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SPECIFICATION FOR

AERIAL SURVEY PHOTOGRAPHY

1973

Interdepartmental Committee

on Air Surveys

CANADA

I.C.A.S.

SPECIFICATION FOR AERIAL SURVEY PHOTOGRAPHY

1973

Additional copies can be obtained from the Canada Map Centre, Department of Energy, Mines and Resources, 615 Booth Street, Ottawa at $1.50 each.

SPECIFICATION FOR

AERIAL SURVEY PHOTOGRAPHY

1973

Copies of "Specification for Aerial Survey Photography" in English or French are obtainable from:

Secretary,
Interdepartmental Committee on Air Survey,
Surveys and Mapping Branch,
Department of Energy, Mines and Resources,
615 Booth Street,
Ottawa, Ontario,
Canada. K1A 0E9

Des exemplaires des "Spécifications pour les travaux de photographie aérienne", en français ou en anglais, sont disponibles en communicant avec:

Secrétaire,
Comité interministériel des levés aériens,
Direction des levés et de la cartographie,
Ministère de l'énergie, des mines et des ressources,
615, rue Booth,
Ottawa, Ontario,
Canada. K1A 0E9

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SPECIFICATION FOR AERIAL PHOTOGRAPHY
1973

INTERDEPARTMENTAL COMMITTEE ON AIR SURVEYS
CANADA

INTRODUCTION

These specifications define the standards which are to apply to all vertical aerial survey photography taken for the Federal Government of Canada, or photography taken by other agencies which is to be stored by, and become a part of, the National Air Photo Library of Canada.

The specifications are based on the Specifications for Air Survey Photography, 1967 (amended to January 1970) which have been further amended and rearranged into four parts:

Part 1 Equipment and Calibration

Part 2 Flight Standards

Part 3 Photographic Processing and Documentation

Part 4 Job Specification

Mandatory requirements of this specification are indicated by the word "shall". In addition, certain desirable and practicable procedures and tolerances are described which would increase the efficiency or accuracy of photogrammetric operations. These items are designated by inclusion of the words "desirable" or "should".

Throughout this Specification references are made to standards established by the Canadian Standards Association (C.S.A.) and the American National Standards Institute (ANSI), formerly A.S.A. Copies of the standards referred to may be purchased from the Canadian Standards Association, 178 Rexdale Blvd., Rexdale 603, Ontario, M9W 1R3 (Phone 416-244-2551)

Parts 1, 2, 3 and an example of Part 4 are contained in this publication.

A specific contract for aerial survey will have its individual Part 4. It will also be governed by contract conditions which define the responsibilities of the Contractor, the terms of payment and other administrative

matters. A sample of these contract conditions will be found in the Appendix to the Specifications.

Copies of this Specification and the forms referred to in it may be obtained by writing to the Secretary, Interdepartmental Committee on Air Survey, Surveys and Mapping Branch, Department of Energy, Mines and Resources, 615 Booth Street, Ottawa, Ontario K1A 0E9, Canada.

PART 1
EQUIPMENT AND CALIBRATION

1. EQUIPMENT AND CALIBRATION

1.1 GENERAL

All equipment shall be in sound mechanical condition. Drive motors, overlap regulators, warning lights, and pumps for the camera shall be operating to the design specifications of the manufacturer(s). The camera shall be clean, free of rust and corrosion and the optical parts be clean and free of any scratches or chips which might impair optical performance.

An operational test of the camera system may be requested by the I.C.A.S. prior to starting a contract. Such a test would normally consist of at least 20 consecutive exposures, having approximately 60% forward overlap, taken over an approved area at a specified altitude.

For the purpose of these specifications aerial cameras are divided into two types: Photogrammetric Cameras

Non-photogrammetric Cameras

All mapping photography shall be taken with cameras meeting the specifications for photogrammetric cameras (see section 1.2). Cameras, other than photogrammetric cameras, may be used for specialized photography. If the use of such a camera is permitted or specified by Part 4 (JOB SPECIFICATION) of the contract then the camera must meet the specifications for non-photogrammetric cameras (see section 1.3).

1.2 PHOTOGRAMMETRIC CAMERAS

Photogrammetric cameras shall have the properties and meet the tolerances described in this section.

1.2.1 CERTIFICATION

Cameras and camera magazines shall be calibrated at the laboratories of the National Research Council prior to use and once a year thereafter. A charge is made for these services by the

National Research Council. Re-calibration will be required if an existing test report is invalidated (see section 1.2.3.10).

Tolerances have been set on the metric precision of cameras in the following sections such that those meeting all the closest tolerances will be classified CATEGORY A. Those cameras not complying fully with all Category A standards, but meeting all Category B standards will be classified CATEGORY B.

The testing methods used shall be in general accord with the "Recommended Procedures for Calibrating Photogrammetric Cameras and Related Optical Tests" of the International Society of Photogrammetry, Commission I. The routine test shall include a check of focus, a calibration, a measurement of shutter speeds, a test of image illumination and a filter deviation test.

The National Research Council shall have the right to refuse to undertake such work if it is considered that the article is in any way unsatisfactory for the purpose intended.

1.2.2 CAMERA PROPERTIES

1.2.2.1 Optical Unit: There shall be a rigid mechanical structure which holds the lens, fiducial marks, and the parts which define the focal plane. The construction shall maintain the dimensional relationships of these components without permanent change under normal conditions of transportation, handling, and use, which may include considerable mechanical and thermal shocks. The mechanical structure holding these components shall be supported in use in such a manner that strains cannot be transmitted to it from the supporting body or mount; i.e., the support shall be of kinematic design.

1.2.2.2 Calibrated Focal Length: Standard wide-angle cameras shall have a calibrated focal length between 151.00 and 155.00mm.

Super-wide-angle cameras shall have a calibrated focal length between 85.0mm and 90.0mm.

1.2.2.3 Stray Light Control: All lens surfaces shall have anti-reflection coatings. Filter surfaces should have anti-reflection coatings. The interior of the optical unit shall have a flat black finish and shall be fitted with baffles or shall be of such a shape as to minimize the reflection of light from the inside of the camera on to the film (see section 1.2.3.5).

If a filter with graded transmission is used, the side with the higher reflectivity shall be mounted toward the camera lens. (For present filters, this means that the side with the anti-vignetting coating shall be toward the camera lens.)

1.2.2.4 Picture Size: The format shall be 230mm x 230mm with a tolerance of + 2mm - 5mm on each dimension. Fiducial marks or other recording devices situated within the corners of the format shall not reduce the semi-field angle to less than 42.6° in the case of standard wide-angle cameras, or to less than 58.0° in super-wide-angle cameras. Fiducial marks on the side of the picture area shall not project more than 1cm into the 23cm x 23cm area.

Preferably the 23cm x 23cm nominal format area should not be reduced by any obstructions.

1.2.2.5 Focal Plane: The film shall be held in the focal plane by a glass register plate with a pressure pad, or by a suction back. The flatness of these surfaces shall be in accordance with Section 1.2.3.1. Precautions shall be taken to ensure that the mechanism is operating to hold the film in the intended plane. For vacuum back cameras, the vacuum differential at the magazine shall be in accordance with the manufacturer's recommendations.

A vacuum gauge or other warning device shall be connected to each vacuum-back magazine. The risk that the device may indicate a satisfactory vacuum when the vacuum at the platen is unsatisfactory due to an obstruction or leak should be minimized by having the device's connection near the platen or by other precautions.

The use of a flow meter in the vacuum line is recommended.

When an objectionable number of scratches occur on a register glass, it shall be replaced and the camera recalibrated.

1.2.2.6 Fiducial Marks: The design of the fiducial marks shall be such that they produce accurate and definite registrations on every negative and such that they are not easily disturbed by accidental or other causes. They shall provide for recording two fixed mutually perpendicular camera distances on each negative. The lines joining the fiducial marks shall intersect at 90 degrees within the tolerances given in Section 1.2.3.4.

The marks shall be shaped to avoid scratching the emulsion of the film during winding.

In order to establish an accurate frame of reference for analytical photogrammetric aerotriangulation all category A cameras shall include in each fiducial mark a central dot of 100 ± 30 micrometres.

1.2.2.7 Shutter: The shutter shall be of the between-the-lens type. True shutter speeds, both total and effective, shall be known by the contractor. Effective speeds shall be known by the photographer and employed in practice when recording shutter speeds on Form I.C.A.S. 2.

1.2.2.8 Filter: A filter shall be regarded as an optical part of the camera with which it is used. A camera shall be calibrated with the filter with which it is to be used. If more than one filter is to be used with a camera, separate calibrations of the camera shall be made with each filter in place. If a camera is to be used without a filter, it shall be calibrated without a filter.

Provision shall be made to ensure that a single orientation for the filter on the camera can be easily and reliably maintained and recovered. The single orientation may be established either by mechanical arrangements or by clear markings or by a combination of the two methods. Orientations shall be established for the filter in its cell as well as for the cell on the camera.

Preferably the single orientation of the filter should be established entirely by mechanical arrangements.

The filter shall meet the deviation requirements of section 1.2.3.7.

The image illumination requirements of section 1.2.3.6 may be met by the use of a filter with a graded transmission. The use of such a filter to achieve the "desirable" illumination levels of section 1.2.3.6 is recommended.

1.2.2.9 Film and Film Spools Accommodated: The camera, including the magazine shall be suitable for use with film, leaders and trailers as specified in Canadian Standards Association Z 7.3.1.5 "Dimensions for Leaders, Trailers, and Roll Film for Aerial Photography".

The camera and magazine shall be suitable for use with Aerial Film Spools of the dimensions specified in ANSI PH 1.2 - Table 6 - 9½" Aerial Film Spools - Spool No. 4 or larger.

1.2.2.10 Auxiliary Data: The camera shall include an auxiliary data panel whose indications are recorded on the survey film concurrently with each exposure. The panel shall include a clock with a sweep second hand, an altimeter, an exposure counter and the serial number and calibrated focal length of the lens.

1.2.2.11 Optical Performance: The camera focus setting shall be that which gives the best average photographic resolving power on low contrast annulus targets at infinity.

The resolution of the lens type shall be in accordance with the possibilities of current design knowledge. The resolution of an individual camera shall be such that its average resolving power is not less than 85% of the mean value for its type.

1.2.3 CAMERA CALIBRATION

1.2.3.1 Flatness of Platens: For standard wide-angle cameras the surfaces determining the film location shall be flat to the following

tolerances:

	Category A	Category B
Flatness	±0.008mm	±0.013mm

These tolerances apply to register glasses, pressure pads, suction backs, calibration frames, and the coplanarity of raised fiducial marks. If a pressure pad faced with compressible material or fitted with an inflated bag is used, its flatness under negligible load, and its compression under load shall be such that some pressure below the average working pressure can be chosen for each small part of the surface which would make the whole surface meet the above flatness requirements. Alternatively, the pressure pad shall, when normally loaded, hold aerial film from a fresh roll in contact with a flat surface over a 23cm x 23cm area to within the following tolerance:

	Category A	Category B
Maximum Separation	±0.008mm	±0.013mm

For super-wide-angle cameras the surfaces determining the film location shall be flat to ±0.008mm or, if the design shape is not flat, shall be accurate to the design shape given in Table 1 to ±0.008mm measured in a direction parallel to the optical axis of the camera. This tolerance shall include any departures which may arise from errors in centering the locating surface.

1.2.3.2 Focal Length: The calibrated focal length shall be chosen by comparing the average radial measured distortion for the camera with the corresponding reference data given in Table 2, and minimizing the largest absolute value of the fractions obtained by dividing the difference at each angle by the tolerance for that angle.

For cameras for which reference data are not given in Table 2, the reference shall be zero distortion.

