

## PHOTOGRAMMETRY AND ITS APPLICATION TO HYDROGRAPHIC SURVEYING

BY

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SINCE THE FOUNDING OF THE AMERICAN SOCIETY OF PHOTOGRAMMETRY IN 1934, THE HYDROGRAPHIC OFFICE OF THE UNITED STATES NAVY HAS TAKEN A DEEP INTEREST IN THE WORK OF THE SOCIETY, NOT ONLY ON ACCOUNT OF ITS DESIRE TO FOMENT A BETTER UNDERSTANDING OF THE MANY APPLICATIONS OF THIS SCIENCE, BUT ALSO BECAUSE THE HYDROGRAPHIC OFFICE PIONEERED IN THIS COUNTRY IN THE APPLICATION OF PHOTOGRAMMETRICAL METHODS TO HYDROGRAPHIC SURVEYS.

UNTIL 1924, THE SURVEYS WHICH WERE CONDUCTED UNDER THE DIRECTION OF THIS OFFICE HAD ALWAYS BEEN CARRIED OUT BY USE OF THE PLANE TABLE, TRANSIT, AND SEXTANT METHODS FOR DELINEATING THE SHORE LINE AND ADJACENT TOPOGRAPHY. THIS SYSTEM WAS SLOW AND INVOLVED MANY HARDSHIPS FOR THE PERSONNEL AS THE MAJORITY OF THE PROJECTS ARE CONDUCTED IN VIRGIN TERRITORY WHERE LANDINGS ARE DIFFICULT AND PERILOUS AND WHERE TRANSPORTATION OF SURVEYING AND CAMPING EQUIPMENT, WATER, AND SUPPLIES IS A MAJOR PROBLEM.

AT THAT TIME, THE NAVY WAS CONDUCTING A HYDROGRAPHIC SURVEY OF THE ISLAND OF CUBA. NO BETTER FIELD FOR EXPERIMENTATION COULD HAVE BEEN FOUND, AS THE THOUSANDS OF MANGROVE CAYS, OFFSHORE REEFS, AND THE INTRICATE SHORE LINE OF THIS "PEARL OF THE ANTILLES" PRESENTED ALL THE OBSTACLES THAT ONLY PHOTOGRAMMETRICAL METHODS COULD OVERCOME IN AN ECONOMICAL, EFFICIENT AND EXPEDITIOUS MANNER.

IN 1924, THE NAVY ORDERED AN AERIAL UNIT TO CUBAN WATERS WHICH CARRIED OUT ITS PHOTOGRAPHIC MISSION WITH SUCH ENCOURAGING RESULTS THAT SINCE THEN AERIAL PHOTOGRAPHY HAS BECOME AN INTEGRAL PART OF ALL NAVAL HYDROGRAPHIC SURVEYS.

DURING THE PAST THIRTEEN YEARS, THE VALUE OF THE AIRPLANE AND AERIAL CAMERA, IN THEIR RELATION TO HYDROGRAPHIC SURVEYING, HAS BECOME INCREASINGLY APPARENT.

YOU WHO ARE FAMILIAR WITH THE PART THAT PHOTOGRAMMETRY IS PLAYING IN CADASTRAL, GEOLOGIC, TOPOGRAPHIC AND ALL LAND UTILIZATION SURVEYS MAY NOT FULLY VISUALIZE ITS USEFULNESS TO THE HYDROGRAPHIC SURVEYOR.

PHOTOGRAMMETRY NOT ONLY AIDS IN THE ESTABLISHMENT OF THE SHORE LINE AND ADJACENT TOPOGRAPHY BUT IT IS MATERIAL ASSISTANCE IN THE DEVELOPMENT OF HYDROGRAPHY, IN THAT IT PERMITS THE CORRECT DELINEATION OF REEFS AND SHOAL AREAS AND FREQUENTLY EXPOSES SUBMERGED DANGERS WHICH THE CAMERA IS ABLE TO RECORD UNDER FAVORABLE CONDITIONS OF LIGHT AND SEA.

