SECTION 127

AIRCRAFT DATA ACQUISITION

By

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INTRODUCTION

NASA Manned Spacecraft Center supported the 1971 Corn Blight Watch Experiment by acquiring remote sensor data with the dedicated use of the RB57F and the University of Michigan C47. See Figures 1 and 2.

Within the Earth Observations Aircraft Program Office, the experiment was known as the Corn Blight Project. The Project was organized into 3 phases based on the mission objectives and imagery required.

The specific objectives of the Project were first to acquire black and white photography with the RB57F to provide enlarged prints of each test segment. This was termed Phase I of the Project and took place in April 1971. These prints were to be sent to the Department of Agriculture to prepare an initial survey of the size and location of all crop fields and other land uses within each test segment.

Then, in May, the RB57F was to obtain color infrared photography while the C47 obtained multispectral scanner data for soils background information. This was termed Phase II. Finally, the aircraft were to collect color infrared photography and multispectral scanner data over their respective test segments repetitively throughout the growing season. This was known as Phase III and extended from mid-June through September. Phase II and III imagery was to be sent to Purdue-LARS.

MISSION REQUIREMENTS

The aerial coverage for the RB57F included extensive areas of Ohio, Indiana, Illinois, Iowa, and portions of Minnesota, Nebraska, and Missouri (Figure 3). Two hundred and ten test segments were defined along 38 flight lines. The dimensions of each test segment was approximately 1 x 8 statute miles.

Approximately 3800 flight line miles of data were to be flown during Phase I and Phase II as well as bi-weekly during Phase III. Each flight line was independent except in western Indiana where eight parallel and overlapping flight lines provided contiguous coverage of an area defined as the Intensive Study Area. The thirty test segments located in the Intensive Study Area were overflown by both aircraft during Phase II and bi-weekly during Phase III. Phase I flights were flown at 50,000 feet to provide a convenient scale for subsequent enlargements. Phases II and III were flown at 60,000 feet for optimum aircraft endurance and sensor coverage.

Data to be acquired by the RB57F during Phase I was Aerographic Type 2402 black and white photography to be provided to the USDA in the form of 24" x 35" paper prints enlarged to a scale of 1:20,000. Aerochrome infrared type 2443 color infrared imagery was to be acquired by the RB57F during Phase II. Duplicate positive transparencies and color prints were to be provided to LARS. Color infrared film was also to be used during Phase III from which duplicate positive transparencies were to be provided to LARS. All RB57F data was acquired using metric cameras with a 9-1/2" format.

Delivery of processed Phase III imagery to LARS was required with minimum delay to permit analysis of photographic imagery in conjunction with ground observations.

RB57F MISSION PLANNING AND OPERATIONS

Planning the RB57F portion of the project was similar to the planning of most previous RB57F missions with two major exceptions. These exceptions were data quality and data delivery.

Color infrared imagery obtained from previous RB57F missions was often nonuniform in exposure within each frame due to several factors including sun angle and atmospheric effects. Nonuniformity also occurred from frame to frame due to sun angle and scene brightness changes. This exposure nonuniformity made analysis difficult when the interpreter was dependent upon subtle tonal differencies. To reduce the exposure nonuniformity, changes were made to camera operation and processing techniques. These efforts, while not eliminating the problem, did result in improved data products. The north-south flight line orientation, while not selected to improve data quality, did permit optimum use of photographic overlap.

A single emulsion batch of color infrared film was obtained to reduce tonal variations anticipated if more than one emulsion batch was used during the Project. Tonal quality and infrared sensitivities have been found to vary between emulsion batches of the same type film causing undesirable tonal variations due to film characteristics.

Two problems occurred with the selected infrared film. Early in the Phase III, LARS detected an abnormal spotting condition on the color IR imagery. The defect was termed "cyan spotting" because the mottled appearance of the imagery was determined to be caused by a defect in the cyan layer of the emulsion. The cyan spots occurred randomly and made analysis of the imagery difficult. The cause of the defect has not been completely isolated, however, a change in manufacturing techniques appears to have provided a temporary solution. During the Project, supplemental film was flown to overcome the cyan spotting problem.

