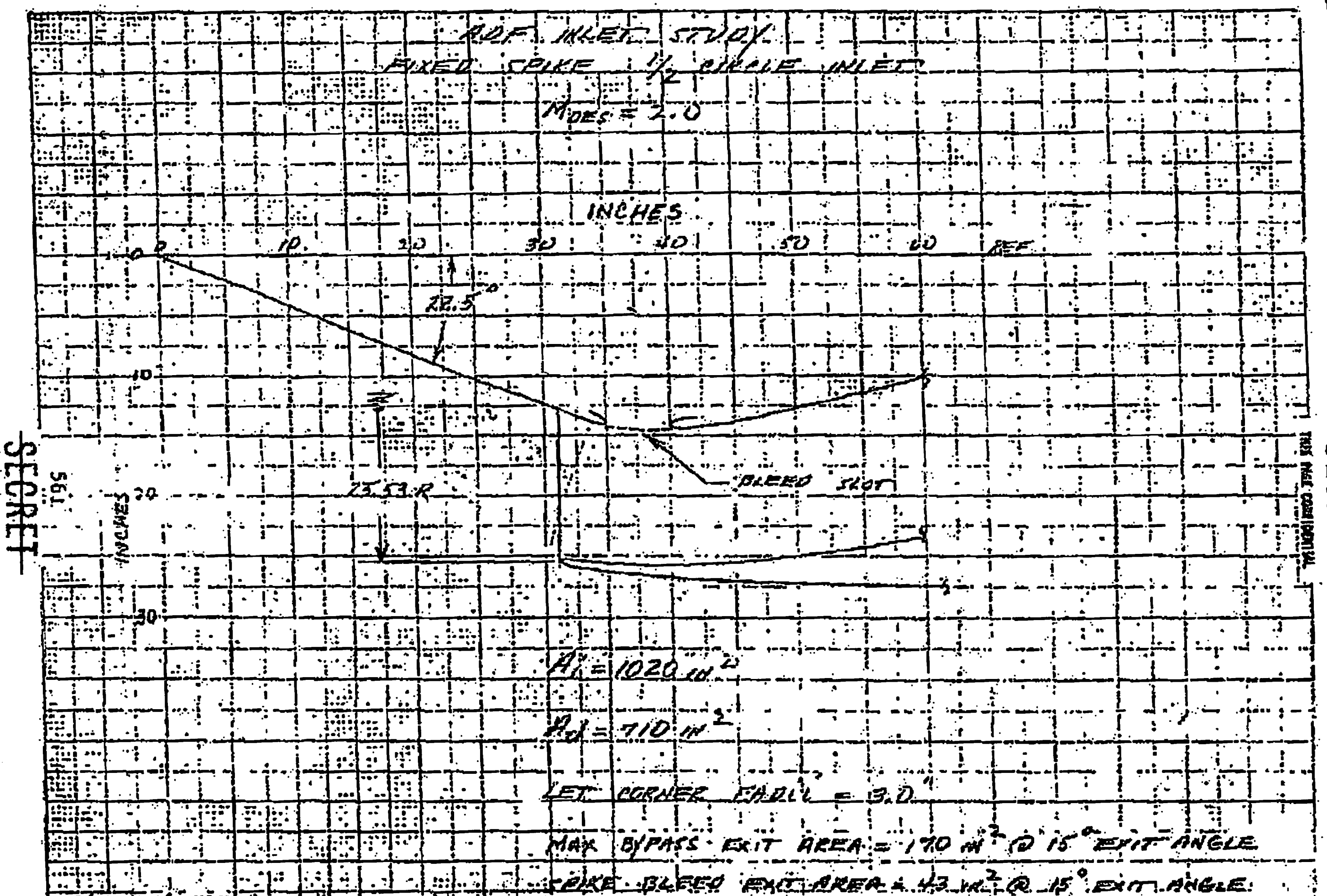
SECRET

SECRET



~~(S)~~ Figure 9.3-3 Area Distribution Curve for Half-Axisymmetric Fixed-Spike Inlet Configuration (U)

SECRET



(S) Figure 9.3-4 Half-Axisymmetric Fixed-Spike Inlet Geometry Definition (U)

~~SECRET~~

BASIC DESCRIPTIONS

G.W. = 16,800 lbs.
W/S = 60 lbs./ft²
T/W = 1.397 (uninstalled)
Eng = P&WA JTF 22A-27

PROJECT: AVFFX PROGRAM

CONFIGURATION: 401B WITH HALF CIRCLE, VARIABLE SPIKE INLET

DATE: 6-29-71

REF FW7104080

BODIES

	LENGTH (IN.)	X (IN.)	Y (IN.)	Z (IN.)
FUSELAGE [illegible]	478	0	0	0
FUSELAGE [illegible]	422	102	±40	0
CANOPY	185.5	[illegible]	0	[illegible]

* INCLUDES NOZZLE LENGTH (OPEN)
= FOR K-35 PROGRAM ONLY

WING REF. AREA (IN^2)

SURFACES

	WING	HORIZ. TAIL	VERT. TAIL	VENTRAL FIN
AREA (FT^2)	280	[illegible]	22.12	[illegible]
AR - ASPECT RATIO	3.0	3.416	1.3265	[illegible]
λ - TAPER RATIO	0.2	0.1369	0.4	[illegible]
L.E. E_1 (+)	+55°	+55°	+45°	+45°
E_2 (+)	+10°41'	+10°41'	-17°22'	+17°22'
a - CUTOUT = $\frac{\tan E_1}{\tan(90-E_2)}$				
C_R - ROOT CHORD (IN.)	[illegible]	126.84	70	[illegible]
C_T - TIP CHORD (IN.)	[illegible]	17.57	28	[illegible]
b - SPAN (IN.)	[illegible]	[illegible]	65	14
AIRFOIL	4% Biconvex	[illegible] Tip - 4% Biconvex [illegible]	Root - 6% Biconvex Tip - 4% Biconvex	6% Biconvex
d (IN.)	54	51.5	0	0
x (IN.)	257.5	440.0	419.5	[illegible]
Y (IN.)	0	0	±54.4 [illegible]	51.0
Z (IN.)	0	-14.1	-3	-13

d = Average buried semi-span

x = Distance aft from fuselage nose to body nose or surface fuselage intersection point.

y = Distance outbd from fuselage ref. line to body ref. line or vertical surface chord line.

z = Distance up (+) or down (-) from fuselage ref. line (WL 92.0) to body or surface ref line.

~~(S)~~ Figure 9.3-5 Basic Description Data Sheet for Half-Axisymmetric Variable-Diameter Double-Cone-Spike Inlet Configuration (U)

~~SECRET~~

SECRET

FRICTION DRAG DATA

G.W. = 14,800 LBS.
W/S = 63 [illegible]
T/W = 1.397 (uninstalled)
Eng = P&WA JTF 22A-27

PROJECT AIFFX Program
CONFIGURATION 401B WITH HALF CIRCLE, VARIABLE SPIKE INLET
DATE 29 JUNE 71
REF DWG FW7104ORD

BODIES

BODY	WETTED AREA (FT²)		LENGTH (IN)	MAX WIDTH (IN)	MAX HEIGHT (IN)
* [illegible]		407.6	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		50.7	148.0	[illegible]	[illegible]
[illegible]		29.8	27.2	43.5 [illegible]	
[illegible]	26.7		[illegible]	[illegible]	
[illegible]		[illegible]			

BODY TOTAL: 1248.1 (741.5)

* [illegible] ([illegible])

SURFACES

SURFACE	WETTED AREA (FT²)		EXPOSED MAC LENGTH (IN)	MAX. THICKNESS SWEEP (DEG.)	AIRFOIL
[illegible]		306.2	[illegible]	[illegible]	
[illegible]		98.0	[illegible]	[illegible]	
[illegible] (2)		[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (1)		14.6	[illegible]	[illegible]	[illegible]