TABLE 1

Design Shape of RC-9 Vacuum Back

R (mm)	h (μm)
0	0
3	0
6	1
9	8
12	19
15	35
18	53
21	74
24	96
27	121
30	146
33	172
36	197
39	217
42	231
45	241
48	246
51	249
54	250
57	248

R (mm)	h (μm)
60	244
63	238
66	233
69	228
72	222
75	217
78	212
81	206
84	200
87	195
90	190
93	185
96	180
99	174
102	166
105	163
108	160
111 & beyond	158

The design shape of the surface of the Wild RC.9 vacuum back is such that at a distance 'R' from the fiducial centre the surface departs by the amount 'h' shown in Table 1 from a perfect plane which touches the surface at the fiducial centre. 'h' is measured parallel to the optical axis of the camera and is positive when the surface is on the side of the reference plane away from the lens.

TABLE 2

Lens Distortion Reference Data

FIELD ANGLE (DEG.)	RADIAL DISTORTION REFERENCE DATA (μm)								
	AVIOGON	UNIVERSAL AVIOGON	PLEOGON	PLEOGON A	PLEOGON A-2	ORTOGON	LAMEGON	SUPER AVIOGON	SUPER AVIOGON II
0	0	0	0	0	0	0	0	0	0
5.6	+5	+5	-2	-5	-2	+8	0	-14	-1
11.2	+8	+8	-5	-7	-3	+14	-1	-21	-3
16.9	+8	+8	-7	-5	-4	+15	-3	-13	-5
22.5	+6	+6	-7	-2	-4	+8	-5	+14	-8
28.1	+2	+2	-6	+2	+1	-2	-3	+39	-9
33.7	-7	-7	-1	-1	+3	-14	+3	+48	-9
39.4	-7	-7	+4	-4	+3	-14	+7	+42	-8
42.2	-3	-3	+7	+8	+3	-3	0	+38	-5
45.0			+8	+25	+3		-30	+33	0
50.6								+19	+12
56.2								+19	-5

1.2.3.3 Radial and Tangential Distortion: The average radial measured distortion for Category A cameras shall not be more than the values given in Table 3(1).

The average radial measured distortion shall not depart from the corresponding reference data given in Table 2 by more than the amount shown in Table 3(2) for the appropriate camera, category, and range of field angles.

Asymmetry of radial measured distortion shall be such that the largest absolute difference between radial measured distortion and average radial measured distortion about the principal point of auto-collimation shall not exceed the amounts shown in Table 3(3) for the appropriate camera, category, and range of field angles.

The largest absolute difference between radial measured distortion and average radial measured distortion about the centre of best symmetry shall not exceed the values shown in Table 3(4) for the appropriate camera, category, and range of field angles.

The tangential distortion shall not exceed the amount shown in Table 3(5) for the appropriate camera, category, and range of field angles.

TABLE 3

Tolerances (mm) for Radial and Tangential Distortion

	CATEGORY	TO 42.2°	WIDE ANGLE BEYOND 42.2	SUPER-WIDE ANGLE Beyond 42.2 to 53.5	Beyond 53.5
(1) Average measured radial distortion	Cat.A	0.015	0.030	0.030	0.060
(2) Departure of Average from reference	Cat.A	0.005	0.010	0.010	0.020
	Cat.B	0.010	0.020	0.020	0.040
(3) Asymmetry about Principal Point of Autocollimation	Cat.A	0.015	0.030	0.030	0.060
	Cat.B	0.035	0.070	0.070	0.140
(4) Asymmetry about Principal Point of Best Symmetry	Cat.A	0.005	0.010	0.010	0.020
	Cat.B	0.010	0.020	0.020	0.040
(5) Tangential Distortion	Cat.A	0.005	0.010	0.010	0.020
	Cat.B	0.010	0.020	0.020	0.040

1.2.3.4 Fiducial Centre: Lines joining opposite fiducial marks shall intersect at $90^{o} \pm 1'$ for all cameras.

Positions of fiducial marks shall be measured and reported in a manner suitable for both the checking of film dimensions and comparator measurements for analytical mapping procedures.

The position of the principal point of autocollimation and of centre of best symmetry shall be measured relative to the fiducial centre. Neither the principal point of autocollimation nor the centre of best symmetry shall be farther from the fiducial centre than 0.05 millimetre for cameras of Category A, or 0.10 mm for cameras of Category B.

1.2.3.5 Veiling Glare: Veiling glare shall not exceed:

	Category A	Category B
Veiling glare	10%	20%

1.2.3.6 Image Illumination: The lowest image illumination shall not be a smaller percentage of the highest image illumination than the mandatory value given in Table 4 for the appropriate camera, category, and range of distances from the fiducial centre. It is recommended that the illumination should not be less than that shown as "desirable" in Table 4.

TABLE 4

Image Illumination

CAMERA	DISTANCE	MANDATORY (MONOCHROME)	MANDATORY (COLOUR)	DESIRABLE (MONOCHROME, COLOUR)
WIDE ANGLE CATEGORY A	to 140mm	30%	50%	60%
WIDE ANGLE CATEGORY B	to 140mm	25%	50%	60%
SUPER-WIDE-ANGLE	to 125mm	30%	50%	60%

The illumination at the centre of the film plane shall not be less than 90% of the highest illumination found.

1.2.3.7 Deviation of Filters and Camera Port Glasses: For collimated light at normal incidence, the deviation produced by either a filter or a camera port glass and the change of deviation from place to place over the area of either the filter or the camera port glass shall be within the following limits:

	Deviation (Sexagesimal Seconds)	Change of Deviation (Sexagesimal Seconds)
Category A	5	1
Category B	10	2

1.2.3.8 Special Tests: A few cameras of each type shall be tested for resolution and veiling glare to establish typical performance data. Such tests shall also be carried out by the National Research Council on any camera for which there are indications that the individual performance may be significantly worse than the typical performance.

On request of the owner, the National Research Council will carry out tests of resolution and veiling glare and determine T-numbers on any survey camera being calibrated.

1.2.3.9 Test Reports: The National Research Council shall send one copy of each test report required by Section 1.2.1 to the owner of the camera, magazine or other air survey equipment, and three copies to the Secretary, I.C.A.S. In addition, on request of the owner of the equipment, the National Research Council shall send copies of the report to any agency having a requirement for them. (A charge may be made for these services by N.R.C.)

The owner of the equipment may make copies of the report to be sent to any agencies using or considering using photographs from the equipment, but such copies shall be of the entire report, including the cover, and shall be produced by a photographic or similar duplication method, not by re-typing.

Further copies of the report may be made when required for use with prints or diapositives supplied by the National Air Photo Library.

Except as detailed above, the test report copies shall be retained by their original recipient and shall not be copied or published in whole or in part without the written consent of the National Research Council.

1.2.3.10 Invalidation of Test Report: A camera or magazine can not be considered calibrated and the report on it is not applicable to photography taken when one of the following conditions exists:

1. When 15 months or more have passed since the date of calibration.
2. Whenever a camera is being used with a filter with which the camera has not been calibrated during the previous 15 months, or being used with no filter unless it has been calibrated with no filter within the previous 15 months.
3. Whenever, for a camera, there is any reason to believe that since the latest calibration, the dimensional relationships of the lens, the fiducial marks, or the camera parts defining the focal plane may have been disturbed by unusual mechanical shock or by any disassembly or alteration.
4. Whenever a magazine has been subject since the latest calibration, to damage, disassembly or alteration which might have affected the flatness of the vacuum back or pressure pad.

If either of the above items 3 or 4 occurs the owner of the camera or magazine shall advise the Instrumental Optics Laboratory of the National Research Council promptly so that the calibration history of the camera or magazine may be kept up to date. The owner shall take this action whether or not the camera is to be recalibrated for future use. The Instrumental Optics Laboratory shall advise the Secretary, I.C.A.S.

The owner of the magazine shall advise the Instrumental Optics Laboratory of the National Research Council and the Secretary of the I.C.A.S. promptly whenever a magazine is fitted with a vacuum back or pressure pad, the type and serial number of the magazine in which it is fitted, and the type and serial number of the magazine from which it was removed, if any.

1.2.4 CAMERA MOUNT

The camera mount shall provide sufficient vibration insulation so that the camera vibration need never be a limiting factor in the selection of shutter speeds. The maximum relative motion between image and film from angular vibration during the longest exposure shall not exceed one-third of the average lens-film resolved distance as determined by the National Research Laboratories (Ref. CSA Z7.3.4.1 "Specifications for standard method of testing the mounting of air cameras").

In general this means that the maximum permissible angular velocity of the camera due to vibration is given approximately by:

$$A = \frac{D}{3FT.}$$

Where A = angular velocity in radians per second.

D = average resolved distance in mm as determined by the National Research Laboratories.

F = focal length in mm.

T = total exposure time in seconds.

As an example, where D equals 0.04mm, F equals 152mm, T equals 1/100 sec.

$$A = \frac{0.04}{3 \times 152 \times 1/100} = 0.009 \text{ radian/sec.}$$

If it is necessary to improve the mounting, the following desirable characteristics are to be sought. The centre of support should be near the centre of gravity. The mount should

feel "soft", that is, yield easily to hand pressure, with its natural frequencies not higher than 5 cycles/sec. Damping should be critical or somewhat underdamped.

The contractor should determine, or have determined, the vibration characteristics of his cameras as they occur in normal survey flying.

1.3 NON-PHOTOGRAMMETRIC CAMERAS

1.3.1 CAMERA PROPERTIES

1.3.1.1 Focus: Cameras used for non-photogrammetric aerial photography should be of a fixed-focus type, focussed on infinity provided the height above ground will not be less than H feet given by

$$H = 0.33 \frac{f^2}{N}$$

where f is the focal length in mm and

N is the f-number.

If the height above ground will be less than H, detailed consideration shall be given to refocussing the camera for the range of heights expected and perhaps to using a different focal length.

If a variable focus camera is used it shall be accurately focussed for an appropriate object distance and the focus locked to ensure that it is not inadvertently altered in operation.

1.3.1.2 Stray-light Control: All lens surfaces shall have anti-reflection coatings. The interior of the optical unit shall have a non-reflecting finish and be of such a design as to reduce to a minimum the amount of non-image-forming light (veiling glare) reaching the film by reflection from interior surfaces of the camera.

Preferably filter surfaces should have anti-reflection coatings.

1.3.1.3 Filters: If a filter with graded-transmission or other reflecting coating is employed, the side with the higher reflectivity shall be mounted toward the camera lens.

1.3.1.4 Focal Plane Flatness: The camera shall have a means of ensuring that the film is held in the plane of best focus during exposure. As a minimum the base of the film shall be pressed against a flat plate by a frame which provides complete support around all four edges of the format. Sufficient pressure (or suction) shall be provided to overcome any tendency of the film to curl in a dry atmosphere.

1.3.1.5 Fiducial Marks: Fiducial marks should be provided to permit rapid location of the approximate principal point of the photograph.

Preferably, the fiducial marks should be located on or near the focal-plane frame defining two mutually-perpendicular lines whose intersection represents the location of the principal point.

Fiducial markers shall be shaped to avoid scratching the film during film transport.

1.3.1.6 Shutter: The shutter may be of focal-plane or between-the-lens type.

The shutter should be capable of a wide range of shutter-speeds faster than 1/50th second. The full range of shutter-speeds should be quickly and easily adjustable in the air, relatively independent of temperature, and independent of the re-cycling rate.

True effective and total shutter-speeds shall be known by the contractor and the true effective speed shall be entered on the film report.

1.3.1.7 Image Illumination: For use with monochrome film, the lowest film plane illumination shall be not less than 30% of the maximum film plane illumination.

