~~TOP SECRET EARPOP~~
HANDLE VIA THE BYEMAN
CONTROL SYSTEM

[redacted]/RLP:wr
BYE-57169-69
3 February 1969

SHIPBORNE EMITTER LOCATION TECHNIQUES

1. Purpose. This report describes recent applications of System POPPY to ocean surveillance by identifying and locating Soviet shipborne radars.

2. Background. [redacted] active POPPY satellites are in orbit and a launch of four satellites is scheduled for the spring of this year. The two satellites still active from POPPY Mission 7104, launched on 9 March 1965, do not have [redacted] and are therefore incapable of activation in the [redacted] POPPY Mission 7105, launched on 31 May 1967, includes [redacted] satellites.

The satellites have a slightly elliptical orbit and an inclination angle of about 70 degrees. They fly at an average altitude of about 500 nautical miles, and their period is approximately 103 minutes per earth orbit.

With this type of orbit a POPPY collection site can receive data when the earth trace of the satellite is within 1750 nautical miles. Each satellite is within the [redacted] acquisition area a minimum of [redacted] minutes during [redacted] of its fourteen daily orbits. A typical pass lasts for about sixteen minutes.

Since the satellite "sees" for another 1750 nautical miles, it is possible to record data from a radar operating

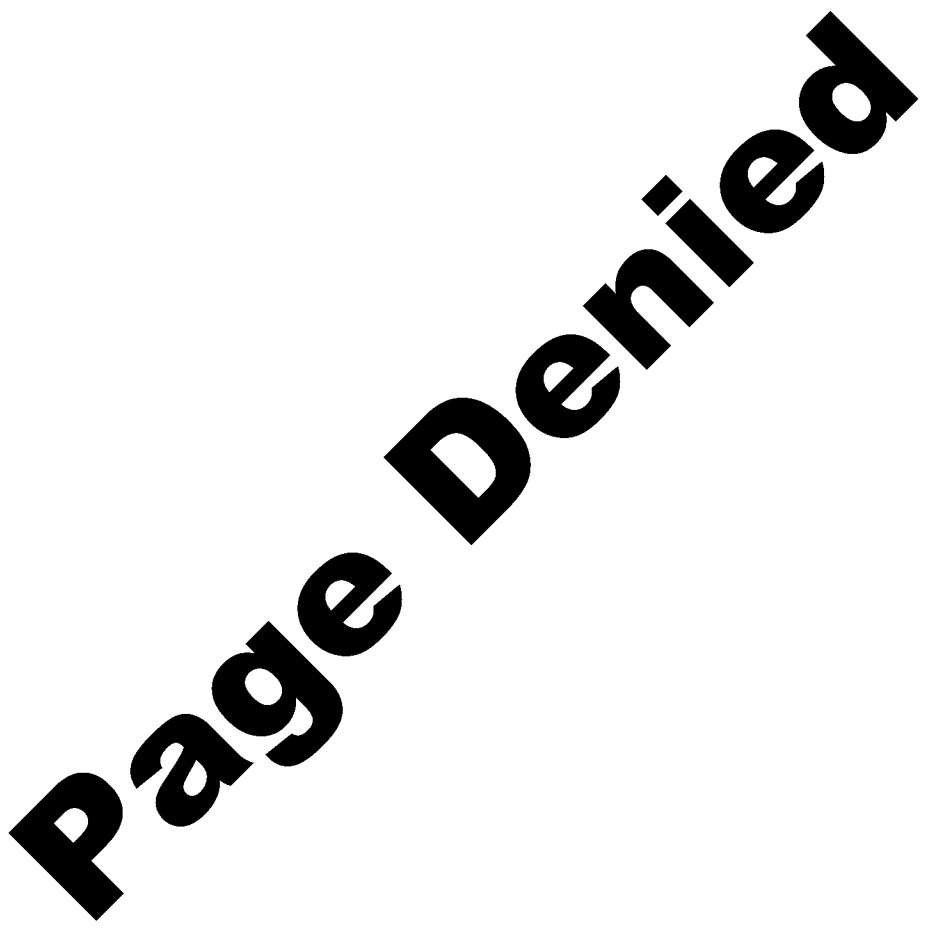
as far away as 3500 nautical miles. Naturally, the maximum would never be realized due to the time lapse between acquisition of the satellite and successful activation of its data links.