IN ORDER TO GIVE A COMPLETE INTERPRETATION OF THE APPLICATION OF PHOTOGRAMMETRY TO MODERN HYDROGRAPHIC OPERATIONS, WE SHALL DESCRIBE IN DETAIL THE METHODS AND PRACTICES OF THE HYDROGRAPHIC OFFICE IN CARRYING OUT ITS SURVEYS.

SINCE ITS ESTABLISHMENT BY ACT OF CONGRESS, IN THE YEAR 1830, THE HYDROGRAPHIC OFFICE HAS, AS PART OF ITS PROGRAM OF PREPARING, PUBLISHING AND FURNISHING NAUTICAL CHARTS, SAILING DIRECTIONS, AND LIGHT LISTS FOR THE SAFE NAVIGATION OF ALL THE SEAS BY THE VESSELS OF THE NAVY AND MERCHANT MARINE, CONDUCTED EXTENSIVE HYDROGRAPHIC SURVEYS NOT ONLY IN THE AMERICAS, INCLUDING THE ANTILLES, BUT ALSO IN THE ARCTIC OCEAN AND BERING SEA, SIBERIA, JAPAN, CHINA, AND THROUGHOUT MANY OF THE ISLANDS AND GROUPS OF ISLANDS OF THE PACIFIC OCEAN.

IN THE PAST FEW YEARS, THE MAJOR PART OF THE SURVEYING ACTIVITIES OF THE HYDROGRAPHIC OFFICE HAS BEEN CENTERED IN THE APPROACHES TO THE PANAMA CANAL WHICH, DUE TO ITS IMPORTANCE AS THE MAIN ARTERY IN INTEROCEANIC TRADE, NECESSITATES MODERN SURVEYS FROM WHICH TO CONSTRUCT COMPLETE AND UP-TO-DATE NAVIGATIONAL CHARTS.

IN ALL THIS WORK, THE AIRPLANE AND AERIAL CAMERA HAVE PLAYED A VERY IMPORTANT PART.

THE FOLLOWING PROCEDURE IS OUTLINED FOR THE PROSECUTION OF SURVEYS CONDUCTED BY THE HYDROGRAPHIC OFFICE.

AFTER AN AREA HAS BEEN ASSIGNED FOR DEVELOPMENT, A THOROUGH STUDY OF THE

AERIAL PROJECT IS MADE TO DETERMINE WHICH TYPE OF CAMERA IS MOST SUITABLE FOR THE WORK, AND THE MOST DESIRABLE SCALES FOR PHOTOGRAPHS OF THE GENERAL COASTLINE, HARBORS, ANCHORAGES AND OTHER DETAILED DEVELOPMENTS. ALL AVAILABLE INFORMATION REGARDING WEATHER CONDITIONS IS CAREFULLY ANALYZED BY THE BUREAU OF AERONAUTICS IN ORDER THAT THE WORK MAY BE EXPEDITED DURING THE PERIODS OF BEST VISIBILITY. EXISTING CHARTS AND MAPS OF THE AREA UNDER CONSIDERATION ARE STUDIED IN ORDER TO DETERMINE THE MOST SUITABLE BASE OF OPERATIONS, WHICH, IN THE MAJORITY OF CASES, MUST BE A PROTECTED ANCHORAGE AS LANDING FIELDS ARE USUALLY TOO DISTANT FOR CONSIDERATION OR ARE NON-EXISTENT.

AFTER THIS PRELIMINARY STUDY IS MADE, THE SPECIFICATIONS ARE PREPARED WITH THE SAME GENERAL REQUIREMENTS AS THOSE FORMULATED BY THE AMERICAN SOCIETY OF PHOTOGRAMMETRY, ALTHOUGH IN THE CASE OF THE HYDROGRAPHIC OFFICE, THE FLYING AND PHOTOGRAPHY COME UNDER THE JURISDICTION OF THE BUREAU OF AERONAUTICS OF THE UNITED STATES NAVY.

