SUMMARY - GUSTO PROGRAM - AS OF 15 MAY 1959

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Lockheed and Pratt and Whitney, as one team, and Convair and Marquardt, as the second design team, are proceeding with aircraft design, wind tunnel model construction and testing, structural investigations, and other testing through 30 June 1959.

The Convair/Marquardt program will cost in the order of $4,000,000. Up to that point the Lockheed program equals roughly $250,000. The principal reasons for this difference are that Convair/Marquardt began work as of 1 January while Lockheed began serious design efforts on the selected configuration within the past month. The J-58 funds needed by Pratt and Whitney for the Lockheed aircraft design are covered by Navy funding of this program.

It is too soon to fully judge the Lockheed configuration since time has not permitted any significant test results; however, there is no reason to expect serious difficulties because of the straightforward design approach. This does pose the objection of a large, heavy aircraft, highly detectable by radar and likely to produce more serious sonic boom effects than the Convair design. The Convair testing to date has demonstrated significant success in reducing the radar return; however, there is still some doubt as to the acceptability of the level at S-band and uncertainty that the sophisticated design techniques intended to reduce radar return at S-band can be utilized fully without compromise of aircraft aerodynamics and ram jet engine performance. Testing will continue to establish necessary compromises.

The Convair configuration has been revised to include the pilot's canopy, landing gear, two turbojet engines for subsonic flight, and other aerodynamic modifications to ensure a stable aircraft, meeting predicted aerodynamic characteristics. The most serious aerodynamic deficiency to date is high drag in the composite configuration which will necessitate additional thrust. It is expected that this can be provided through one or another alternative method. The original estimated gross weight has been increased by the above changes; however, there is no sacrifice in operational altitude nor range. The ram jet engine performance with the special modifications needed to reduce radar return is uncertain; however, additional electrical and thermodynamic tests are continuing.

The camera design is not firmly established because of the several possible locations which can be utilized. The relative advantages of these should be established within two weeks. All other subsystem developments are proceeding satisfactorily. Convair has now firmly selected a capsule type pilot compartment which will not require special pressure suit development. Lockheed, on the other hand, will require a specially developed full-pressure suit with cooling provisions for the high temperature environment.

DESCRIPTION AND PERFORMANCE:

The Convair design is a relatively small vehicle with a gross weight at present of roughly 40,000 pounds. The aircraft is staged from a B-58 mother aircraft and flies alone a range of 4,000 miles beginning at 90,000 feet altitude. The aircraft is powered by two 40-inch diameter Marquardt ram jets. It is roughly 50 feet in length, 35 feet in wing span. The Lockheed aircraft is powered by two J-58 Pratt and Whitney turbo-jets, has a fuselage just over 100 feet long, and a wing span of slightly more than 50 feet. Gross weight at take-off is about 92,000 pounds. This aircraft will fly 4,000 miles beginning at about 87,000 feet altitude. Both the Lockheed and Convair aircraft use JP type fuel exclusively. Unlike the Lockheed design, the Convair aircraft attempts by configuration and special materials to minimize the likelihood of detection and tracking by enemy radar.

TEST STATUS:

Radar testing. The Lockheed design makes little, if any, concession to incorporate features intended to reduce the radar return. Prior attempts by Lockheed to exploit these features have been relatively unsuccessful. No large-scale radar test program will be undertaken by Lockheed on this configuration.

Convair design, at 70 megacycles, as established by tests of a 1/8 scale model, has essentially reached the established goal of a maximum return equivalent to 6 square meters except for a minimum number of narrow spikes which slightly exceed this value. Recent design modifications which extend the fuselage slightly and modify the wing plan are not expected to disclose serious troubles in this regard. However, radar testing with the 1/8 scale model will continue through 30 June.

At S-band the radar return has been reduced to the original goal of 2/10 square meter except for 2 broadside flashes approximately 20 degrees each where the return rises from 6/10 to 1 square meter. Recent estimates of Soviet barlock radar capability has caused a revision of the desired return at S-band. The most difficult goal is now set at .02 square meters but there is some expectation that this may be too severe. S-band tests have been conducted on a full-scale model and also will continue through the end of June. Considerable detailed inventiveness has been required to reduce the S-band radar return. The engine air inlet requires radar-absorbent materials on the inlet ramp and lip. The ram jet plug has been cut off at the nozzle end of the engine to present a flat pie-plate appearance. This and the overhanding nozzle lip also require the use of radar-absorbent materials and it may be necessary to employ extreme high temperature metal plates radially exposed in the exhaust gas path. Full-scale radar testing at S-band will continue to establish the effects of design modifications, which include pilot's canopy, revised vertical tail, extended fuselage, and finalized inlet and exhaust nozzle configuration.