Since the above approximations apply to any point on earth, world-wide collection sites and an adequate number of satellites would provide continuous surveillance of all seas and oceans.

On the following page is a polar projection with the [redacted] acquisition area circled in black, a typical satellite earth trace indicated by dashed lines and the corresponding intercept swath bounded by orange. The acquisition circle is cut at 70 degrees north since POPPY satellites never go above this latitude due to the inclination of their orbits.

On the second following page the same orbit is plotted on a section of a tracking chart. All graphs, illustrations and examples in this report will be based on the orbit plotted and on a hypothetical radar located in the English Channel. To bring out various points the radar will be defined as emitting 2000 pulses per second and rotating clockwise at five seconds per revolution.

3. Tasking. The satellites are tasked in accordance with assignments promulgated by the Naval Security Group Command



(NSGC). The "Summary of Command System Operation for 7105 Series" revised 1/19/67, promulgated by NSGC, describes the [redacted] data links in each of the satellites and arranges the data links into tasking groups. Weekly tasking assignments are by sequential orbit number and the group of data links to be activated.

NSGC also promulgates six month SPASUR predictions for equator crossing times and longitudes. From these predictions are derived azimuth and elevation bearings for training the transmission and receive antennas during each satellite pass.

4. Interrogation. The satellite's data links are activated by using an encoder to read a pre-tested punch card and generate [redacted] which are transmitted by a directional antenna. On the following pages are photographs of the interrogation positions and the transmitting antenna.

The status of the satellite can be monitored using the signal from its continuously operating telemetry transmitter. Using a telemetry discriminator and readout device, keying success is indicated by the position of segments that correspond to each data link on the [redacted] segment portion of the telemetry channel. The satellite's activation is indicated by a [redacted] on the data channels at the collection position. The complete interrogation can be accomplished in less than [redacted] when the satellite is

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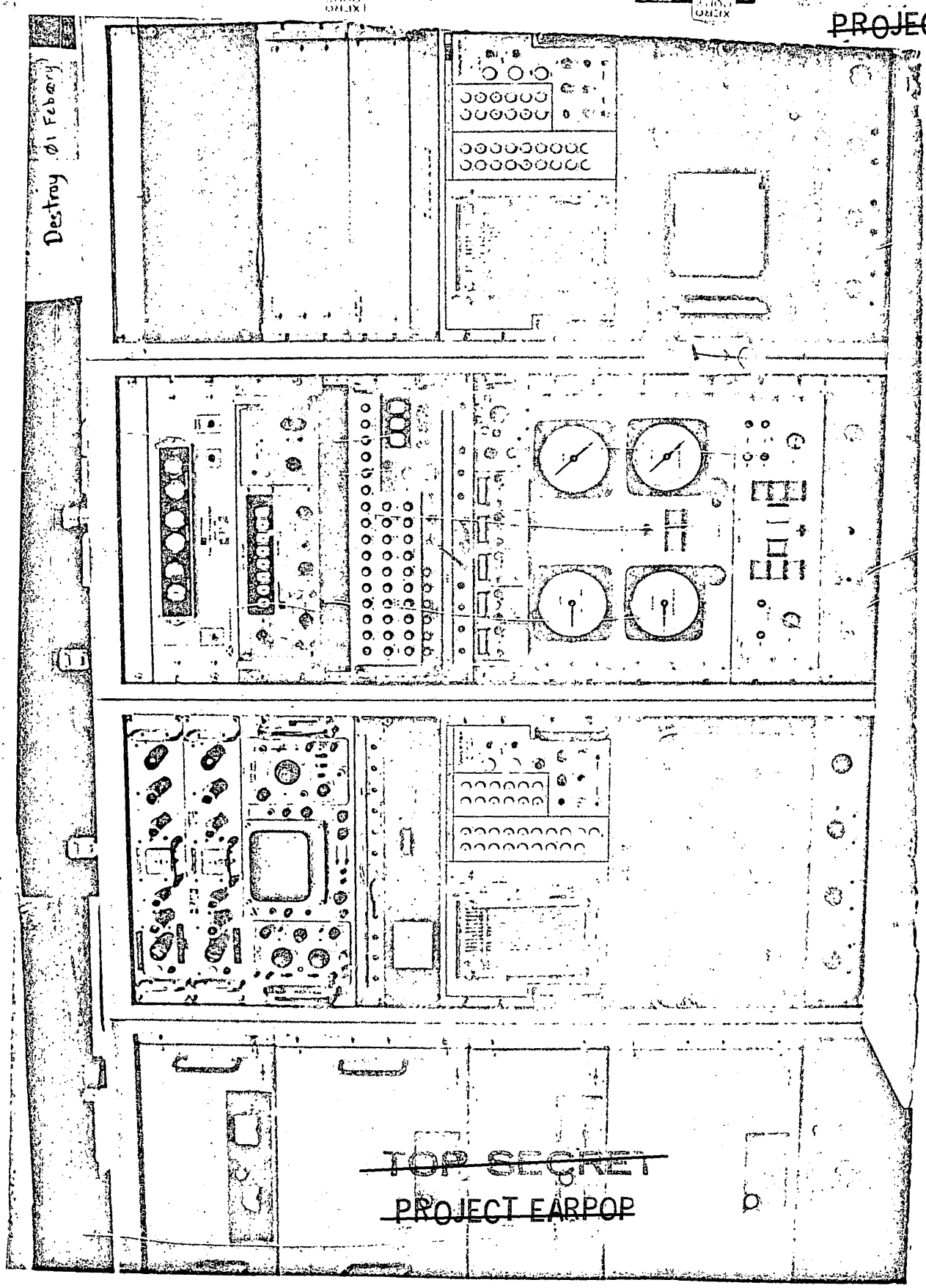