In addition to the cyan spotting problem, the selected color IR film lacked adequate range in infrared tonal variations. In other words, the film appeared too red or "hot". This problem, also, was eliminated with the use of the supplemental film.

Timely delivery of the data to LARS presented a difficult problem. A data management plan was prepared in order to meet the required delivery dates while minimizing the impact to ongoing programs. Data was flown by jet courier aircraft from the field to MSC where it was processed. Data schedules were generally met. An overall average of 10 days was required from exposure until delivery to LARS. Changes in procedures were required midway through the project to meet the desired delivery. This involved shipment of the processed film to LARS by direct airline flights to Indianapolis where a LARS representative picked up the film.

Weather is frequently a deciding factor in planning aircraft remote sensing missions. The Corn Blight Project made greater use of long range weather planning guides, such as "The Aerial Photographer's Clear Day Map" from the Manual of Color Aerial Photography, than most other missions in order to estimate the scope of coverage that should be attempted. Day to day mission operations were conducted with the assistance of an onsite meteorologist who monitored weather conditions and was prepared to advise the aircrew on the most suitable test site areas. While no attempt was made to compare actual versus forecast weather, the success of the data acquisition indicates that both long and short term weather forecasts are essential to mission planning and operations.

A factor that increased the operational flexibility of the RB57F and directly affected the success of the mission was the use of a standard sensor configuration. This eliminated sensor configuration changes in day to day operations and permitted data acquisition limited only by weather conditions, film capacity, and aircraft endurance.

In summary, the RB57F efforts resulted in the completion of 85% of the required coverage with less than 30% cloud coverage affecting the imagery. Fifty-four flights were flown over the Corn Belt. Four Hundred hours of flight time were expended on the Corn Blight Watch which is approximately 2/3 of the annual RB57F flight time allocation. Thirty percent of the available mission time was lost due to unsuitable weather, 20% was lost due to unscheduled maintenance, and 5% was lost due to scheduled maintenance. A 50% utilization factor is probably a good planning figure for future missions under similar conditions.

As many of the investigators are well aware, the Corn Blight Project resulted in the cancellation of five previously planned RB57F missions and 19 test sites. However, 12 test sites were flown on a contingency basis during the Project.

C47 MISSION PLANNING AND OPERATIONS

The University of Michigan C47 was also dedicated to the 1971 Corn Blight Watch Experiment. The C47 provided Phase II and Phase III coverage of the 30 test segments within the Intensive Study Area (Figure 4) with the 12 channel multispectral scanner, and supplemental photography. Phase II coverage was coincident with the RB57F Phase II operations. Phase III operations began in late June and continued bi-weekly until in early October. The 30 test segments were flown individually at 5,000 feet AGL.

Of the 30 test segments within the Intensive Study Area, 15 were analyzed by LARS and the other 15 by Willow Run Laboratories. The original analog tapes containing the LARS test segments were delivered to LARS the day they were flown along with the supplemental film.

Operational criteria was established which would provide acceptable multispectral scanner data. These criteria specified that visibility at the flight altitude must be at least 6 miles with less than 30% cloud cover above the aircraft and less than 15% below the aircraft. The minimum acceptable sun angle was 50° although this limit would

not be possible to meet later in the mission. These criteria proved to be satisfactory, however, an additional constraint was added later in the mission. It was determined that an excessive aircraft drift angle was unacceptable due to excessive image distortion. A limit of 15° drift angle was imposed to reduce the image distortion to acceptable levels.

In summary 98.4% of the sample areas were satisfactorily completed by the C47. One hundred and fourteen flight hours were expended. Use of the C47 in the 1971 Corn Blight Watch Experiment resulted in the cancellation of five previously planned missions.

CONCLUDING REMARKS

In conclusion the project was different than previously planned missions in duration, coverage, and sensor configuration. The wide areal coverage and single sensor configuration did provide flexibility in mission operations that greatly contributed to mission success.