AERODYNAMIC TESTING:

No aerodynamic testing has been conducted by Lockheed although wind tunnel model construction is underway at present. There is no apparent reason to expect major difficulties in the Lockheed aerodynamic design. Convair tests. Wind tunnel tests have established that the subsonic lift/drag ratio is between 6.5 and 7 as against 5.5 estimated. This indicates that with the addition of a landing gear and added turbo-jet power the aircraft would be capable of flight in the subsonic regime. The supersonic lift/drag ratio was 5.85 from wind tunnel tests as against 5.9

estimated. The supersonic aerodynamic center was established within one-half of 1% of the predicted value at Mach 4. However, the subsonic aerodynamic center location came out to be about 5% forward of its estimated location, which together with a further aft band estimated CG location resulted in an unstable configuration at landing. This has required relocation of the subsonic turbo-jet engines, revision of wing plan form and other equipment relocations, which have now resulted in a CG location forward of the subsonic aerodynamic center, and hence a stable aircraft for landing. These aerodynamic changes will be checked in additional wind tunnel tests beginning 25 May and in the additional radar testing described previously.

Perhaps the most serious deficiency which the wind tunnel test program has disclosed so far is high drag at subsonic speeds in the composite configuration, that is, with the aircraft attached to the B-58 mother. Additional thrust will be required in order to accelerate to launch speed of Mach 2. This additional thrust can be obtained from ignition of the ram jets at just above sonic speeds, or by utilizing the higher thrust J-79-9 engines, retro-fitted to B-58A aircraft; or as will be standard on the B-59B series. The needed extra thrust could also be obtained by two additional J-79-5 engine pods, making a total of 6 on the B-58A mother aircraft. The feasibility of each of these approaches is being investigated.

AERO-THERMAL-DYNAMICS TESTING:

No serious problems are anticipated in the Lockheed configuration in this regard due to the straightforward nacelle-type J-58 installation. Convair engine inlet tests have been only partially successful to date due to deficiency in the construction of the model itself. It was possible to establish a ram recovery of 67% at the inlet throat during Mach 4 cruise conditions. A ram recovery of 70% was estimated at the ram jet engine inlet station. Additional tests will begin on 25 May with a rebuilt inlet model to establish ram recovery and flow distribution at the engine inlet. The present duct design has been straightened out due to relocation of the turbo-jet engines and will undoubtedly demonstrate higher ram recovery than is expected from the tests to be conducted since these will be based upon the S-shaped original duct configuration.

STRUCTURAL TESTING:

Lockheed is proceeding with fabrication and testing of specimens and minor structural components using titanium. Convair has conducted and is testing several hundred samples of various structural fittings and sections. No serious difficulty has been encountered nor is expected in this area.

PAYLOAD EQUIPMENT BAY:

The Lockheed design will incorporate a camera bay roughly equivalent to that of the U-2 aircraft. Several alternate payload locations are under discussion with Convair and final camera configuration remains undecided. Recommendations based upon Perkin-Elmer and Convair discussions are expected within two weeks.

ENGINE TESTS:

The Pratt and Whitney J-58 development program is understood to be firm for the next fiscal year through funds provided by Navy. Additional funding will be required for advancing the engine to Mach 3.2 performance and the development of the fully rated after-burner required by the Lockheed design. Marquardt for the Convair aircraft have conducted small-scale model tests of the ram jet to establish combustion efficiency. A two-inch diameter model demonstrated satisfactory results; however, when the model size was increased to 4-inches, the combustion efficiency was about 2-1/2% lower than estimated. This could result in a 10-15% loss in range. The 4-inch diameter burner test results are under suspicion due to possible instrument inaccuracies. These tests have been conducted at the Fluidyne facility in Minneapolis. A new series of 4-inch burner tests is to begin 15 May at the AEDC test facility, Tullahoma, Tenn.

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