SURFACE TOTAL: 507.3

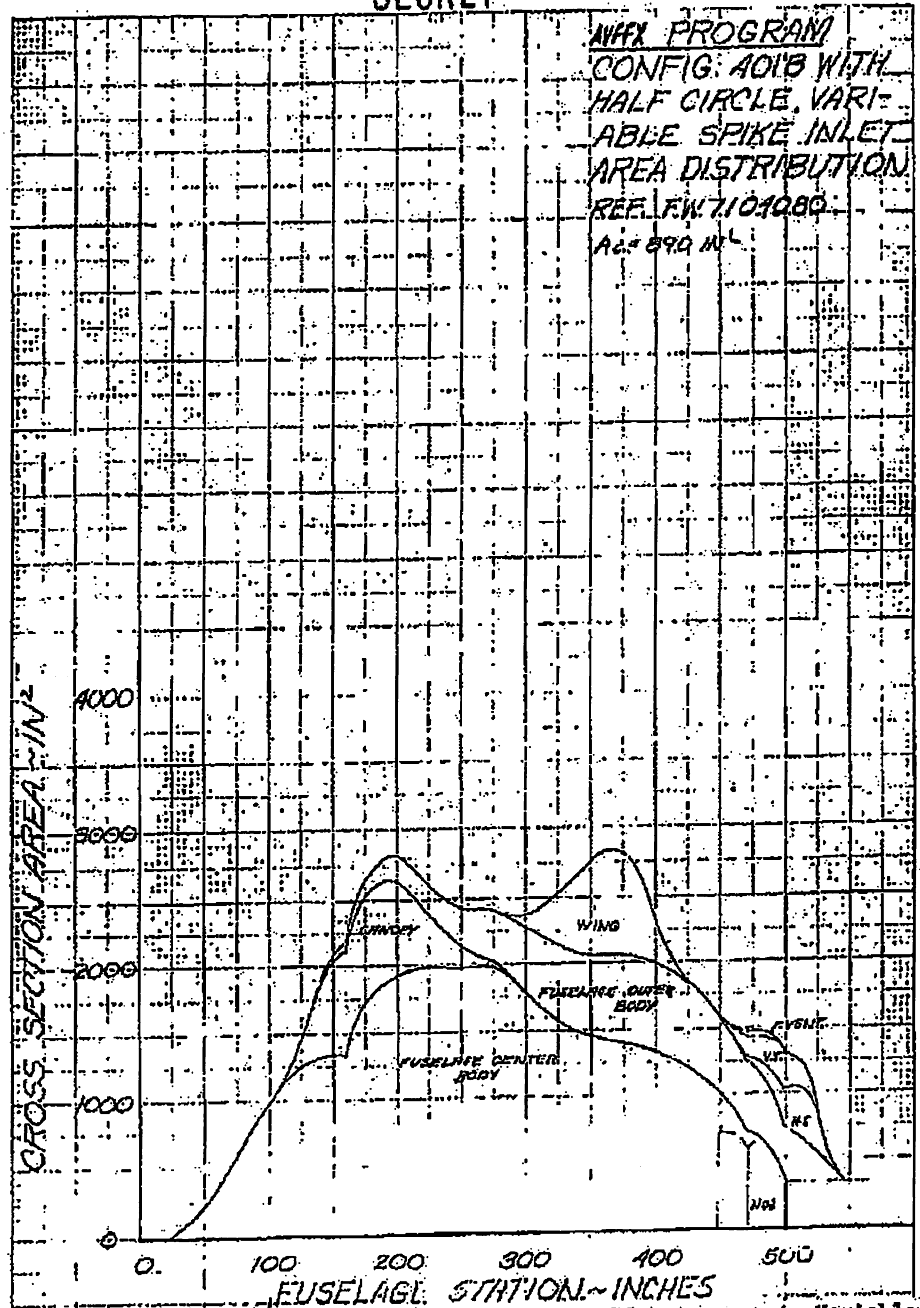
AIRPLANE TOTAL: 1245.4 (1248.8)

BASIC WING GEOMETRY:

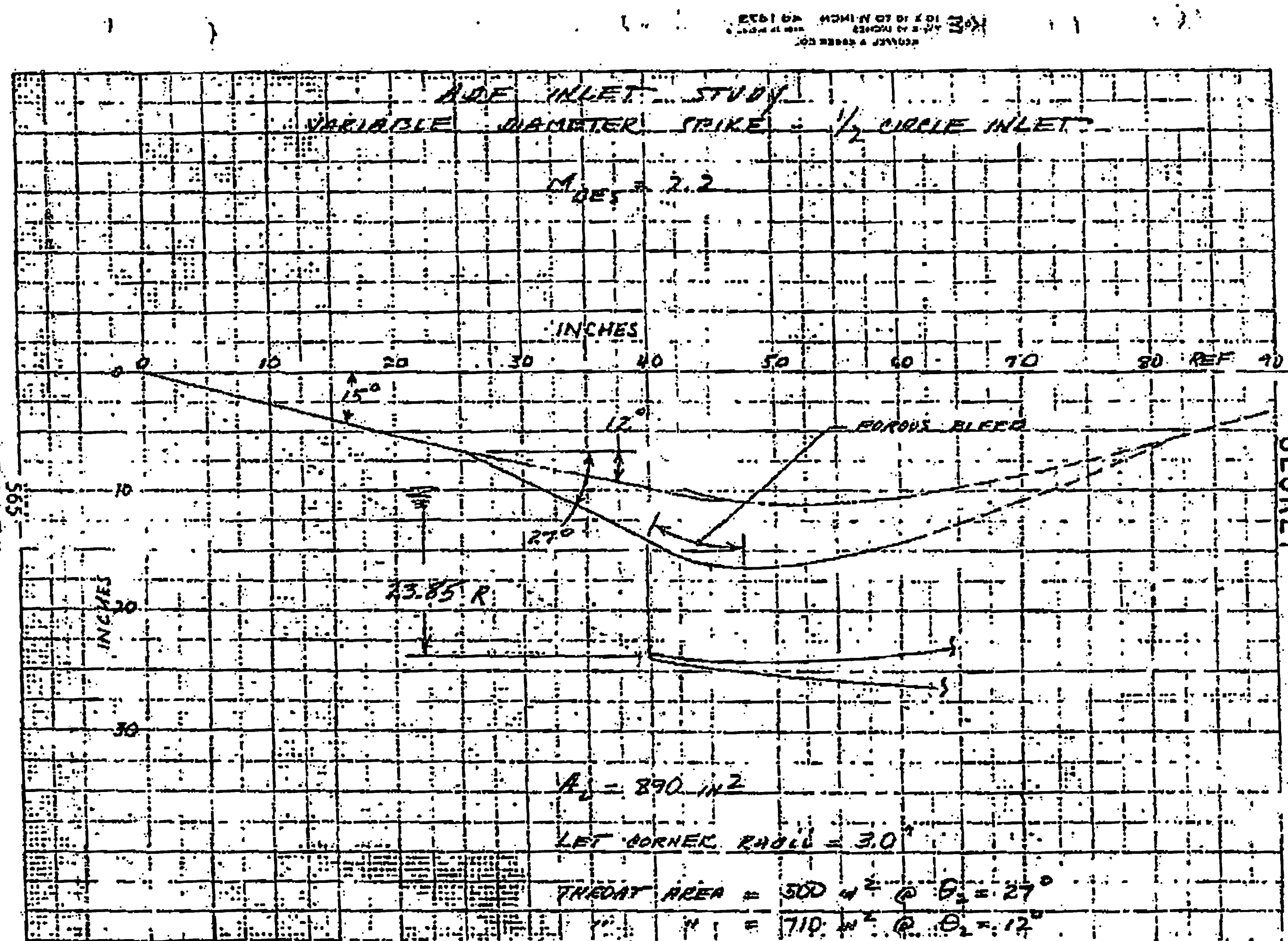
	[illegible]	[illegible]
AREA (FT²)	280	[illegible]
ASPECT RATIO	3.2	3.2
TAPER RATIO	[illegible]	[illegible]
LEADING EDGE SWEEP (DEG.)	[illegible]	[illegible]