This project provided a unique opportunity for review of the data on a timely basis permitting sensor corrections to be made and evaluated in the field.

The Project also provided a excellent prelude to future support of complex aircraft and spacecraft missions.

RF

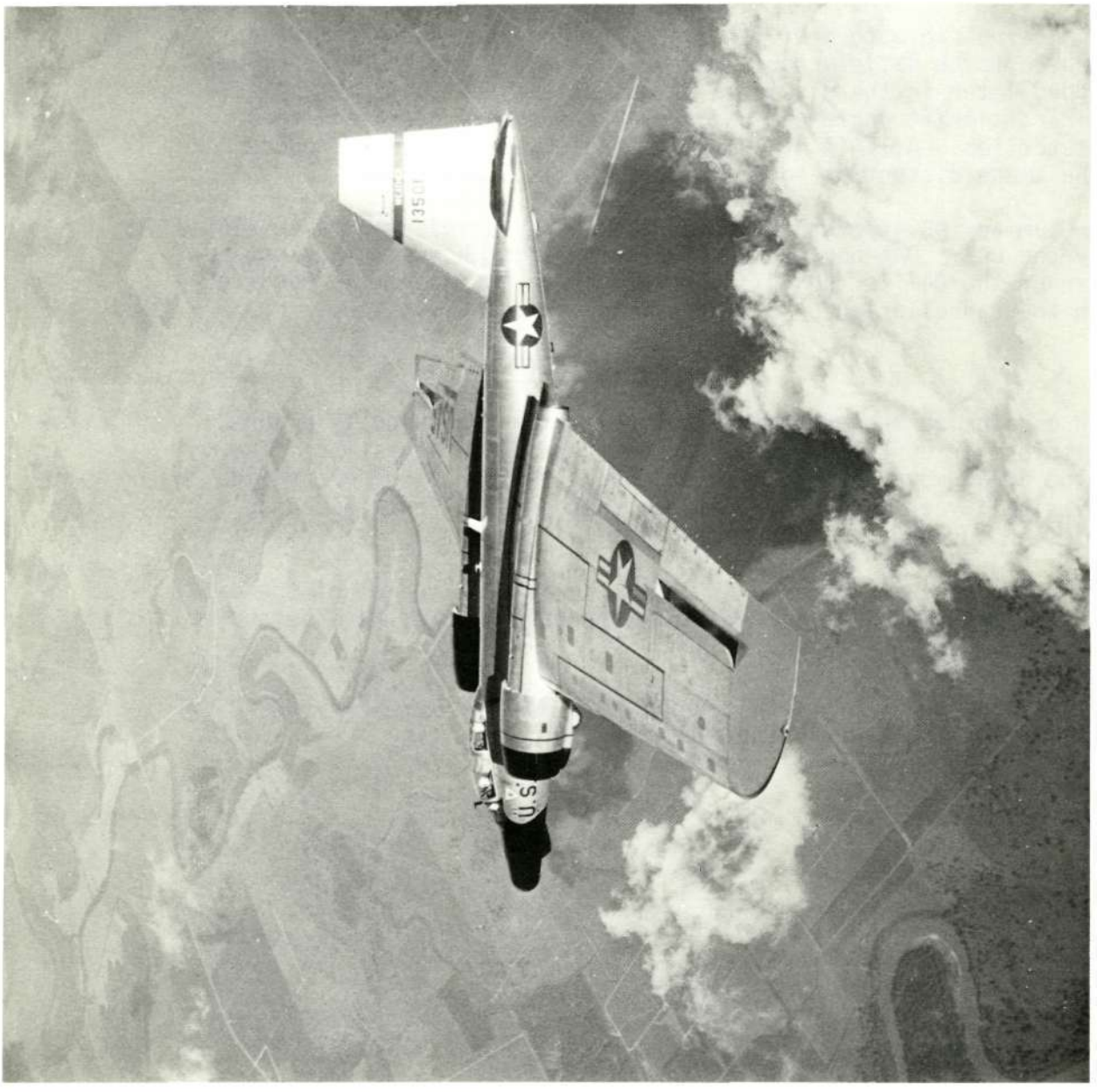