For use with colour film the lowest film plane illumination shall be not less than 50% of the maximum. It is recommended that for both uses that the lowest film plane illumination should not be less than 60% of the maximum.

1.3.2 TESTS

A check of focus and a shutter-speed calibration should be carried out periodically and at least once a year.

If the camera is electrically operated, the power supplies in both the aircraft and the testing laboratory shall be adequate to operate the camera at peak load.

If there is doubt that a particular camera is in satisfactory operating condition, the I.C.A.S. may require an operational test or a laboratory inspection by the National Research Council, the cost to be borne by the contractor.

T-numbers should be determined and used to establish correct exposure, rather than the geometric f/number.

1.3.3 INSTALLATION

If stereoscopic photography is required, the camera shall be mounted so that film transport over the focal plane is in the direction of flight.

1.4 AUXILIARY EQUIPMENT

1.4.1 ALTIMETER

The altimeter shall be calibrated by the National Research Council laboratories before use, at least once a year thereafter, and whenever servicing the instrument might lead to a disturbance of the calibration. These laboratories shall have the right to refuse to undertake such work if it is considered that the article is in any way unsatisfactory for the purpose intended. The altimeter calibration shall be based on the I.C.A.O.-N.A.C.A. atmosphere. Two copies of the calibration report shall be sent

to the owner of the instrument, who shall send one copy to the Secretary, I.C.A.S. It shall state instrument errors, that is, instrument reading minus true value.

1.4.2 THERMOMETERS

The outside temperature gauge shall be calibrated before use, at least once every two years thereafter, and whenever there is any reason to believe that the calibration may have been disturbed. The corrections to be applied due to air speed shall be determined. The temperature gauge shall be shielded to minimize radiation errors. The velocity of the air past the gauge in flight causes a temperature rise T given by

$$\Delta T = K\left(\frac{V}{100}\right)^2$$

where V is the air velocity in knots at the gauge and K is a constant usually between 0.8 and 1.1. For a particular gauge installation, K can be found by flying the aircraft in circles in stable atmospheric conditions and noting the indicated temperature T at various air speeds S, covering as wide a range as is practicable. Assuming V is proportional to S, plotting T against S^2 should give a straight line relationship which can be extrapolated to S = 0 at T_0, the true air temperature. Then $\Delta T = T - T_0$ as a function of S can be plotted or prepared in tabular form for use in subtraction from observed temperature values to obtain true values. In general ΔT, obtained from S the true air speed, will be sufficiently constant during climb so that an average value of ΔT can be chosen for each aircraft and applied to the arithmetic mean actual air temperature.

Inside temperature gauges shall be checked by comparison with a calibrated thermometer. They shall be accurate to $\pm 0.5^{\circ}C$.

1.4.3 SENSITOMETER

The sensitometer shall be calibrated or its calibration verified at intervals not exceeding 15 months. The calibrating or

verifying laboratory shall furnish the Secretary of the I.C.A.S. with three copies of the report. Calibration and verification may be carried out by the National Research Council of Canada or by any other laboratory competent in the technical fields involved.

The sensitometric exposures shall be equivalent to that specified in C.S.A. Z 7.3.2.1, 1969 "Sensitometry of Monochrome Aerial Films". Determination of film speeds and average gradients shall be in accordance with standard methods defined by the same publication.

Three sample exposures of the step tablet shall be supplied to the Secretary of the I.C.A.S. by the contractor. Each step of the wedge shall be positively identifiable; as a minimum, steps 5, 10, 15 of a standard 21-step wedge should be numbered beginning with the thin end of the sensitometer wedge. The numbers shall be legible on the sensitometric exposure.

1.4.4 DENSITOMETER

The densitometer used in the measurement of sensitometric exposures and film densities shall read diffuse transmission density as defined in C.S.A. Z 7.2-1973 "Specification for Diffuse Transmission Density" C.S.A. Type V1-b.

PART 2
FLIGHT
STANDARDS

ICAS TECHNICAL SPECIFICATIONS

2. FLIGHT STANDARDS

2.1 GENERAL

The specifications of this section pertain primarily to the operation of the aircraft and the equipment described in Section 1.

These specifications may be augmented in the contract by the job requirements. In particular, cameras, films, filters and photographic flight tolerances for a particular job will be specified in greater detail in Part 4 (JOB SPECIFICATION) of the contract.

2.2 CAMERA INSTALLATION

2.2.1 CALIBRATION

The photogrammetric camera shall have a valid calibration (see section 1.2.1 and 1.2.3.10) and be of the type and Category required by Part 4 (JOB SPECIFICATION) of the contract.

2.2.2 CAMERA DATA PANEL

The camera data panel (see section 1.2.2.10) shall be photographically recorded at the time of each exposure. Lighting of the panel shall be adjusted to suit the film speed, so that good legibility of the data is obtained on negatives and prints.

The clock shall record Greenwich Mean Time during the flight; and the altimeter shall be set to agree with the calibrated altimeter. The exposure counter should be set to correspond with the counter visible to the camera operator (both set to zero for the start of a roll if this is possible).

Failure of instrument lights resulting in a loss of fiducial marks on the negatives (see section 1.2.2.6) is grounds for rejection of mapping photography.

2.2.3 VACUUM SUPPLY

The vacuum supply to the camera shall be checked to ensure it meets camera operating requirements (see section 1.2.2.5).

2.2.4 MOUNTING

The camera shall be mounted vertically in the aircraft and oriented so that the film transport over the focal plane is in the direction of flight.

The camera shall be isolated from the vibration of the aircraft by a suitable mount. Angular vibration of the camera shall be reduced to a level which does not significantly affect resolving power at the shutter speeds used (see section 1.2.4).

Provision shall be made for levelling the camera in flight and compensating for the crab of the aircraft.

2.2.5 CAMERA PORT GLASS

The camera shall be mounted behind a camera port glass. The camera port glass shall meet the deviation requirements of Section 1.2.3.7. Mounting of the window in the aircraft shall be such that these requirements shall continue to be met after installation. The camera port glasses shall be kept clean and free of scratches.

2.2.6 TEMPERATURE

The camera compartment shall be maintained at a temperature of $15^{o}C \pm 10^{o}C$. Temperature variations shall not exceed 4^{o} throughout all portions of the camera where temperature variations might affect either the sharpness or metric properties of the image.

As of January 1, 1974 the camera compartment shall be maintained at a temperature of $20^{o}C \pm 2^{o}C$ (see section 1.4.2).

2.3 FILMS AND FILTERS

2.3.1 FILM

The film shall have a dimensionally stable polyester base. It is preferable that the base have an anti-curl backing. The film shall be stored and handled in accordance with the manufacturer's recommendations.

2.3.2 FILTER

The filter shall have been calibrated with the camera on which it is being used (see section 1.2.2.8). The standard filter used for mapping photography shall be a sharp cut minus blue filter such as a Wild Pan 500 or a Zeiss B. The filter type shall be stated on the Air Photography Report I.C.A.S.-2 (see section 2.6).

This type of filter shall be used for all exposures except where some other filter is specified in Part 4 of the Contract.

2.3.3 EXPOSURE

2.3.3.1 Film Speed vs Development: The exposure shall produce a negative which results in most of the photograph being on the approximately straight line portion of the characteristic curve of the negative material.

For monochrome films, the photographer shall know the specified average gradient required (Part 4 of the contract) or if this has not been stated in Part 4, shall assign the degree of development to which the film will be processed, and thus know the effective film speed, before setting the exposure.[1]

The degree of development shall be assigned with due regard for the brightness range of the terrain photographed.[2]

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1) It must be borne in mind that the effective film speed varies with the degree and method of development. At low values of average gradient the effective film speed will usually be markedly less than the published speed, necessitating a compensating increase of camera exposure. The photographer should be thoroughly familiar with the speed vs average gradient characteristics of the material he is using (Ref. "Resolution of Four Films in a Survey Camera" and "Cameras, Films and Camera Mounts", P.D. Carman, National Research Council, Reprints available from the author on request).

2) Experience shows that under Canadian conditions desirable values of average gradient may range from a minimum of 0.70 to a maximum of 2.00 in extreme cases. Photography of terrain of low brightness range (e.g. muskeg) from high altitude will benefit from being processed to values of average gradient in the order of 1.3 or higher. The long brightness range encountered in mountains, from shadows to sunlit snow can be accommodated with lower average gradient 0.70.

2.3.3.2 Resolution: With due consideration of the brightness range of the terrain and the effective film speed at the average gradient necessary to deal with that range, exposure shall be made at the aperture and shutter-speed setting for maximum resolution.

2.3.3.3 Image Motion: For very large-scale-photography or whenever image-motion due to ground-speed is likely to be the limiting factor of resolution, exposures shall be made at the maximum shutter speed consistent with adequate exposure.

2.3.4 HUMIDITY CONTROL

Humidity should be controlled in the camera compartment to 58% ± 2% relative humidity. The film should be kept at the above humidity from the time it is removed from the sealed container until it is all exposed.

If no humidity control is used, the following procedure shall be observed:

The camera shall be started sufficiently in advance of the beginning of each flight line to take at least the number of exposures indicated in the table below before beginning the line. These extra exposures should all be taken at the usual time interval, and at least the last four shall be taken at the usual time interval.

Time since end of preceding line or loading of magazine	No. of extra exposures before line
less than 30 minutes	4
30 min. to 2 hours	5
2 hrs. to 8 hrs.	7
8 hrs. to 24 hrs.	8
24 hrs. to 4 days	9
4 days or longer	10

As an alternative which may be desirable when the interval between lines is short, the camera may be left operating at its normal rate throughout the whole interval.

2.4 ESTABLISHMENT OF TRUE ALTITUDE

The altitude for photography specified in Part 4 of the contract is the true altitude above sea level. The indicated altitude to fly shall be determined from the required true altitude by subtracting the correction for air temperature and adding the instrument error (see section 1.4.1) as described in the following sections.

2.4.1 SETTING THE CALIBRATED ALTIMETER

The calibrated altimeter's subscale shall be set to the local value of sea level pressure before take-off, or failing the availability of this information, it shall be set to indicate the height of the airfield plus the instrument error.

During flight, before commencing photography of an area, it shall be reset to the value of local sea level pressure which best applies to the area.[3]

2.4.2 CALCULATION OF INDICATED HEIGHT TO FLY

The correction for air temperature is obtained as follows:

Outside temperature at every integral 1000 feet of indicated altitude during climb is to be recorded on Form ICAS 2,B. Outside temperature readings should ideally be taken in the area to be photographed. The use of temperature readings which might differ seriously from those in the photographed area, by reason of distance, time, or weather, should be avoided.

a) Calculate the arithmetic mean actual air temperature from the outside temperature readings taken during climb and corrected for air speed.

b) Calculate the arithmetic mean standard air temperature from the I.C.A.O.-N.A.C.A. standard air temperatures for the corresponding altitudes.

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3) Within the "standard pressure region" as defined by the Ministry of Transport, it may be necessary to carry more than one altimeter to conform as well to MOT regulations.

c) Subtract the mean standard air temperature from the mean actual air temperature, in degrees Centigrade.

d) Multiply the result by 0.00367 times the height of the air column in feet to obtain the correction for temperature.

e) Where take-off is from an airport that is not at sea level, temperature soundings will be recorded for only that depth of the atmosphere through which the survey aircraft climbs to reach operating altitude. The resulting actual average air temperature must be compared with the average temperature of the standard atmosphere over the same range of altitudes, and the correction computed on the basis of the height climbed.

A sample calculation is shown in Figure 1.

2.5 PHOTOGRAPHIC FLIGHT TOLERANCES

2.5.1 FLIGHT LINE PATTERN

The flight lines will normally be spaced for 30% lateral overlap at mean ground level unless otherwise specified in Part 4 of the contract.