EXCELLENT RESULTS HAVE BEEN OBTAINED THROUGH THE COOPERATION OF THE BUREAU OF AERONAUTICS, THE NAVY FLIERS AND THEIR AERIAL PHOTOGRAPHERS. WITHOUT THEIR KNOWLEDGE OF AERIAL PHOTOGRAPHY AND THE DESIRE OF THE CHIEF OF BUREAU AND HIS STAFF TO KEEP ABREAST OF DEVELOPMENTS, NOT ONLY IN EQUIPMENT BUT ALSO IN TECHNIQUE, OUR SUCCESS IN APPLYING PHOTOGRAMMETRY TO HYDROGRAPHIC SURVEYS WOULD NOT BE AS FAR ADVANCED AS IT IS TODAY.

UPON COMPLETION OF THE AERIAL SURVEY, THE RESULTS ARE CHECKED IN THE FIELD TO INSURE AGAINST GAPS, LACK OF SUFFICIENT OVERLAP, CLOUDED AREAS, ETC. AFTER WHICH THE DATA ARE THEN FORWARDED TO THE HYDROGRAPHIC OFFICE, SECTION OF NAVAL SURVEYS, WHERE PRELIMINARY SHEETS, RADIALLY CONTROLLED, ARE PREPARED FOR A GENERAL STUDY OF THE AREA.

THERE ARE TWO QUESTIONS THAT MAY WELL BE ASKED: WHAT IS THIS GENERAL STUDY? AND WHAT BEARING HAS AERIAL PHOTOGRAPHY ON EXPEDITING THE HYDROGRAPHIC WORK?

ANY SURVEY, IN ORDER TO BE ECONOMICAL, ACCURATE, AND EXPEDITIOUS, REQUIRES A CAREFUL AND COMPLETE RECONNAISSANCE. WITHOUT A THOROUGH KNOWLEDGE OF THE TERRAIN TO BE SURVEYED, ACQUIRED IN ADVANCE OF ACTUAL OPERATIONS, NO PROJECT CAN BE CARRIED OUT EFFICIENTLY.

PRIOR TO THE USE OF THE AIRPLANE AND THE CAMERA AS AN INTEGRAL PART OF MARINE SURVEYS, A GREAT DEAL OF TIME WAS CONSUMED CARRYING OUT A RECONNAISSANCE. IT SHOULD BE REMEMBERED THAT, IN PRACTICALLY ALL THE PROJECTED SURVEY AREAS, THE EXISTING CHARTS, IF ANY, ARE INADEQUATE IN HYDROGRAPHY AND TOPOGRAPHY AND THAT SHOWN IS USUALLY IN ERROR. THE BEST TRANSPORTATION FOR RECONNAISSANCE IS NECESSARILY SLOW AND NATURALLY MUST BE ACCOMPLISHED WITH CAUTION IN UNCHARTED WATERS. THE ADVENT OF AERIAL PHOTOGRAPHS HAS SPEEDED UP THIS PHASE OF THE SURVEY TO A POINT WHERE THE TIME NOW REQUIRED IS ALMOST NEGLIGIBLE SINCE A COMPREHENSIVE PLAN CAN BE FORMULATED PRIOR TO ARRIVAL AT THE SURVEY AREA.