FIGURE 1 - NASA/USAF RB57F

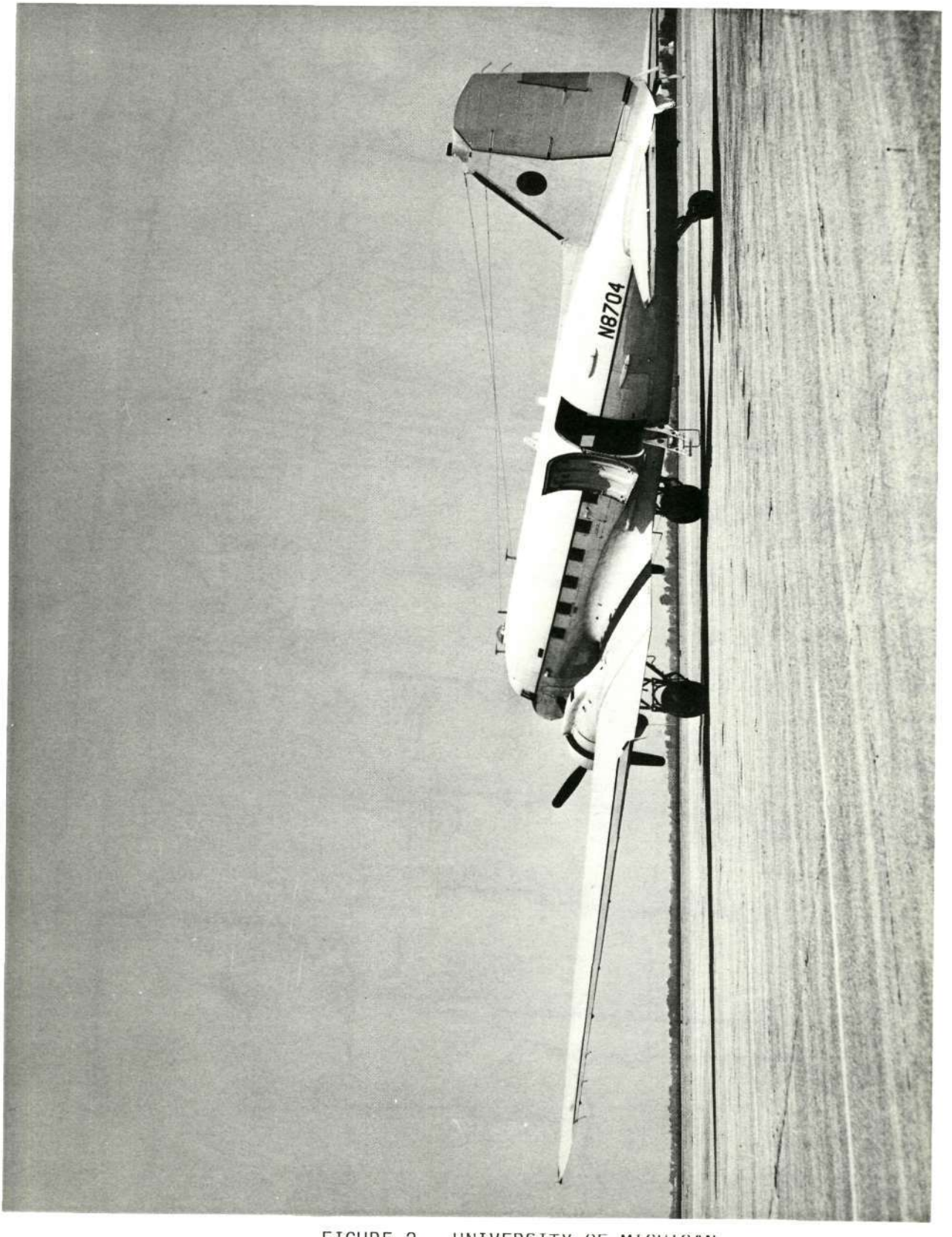

FIGURE 2 - UNIVERSITY OF MICHIGAN
C47

CORN BELT TEST SITE

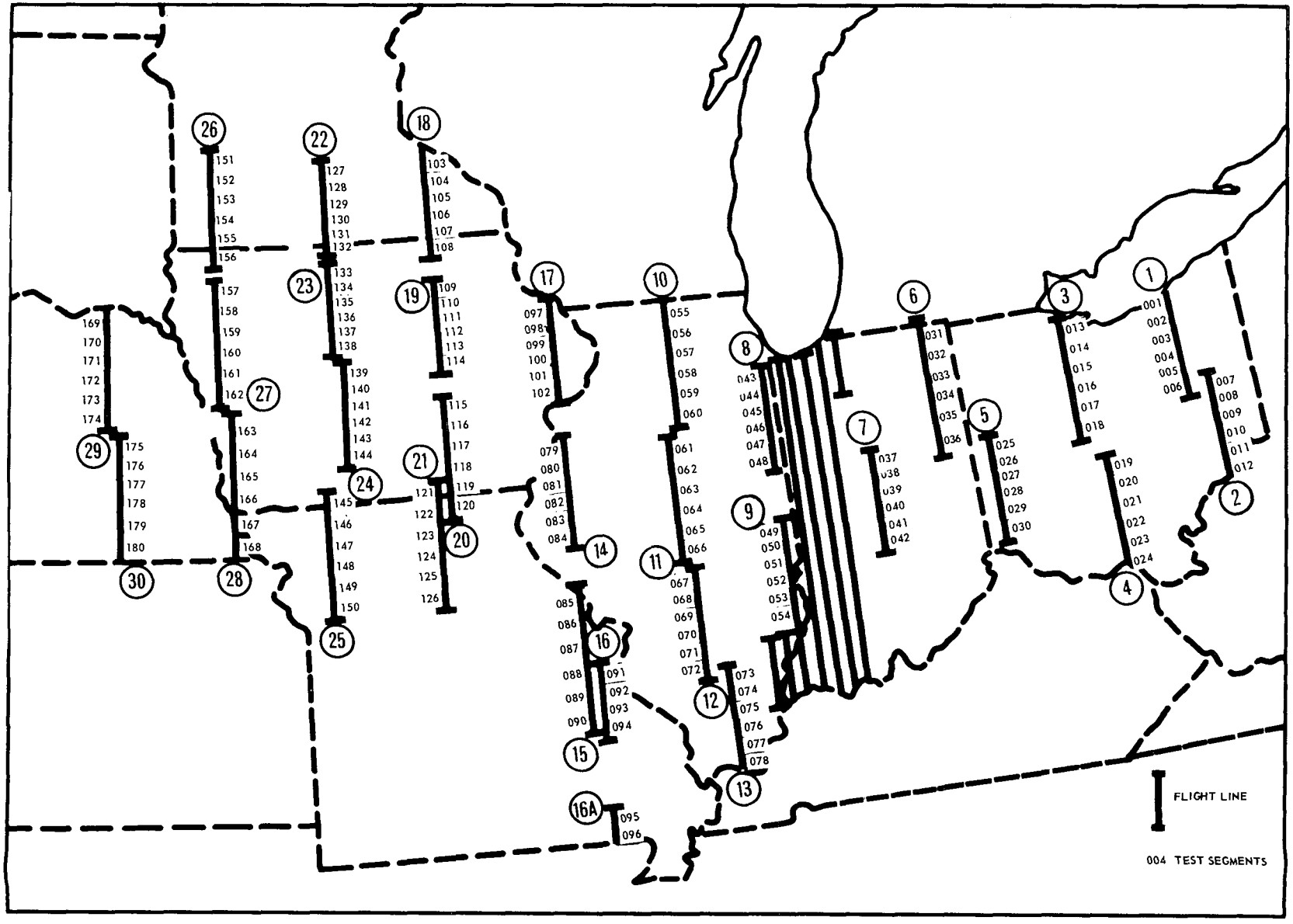