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INTERROGATION POSITION

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INTERROGATION ANTENNA

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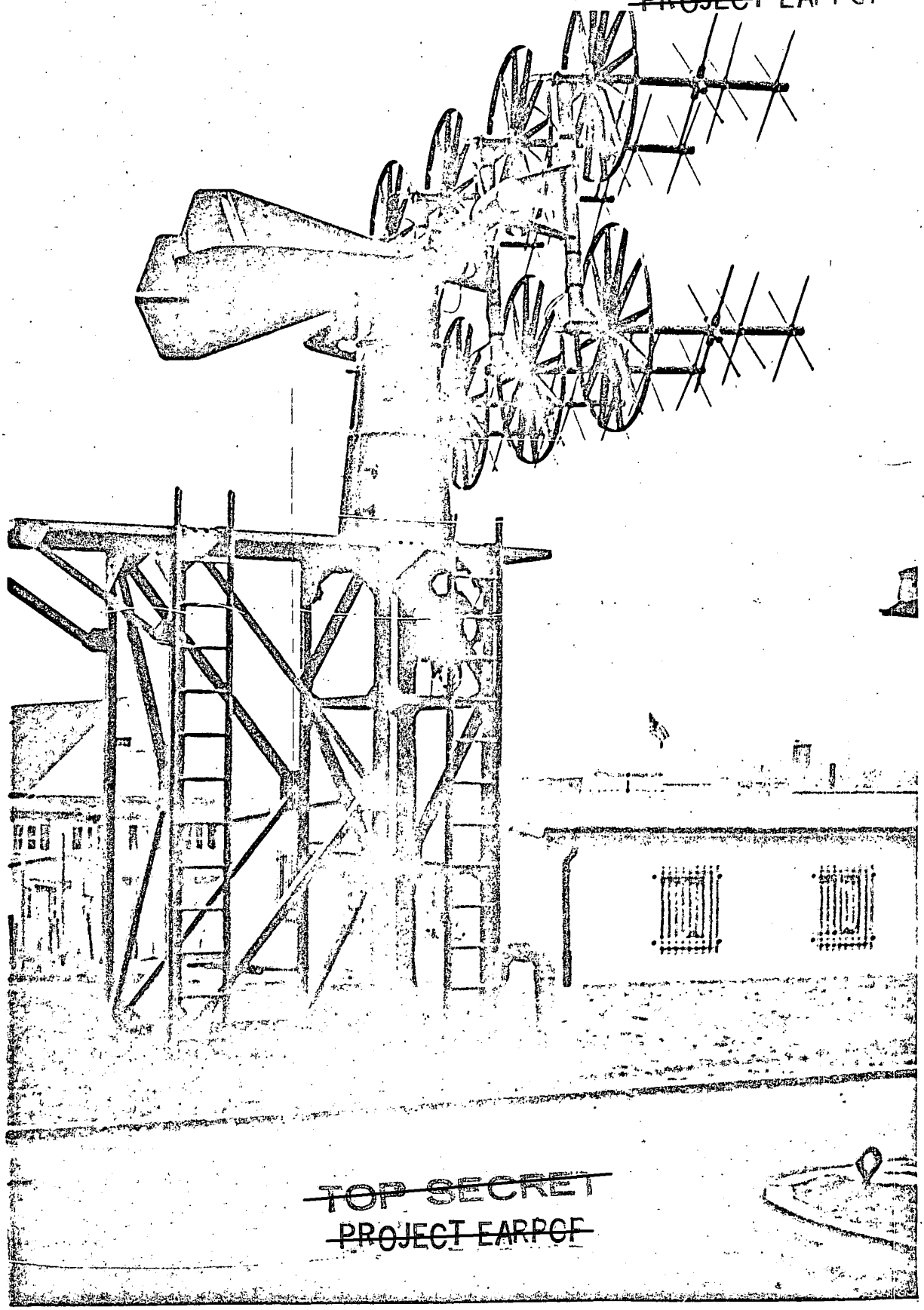