THEREFORE, AS OUR ANSWER TO THE TWO QUESTIONS "WHAT IS THIS GENERAL STUDY THAT IS CONDUCTED AFTER THE AERIAL PHOTOGRAPHIC FLIGHTS HAVE BEEN COMPLETED AND ITS BEARING ON THE SUCCESS OF MODERN HYDROGRAPHIC SURVEYING" WE WILL SAY: THE PRELIMINARY PLOT AND ALL THE PHOTOGRAPHS ARE STUDIED AND SCRUTINIZED TO DETERMINE LOGICAL AND ADEQUATE SITES FOR MAIN AND SECONDARY TRIANGULATION STATIONS AND FOR HYDROGRAPHIC SIGNALS. FROM A STEREOSCOPIC EXAMINATION OF THE PHOTOGRAPHS, WE CAN DETERMINE BEFOREHAND THE TYPE AND HEIGHT OF SIGNALS REQUIRED. WITH SEA LEVEL FOR A DATUM, AND WITH THE FACTORS OF FOCAL LENGTH AND APPROXIMATE HEIGHT OF THE AIRPLANE AT THE INSTANT OF EXPOSURE, CALCULATIONS ARE MADE, PROVIDED TILT IS WITHIN THE LIMITS SPECIFIED, WHICH ARE ACCURATE ENOUGH TO DETERMINE THE ELEVATIONS OF THOSE SITES TENTATIVELY SELECTED AND THEIR INTERVISIBILITY WITH OTHER STATIONS IN THE TRIANGULATION NET.

WE CAN DETERMINE LONG BEFORE THE EXPEDITION LEAVES ITS HOME PORT ALL THE DIFFICULTIES THAT MAY BE EXPECTED WITH RESPECT TO LANDINGS ON EXPOSED SHORES AND THE LOGICAL POINTS AT WHICH TO LAND EQUIPMENT AND PERSONNEL WITH A MINIMUM OF DANGER. WE CAN SELECT THE PROPER APPROACH TO A HILL OR A SCARPED CLIFF AND INSURE AGAINST WASTEFUL DELAYS. WE CAN PLOT THE COURSE THE BOATS SHOULD FOLLOW THROUGH TORTUOUS AND DANGEROUS REEFS INSTEAD OF RELYING JUST ON LUCK AND SEAMANSHIP.

THE TYPE OF SHORE LINE, ITS CULTURE AND GENERAL CHARACTERISTICS ARE PAL-

PABLE TO THE OBSERVER OF THE AERIAL PHOTOGRAPHS THUS AIDING HIM IN PLANNING THE CONDUCT OF A SURVEY WHILE THOUSANDS OF MILES AWAY FROM THE SCENE OF ACTION.

SO FAR IN OUR DISCUSSION, WE HAVE NOT MENTIONED THE INNUMERABLE ADVANTAGES THAT THE HYDROGRAPHIC PARTIES CONDUCTING THE SOUNDING OPERATIONS WILL RECEIVE BY HAVING THE RESULTS OF THE AERIAL SURVEY AVAILABLE TO THEM. WHEN A NAVAL SURVEY EXPEDITION STARTS THE HYDROGRAPHIC WORK, THE BOAT OFFICER HAS MORE THAN A MERE PROJECTION ON WHICH THE SIGNALS HAVE BEEN PLOTTED. HE HAS, BY THE APPLICATION OF PHOTOGRAMMETRY TO HYDROGRAPHIC SURVEYS, A SHEET ON WHICH NOT ONLY THE SIGNALS, BUT THE SHORE LINE AND OFFSHORE REEFS AS WELL HAVE ALREADY BEEN DELINEATED. FULL ADVANTAGE CAN BE TAKEN OF ALL NATURAL OBJECTS AS THE CAMERA HAS BROUGHT THEM TO THE ATTENTION OF THE ENGINEER AND HE HAS MADE A SPECIAL EFFORT TO ACCURATELY LOCATE THEIR POSITIONS.

DISCREPANCIES ARE BROUGHT TO LIGHT AT A TIME WHEN THEY CAN BE INVESTIGATED AND CORRECTED, INSTEAD OF WAITING FOR THE SMOOTH PLOTTING FAR AWAY FROM THE SCENE OF THE SURVEY, WHEN, NO MATTER WHAT IS DONE, A DISCREPANCY BETWEEN THE HYDROGRAPHIC AND THE TOPOGRAPHIC SHEETS ALWAYS LEAVES A CERTAIN AMOUNT OF DOUBT.