FIGURE 3 - CORN BELT TEST SITE

INDIANA
INTENSIVE STUDY AREA

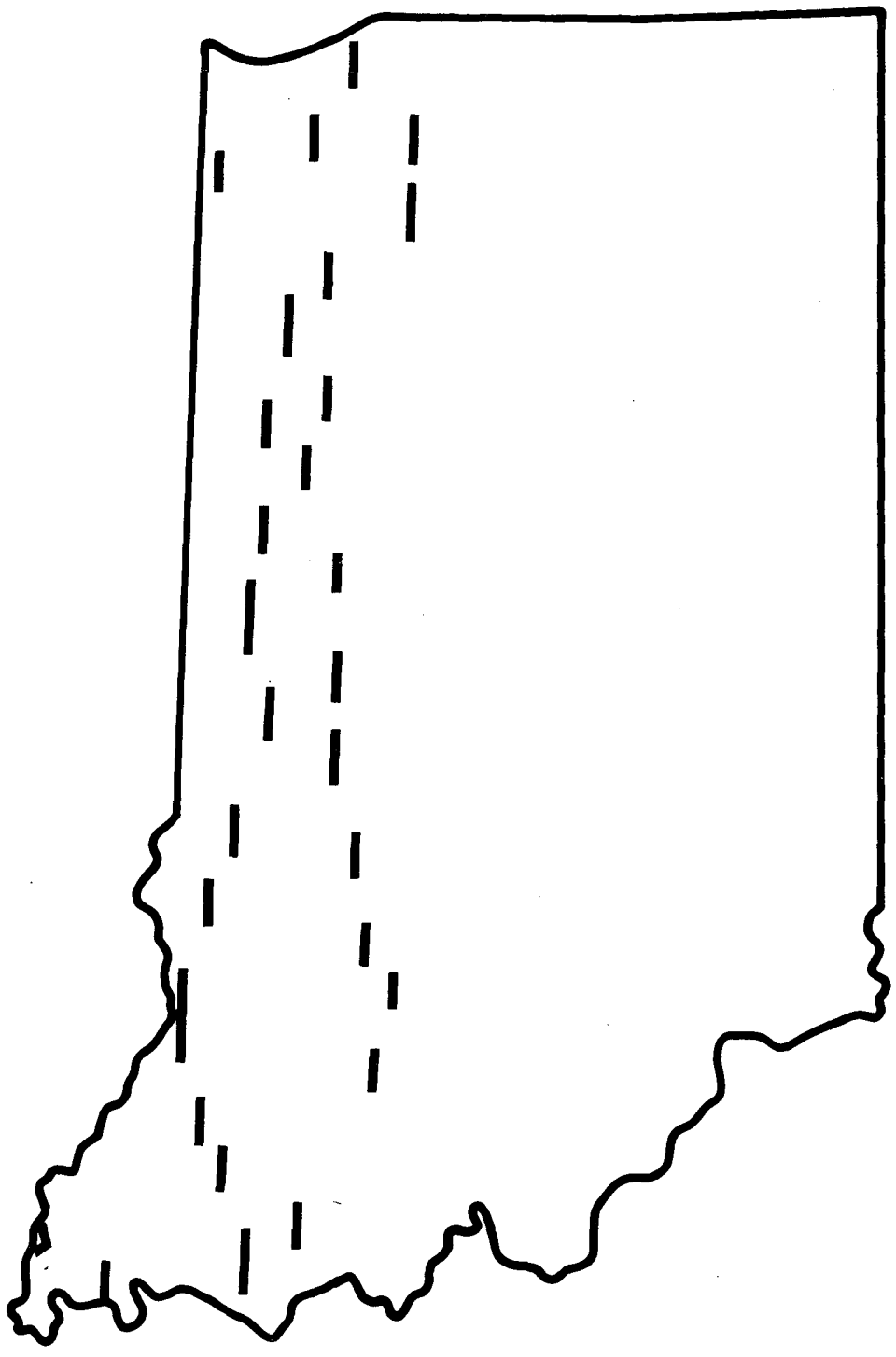

FIGURE 4 - INDIANA INTENSIVE STUDY AREA