The layout of photo lines shall be such that the outside line shall not fall more than ½ the line-spacing from the lateral boundary.

2.5.2 AREA COVERAGE

The photographic flight shall extend far enough beyond the borders of the specified area to ensure full stereoscopic cover of the entire area included within the borders.

All photo lines should be flown in a continuous unbroken strip. Where it is necessary to break a line and fly the remainder at another time, the two parts of the line shall overlap at the break by at least two photographs.

FIGURE 1

INTERDEPARTMENTAL COMMITTEE ON AIR SURVEYS

AIR PHOTOGRAPHY REPORT SUPPLEMENT

RECORD OF TEMPERATURE SOUNDINGS
AND
TRUE HEIGHT COMPUTATIONS

DATE: May 19/72

	TAKEOFF FROM	LAND AT
BASE	Winnipeg	Timmins
TIME	1500 GMT	1750 GMT

ALTITUDE IN THOUSANDS OF FEET	Temp. °C.		Temp. °C.
1	+ 18	B.F.	
2	19	31	
3	19	32	
4	20	33	
5	20	34	
6	20	35	
7	21	36	
8	21	37	
9	19	38	
10	17	39	
11	15	40	
12	13	41	
13	11	42	
14	9	43	
15	7	44	
16	5	45	
17	3	46	
18	1	47	
19	0	48	
20	- 2	49	
21	4	50	
22	6	51	
23	8	52	
24	10	53	
25	12	54	
26		55	
27		56	
28		57	
29		58	
30		59	
SUB.		60	

TOTAL	+ 216
AVERAGE	+ 9
AIRSPEED CORRECTION	-
CORRECTED AVERAGE	+ 9
I.C.A.N. AVERAGE	- 11
DIFFERENCE	20

CORRECTION*	1830
REQ'D. TRUE ALTITUDE	25000'
AIR TEMP. CORRECTION	-1830'
ALTIMETER ERROR	+ 40
INDICATED HT. TO FLY	23210

ICAN STANDARD ATMOSPHERE

HT.	TEMP.
1000	+ 13
2000	11
3000	9
4000	7
5000	5
6000	3
7000	+ 1
8000	- 1
9000	- 3
10000	- 5
11000	- 7
12000	- 9
13000	- 11
14000	- 13
15000	- 15
16000	- 17
17000	- 19
18000	- 21
19000	- 23
20000	- 25
21000	- 27
22000	- 29
23000	- 31
24000	- 33
25000	- 35
26000	- 37
27000	- 39
28000	- 41
29000	-
3000	57
31	0 - 57
	1000 - 57
51000	- 57
52000	- 57
53000	- 57
54000	- 57
55000	- 57
56000	- 57
57000	- 57
58000	- 57
59000	- 57
60000	- 57
TOTAL	-275
ICAN AVG.	-11

CORRECTION = DIFFERENCE × 3.67 × ALTITUDE IN THOUSANDS OF FEET
= 20 X 3.67 X 25 = 1830'

N.B. IF ACTUAL AVERAGE TEMPERATURE IS WARMER THAN I.C.A.N. AVERAGE, SUBTRACT CORRECTION.

2.5.3 PHOTOGRAPHIC CONDITIONS

Photography shall be taken under clear skies with a minimum amount of atmospheric haze. The reduction of contrast on the negative due to the presence of haze will be the determining factor in the acceptance for rejection of photography taken under less than optimum conditions. When the contractor finds that, because of haze, a normal density range has not been obtained, he should discuss the matter with the I.C.A.S. before printing the negatives.

The solar altitude shall be at least 20°.[4] A higher altitude may be specified in Part 4 (JOB SPECIFICATION).

2.5.4 FLIGHT DEVIATIONS

2.5.4.1 Course Corrections: Corrections to the survey aircraft's course between successive photographs shall not exceed 3°.

2.5.4.2 Crab: During vertical photography, the camera shall be compensated for crab of the aircraft with a resultant error not exceeding 3°.

2.5.4.3 Verticality: The contractor shall prevent the lens axis from departing from the vertical during any exposure by an angle greater than 2.5°.

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4) The periods of the year during which the solar altitude is over 20° and over 30° for at least one hour per day are given below.

LATITUDE	20°	30°
40°N	all year	Jan 22 to Nov 20
50°N	Jan 25 to Nov. 19	Feb 25 to Oct 18
60°N	Feb 26 to Oct. 16	Mar 22 to Sept 23
70°N	Mar 24 to Sept 20	Apr 16 to Aug 28
80°N	Apr 17 to Aug 28	May 25 to July 22

The exact time and number of hours of photographic light at a particular date and latitude can be determined from "Solar Altitude Nomograms" Reprint 18, Surveys and Mapping Branch, Dept. of Energy, Mines and Resources, Ottawa.

2.5.4.4 Overlap, Forward and Lateral: The forward overlap between successive pictures shall fall within the range 55% to 61% (58±3%) and the lateral overlap shall fall between 15% and 45% (30±15%) at mean ground level unless specified to the contrary in Part 4 (JOB SPECIFICATION).

2.5.4.5 Altitude: The indicated altitude shall be held within ±100 feet of the "indicated height to fly" (see section 2.4). The actual true altitude shall be within ±(3%+200 feet) of the required true altitude.

A closer altitude tolerance for photography taken below 10,000 feet may be specified in Part 4 (JOB SPECIFICATION).

2.6 AIR PHOTOGRAPHY REPORT - ICAS-2

The complete details of the survey flight shall be recorded on the Air Photography Report ICAS-2 (Figure 2). This report shall contain the following information:

(1) I.C.A.S. Job number
(2) Federal Roll number (see section 3.3.2)
(3) Contractor's roll number
(4) Average Scale: as defined in Part 4 or as determined from flying height and mean ground elevation.
(5) Camera Type: such as RC8, ZEISS RMK etc.
(6) Lens Number and Calibrated focal length as given in the NRC test report.
(7) Film type, emulsion number and expiry date as given on the manufacturer's packaging.
(8) Magazine serial number.
(9) Filter type and number: such as Pan 500, # NRL 20-7-64-1.
(10) Camera port category and number as given on the NRC test report.
(11) Autopilot, if used.
(12) Contractor's name and names of navigator, photographer and pilot.
(13) Calibrated Altimeter number.

⑭ Log of flights on which the roll was exposed.

for each flight line

⑮ Date of photography - day, month, year.

⑯ Annotated negative numbers - (see section 3.2.2).

⑰ Line Number and direction

⑱ Exposure number (see section 2.2.2) this number should correspond with the number on the Camera data panel.

⑲ Greenwich Mean Time at the start and end of the line.

⑳ True Altitude above sea level (see section 2.4)

㉑ Camera Exposure: relative aperture and effective shutter speed (see section 1.2.2.7)

㉒ Remarks: this should include:

(a) Area name and identifying number or letter.

(b) Line complete, or if incomplete, the co-ordinates of start and finish.

(c) Scales - if more than one.

(d) Blanks, run-up, overrun, rejections and reasons for rejection.

(e) Atmospheric conditions.

(f) Solar altitude(s).

(g) Splices, removal of section of the roll, location of step wedges, etc.

(h) Any other information that will complete the historical data of the roll.

FIGURE 2

SIDE 1

INTERDEPARTMENTAL COMMITTEE ON AIR SURVEY

ICAS 2 1973

CONTRACTOR'S JOB NO.

AIR PHOTOGRAPHY REPORT

(1) I.C.A.S. JOB NO. 73/07 73/03

CAMERA TYPE (5) Wild RC8	FILM TYPE (7) Kodak Double X	B&W X	Colour	FEDERAL ROLL NO. (2) A24171
LENS NO. (6) 15Ag 74	EMULSION NO. (7) 2405-567-98	EXPIRY DATE (7) Aug.'74		CONTRACTOR'S ROLL NO. (3) 1476
CALIBRATED F.L. (6) 152.79mm	MAGAZINE No. (8) 784	FILTER TYPE & NO. (9) Pan 500 NRL 20-7-64-1		AVERAGE SCALE (4) 1:40,000 1:6,000

Date (15)	Annotated Neg. Nos. (16)	Line No. & Direction (17)	Exposure No. Start (18)	Exposure No. Finish (18)	GMT Start (19)	GMT Finish (19)	TRUE ALT. ASL (20)	Camera Exposure (21)	REMARKS (22)
									ICAS 73-07 Block A
July 15 1973			000	015					Clear, Solar Alt. 35°
	1-52	3-E	016	067	1604	1632	21,200'	5.6/200	122°10' to 119°00'
		3-E	068	070					Over-run
		4-W	071	075					Off line
	53-106	4-W	076	129	1652	1729	21,200'	5.6/200	119°00' to 122°12' 2'
		4-W	130	136					Cloud
			137	139					Step wedge
July 16 1973			140	156					Camera test
	107-138	7-W	157	188	1610	1640	21,200'	5.6/200	119°00' to 121°04'
									lt. Haze, Solar Alt. 35°
July 17 1973			191	215		STEP	WEDGE		ICAS 73/03
	139-152	1-N	216	229	1912	1915	5200'	5.6/350	complete
	153-165	2-S	234	246	1919	1922	5200'	"	" filter removed
	166-181	3-N	252	267	1927	1930	5200'	"	"

DATE (14)	July 15, 1973		July 16, 1973		July 17, 1973		AUTOPILOT YES X NO (11)
	TAKEOFF FROM	LAND AT	TAKEOFF FROM	LAND AT	TAKEOFF FROM	LAND AT	
BASE	Hay River	Hay River	Hay River	Edmonton	Edmonton	Edmonton	
TIME	15 30 GMT	1810 GMT	1545 GMT	2015 GMT	1850 GMT	2000 GMT	

AIRCRAFT REGISTRATION CF-PDQ

TYPE CESSNA 414T

CAMERA PORT CATEGORY A (10)

CAMERA PORT NO. NRL 27.3.27

CONTRACTOR (12) Bluenose Air Surveys Ltd.

ALTIMETER NO. 65093 (13)

NAVIGATOR G. Haries (12)

PHOTOGRAPHER D.A. Phragm

PILOT P. O'Proon

PART 3
PHOTOGRAPHIC PROCESSING AND DOCUMENTATION

3. PHOTOGRAPHIC PROCESSING AND DOCUMENTATION

3.1 GENERAL

The photographic processing shall be done in accordance with normal good photographic practice and shall comply with the procedures and tolerances specified in the following sections. Accurate records shall be maintained and a summary of the processing shall be recorded on side 2 of ICAS-2 (Figure 3).

3.2 SENSITOMETRIC CONTROL

3.2.1 SENSITOMETRIC EXPOSURE

At least one sensitometric step-wedge shall be exposed on each roll of film prior to processing. The exposure shall be made on an area of the film that is unexposed, free of fog and which will not be subject to anomalous development effects.

The exposure shall be made on a sensitometer meeting the requirements of Section 1.4.3. The calibration report number shall appear on the exposure.

All sensitometric exposures shall normally be printed with no auxiliary filter in the sensitometer, except in the following circumstances:

a) if an auxiliary filter is available whose spectral transmission is equivalent to that of the filter used on the camera when the aerial film was exposed, it may be used in the sensitometer to print the wedges on that roll.

b) in the particular case of infrared colour film which must always be exposed behind a minus blue filter, a Wratten #12 or equivalent filter shall be used in the sensitometer when printing the step wedge.

The film report for each roll shall state clearly what auxiliary filter was used in the sensitometer, or that no auxiliary filter

was used, in printing the wedge(s) on that roll. The statement shall be initialled by the photographic technician who made the sensitometric exposure (Figure 3).