~~(S)~~ Figure 9.3-6 Friction Drag Data Sheet for Half-Axisymmetric Variable-Diameter Double-Cone-Spike Inlet Configuration (U)

SECRET



~~(S)~~ Figure 9.3-7 Area Distribution Curve for Half-Axisymmetric Variable-Diameter Double-Cone-Spike Inlet Configuration (U)



(C) Figure 9.3-8 Half-Axisymmetric Variable-Diameter Double-Cone-Spike Inlet Geometry Definition (U)

SECRET

565

SECRET

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.(b)(4)
1.4. (a)(g)

88th ABW/IP)
~~FOIA (b)(1)~~
E.O.13526 SEC. 3.3.(b)(4)
1.4. (a)(g)

~~SECRET~~

BASIC DESCRIPTIONS

S.W. = 16,800 lbs.
W/S = 60 lbs./ft²
T/W = 1.397 (uninstalled)
Eng = P&WA JTF 22A-27

PROJECT: AVFFX PROGRAM

CONFIGURATION: 401B WITH 2-D VARIABLE RAMP INLET

DATE: 10 Aug 71

REF FW 7104111

BODIES

	LENGTH (IN.)	X (IN.)	Y (IN.)	Z (IN.)
FUSELAGE [illegible]	473	0	0	0
[illegible]	422	[illegible]	[illegible]	[illegible]
[illegible]*	135.5	[illegible]	[illegible]	[illegible]

* INCLUDES NOZZLE LENGTH (OPEN)
\+ FOR [illegible] PROGRAM ONLY

WING REF. AREA (IN²)

SURFACES

		[illegible] WING	[illegible] HORIZ. TAIL	[illegible]	[illegible]
AREA (FT²)		280	123.31	22.12	[illegible]
AR - ASPECT RATIO		3.0	3.415	1.3265	[illegible]
λ - TAPER RATIO		0.2	0.1369	0.1	0.59074
L.E.	E_1	+55°	+55°	+45°	+45°
E_2(+)	E_2	+10°41'	+10°41'	-19°22'	+19°22'
a - CUTOUT = [illegible]					
C_R - ROOT CHORD (IN.)		193.22	126.84	70	47
C_T - TIP CHORD (IN.)		38.64	17.37	28	28
b - SPAN (IN.)		347.79	216.31	65	14
AIRFOIL		4% Biconvex	Exp Root - 6% Biconvex Tip - 4% Biconvex Exp Root @ 51.5	Root - 6% Biconvex Tip - 4% Biconvex	6% Biconvex
d (IN.)		54	51.5	0	0
x (IN.)		257.5	440.0	419.5	429.5
Y (IN.)		0	0	±54.4 @ MAC	51.0
Z (IN.)		0	-14.1	-3	-13

d = Average buried semi-span
x = Distance aft from fuselage nose to body nose or surface fuselage intersection point.
y = Distance outbd from fuselage ref. line to body ref. line or vertical surface chord line.
WL 92.0
z = Distance up (+) or down (-) from fuselage ref. line to body or surface ref line.

~~(S)~~ Figure 9.3-9 Basic Description Data Sheet for Two-Dimensional Variable-Ramp Inlet Configuration (U)

~~SECRET~~

FRICTION DRAG DATA

G.W. = 16,800 LBS
W/S = 60 LBS/FT²
T/W = 1.397 (uninstalled)
Eng = P&WA JTF 22A-27 (AF Designation - F100-PW-100)

PROJECT AVFFX PROGRAM
CONFIGURATION 401B WITH 2-D VARIABLE RAMP INLET
DATE 10 Aug 71
REF FW 7104111

BODIES

BODY	WETTED AREA (FT²)		LENGTH (IN)	MAX WIDTH (IN)	MAX HEIGHT (IN)
[illegible]		406.9	*476.6	54.0	73.0
[illegible]		259	422	28.0	18.0
[illegible]		50.7	143.0	40.0	27.0
Nozzle (Closed)		20.8	27.2	43.5 Dia	
Nozzle (Open)	26.7		28.6	43.5 Dia	
BODY TOTAL		737.4			

* Length Includes Nozzle Closed – A wet for Nozzle Shown Separately

SURFACES

SURFACE	WETTED AREA (FT²)		EXPOSED MAC LENGTH (IN)	MAX. THICKNESS SWEEP (DEG.)	AIRFOIL
Wing		306.2	102.23	14°30'	4% Biconvex
Horiz Tail		98.0	56.09	14°30'	Exp Root 6% Biconvex
Vert. Tail (2)		88.5	52.00	34°15'	Tip 4% Biconvex
Ventral Fin (2)		14.6	38.30	17°45'	6% Biconvex
SURFACE TOTAL		507.3			
AIRPLANE TOTAL		1244.7			

BASIC WING GEOMETRY: TRAPEZOID SHAPE BASIC REF. WING

AREA (FT²) 280

ASPECT RATIO 3.0

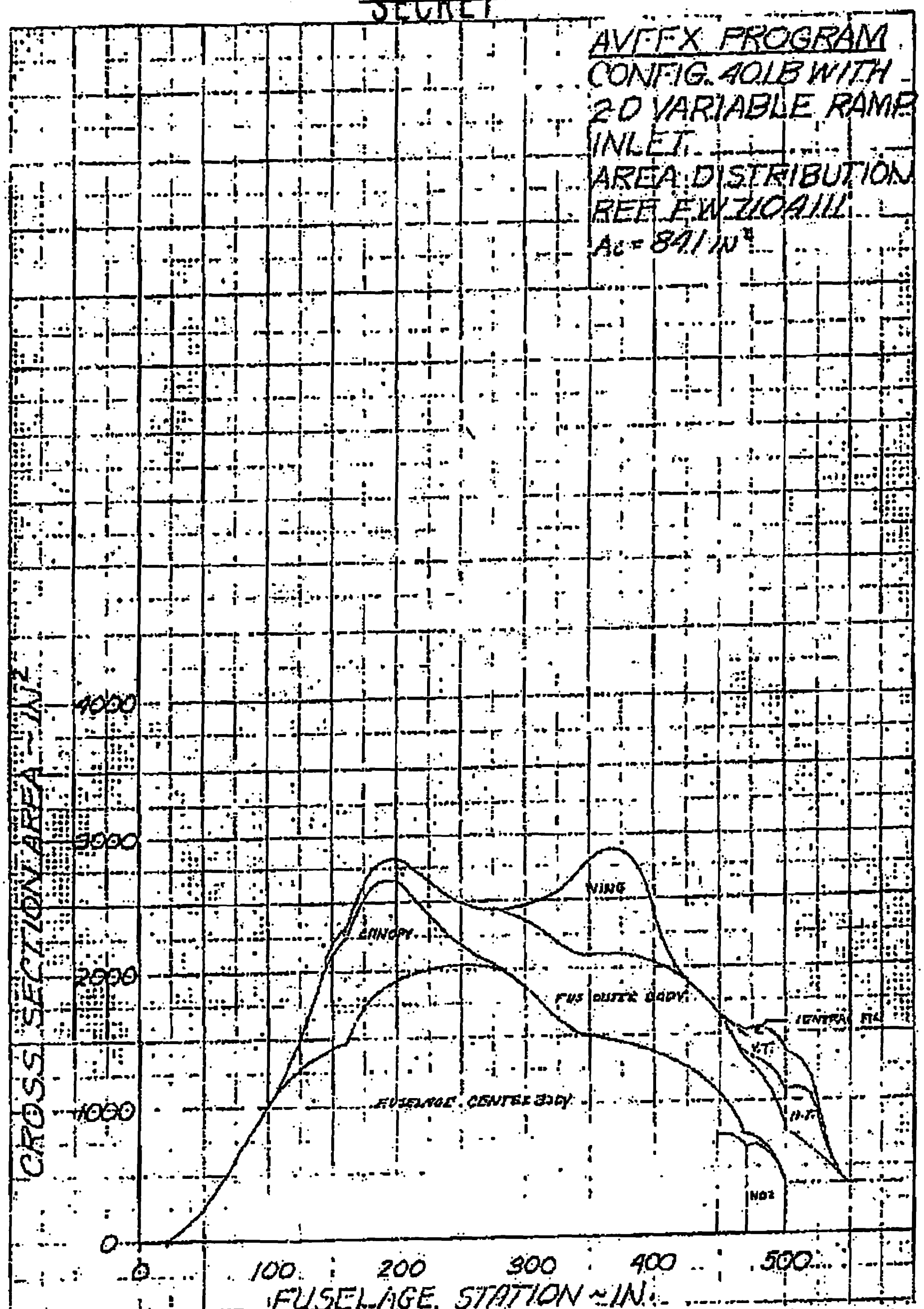
TAPER RATIO 0.2

LEADING EDGE SWEEP (DEG.) 35°

~~(S)~~ Figure 9.3-10 Friction Drag Data Sheet for Two-Dimensional Variable-Ramp Inlet Configuration (U)