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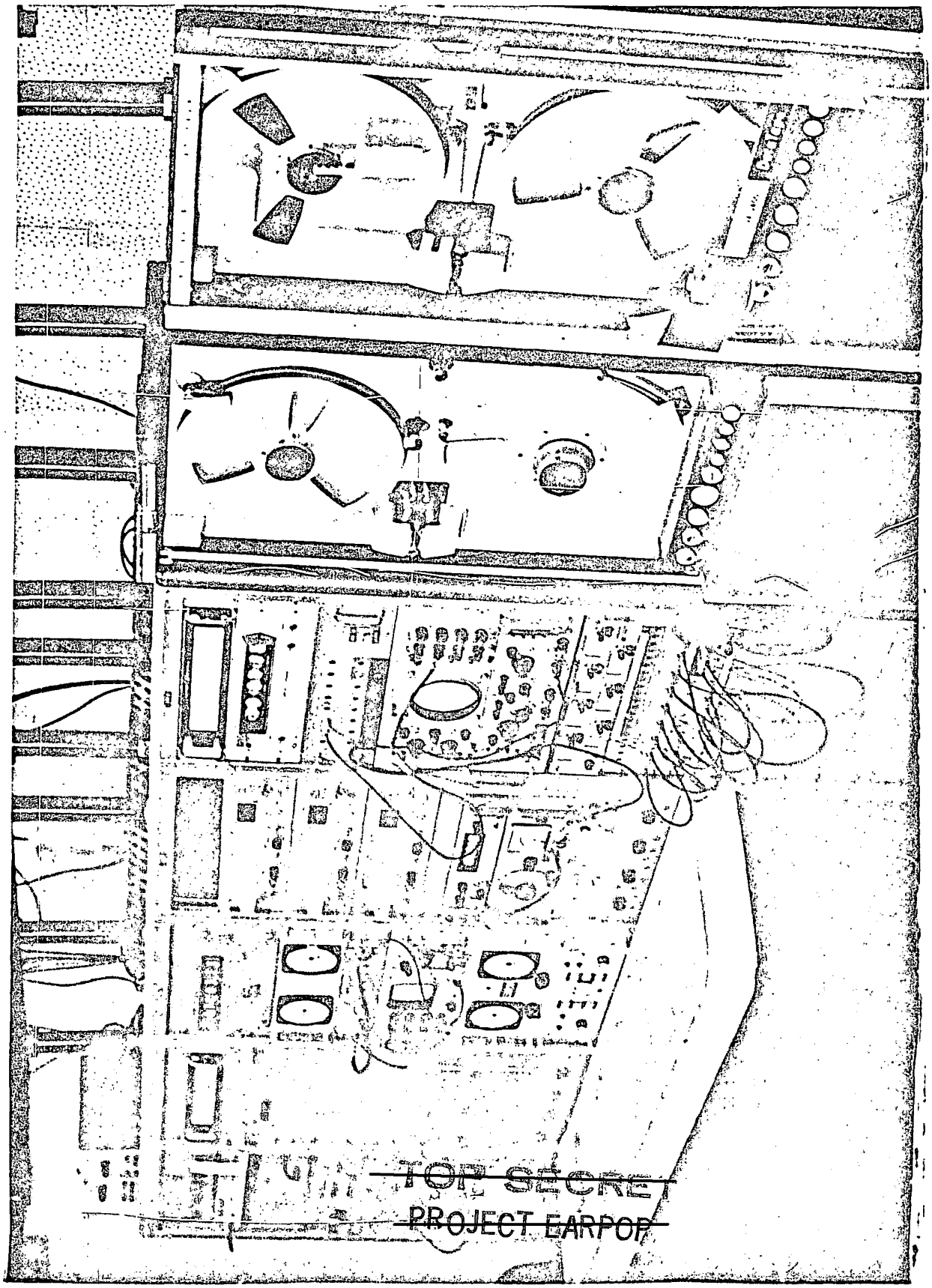
working properly. Each satellite has its unique address as [redacted] to interrogation.