3.2.2 AVERAGE GRADIENT

The degree of development shall be that upon which the photographer based his film speed and exposure determination (see section 2.3.3). The contractor shall determine film speeds and average gradients[5] for his own processing conditions.

3.2.3 DENSITY REQUIREMENTS

The densities of the aerial negative shall be such that most of the densities of the photograph fall on the approximately straight portion of the characteristic curve of the negative material. The minimum density on the negative in the area out to 10cm from the fiducial centre shall be between 0.2 and 0.6 above base plus fog. The minimum density anywhere on the negative shall not be less than 0.1 above base plus fog. Except for the images of extremely bright spots, such as specular reflections of the sun, the maximum density on the negative shall not exceed 2.0 above base plus fog. The density values on negatives shall be read with a densitometer aperture of about 1 mm diameter.

3.2.4 PROCESSING

All air film both monochrome and colour, flown for the Federal Government, shall be processed in a continuous processing machine. The processing procedure shall be sufficiently uniform to ensure

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5) "Average Gradient" of air survey film is defined as follows: The lower point M is located on the characteristic curve where the net density is 0.30. With point M as centre an arc is described with radius equal to 1.5 on the LogE or density scale. The intersection of this arc with the characteristic curve determines the upper point N. The average gradient is the slope of the line MN. (Ref: - C.S.A. Z7.3.2.1 - "Standard Method for Sensitometry of Monochrome Aerial Films"). Typically gamma values are higher than average gradient values by some amount between 0.1 and 0.4.

that the average gradient shall not vary by more than 10% from the specified value.

If for some special reason it seems desirable to use a processing technique other than a continuous processing machine, the suitability of the processing technique shall be established to the satisfaction of I.C.A.S., prior to bidding.

The processing procedure shall not have an injurious effect on the dimensional characteristics of the photographic image. At no time during development or drying shall the film be subjected to a tension or a temperature sufficient to cause permanent dimensional changes greater than 0.03% + 15 micrometres or differences of dimensional changes greater than 0.02% + 15 micrometres.[6]

Permanency of the photographic image shall be the best which can be obtained by normal processing and thorough washing. For the test to determine permanency see CSA Z7.2 (ANSl PH1.28 and PH4.8), "Specifications for films for Permanent Records".

3.2.5 SPOOLING OF NEGATIVES

Rolls of survey film shall normally be left uncut and submitted for storage on a spool of the same kind as that which it was originally supplied. The container shall be a Kodak Code 3000 plastic case, or equivalent.

Rolls of 70mm film shall be delivered on a flanged spool in a matching can.

Each roll of air survey film shall be delivered with at least twelve feet of leader and six feet of trailer containing no annotated negatives.

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6) The National Research Council makes such measures on request. To obtain good maintenance of film dimensions, it is generally desirable to keep the tension on the film below 100 grams per centimeter of width and the drying temperature below 63°C (145°F).

If a splice should be necessary (e.g. as for removal of non-federal photography), at least two feet of film containing no annotated negatives shall be retained on each side of the splice. The splice shall be a butt-join using an approved type of splicing tape, (such as 3M No. 810 transparent mending tape or equivalent) applied to both surfaces of the film.

3.3 CHECKING PROCEDURES

3.3.1 VERIFICATION OF FLIGHT TOLERANCES

The photography shall be checked by the contractor to ensure that the job specifications have been met and a summary of this inspection shall be recorded on ICAS-2 (side 2) as shown in Figure 3. Particular note should be made of the following:

3.3.1.1 Forward and Lateral Overlap: In the case of photography for photogrammetric mapping, departures from the requirements of Section 2.5.4.4 which result in total loss of overlap may be sufficient grounds for rejecting all the photographs in the flight line, or that portion of the flight line between control points.

3.3.1.2 Crab, Course Correction and Verticality: The combined effect of photographic displacements due to crab, course changes and lack verticality (see section 2.5.4) shall not exceed an apparent crab measurement of 5^{o} on the successive photographs; that is, the angle between the line joining fiducial marks in the direction of flight and the flight path as defined by the position of the photo centres shall not be greater than 5^{o}.

3.3.1.3 Photogrammetric Check: The acceptance of photography for mapping purposes will be based on verification of the geometric properties of the imagery in a photogrammetric instrument. The stereoscopic models tested shall be free of Y-parallax. Failure of any test model in this respect will result in rejection of the entire roll from which the model was selected.

FIGURE 3

Side 2 of ICAS-2

TO BE COMPLETED BY CONTRACTOR

PHOTO LABORATORY

Auxiliary filter used on Sensitometer _____

or

No auxiliary filter used on Sensitometer X

Average gradient 1.1 Step Wedge No. 4ST204

Base, plus fog 0.1

Maximum net density 1.4

Minimum net density 0.3

Density range 1.1

Signature

INSPECTION

Exposure: Good ☒ Under ☐ Over ☐

Amount of atmospheric haze July 18/Light July 21/Nil

Instruments: Operation OK

Legibility Clock Fair

Fiducials (definition) OK

Sub-standard lateral overlaps (negative and line numbers)

Lines 3/4 10% at (18-22) (73-76)

Sub-standard forward overlaps (negative numbers)

Line 6(91-130) 65% av.

Sub-standard - Obscuring Media (cloud, haze, smoke, flares, reflections, etc.)

Clouds at the end of line 6 are covered on joining flight.

Signature

3.3.2 ANNOTATION

Each negative of an air survey film roll which forms part of the contract committments shall be correctly and neatly annotated in accordance with the following specifications.

Exposures not constituting part of the contract shall not be annotated but shall be accounted for on Air Photography Report ICAS-2 as shown in figure 2.

A roll of survey film shall not contain photography from more than one camera.

3.3.2.1 Roll Number: When a roll is ready for annotation a Federal roll number shall be requested from the Chief, NAPL Reproduction Centre, Department of Energy, Mines and Resources. The request shall state the ICAS Job number, film format ($9\frac{1}{2}$" or 70mm) and the type of film (black and white or colour).

3.3.2.2 Numbering Sequence: Every exposure constituting part of the contract shall be annotated in numerical sequence, starting with number 1, from the beginning to the end of the roll.

To orient the film prior to annotating, place the film emulsion down, in such a manner that the direction of the flight of the aircraft as indicated by the negatives, is from left to right. When the film is thus oriented, the annotation shall normally be placed in the lower left-hand corner of each negative on the roll. Each sequential number shall be preceded by the Federal roll number (eg. A20741-1, A20741-2 ... etc.).

3.3.2.3 First Picture Annotation: The first annotated exposure on each roll shall contain the following additional information:

a) ICAS Job number, and area, Altitude Above Sea Level
b) Line number, direction, negative numbers, date
c) Camera type, magazine number, Film type (panchromatic, IR)
d) Lens number, calibrated focal length, filter type.

The first annotated exposure of each line shall contain the following additional information:

a) ICAS Job number and area

b) Line number, direction, negative numbers, altitude, date

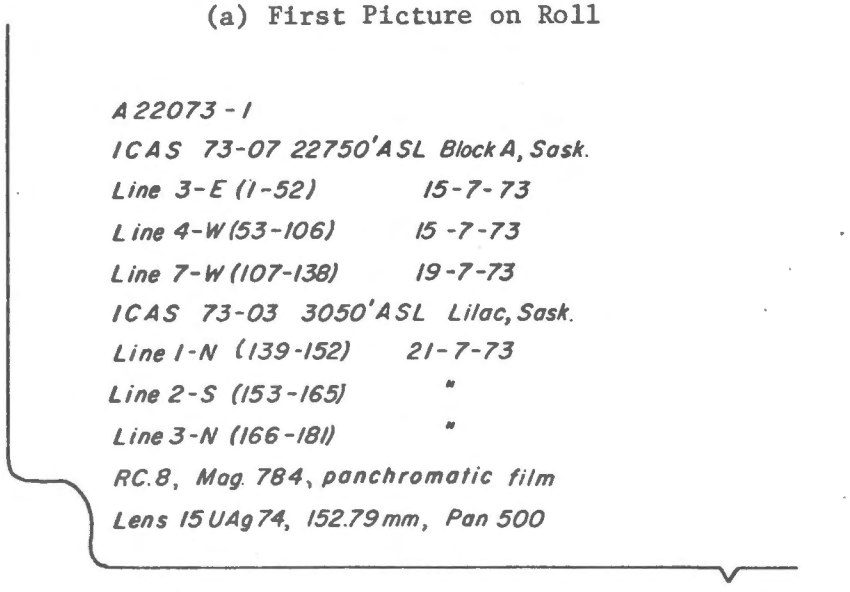
c) Lens number, calibrated focal length.

The form of the annotation is illustrated in Figure 4.

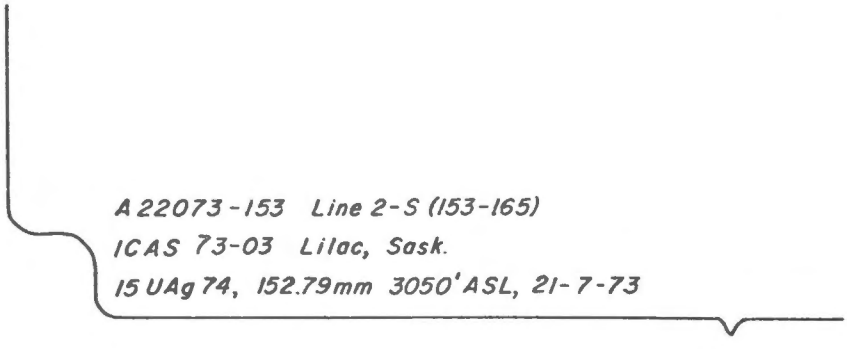
FIGURE 4

Example of Annotation

(a) First Picture on Roll



(b) First Picture on Line



3.3.3 INDEX MAPS

Three copies of an index map of the photography shall be supplied. At least one of these copies shall be a full-colour map. The index shall be drawn in accordance with the following specifications; (as illustrated in Figure 5).

1 Every fifth photo center shall be plotted accurately on the index map.

2 The center of each indexed photograph shall be represented by a small open circle of radius approximately equal to 10% of the flying height above ground at map scale.

3 The circles shall be joined by straight lines and each continuous line overlap shall be represented by a chain of unbroken lines and circles. The terminal circles of each continuous line shall be filled in.

4 Each circle shall be identified with the exposure number it represents, and each continuous line shall be identified as to roll number.

5 The latitude and longitude of the index map shall be shown along at least two borders of the map. The scale of the map should be 1:250,000 if this scale is consistent with legibility and compactness.

6 The index shall show only the flight lines as flown and shall not include the prescribed lines. Lines shall be numbered in the same manner as the prescribed lines.