88th ABW/IPI
FOIA (b)(1)
~~E.O. 13526 SEC. 3.3.(b)~~
(4)
1.4. (a)(g)

~~SECRET~~



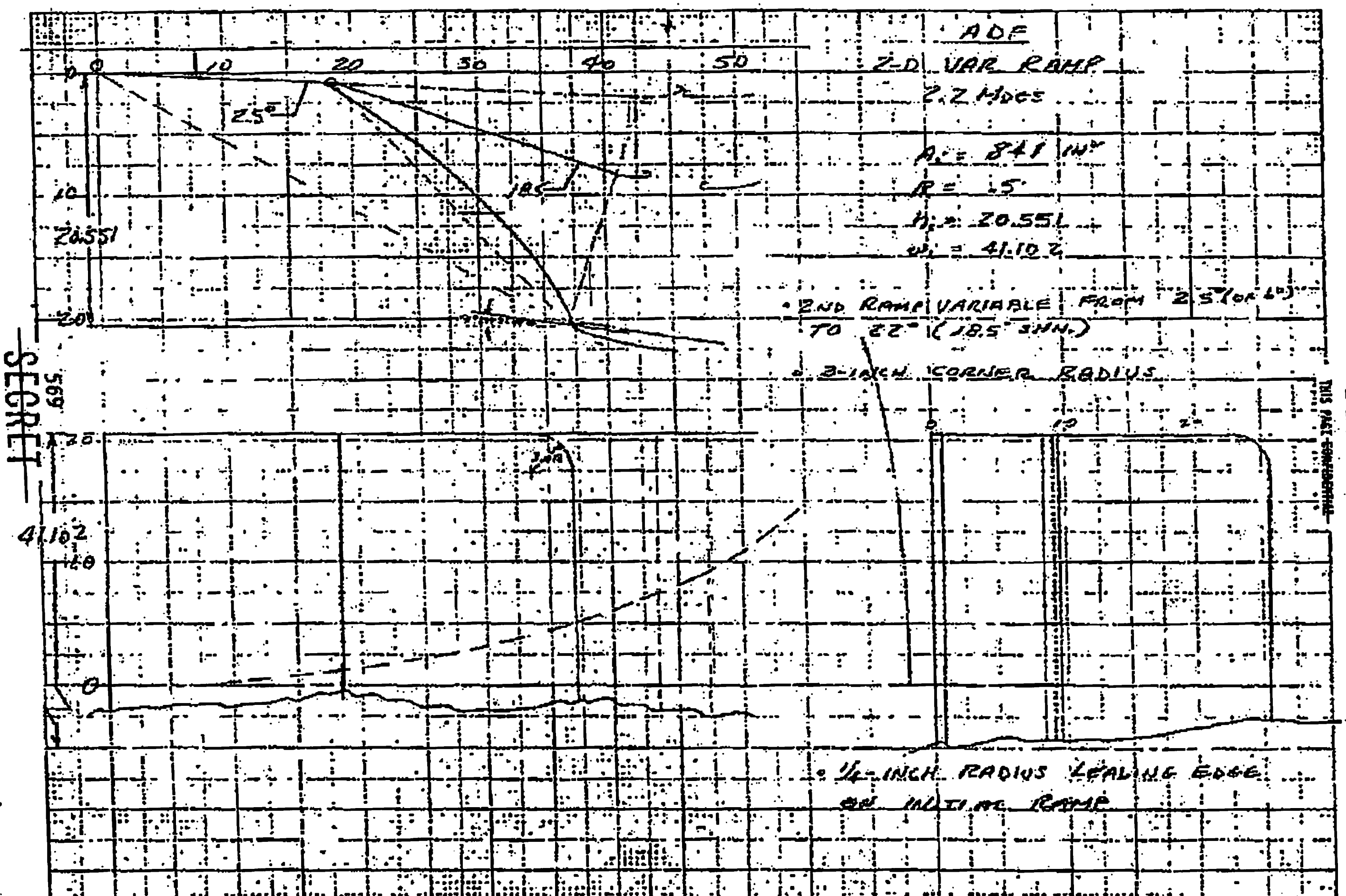
~~(C)~~ Figure 9.3-11 Area Distribution Curve for Two-Dimensional Variable-Ramp Inlet Configuration (U)

~~SECRET~~

SECRET

THIS PAGE CONFIDENTIAL

569



(C) Figure 9.3-12 Two-Dimensional Variable-Ramp Inlet Geometry Definition (U)