IT MAY ALSO BE ASKED: "HOW ARE THE AERIAL PHOTOGRAPHS CONTROLLED?" IN HYDROGRAPHIC SURVEYS, SIGNALS ARE SPACED AT CLOSE INTERVALS IN ORDER TO PERMIT THE FIXING OF THE SHIP OR BOAT'S POSITION AT ALL TIMES, WHICH WHILE WITHIN THE RANGE OF VISIBILITY OF SHORE SIGNALS IS DETERMINED BY OBSERVING SIMULTANEOUS ANGLES WITH SEXTANTS TO THREE OR MORE LOCATED STATIONS.

THEREFORE, AT INTERVALS OF FROM TWO TO THREE MILES ON THE OPEN COAST, AND IN THE CASE OF HARBOR SURVEYS STILL CLOSER, SIGNALS ARE LOCATED AND SPOTTED IN THE CORRESPONDING PHOTOGRAPHS. FOR SPOTTING THEM EITHER ADDITIONAL PHOTOGRAPHS (VERTICAL OR OBLIQUE) ARE TAKEN AFTER THE SIGNALS HAVE BEEN BUILT, OR THEY ARE LOCATED FROM ACTUAL MEASUREMENTS FROM IDENTIFIABLE OBJECTS, NEAR THE STATION, ALREADY APPEARING ON THE PHOTOGRAPHS.

THE FACT THAT AERIAL PHOTOGRAPHS ARE AVAILABLE OF THE AREA BEING SURVEYED DOES NOT MEAN THAT A THOROUGH AND COMPREHENSIVE GROUND STUDY OF THE COAST LINE, OUTLYING DANGERS, AND TOPOGRAPHY IS NOT REQUIRED.

HIGH ALTITUDE PHOTOGRAPHS, AND PARTICULARLY THE FIVE LENS TYPE, MAKE IT ESSENTIAL THAT IN ORDER TO PROPERLY AND FULLY INTERPRET THE CULTURE OF THE TERRAIN, AND INSURE THAT NO DANGERS HAVE BEEN MISSED, AN INTERCOMPARISON BETWEEN THE PHOTOGRAPHS AND THE GROUND BE MADE IN CONNECTION WITH THE DETERMINATION OF THE HORIZONTAL AND VERTICAL CONTROL. PROPER NOTATIONS ARE MADE ON THE PHOTOGRAPHS AT THE TIME THIS PARTICULAR WORK IS CONDUCTED. CLIFFS, BLUFFS, SANDY SHORES, CONSPICUOUS NATURAL OBJECTS, OUTLYING REEFS AND THEIR HEIGHTS ABOVE THE DATUM, HEIGHTS OF ROCKS, HILLS, ARE ALL FACTORS THAT ENTER INTO THE CONSTRUCTION OF A HYDROGRAPHIC CHART AND ARE, THEREFORE, GIVEN FULL CONSIDERATION WHEN CONDUCTING THE GROUND STUDY.

OUR AERIAL SURVEYS ARE CONDUCTED EITHER WITH K-3B CAMERAS OF  $8\frac{1}{4}$  OR 12 INCH FOCAL LENGTH OR WITH FAIRCHILD T-3A (FIVE LENS) CAMERAS OF APPROXIMATELY 6 INCH FOCAL LENGTH. ALL THESE CAMERAS ARE INSTRUMENTS OF PRECISION AND EACH ONE POSSESSES CERTAIN ADVANTAGES OVER THE OTHERS WHICH ARE INFLUENCING FACTORS IN DECIDING THE TYPE TO BE USED FOR EACH PARTICULAR PROJECT.