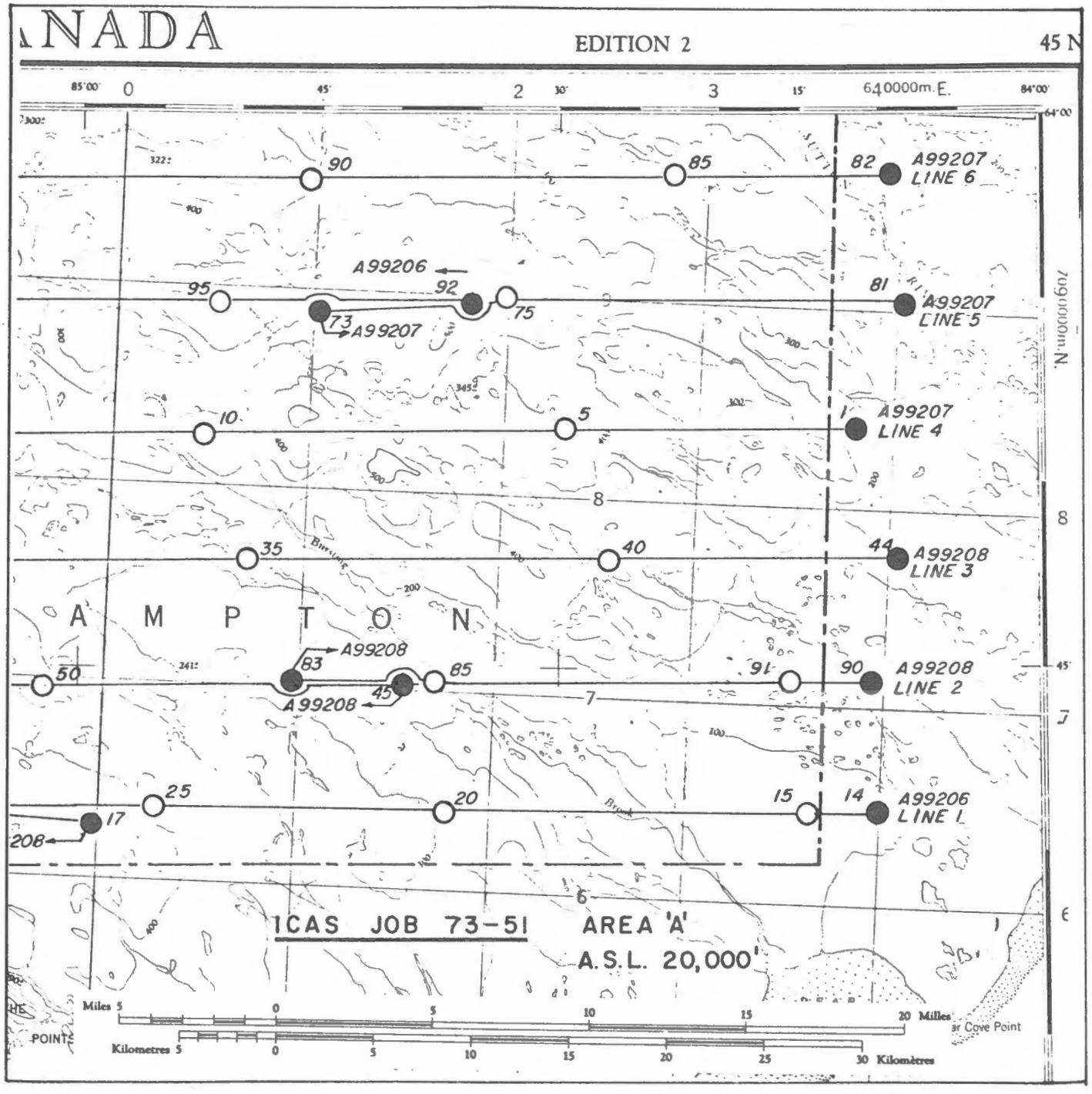
3.4 PRINT PRODUCTION

3.4.1 PRINTER AND PRINT MATERIAL

All contact printing shall be done on an autododging printer meeting the requirements of CSA Z7.2 (ANS1 PH3.8), Z7.2.1 and Z7.2.2. Measurement of uniformity of illumination to these standards may be made by photographic means with either no negative or a uniform neutral negative in the printer.

FIGURE 5

Sample Index Map



The nature of the print material and of the processing and drying procedures shall be such that the dry prints remain flat indefinitely over a wide range of relative humidities.

The prints shall be free of processing stains and the permanency of the image shall be the best which can be obtained by normal processing and thorough washing.

3.4.2 NUMBER OF PRINTS

Each annotated negative shall be printed. The required number of copies will be specified in Part 4 of the contract.

A legible image of the camera data panel shall be printed on each photograph.

3.4.3 PRINT DENSITY AND CONTRAST

For paper prints the minimum reflection density should be 0.2 and the maximum 1.1. Densities are for 45° illumination and normal viewing with unexposed fixed-out paper used as zero density. They apply to measurements made on an area about three millimetres in diameter.

3.5 COMPLETION OF CONTRACT (DELIVERY)

The following items, delivered together, to the Secretary of the I.C.A.S. shall constitute a submission of aerial photography on a contract.

1 Prints: the number of sets specified in Part 4.
2 Air Photography Report ICAS-2: 4 copies.
3 Air Photography Report Supplement ICAS-2b: 1 copy for each flight containing the computations of Section 2.4.2.
4 Aerial Negatives: delivered on the prescribed spool and in the predescribed can (see 3.2.5).
5 Index map: 3 copies (see 3.3.3).
6 Packing Slip: 2 copies; containing the following information:

a) ICAS Job number

b) Area by roll(s) and negative number

c) line numbers and mileage per line

d) number of sets of prints

e) forms and indexes supplied

f) whether the delivery is progressive or final.

PART 4
JOB SPECIFICATION

4. JOB SPECIFICATION

GENERAL

This part of the Technical Specifications defines the requirements for a particular job.

For any contract area, these requirements will be found on I.C.A.S. Form 7 - "Job Specification" in the contract.

An example of such a job specification follows.

EXAMPLE OF JOB SPECIFICATION

ICAS-7

General Requirement

Vertical photography meeting the ICAS Technical Specifications, 1973 Parts 1, 2, 3 and 4, for the following purpose:

Required by the Surveys & Mapping Branch for photogrammetric mapping involving aero-triangulation in A.7 plotters, numerical adjustment, and subsequent compilation using Balplex plotters.

A. COVERAGE

1. Flight line plan

Attached. Consists of 14 lines and part lines totalling 1237 line miles of photography.

2. Flying height, photo scale

Flying height shall be 22,750'ASL to produce average photo scale of 1:40,000 (3333'/in.) at datum elevation 2750'ASL.

3. Navigation, line spacing

Line spacing is 21,000 feet. Lateral overlap at datum, 30%; at maximum ground elevation of 4000', overlap will be 24%, assuming no deviation from prescribed flight lines. Minimum lateral overlap of 5% may be accepted at discretion of Air Survey Section in isolated cases where due to extreme relief.

4. Camera operation, forward overlap

Average forward overlap shall be 58%. Isolated overlaps less than 52% due to relief may be accepted only where overlap common to 3 successive exposures is at least 5%.

EXAMPLE OF JOB SPECIFICATION....Con't

B. PHOTOGRAPHIC REQUIREMENTS

1. Camera

Category A standard wide-angle survey camera.

2. Film, filters

Panchromatic film on stable polyester base, exposed behind a minus-blue filter excluding wavelengths shorter than 450nm.

3. Film processing, Average Gradient

Negatives shall be exposed and processed for a minimum density range of 1.0.

Average gradient 1.3 ± .1

4. Prints, printing

Two sets auto-dodged contact prints on double-weight, semi-matte, stable-base paper. Representative sample prints shall be submitted for user's approval prior to printing bulk of contract.

C. CONDITIONS

1. Solar altitude

Minimum 30^{o}

2. Timing

Photography to be carried out after disappearance of seasonal snow, and prior to October 1st.

3. Photo conditions, weather limitations

Clear sky or thin uniform overcast. Lower cloud or cloud shadow, not obscuring more than 5% of any photograph may be accepted at discretion of Air Survey Section, if the terrain obscured thereby is alternatively covered stereoscopically by forward or lateral overlap.

D. GENERAL

1. Termination Date

December 31st, 1974

2. Delivery instructions

Prints, negatives, film reports (4 copies) and indexes (3 sets) shall be delivered to the Secretary, I.C.A.S., not later than 60 days after exposure of the film.

3. Liaison

4. Remarks

APPENDIX
GENERAL CONDITIONS

APPENDIX

1. GENERAL CONDITIONS

INTERDEPARTMENTAL COMMITTEE ON AIR SURVEYS

1.1 GENERAL CONFLICTING REGULATIONS

Where regulations exist which conflict with the requirements of a contract, the contractor shall inform the Secretary, ICAS.

1.2 EMR PERSONNEL

No person who is employed by the Department of Energy, Mines and Resources may be employed or used in any way by a contractor in the production or inspection of photography required or dealt with in contracts awarded on behalf of ICAS.

1.3 COPYRIGHT

Copyright to all air photography produced under Federal contract is invested in the Crown from the moment of exposure. The contractor shall not make prints, diapositives or other reporductions from such negatives for any agency or purpose other than those set out in the contract, without written authorization from the Secretary, ICAS.

1.4 REPORTS

The contractor shall forward a scheduled weekly report of progress to the Secretary, ICAS. The report shall list current ICAS projects and areas thereof that are held by the contractor and shall include all information indicated on Form ICAS 4.

The reporting period shall begin when the contract is awarded and shall continue until final delivery of all materials of until terminated by the ICAS.

1.5 DELIVERY

All film, prints, film reports and indexes shall be delivered as specified or as directed by the Secretary, ICAS. All deliveries shall be prepaid.

Every delivery of prints or film shall be accompanied by a packing slip, in duplicate, four copies of Form ICAS 2 for each roll, one copy of Form ICAS 2B for each roll and three copies of the index maps. Each packing slip shall indicate the relevant ICAS project number. If materials relevant to more than one contract are included in a single delivery, a separate packing slip for each contract shall be provided.

All packing slips shall list the area by roll and negative numbers, scale, line number and mileage per line and shall state the number of sets of prints supplied. The packing slip shall also list the forms and indexes attached and shall indicate whether the delivery is progressive or final.

1.6 INVOICES - SUBMISSION

Separate invoices for each contract shall be submitted in quadruplicate to the Secretary, Interdepartmental Committee on Air Surveys and shall show ICAS reference number and DSS contract number. Distinct units of the contract shall be itemized separately. Invoices covering more than one area or a portion of one area shall have as an appendix a copy of the packing slip or slips to which the invoice refers or shall list the areas by roll and negative numbers.

Contracts valued under $2,000.00 shall be covered by one invoice.

1.7 INVOICES - PAYMENT

Invoices for contracts under $2,000.00 will be paid in full when acceptability of the photography has been established.

With the exception of uncompleted blocks of Block Photography and stand-by contracts, payment shall be made on invoices for contracts valued over $2,000.00 at 75% of the invoiced amount. Payment of the balance will be deferred until complete acceptability of the photography has been established.

At the end of the photo season in any year, the contractor may invoice for the delivered line mileage in uncompleted blocks and the Secretary, ICAS may authorize payment of 50% of the line mile rate for all acceptable photography in any such uncompleted block.

Progress payments do not constitute evidence of acceptability of air survey photography, and any such payment for any photography subsequently judged unacceptable shall be debited against the value of portions that are acceptable. In the event that progress payments to the contractor exceed the value of accepted air survey photography, the contractor shall be liable to the Crown for the amount of such excess.

1.8 BLOCK PHOTOGRAPHY

Block photography applies only to mapping. A block is a 1:50,000 or 1:25,000 map sheet as specified in the contract.

1.9 REJECTED AND SUB-STANDARD PHOTOGRAPHY

Photography, which does not meet ICAS Specifications, will be either classified as sub-standard or rejected.

Rejected photographic film will be returned to the contractor at the contractor's expense. The contractor will be responsible for ensuring that the Federal Annotation is removed.

Sub-standard photography used to complete contract commitments will not be eligible for payment at the full contract rate. The contractor will be notified by the Minister of any photography classed as sub-standard and the adjusted rate that will be applied to it. A

schedule of discounts covering sub-standard photography will be issued each March by Secretary, ICAS.

Isolated bits and pieces of photography are of no use to ICAS and if submitted, will not be paid for.

1.10 TERMINATION OF CONTRACT

Unless otherwise stated, all contracts terminate 31 December in the calendar year in which they were issued.

1.11 PERFORMANCE STANDARDS

Penalties may be assessed for non-performance and unsatisfactory performance, as detailed in individual contracts, in accordance with the Schedule of Discounts issued by the Interdepartmental Committee for Air Surveys on 1 April each year.