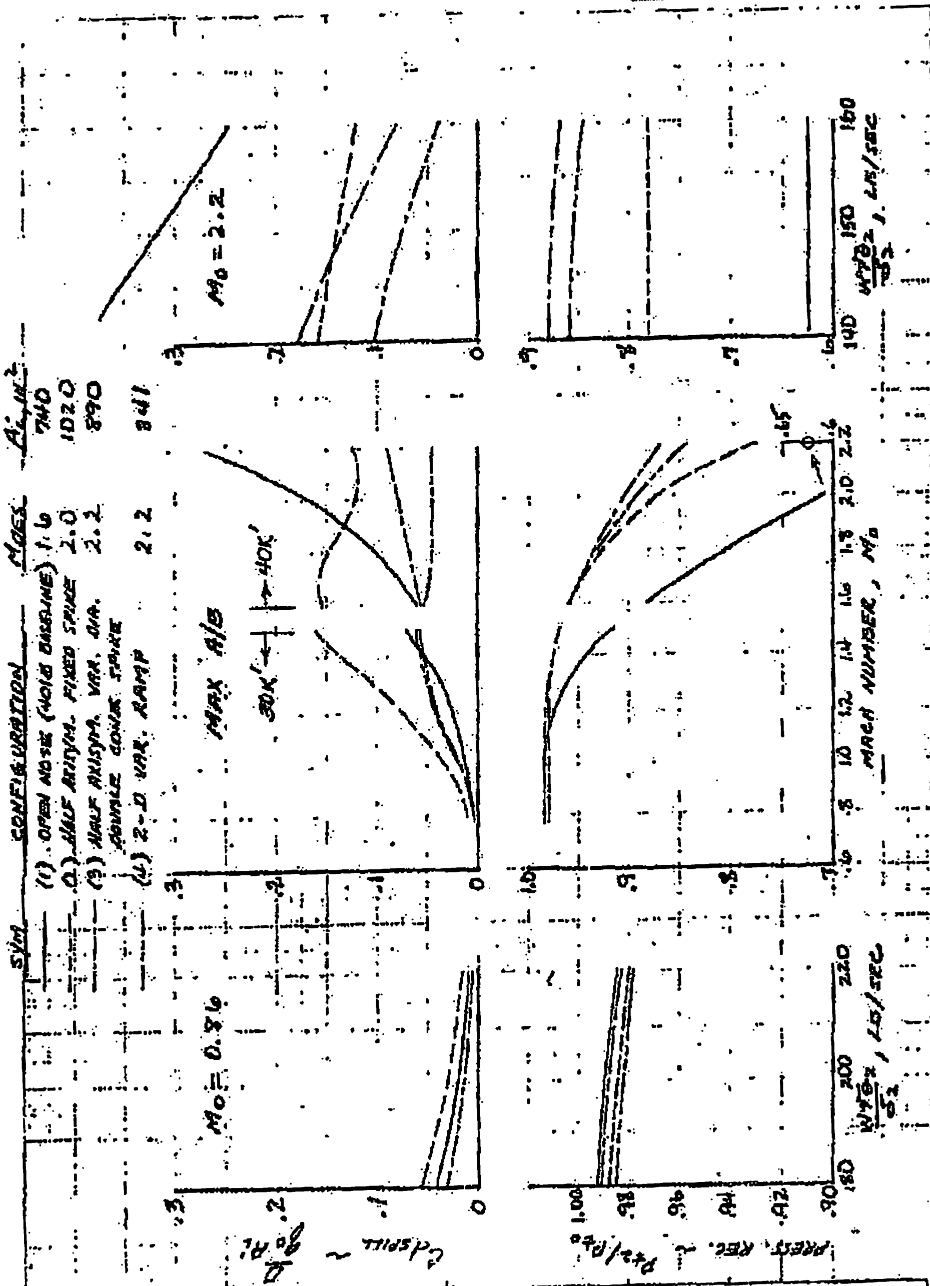
SECRET

THIS PAGE CONFIDENTIAL

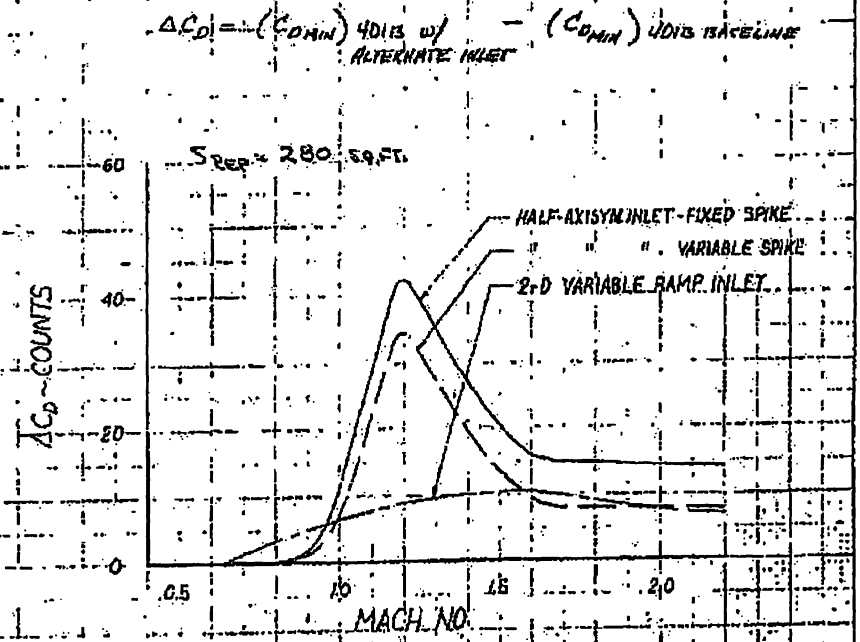
9.4 AERODYNAMICS AND INLET PERFORMANCE

(S) A summary of [the inlet performance used in the analyses is presented in Figure 9.4-1. Spillage drag and pressure recovery are presented as a function of (1) engine corrected airflow for the Mach 0.86 cruise and Mach 2.2 flight condition and (2) Mach number for a Maximum afterburning power setting. Spillage drag includes additive drag, lip suction, and bleed and bypass drags (as applicable).]

(U) The external drag increments between the baseline inlet configuration and the alternate inlet configurations are shown in Figure 9.4-2. Since wetted-area differences are negligible, the increments reflect differences in supersonic wave drag and cowl drag (see Subsection 3.3.11).



(S) Figure 9.4-1 Inlet Performance Comparison for the Inlet Trade Study on Configuration 401B (U)



(S) Figure 9.4-2 Incremental Airplane External Drag for the Inlet Trade Study on Configuration 401B (U)

9.5 STRUCTURES AND WEIGHTS

(C) Weight comparisons for the inlet configuration trade study are presented in Table 9.5-1. These weights are based on the analytical-statistical weighing equations discussed in Section 3.5. The following assumptions were used in the analysis:

1. Half-Axisymmetric Fixed-Spike Inlet - This inlet has a capture area of 1020 sq.in. allowances include bypass provisions at the engine compressor face and spike bleed provisions.

2. Half-Axisymmetric Variable-Diameter, Double-Cone-Spike Inlet - This inlet has a capture area of 890 sq in. and an expanding non-translating spike with bleed provisions. No blow-in doors or bypass provisions are considered in the weight calculations.

3. Two-Dimensional Variable-Ramp Inlet - This inlet has a capture area of 841 sq in. and an expanding ramp with bleed provisions. No blow-in doors or bypass provisions are considered in the weight calculations.

Table 9.5-1 INLET TRADE STUDY WEIGHT COMPARISONS
(pounds)

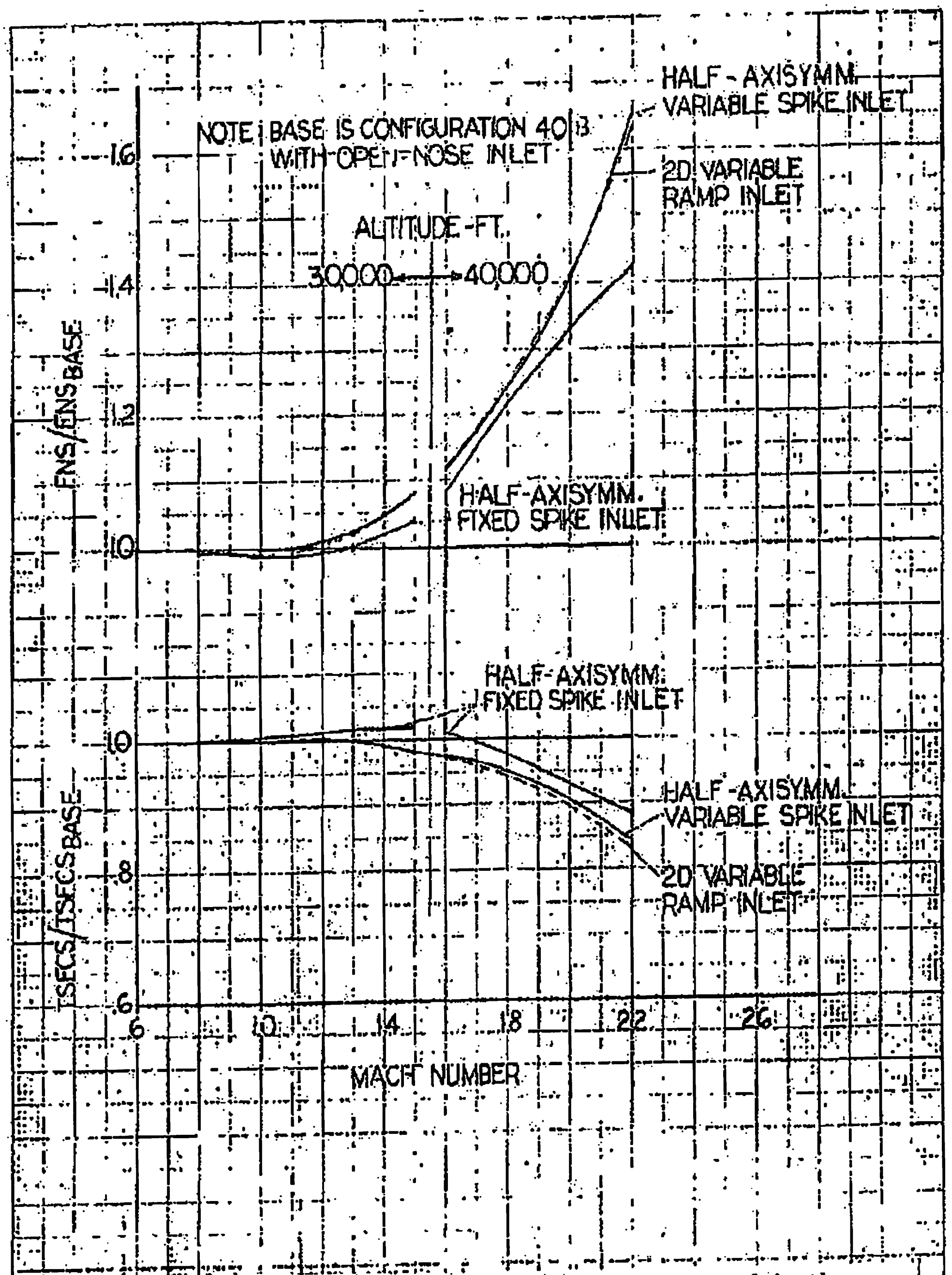
Weight Element	Inlet Description		
	Half-Axisymm. Fixed-Spike	Half-Axisymm. Variable-Spike	Two-Dimensional Variable-Ramp
Fuselage			
Duct Provisions	114	110	113
Wetted Area Change	8	3	2
Air Induction			
Duct	409	398	450
Spike	89	229	-
Bypass	94	-	-
Variable Ramp	-	-	145
Total Weight	714	740	710
Less:			
Baseline Duct Provisions	98	98	98
Baseline Duct	322	322	322
Weight Increase	294	320	290