5. Collection. Photographs of one of the collection positions and both receive antennas are provided on the following pages. There are two collection positions, one for each of the satellites [redacted] The collection operator tracks the satellites in azimuth and elevation by following a time/bearing log prepared for each pass and by monitoring the data on the receivers.

The data from both satellites is recorded on two analog tapes using VR-2800 recorders and on digital tape using an Ampex BTM-9 recorder and a Data Processing Unit. Output from a time code generator is written on one of the tracks of the analog tape. Bits are written on the digital tape to define the time of arrival of the leading edge of each incoming pulse.

In order to conserve tape the master digital tape is packed with as many tasked missions as it will hold. Generally, fourteen missions of two satellites each can be recorded on a single digital tape. However, one [redacted] mission on a 7105 Charlie and Delta orbit fills an entire recording, which is an illustration of the extreme density on Group [redacted] tasks.

Each satellite has two data transmitters operating on different frequencies. When the satellite is illuminated by energy above a certain threshold, a one-shot device is



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CONTROL SYSTEM

COLLECTION POSITION

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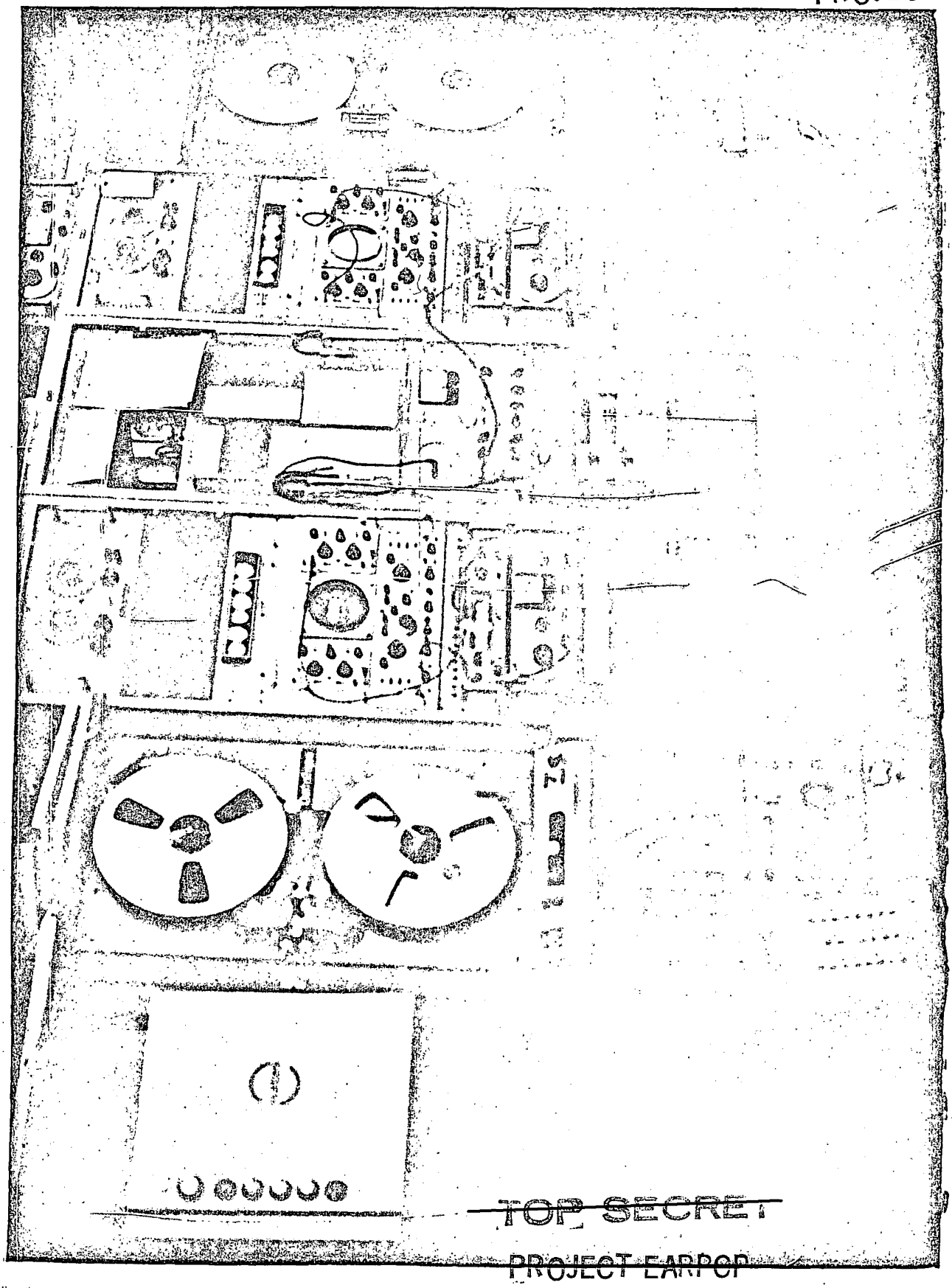
triggered to transpond a pulse of [redacted] on the appropriate transmitter. This [redacted] in each of the two data channels, identifies the frequency range of the data received. Therefore, [redacted] data links on each satellite can be activated without confusing the radio frequency source of the incoming pulses.