2. GENERAL CONDITIONS

DEPARTMENT OF SUPPLY AND SERVICES

1026 (S-100 A)

1. Interpretation

(1) Unless the context otherwise requires,

(*a*) "the agreement" means the particular agreement or contract of which, in each specific case, these general conditions are made a part;

(*b*) "the contract" includes the agreement, these general conditions and any supplemental general conditions, specifications, labour conditions, schedules and any other documents referred to in the agreement as constituting the contract;

(*c*) "supplemental general conditions" means any other general conditions forming part of the contract;

(*d*) "herein", "hereby", "hereof", "hereunder" and similar expressions, when used in any section, shall be understood to relate to the contract as a whole and not merely to the section in which they appear;

(*e*) "work" means the whole of the work, materials, matters and things required to be done, furnished and performed in order to carry out the contract;

(*f*) "finished work" means the supplies or projects or other work completed in accordance with the provisions of the contract;

(*g*) "equipment" includes machinery, apparatus, jigs, tools, dies, gauges, instruments and equipment of all kinds;

(*h*) "specifications" means the specifications, plans, drawings, designs and models, if any, furnished to the Contractor by Her Majesty or the Minister for the carrying out of the contract;

(*i*) "Government Issue" means all materials, parts, components, equipment, specifications, articles and things which may be supplied to the Contractor by or on behalf of Her Majesty for the purposes of the work;

(*j*) "contract price" means the amount expressed in the contract to be payable to the Contractor for the finished work;

(*k*) "Minister" means the Minister responsible for the contract and includes his Deputy Minister and any Acting, Associate or Assistant Deputy Minister and any duly authorized officer or representative of the Minister;

(*l*) "Inspector" means the person designated as such by the contract and any person acting on behalf of Her Majesty or the Minister as the Inspector under the contract;

(*m*) "invention" means any new and useful art, process, machine, manufacture or composition of matter, or any new and useful improvement in any art, process, machine, manufacture or composition of matter;

(*n*) the singular number includes the plural and vice versa.

(2) In the event of any inconsistencies, the provisions of the agreement and these general conditions shall prevail over the specifications and the provisions of the agreement and supplemental general conditions shall prevail over these general conditions.

2. Powers of Minister

The Minister is the agent of Her Majesty for all purposes of the contract. Nothing contained in or omitted from the contract shall restrict any of the rights or powers of Her Majesty or the Minister. Every right, remedy, power and discretion vested in the Minister under the contract or otherwise shall be cumulative and non-exclusive.

3. Assignment and Sub-Letting

(1) The Contractor shall not assign the contract or sub-let any of the work without the prior written consent of the Minister and any assignment or sub-letting made without such consent shall be of no effect; provided that, unless the contract or the Minister directs otherwise, the Contractor may sub-let such portions of the work as is customary in the carrying out of similar contracts. No assignment or sub-letting shall relieve the Contractor from any of its obligations under the contract or impose any liability upon Her Majesty or the Minister to an assignee or sub-contractor.

(2) Unless otherwise agreed to by the Minister in any assignment or sub-letting the contractor agrees to bind each assignee or sub-contractor by the terms of the general conditions, the supplemental general conditions, if any, the labour conditions, the drawings and specifications as far as applicable to the work.

(3) No act or omission of the contractor whether before or after the entry into the contract shall have the effect of rendering any monies payable by Her Majesty under the contract payable to any person, firm or corporation other than the contractor unless Her Majesty consents thereto.

(4) Subject to the preceding provisions of this section, the contract shall enure to the benefit of and shall be binding upon the successors and assigns of Her Majesty and of the Contractor, respectively.

4. Conduct of the Work

(1) The Contractor agrees to carry out the work diligently and to provide efficient supervision and inspection thereof and that the work will be of proper quality, material and workmanship and in full conformity with the specifications, drawings, models or samples, if any, and all other requirements of the contract.

(2) No materials or parts shall be used or processed and no finished work shall be submitted for acceptance or shall be delivered unless or until approved by the Contractor's inspection staff and, wherever practicable, marked with an approval stamp satisfactory to the Inspector. The Contractor shall keep proper and adequate inspection records which shall at all times be open to examination by the Inspector who may make copies thereof and take extracts therefrom.

(3) The Minister and the Inspector shall have access to the work at all times and to the plant and premises where any part of the work is being carried on, and may make such inspections and tests, of the work and of parts, materials and work-in-process as the Minister or the Inspector may think fit. The Contractor shall provide at its own expense all assistance and facilities, test pieces and samples which the Minister or the Inspector may reasonably require for the carrying out of any such inspections and any such tests as aforesaid, and shall forward at its own expense such test pieces and samples to such person or location as the Minister or the Inspector may direct. The Contractor shall at its own expense provide the Minister and the Inspector with such accommodation as they may require for the purpose of such inspections and any such tests and for the exercise of any other powers conferred upon them hereunder.

(4) The Contractor shall not stop or suspend work pending the settlement or determination of any differences arising under the contract, unless so instructed by the Minister.

5. Specifications, Drawings, Etc.

(1) All specifications, drawings, patterns, samples and other information furnished the Contractor in connection with the contract shall be used by the Contractor solely for the purpose of carrying out the work and for no other purpose except with the consent in writing of the Minister and shall remain the property of Her Majesty and be returned to her Majesty or the Minister upon demand.

(2) Any minor part or parts not shown in the specifications, drawings, patterns or samples, but which are necessary for the due completion of the work shall be deemed to be included in the contract price and no addition to the contract price will be allowed by reason of such omission, unless otherwise agreed to by the Minister.

6. Inspection

All work shall be subject to inspection by the Inspector prior to acceptance. Should the work be defective in materials or workmanship or otherwise not be in accordance with the requirements of the contract, the Inspector shall have the right to reject the work or to require its correction. Inspection by the Inspector either at the plant of the Contractor or of any of its sub-contractors shall not relieve the Contractor from responsibility for defects or other failure to meet the requirements of the contract. The Contractor agrees to accept and be bound by the Inspector's Interpretation of the meaning of the specifications.

7. Title and Acceptance

Except as otherwise provided in the contract, title to the work or any part thereof shall vest in Her Majesty upon delivery to the consignee and acceptance thereof by the consignee. Acceptance by the consignee of the work or any part thereof shall be deemed to be acceptance thereof by Her Majesty.

8. Warranty

Notwithstanding prior acceptance of the finished work, and without restricting any other term of the contract or any condition, warranty or provision implied or imposed by law, the contractor, if requested by the Minister to do so at any time within 12 months from the date of delivery, shall: –

(*a*) replace or make good at its own expense any finished work, excluding Government Issue incorporated therein, which becomes defective or which fails to conform to contract requirements as a result of faulty or inefficient manufacture, material or workmanship;

(*b*) deliver such finished work free from all defects to the delivery point specified in the contract unless otherwise agreed to by the Minister;

provided that where, in the opinion of the Minister, it is not expedient to remove such defective finished work from its location, the contractor shall replace or make good the defective finished work at such location, and shall be paid the actual costs incurred in so doing (including reasonable travelling and living expenses) with no allowance thereon by way of overhead or profit, less a sum equivalent to the cost of making good the defective finished work had it been made good at the contractor's plant.

9. Government Issue

(1) All items comprised in any Government Issue shall be used by the Contractor solely for the purposes of the contract and shall always be and remain the property of Her Majesty and wherever feasible the Contractor shall maintain adequate accounting records of all Government Issue and shall mark the same as being Her Majesty's property.

(2) All Government Issue (except such as are installed or incorporated in the work) shall be returned to Her Majesty upon demand, in the same condition as when supplied to the Contractor; provided that the Contractor shall not be responsible for any loss or damage resulting from ordinary wear and tear, fire or causes beyond the Contractor's control.

(3) All scrap and waste materials derived from any Government Issue or from any other materials, articles or things which are the property of Her Majesty, shall, unless otherwise specifically provided herein, remain the property of Her Majesty and shall be disposed of only as prescribed by the Minister.

10. Conditions Precedent to payment

No payment shall be made to the Contractor unless or until,

(*a*) invoices, inspection notes and all other documents prescribed from time to time by the Minister or Inspector are submitted in accordance with the terms of the contract or instructions of the Minister; and

(*b*) the contractor, if required to do so, establishes to the satisfaction of the Minister that all materials, parts, work-in-process or finished work in respect of which payment is being made are free from all claims, liens, attachments, charges or encumbrances.

11. Indemnity Against Claims

Except as otherwise provided in the contract, the Contractor shall indemnify and save harmless Her Majesty and the Minister from and against any and all claims, damages, loss, costs and expenses which they or either of them may at any time incur or suffer as a result of or arising out of,

(*a*) any injury to persons (including injuries resulting in death) or loss of or damage to property of others which may be or be alleged to be caused by or suffered as a result of the carrying out of the work or any part thereof; and

(*b*) any liens, attachments, charges or other encumbrances or claims upon or in respect of any materials, parts, work-in-process or finished work delivered to or in respect of which any payment has been made by Her Majesty.

12. Title on Progress Payments

Upon any payment being made to the Contractor for or on account of materials, parts, work-in-process, or finished work, either by way of progress payments or accountable advances or otherwise, title in and to all materials, parts, work-in-process and finished work so paid for by such progress payments or accountable advances or otherwise shall vest and remain in Her Majesty unless already so vested under any provision of the contract and the Contractor shall be responsible therefor in accordance with the provisions of Section 14 hereof, it being understood and agreed that such vesting of title in Her Majesty shall not constitute acceptance by Her majesty of such materials, parts, work-in-process and finished work and shall not relieve the Contractor of its obligations to perform the work in conformity with the requirements of the contract.

13. Further Assurances

Wherever it is herein provided that title to any parts, materials, work-in-process or finished work becomes vested in Her majesty, the Contractor shall execute such conveyances thereof and other instruments as the Minister may request.

14. Care of Crown Property

Except as otherwise provided in the contract, no insurance shall be carried by the Contractor on any property, title to which is vested in Her Majesty, including any machinery, equipment and production tooling which is the property of Her Majesty. The Contractor shall take reasonable and proper care of all property, title to which is vested in Her Majesty, while the same is in, on or about the plant and premises of the Contractor or otherwise in his possession or subject to his control and shall be responsible for any loss or damage resulting from his failure to do so other than loss or damage caused by fire or by ordinary wear and tear.

15. Time of Essence

Time shall be deemed to be of the essence of the contract, provided that the time for completing any of the work which has been or is likely to be delayed by reason of force majeure or other cause beyond the reasonable control of the Contractor shall be extended by a period equal to the length of the delay so caused, provided that prompt notice in writing of the occurrence causing or likely to cause such delay is given to the Minister.

16. Secrecy and Protection of Work

(1) The contract and the specifications and all information issued, used or disclosed in connection with the work are confidential and may be classified as to the degree of precaution necessary for their safe-guarding. The Contractor shall at all times take all measures reasonably necessary, including those set out in any Government Issue against espionage, sabotage or fire.

(2) If directed by the Minister, the Contractor shall dispense with the services in connection with the work of any person employed or engaged thereon.

(3) The Contractor shall permit the Minister to maintain guards on or about the premises of the Contractor where the work is being carried on, and to take such other protective measures as may be advisable.

(4) Without limiting the generality of the foregoing, when the contract or any part thereof or any of the work is classified for security purposes "Top Secret", "Secret", "Restricted", or "Confidential" or other category, the Contractor undertakes to comply with and carry out all instructions issued by the Minister dealing with such classified material.