CONFIDENTIAL
(This Page Is UNCLASSIFIED)

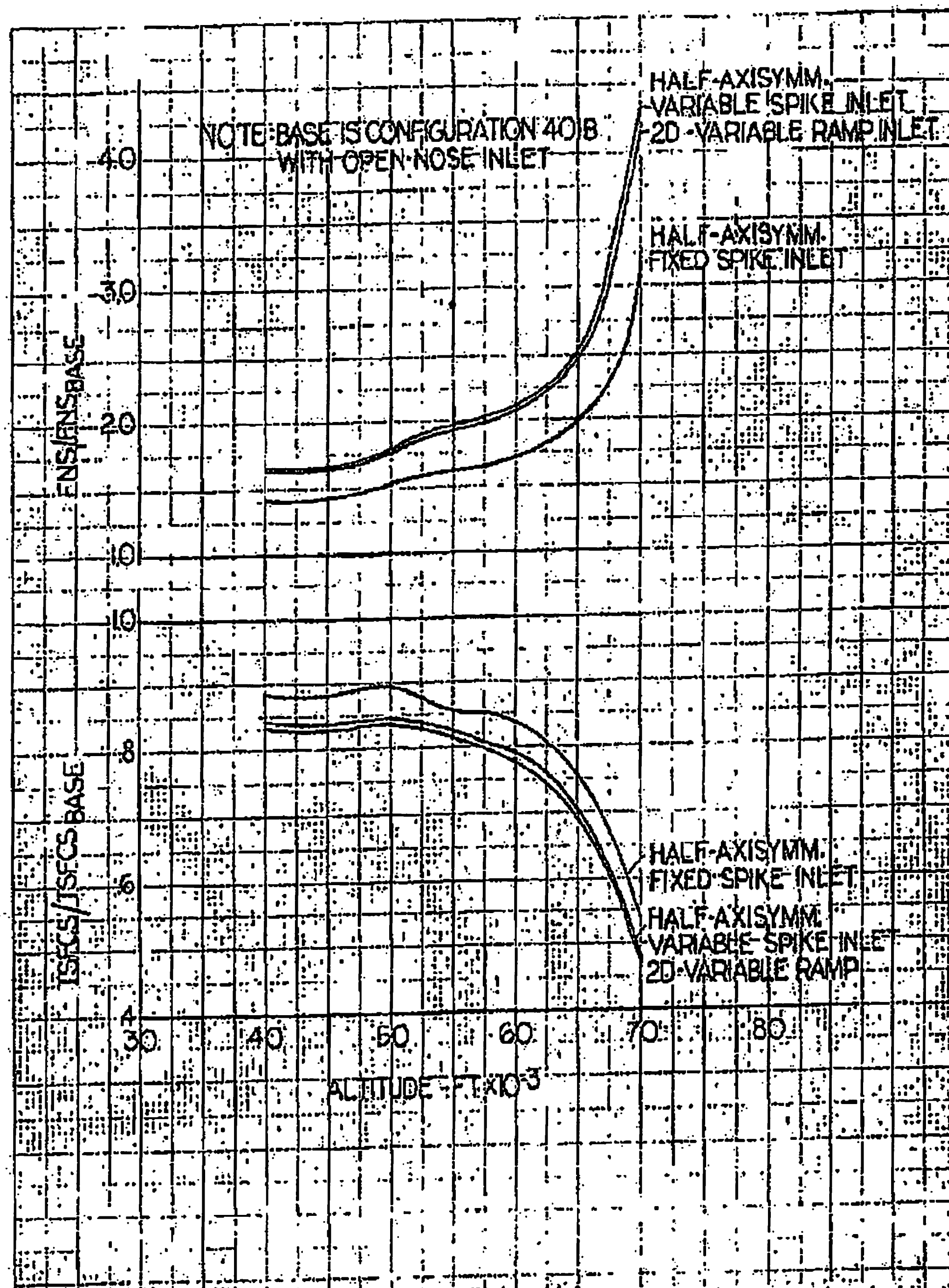
9.6 PROPULSION PERFORMANCE

(U) The propulsion performance data used in the inlet trade study are shown in Figure 9.6-1 through 9.6-3. The installed propulsion system thrust, F_{NS}, and specific fuel consumption, TSFCS, are presented for each alternate inlet as a ratio to the F_{NS} and TSFCS for the baseline airplane (401B/F100-PW-100). The baseline propulsion system performance is given in Subsection 3.6.1.

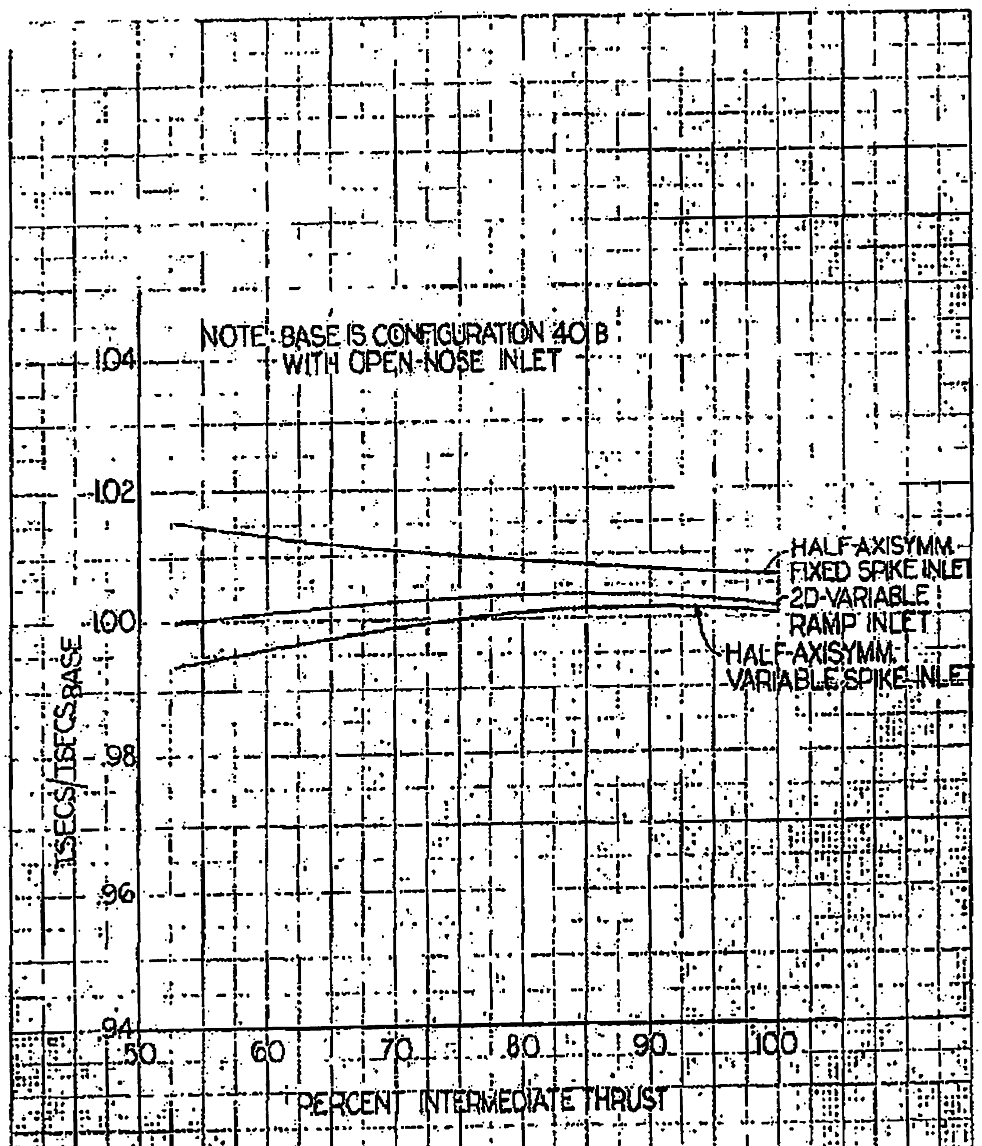
(U) The data shown in Figures 9.6-1 through 9.6-3 account for the same installation effects as the baseline data except for the inlet pressure recoveries and inlet spillage drags. Inlet recoveries and spillage drags are given in Section 9.4. The remainder of the installation effects taken into account are given in Section 3.6.