6. Analog Analysis. The primary analysis mission has been to search all recordings for the NSA-designated signals of interest and for unidentified signals suspected to be Soviet. Results are reported daily by message. The effort against Soviet shipborne radars has been on a not-to-interfere basis per NSGC message Cite G52C/807-67 141810Z AUG 67. There has been no technical feedback on shipborne radar reports and it is highly probable that many reported radars had parameters that also fit various military and commercial radars, friendly and threat. There has been some hesitancy to report on those radars which have parameters common to many radars.

A photograph of the two analog analysis positions is enclosed on the following page. The analyst's identification of a radar is based on three characteristics: (1) [redacted] intercepted, (2) pulse repetition frequency, and (3) the interval between successive bursts of pulses which



ANALOG ANALYSIS POSITION

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approximately equals the rotation rate of the radar's antenna [redacted]

To know what to look for in given data links, the analyst is provided with the parameter ranges for all radars of interest. The analyst uses a stop watch to time intervals between bursts and he has an oscillator to determine the pulse repetition frequency. Up and down times in GMT are provided by the time code translator from the output of the time track.

We have no synthesizer - hence, the analyst cannot control the tape speed by locking on the 50 kilocycle reference tone. Therefore, since his playback recorder speed may differ slightly from that of the collection recorder, his measurements are not always precise.

The analyst has one major problem: lacking any sort of filtering capability, he cannot confine his attention only to those pulse repetition frequencies of interest. Everything recorded on the channel, [redacted] appears on his oscilloscope and in his audio phones. In all data links, except 7105 Charlie data links [redacted] and 7105 Delta data link [redacted] the data is sparse enough for the analyst to handle. In these [redacted] the data is so dense that the analyst can identify only those emitters that

have unique scan characteristics. My message 181625Z DEC 68 gave an evaluation of the data links on the 7105 series satellites and made recommendations applicable to the 7106 Mission, for changes in sensitivities and/or radio frequency spreads in order to provide a greater yield in some bands and reduce the data in others.

The importance of the analog analyst to the ocean surveillance effort is that with current hardware and software capabilities, his analysis is the quickest method to determine whether or not Soviet shipborne radars were recorded on a pass. His shipborne radar tip-off with up and down times aids in the [redacted] of digital data in addition to informing the digital analyst that the pass is worth looking at. Cross training has resulted in additional remarks on the tip-off sheet which give the digital analyst a feel for how easy or difficult the processing will be.

7. Reformatting the Digital Data. The first step in digital processing is to read and copy the master digital tape, which is then forwarded to NSA. During the copying, the bits on the master tape are translated to octal numbers [redacted] times are given in microseconds from an arbitrary reference time which usually corresponds to the beginning of the pass. Program [redacted] which

was written by Mr. Daniels at HRB-Singer Corp., is used for this purpose. Each of the events are assigned fixed numbers to identify their data link source.