IF THE FACTOR OF DEFINITION IS THE CONTROLLING ONE, THE K-3B CAMERA WITH A 12 INCH FOCAL LENGTH WILL GIVE THE RESULTS DESIRED. FOR EXTENSIVE PROJECTS, AND ESPECIALLY WHERE THE COAST LINE IS TORTUOUS AND WHERE THERE ARE OFF-LYING ISLANDS OR REEFS, THE T-3A CAMERA PERMITS GREATER AND BETTER CONTROLLED COVERAGE IN A MINIMUM OF FLYING HOURS. THE RESULTING PHOTOGRAPHS ARE OF MATERIAL AID IN SELECTING THE MOST ADVANTAGEOUS LOCATIONS FOR THE INLAND TRIANGULATION STATIONS.

THE MULTIPLE LENS CAMERA, ALTHOUGH REQUIRING RECTIFICATION OF WING PRINTS AND MOUNTING OF THE PHOTOGRAPHS, HAS PROVEN OF MATERIAL AID IN OUR WORK. HOWEVER, WHEN THE AERIAL WORK CANNOT BE CONDUCTED WELL IN ADVANCE OF HYDROGRAPHIC OPERATIONS, AND THERE IS URGENCY FOR THE SURVEY, SINGLE LENS PHOTOGRAPHY WILL BE MORE EXPEDIENT AS THE PRINTS CAN BE MADE AVAILABLE WITHIN 24 HOURS OF THE COMPLETION OF THE FLYING.

WE ARE NOT READY TO STATE, AS YET, WHICH CAMERA WILL FULFILL ALL REQUIREMENTS FOR AERIAL SURVEYS IN CONNECTION WITH HYDROGRAPHIC OPERATIONS. ALTHOUGH

THE WIDE ANGLE LENS CAMERA SHOWS A GREAT DEAL OF PROMISE, NO COMPARISONS CAN BE MADE AT THIS TIME WITH OUR STANDARD EQUIPMENT UNTIL A CAMERA OF THAT TYPE HAS BEEN GIVEN RIGID TESTS IN THE TYPE OF WORK REQUIRED IN HYDROGRAPHIC SURVEYS.

WE MUST NOT OVERLOOK OBLIQUE PHOTOGRAPHY AND ITS MANY ADVANTAGES NOT ONLY IN RECONNAISSANCE SURVEYS BUT IN OBTAINING TOPOGRAPHIC DETAIL BEYOND THE LIMITS OF THE VERTICAL PHOTOGRAPHS. THE MILLER METHOD CAN AND SHOULD BE GIVEN WIDER USE.

GREAT PROGRESS IS BEING MADE IN BETTERING CAMERA EQUIPMENT, SO THE FUTURE WILL DECIDE THE TYPE WHICH WILL EVENTUALLY BE ADOPTED FOR ALL HYDROGRAPHIC WORK.

OUR ENTHUSIASM, OUR ENDORSEMENT OF PHOTOGRAMMETRICAL METHODS AS AN AID IN HYDROGRAPHIC SURVEYS ARE FULLY JUSTIFIED BY THE RESULTS WE HAVE OBTAINED SO FAR. WE FEEL CONFIDENT THAT ANY CHARTING ORGANIZATION, NOT ALREADY UTILIZING THE AIRPLANE AND THE CAMERA FOR THEIR HYDROGRAPHIC WORK, WILL FIND THAT THE APPLICATION OF PHOTOGRAMMETRY TO THEIR SURVEYS WILL PERMIT A MORE DETAILED DELINEATION OF THE TOPOGRAPHIC FEATURES AND, IN ADDITION, EXPEDITE THE COMPLETION OF A PROJECT IN A MORE EFFICIENT AND ECONOMICAL MANNER.