(U) Figure 9.6-1 Changes in Propulsion System Performance Used in the Inlet Trade Study, Maximum Power, 30,000, 40,000 feet (U)



(U) Figure 9.6-2 Changes in Propulsion System Performance Used in the Inlet Trade Study, Maximum Power, Mach 2.2 (U)



(U) Figure 9.6-3 Changes in Propulsion System Performance Used in the Inlet Trade Study, Mach 0.86, 45,000 feet (U)

SECTION 10

OTHER TRADES AND CONSIDERATIONS ON 401B

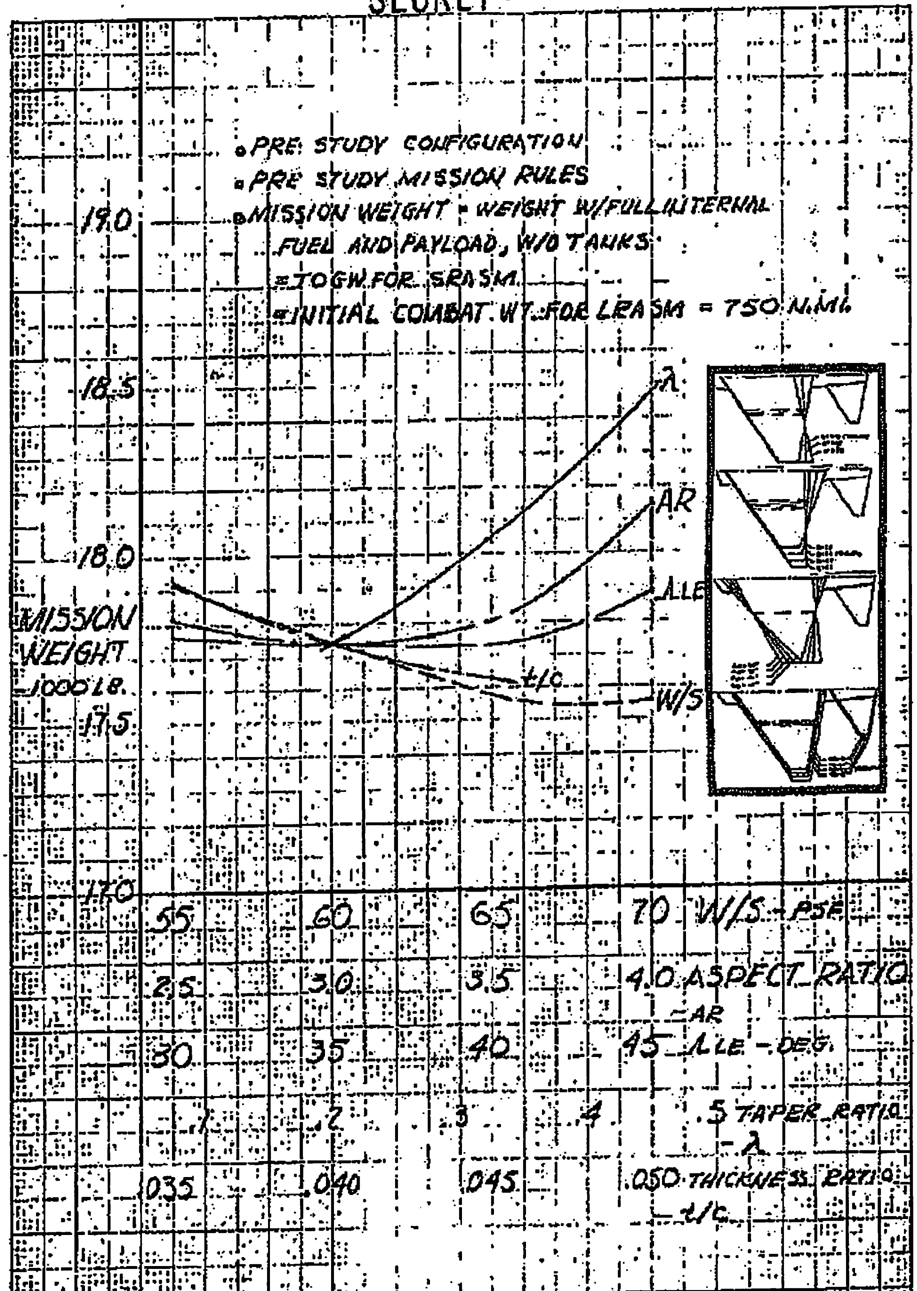
10.1 WING-GEOMETRY TRADES

~~(S)~~ A parametric wing study was conducted prior to the contracted study to help establish design guidance for the study configuration. [Independent variations were made of wing loading, aspect ratio, wing sweep, taper ratio, and thickness/chord ratio from a baseline point of 60-psf wing loading, 3.0 aspect ratio, 35-degree sweep, 0.2 taper ratio, and 4-percent thickness/chord. Mission combat rules were slightly different from the subsequent study rules (one acceleration to Mach 1.4, two 360-degree turns at Mach 1.2, five 360-degree turns at Mach 0.8,] and missiles expended at initial engagement); however, the trends established should be relatively valid. A summary of these results in terms of airplane gross weight (less external fuel tanks) required to perform the LRASM is presented in Figure 10.1-1.

(U) The most predominate variable is taper ratio, where the required airplane gross weight increases significantly with increasing taper ratio. It was concluded that taper ratio should be as low as practical, consistent with reasonable tip-chord thickness. Subsequent studies on Configuration 401B (see Section 6) show that the penalty due to higher taper ratio can be reduced by using a tapered t/c; however, the penalty is still significant and a 0.2 taper ratio was selected for the study.

~~(S)~~ Since the specified mission uses only a small portion of the total fuel at supersonic speeds, [the t/c trade study shows that thicker wings reduce the required aircraft size. However, since the design intent is to provide an aircraft with good supersonic maneuverability (Mach 1.0 - 1.6), it was concluded that the wing should be as thin as practical, consistent with flutter and aileron reversal considerations. Therefore, the basic 4-percent t/c was retained.]