The reformatting takes from [redacted] minutes depending upon the length of the pass and the data density. Mr. Lybarger, contracted from HRB-Singer and representing NRL at this site, has started studying data flow to determine the feasibility of reformatting data simultaneous with recording of the master digital tape.

Either simultaneous reformatting, or a second digital recorder could provide a means to make shipborne radar locations more timely by eliminating the lapse between the orbit of interest and packing of the master digital tape, which is up to 11 hours. We do have a backup capability to record simultaneously using the Ampex TM-11 transports in conjunction with the computer. The disadvantage is that the

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COMPUTER DPU & BTM-9
CONFIGURATION

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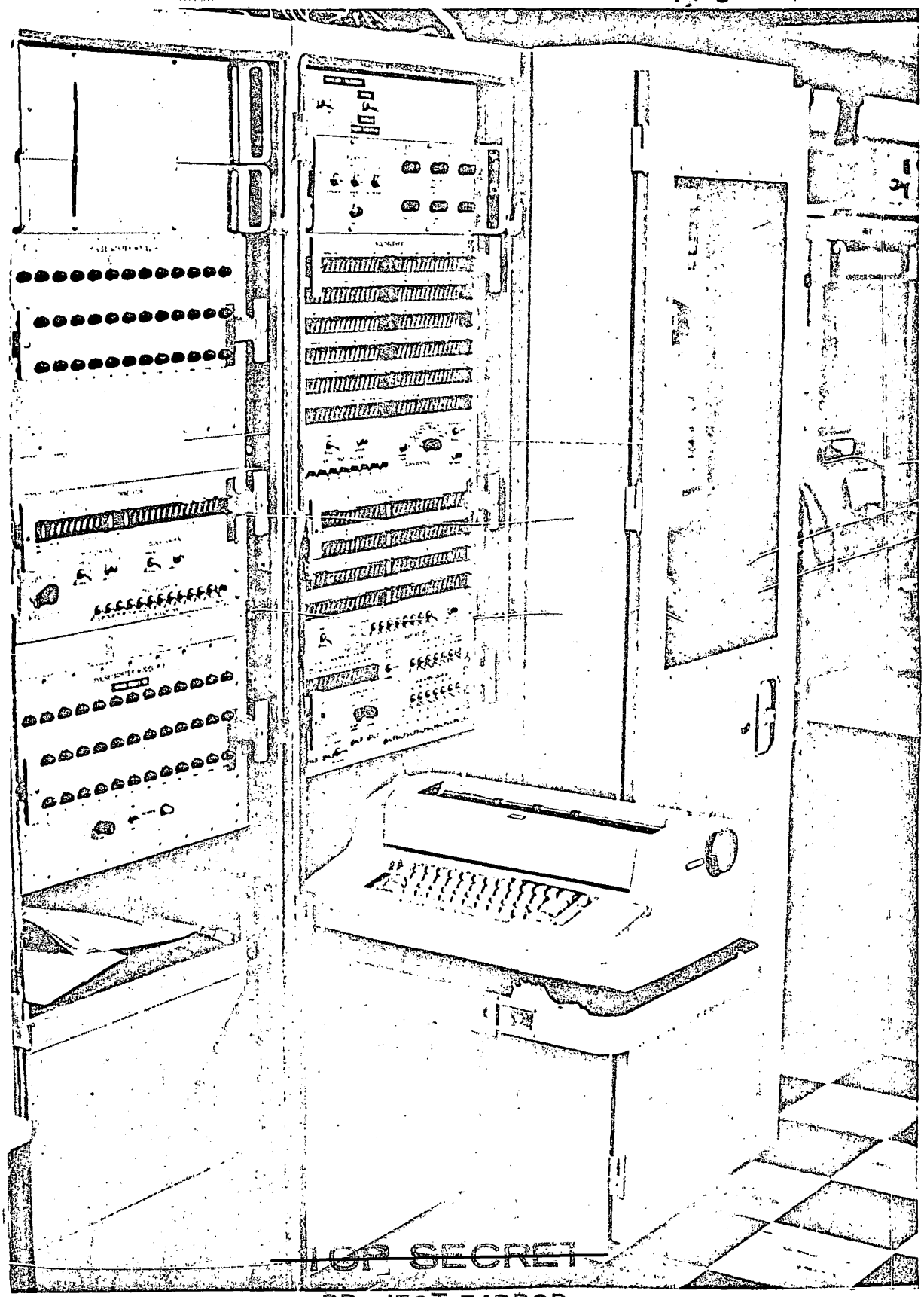