### APPLICATION OF PHOTOGRAMMETRY TO HYDROGRAPHIC CHARTS

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I WOULD LIKE TO FIRST POINT OUT THAT, IN THE COMPILATION OF TOPOGRAPHY FOR HYDROGRAPHIC CHARTS, WE ARE PRIMARILY INTERESTED IN THE CORRECT DELINEATION OF THE SHORE LINE AND THE EXACT POSITION OF ALL OUT-LYING ISLANDS AND ROCKS, SUBMERGED OR OTHERWISE. OUR SECOND INTEREST, OF COURSE, IS IN THE AIDS TO NAVIGATION SUCH AS CHURCH SPIRES, WATER TANKS, HIGH CHIMNEYS, LIGHTHOUSES, PROMINENT PEAKS, AND ALL FEATURES THAT WILL ASSIST THE NAVIGATOR IN DETERMINING HIS POSITION. THESE FEATURES ARE USUALLY CUT IN AND ESTABLISHED BY THE FIELD PARTY; THIRD, THE PLANIMETRIC DETAIL ADJACENT TO THE SHORE LINE.

OUR PHOTOGRAPHS ARE TAKEN AT SCALES RANGING FROM 1:7,000 TO 1:30,000 WITH A K-3B SINGLE LENS 7x9 CAMERA OR A FAIRCHILD T-3A FIVE LENS CAMERA. AS A GENERAL RULE, SINGLE LENS PHOTOGRAPHS ARE TAKEN WHERE THERE IS TO BE A CLOSE DEVELOPMENT OF THE HYDROGRAPHY, AND FIVE LENS PHOTOGRAPHS OF AREAS FOR GENERAL DEVELOPMENT. THESE ARE TAKEN, WHENEVER POSSIBLE, IN ADVANCE OF THE SURVEY.

GETTING SUFFICIENT GROUND CONTROL ACCURATELY SPOTTED ON THE PHOTOGRAPHS BECOMES QUITE A PROBLEM AT TIMES, AS MOST OF OUR SURVEYS ARE MADE IN WHAT MIGHT BE TERMED VIRGIN TERRITORY. THEREFORE, WE DO NOT HAVE THE NUMEROUS MAN-MADE FEATURES SUCH AS ROAD-INTERSECTIONS, FENCE CORNERS, HOUSES, BARNs, ETC., TO USE AS CONTROL POINTS EXCEPT ON RARE OCCASIONS. EVEN THOUGH WE ARE WORKING IN AREAS THAT HAVE SOME OR ALL THESE FEATURES, THEY GENERALLY LIE SO FAR BACK FROM THE SHORE LINE THAT THE LIMITED PERSONNEL AND TIME DO NOT PERMIT THEIR ACCURATE LOCATION. IT IS, THEREFORE, NECESSARY TO USE NATURAL FEATURES AND THE SIGNALS ESTABLISHED BY THE FIELD PARTY. SUFFICIENT NATURAL FEATURES ALONG THE SHORE LINE ARE SOMETIMES DIFFICULT TO FIND, AND THE SPOTTING ON THE PHOTOGRAPHS OF THE EXACT LOCATION OF THE SIGNALS IS, AT TIMES, EXTREMELY DIFFICULT.

THE HYDROGRAPHIC OFFICE DOES NOT BELIEVE IT PRACTICABLE TO LAY DOWN A SPECIFIC RULE FOR SPOTTING THE SIGNALS ON THE PHOTOGRAPHS THAT WOULD MEET ALL CONDITIONS. IT IS LEFT TO THE DISCRETION OF THE SENIOR HYDROGRAPHIC ENGINEER OF THE SURVEY EXPEDITION TO SEE THAT SUFFICIENT INFORMATION IS OBTAINED TO ACCURATELY TIE THE PHOTOGRAPHS TO THE GROUND CONTROL BEFORE LEAVING THE SURVEY AREA. (FIGURE 1.)

A METHOD OF IDENTIFYING THESE SIGNALS, USED ON NAVAL SURVEYS WHERE CONDITIONS PERMIT, THAT MIGHT BE OF INTEREST TO THE SOCIETY, IS THE USE OF LOW ALTITUDE, NEARLY VERTICAL PHOTOGRAPHS OF ALL SIGNALS. THIS NOT ONLY ASSURES AN ACCURATE SPOTTING OF AT LEAST 75% OF ALL SIGNALS ON THE SMALL SCALE MAPPING