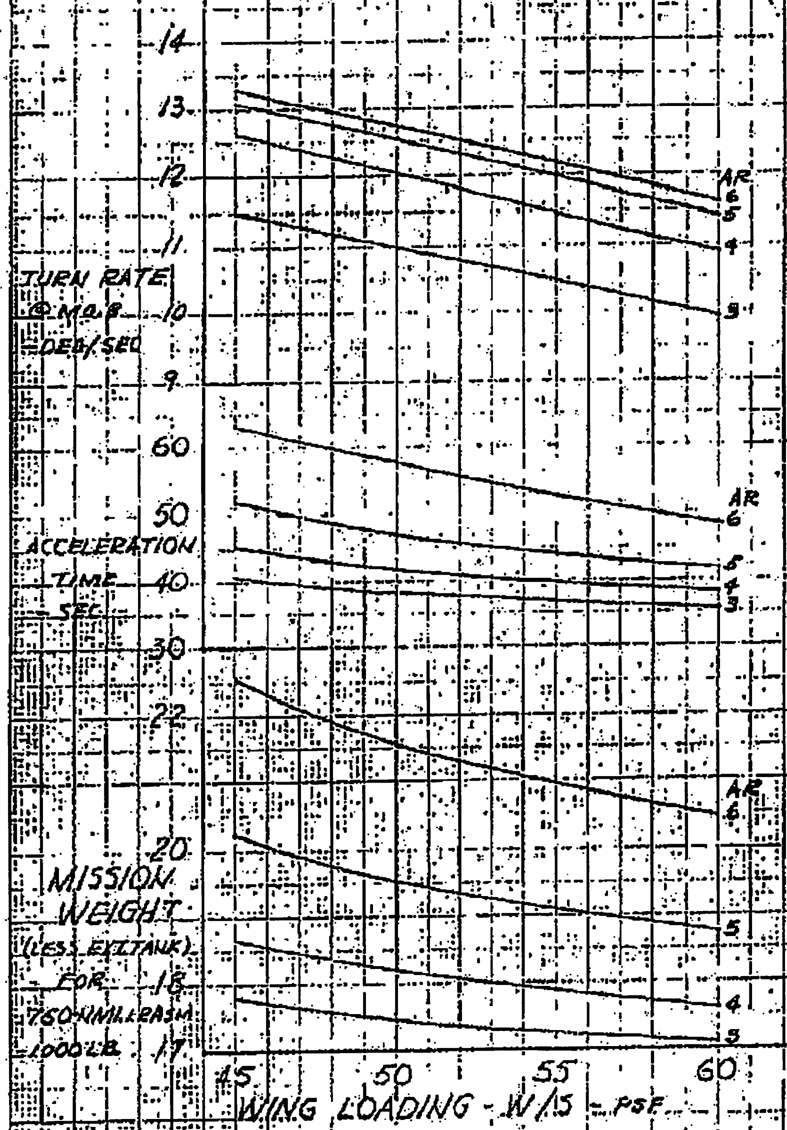
(U) Aircraft size required to perform the mission is relatively independent of wing sweep within the sweep range of 30 to 40 degrees. Some penalty is noted at 45 degrees sweep; also, the higher sweeps are more prone toward aileron



~~(S)~~ Figure 10.1-1 Sensitivity of Required Mission Weight to Wing Design Parameters (U) reversal due to aeroelastic effects. The 35-degree sweep was selected as a reasonable compromise between Mach critical and pitchup considerations.

~~(S)~~ The two parameters having a large influence on maneuverability are wing loading and aspect ratio. [The trend curves of Figure 10.1-1 show an aspect ratio of 3.0 to result in ~~(S)~~ the lowest gross weight for aspect-ratio variations, and a decreasing gross weight with increasing wing loading. This subject was given further study with the all-aluminum baseline case for the composite material trade study on 401B (Section 8). Since the objective of the study was to maximize maneuverability (acceleration and turning capability), it was decided to not consider wing loadings higher than 60 psf.] Summary results in terms of airplane gross weights required to perform the LRASM are presented in Figure 10.1-2 for parametric variations of [wing loadings between 45 and 60 psf and aspect ratios of 3 to 6. Also shown in the effect of these design parameters on turn rate (Mach 0.8 at 30,000 ft) and time to accelerate (Mach 0.9 to 1.5 at 30,000 ft). As shown in the performance data of Section 8, various combinations of aspect ratio and wing loading result in a tradeoff of acceleration versus sustained turning performance. The combination of an aspect ratio of 3.0 and a wing loading of 60-psf provides the lowest-gross-weight airplane and the best acceleration capability. Lower wing loadings and slightly higher aspect ratios will provide increased subsonic sustained turn rates but at the expense of acceleration capability and other supersonic-related performance such as maximum speed in intermediate power.] Until complete energy-maneuverability plots, including maximum maneuver diagrams, are completed for several potential aspect-ratio/wing-loading combinations (to display the differences over the whole maneuvering spectrum) it was decided to [select the aspect ratio of 3.0 and the wing loading of 60 psf for the basic study.]

~~(U)~~ The only other wing variation considered was rounded wing tips. When rounded in a manner to maintain equal wing area the aspect ratio is increased from 3.0 to 3.2 with very little dry-weight penalty. Previous studies have shown improved minimum drag and aileron effectiveness due to tip rounding and drag polar due to aspect ratio increase. Therefore, the rounded tip design was incorporated in the basic wing designs of this study (see Section 3.3).



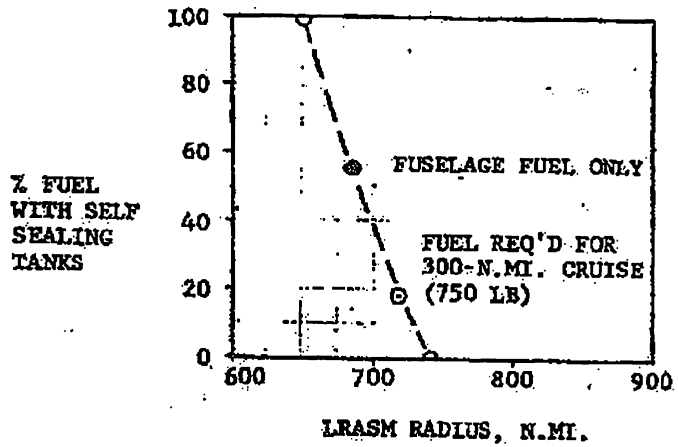
(S) Figure 10.1-2 Configuration 401B: Effect of Wing Loading and Aspect Ratio on Required Mission Weight, Turn Rate and Acceleration Capability (U)

10.2 SELF-SEALING FUEL TANK TRADE

(U) The tradeoff of the Long-Range Air-Superiority Mission (LRASM) radius with percentage of total internal fuel in self-sealing fuel tanks, presented in Figure 10.2-1, illustrates the effects of design discipline. An arbitrary requirement for 100 percent of the internal fuel to be in self-sealing tanks would result in an 88-n.mi-radius loss for Configuration 401B when compared to its radius capability with no self-sealing tanks. It is questionable if such a requirement is justifiable, since the frequency of being hit at the start of combat, when the tanks are full, is expected to be quite low. It would be assumed that the main concern after suffering damage is to return to friendly territory. The problem is to determine the amount of fuel that should be protected in self-sealing tanks. A reasonable criterion would appear to be the capability to fly at least 300 n.mi after being hit to return to friendly territory. For Configuration 401B, this would require approximately 750 lb of fuel. The radius loss for providing self-sealing tanks for this quantity of fuel is 23 n.mi. The radius loss for having all fuselage fuel in self-sealing tanks is 54 n.mi, which is 34 n.mi less than the loss with 100 percent internal fuel protection.

(16,800-Lb A/P W/O Tanks)

TOTAL FUEL LB	FUEL IN SELF SEALING TANKS LB	% TOTAL FUEL	BOW LB	LRASM RADIUS, N.MI.
3,981	3,981	100	12,186	652
4,060	2,264	55.8	12,107	686
4,133	750	18.1	12,034	717
4,185	0	0	11,982	740



~~(S)~~ Figure 10.2-1 Configuration 401B Selfsealing Fuel-Tank Trade (U)