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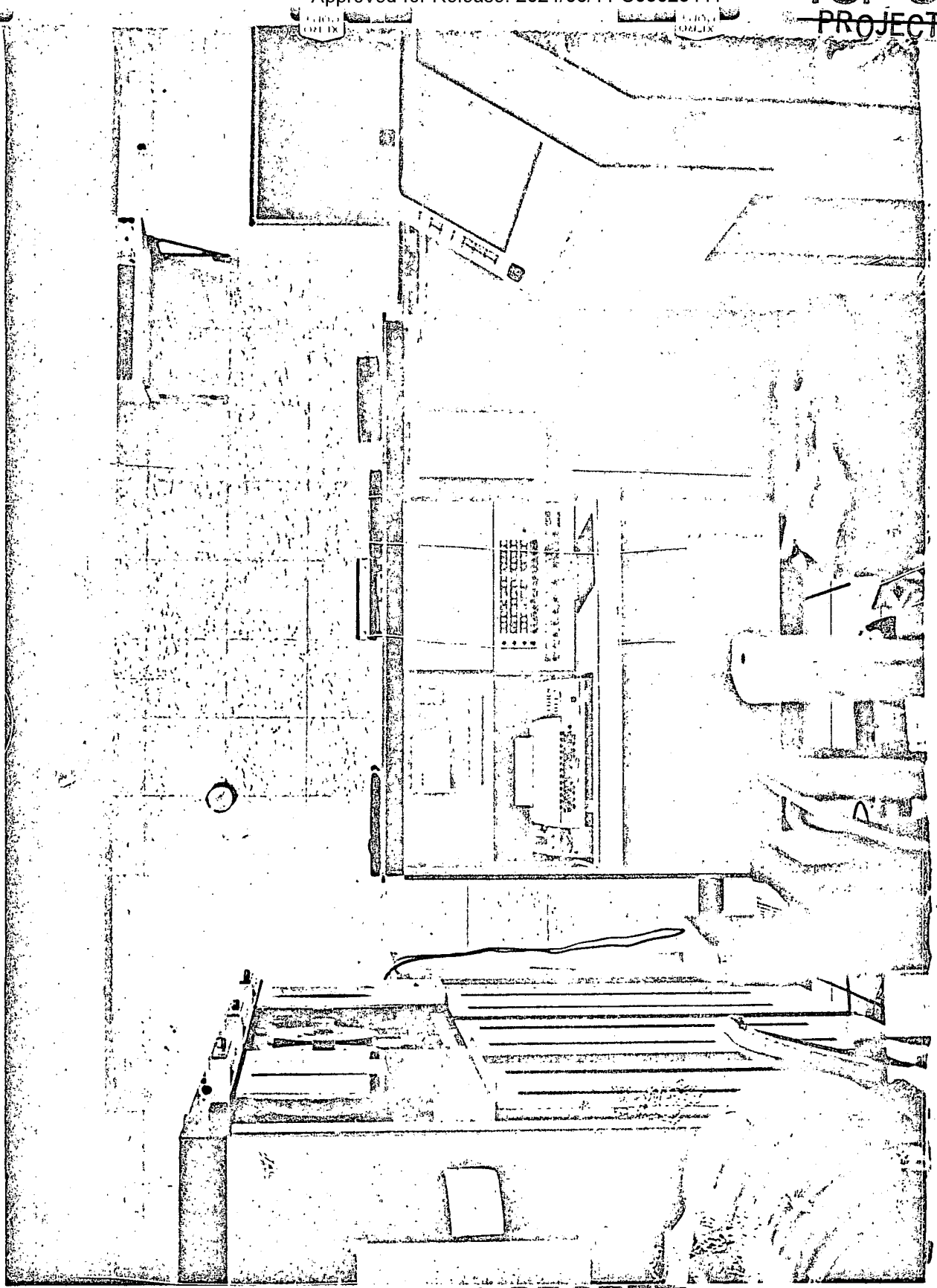

COMPUTER PROCESSING ~~TOP SECRET EARPOP~~
POSITION HANDLE VIA THE BYEMAN
(with input, output peripheral units) CONTROL SYSTEM

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