17. Patent Claims and Royalties

(1) The Contractor shall indemnify Her Majesty against all claims, actions, suits and proceedings for the infringement or alleged infringement of any patent based upon the use of any invention protected by such patent and for royalties or other payments which may be payable, in connection with the carrying out of the contract and in respect of the use of or disposal by Her Majesty of articles and supplies furnished pursuant to the contract.

(2) Upon notification from the Minister that any such claim, action, suit or proceedings has been made or commenced, the Contractor shall, unless otherwise instructed by the Minister, conduct at its own expense all negotiations for the settlement of the same.

(3) The Contractor shall forthwith notify the Minister of all royalties which the Contractor or any of its sub-contractors will or may be obligated to pay or proposes to pay for or in respect of the carrying out of the contract, and the basis thereof, and the parties to whom the same are payable, and shall from time to time promptly advise the Minister of any and all claims or arrangements made or proposed which would or might result in further or different payments by way of royalties being made by the Contractor or any of its sub-contractors.

(4) If and to the extent that the Minister so directs, the Contractor shall not pay, and shall direct its sub-contractors not to pay any royalties in respect of the carrying out of the contract except with the consent in writing of the Minister and subject to such conditions as the Minister may impose.

(5) From and after the giving of any such direction, and subject to compliance by the Contractor with the foregoing provisions, Her Majesty shall relieve and indemnify the Contractor from and against all claims, actions or proceedings for payment of such royalties as are covered by such direction.

(6) The contract price shall be reduced by the amount of royalties included therein to which the indemnity provided by sub-section (5) of this section shall apply.

18. Technical Information

The Contractor shall grant to Her Majesty the right to use, publish, translate, reproduce, deliver, perform and dispose of, free of the payment of any royalty, all reports, drawings, blue-prints, data and other technical information specified to be delivered under the contract, but such right shall not imply a license to Her Majesty under any patent or be construed as affecting the scope of any license or other right granted to Her Majesty under any patent.

19. Suspension of Work and Change in Specifications

The Minister may at any time and from time to time order a suspension of the work in whole or in part, and make modifications of, changes in or additions to the specifications, changes in methods of shipment or packing and in the place or time of delivery. All directions given by the Minister with respect to the foregoing shall be complied with by the Contractor. If any such suspension, modification, change or addition shall result in an increase or decrease in the cost of the work the contract price shall be adjusted accordingly provided that the Contractor shall in no event be entitled to compensation for any loss of anticipated profits and provided further that minor increases or decreases in cost shall be disregarded.

20. Use of Canadian Labour and Materials

(1) The Contractor shall use Canadian labour and materials in carrying out the work, to the full extent to which they are procurable, consistent with proper economy and the expeditious carrying out of the work.

(2) Subject to subsection (1) the Contractor shall employ labour from the locality where the work is being executed if it is available.

(3) Subject to subsections (1) and (2) the Contractor shall employ a reasonable proportion of men who have served on active service with the armed forces of Canada and have been honourably discharged therefrom.

21. Default by Contractor

(1) If the Contractor is in default in carrying out any of the terms, conditions, covenants or obligations of the contract, or if the Contractor becomes bankrupt or insolvent, or has a receiving order made against it, or makes an assignment for the benefit of creditors, or if an order is made or resolution passed for the winding up of the Contractor, or if the Contractor takes the benefit of any statute for the time being in force relating to bankrupt or insolvent debtors, the Minister may upon giving notice in writing to the Contractor terminate the whole or any part of the contract.

(2) Upon the giving of such notice the Contractor shall have no claim for any further payment save as hereinafter in this Section 21 provided, but shall remain liable to Her Majesty for all loss and damage which may be suffered by her Majesty by reason of the default or occurrence upon which such notice was based.

(3) Notwithstanding the provisions of sub-section (2) of this section the Contractor shall not be liable for any loss or damage if the failure to perform the contract on which the notice of termination is based arises out of causes beyond the control and without the fault or negligence of the Contractor. Such causes include but are not restricted to strikes, floods, fires, epidemics, Act of God or of the Queen's enemies.

(4) Upon termination of the contract under this section the Minister may require the Contractor to deliver to Her Majesty, in the manner and to the extent directed by the Minister, any finished work which has not been delivered and accepted prior to such termination and any materials, parts, work-in-process, or tools, which the Contractor has specifically acquired or produced for the fulfilment of the contract. Subject to the deduction of any claim which Her Majesty may have against the Contractor arising under the contract or out of the termination, Her Majesty shall pay or credit to the Contractor the value of all such finished work delivered pursuant to such direction and accepted by Her majesty determined in accordance with the contract price and shall pay or reimburse the Contractor the reasonable and proper cost to the Contractor of all materials, parts or work-in-process delivered to Her Majesty pursuant to such direction.

(5) If after notice of termination of the contract under the provisions of sub-section (1) of this section it is determined by the Minister that the default of the Contractor is due to causes beyond the control of the Contractor, such notice of termination shall be deemed to have been issued pursuant to Section 26 (Termination) of these general conditions and the rights and obligations of the parties hereto shall be governed by that section.

22. No Bribe, Etc.

The Contractor warrants,

(*a*) that no bribe, gift, or other inducement has been paid, given, promised or offered to any official or employee of Her Majesty for, or with a view to, the obtaining of the contract by the Contractor, and

(*b*) that it has not employed any person to solicit or secure the contract upon any agreement for a commission, percentage, brokerage or contingent fee.

23. Labour and Health Conditions

The Contractor shall comply with all labour conditions, and with all health conditions and requirements, from time to time applicable to the work.

24. Members of the House of Commons

No member of the House of Commons shall be admitted to any share or part of the contract or to any benefit to arise therefrom.

25. Notice

Any notice to the Contractor hereunder shall be effectively given if sent by letter or by telegram, postage prepaid or with charges prepaid as the case may be, addressed to the Contractor at its address as given in the contract or, if no address is so given, at its address as shown by the records of the Minister. Any notice so given shall be deemed to have been received by the Contractor at the time when in the ordinary course such letter or telegram should have reached its destination.

26. Termination

(1) Notwithstanding anything in the contract contained the Minister may, by giving notice to the Contractor (hereinafter sometimes referred to as a "termination notice") terminate the contract as regards all or any part or parts of the work not theretofore completed. Upon a termination notice being given, the Contractor shall cease work (including the manufacturing and procuring of materials for the fulfilment of the contract) in accordance with and to the extent specified in such notice. The Minister may, at any time or from time to time, give one or more additional termination notices with respect to any or all parts of the work not terminated by any previous termination notice.

(2) In the event of a termination notice being given under the provisions of this section, and subject as hereinafter provided;

(*a*) all finished work, whether completed before the giving of such notice or completed thereafter pursuant to such notice, shall be paid for (subject to acceptance in accordance with the provisions of the contract) on the basis of the contract price;

(*b*) in respect of work not completed before the giving of such notice, and not completed thereafter pursuant to such notice, the Contractor shall be entitled to be reimbursed the actual cost to the Contractor of such uncompleted work, and to receive in addition an amount representing a fair and reasonable profit in respect of work done thereon. Cost shall be determined in accordance with the provisions of the contract, subject to any modifications thereof which the Minister may consider to be appropriate in the circumstances;

(c) Subject as provided in paragraph (d) of this sub-section (2) the Contractor shall be entitled to be reimbursed the amount of any capital expenditures specifically authorized by the contract or approved by the Minister for the purpose of the contract (and actually made or incurred) to the extent that the same (less any depreciation in respect thereof already taken into account in determining cost) were reasonably and properly incurred by the Contractor in respect of and are properly apportionable to the performance of the contract and not included in the amounts paid or payable to the Contractor in respect of finished work;

(*d*) If the contract is exclusively a contract for the making of capital expenditures in respect of additional equipment or plant additions, the foregoing paragraphs (a) to (c) inclusive of this sub-section (2) shall not apply but Her Majesty shall pay, or reimburse the Contractor for the reasonable and proper cost to the Contractor (not previously paid by Her Majesty) of

(i) all additional equipment which prior to the giving of the termination notice shall have been purchased, acquired or manufactured by the Contractor, or contracted for and for which the Contractor is obligated to make payments; and

(ii) all additional equipment in process of manufacture by the Contractor as at the date of the giving of such notice and all work in connection with the construction of the plant addition up to the said date, including the cost of materials and parts contracted for by the Contractor for the purpose of such manufacture or construction and for which the Contractor is obligated to make payment.

(3) Provided always that no reimbursement shall be made in respect of work which has been or may be rejected after inspection as not complying with the requirements of the contract.

(4) The Contractor shall not be entitled to be reimbursed any amount which, taken together with any amounts paid or due or becoming due to the Contractor under the contract, shall exceed the contract price applicable to the work or the particular part thereof.

(5) Notwithstanding the provisions of any of the foregoing sub-sections (1) to (4) inclusive, the amounts which the Contractor shall be entitled to be reimbursed in the event of the giving of a termination notice under this Section 26 shall include, subject as hereinafter provided, the costs of the Contractor of and incidental to the cancellation of obligations incurred by the Contractor pursuant to the termination notice, the cost of preparing the necessary accounts and statements with respect to work performed to the effective date of such termination and commitments made by the Contractor with respect to the terminated portions of the work, wages which the Contractor is obligated under any laws and regulations for the time being in force, to pay to employees whose services are no longer required by reason of such termination, the costs of and incidental to the taking of an inventory of

materials, components, work-in-process and finished work on hand at the effective date of the termination and other costs and expenses of and incidental to the termination, in whole or in part, of operations under the contract; provided always that payment and reimbursement under the provisions of this paragraph shall be made only to the extent that is established to the satisfaction of the Minister that the costs and expenses aforesaid were actually incurred by the Contractor and that the same are reasonable and are properly attributable to the determination of the work or the part thereof so terminated.

(6) In case of disagreement as to the amount which the Contractor is entitled to be reimbursed, the matter shall be referred to the Exchequer Court.

(7) As far as practicable, the Contractor shall place purchase orders and sub-contracts on terms that will enable the Contractor to terminate the same upon conditions and terms similar in effect to these provided in this section, and generally the Contractor shall co-operate with the Minister and do everything reasonably within its power at all times to minimize and reduce the amount of Her Majesty's obligations in the event of termination hereunder.

(8) Title to all materials, parts, plant, equipment and work-in-process in respect of which reimbursement is made to the Contractor as herein provided shall, upon such reimbursement being made, pass to and vest in Her Majesty unless already so vested under any other provision of the contract and such materials, parts, plant, equipment and work-in-process shall be delivered to the order of the Minister, but the materials thus taken over will in no case be in excess of what would have been required for performing the contract in full if no termination notice had been given.

(9) If the Minister is satisfied that by reason of any action taken under the provisions of this section exceptional hardships have resulted to the Contractor, then the Minister may, in his absolute discretion, grant such allowance (not to include in any case, however, any allowance or compensation for loss of profit) to the Contractor as, in the opinion of the Minister, is warranted by the circumstances.

(10) The Contractor shall have no claim for damages, compensation, loss of profit, allowance or otherwise by reason of or directly or indirectly arising out of any action taken or notice given by the Minister under or pursuant to the provisions of this section except to the extent in this section expressly provided.

27. Accounts

The Contractor shall keep proper accounts and records of the cost to the Contractor of the work and of all expenditures or commitments made by the Contractor in connection therewith and the invoices, receipts and vouchers relating thereto. Such accounts, records, invoices, receipts and vouchers shall at all times be open to audit and inspection of the authorized representatives of the Minister (who may make copies thereof and take extracts therefrom) and the Contractor shall afford all facilities for such audits and inspections and shall furnish the Minister and his authorized representatives with all such information as he or they may from time to time require with reference to such accounts, records, invoices, receipts and vouchers. The Contractor shall not, without the consent of the Minister, dispose of any such accounts, records, invoices, receipts and vouchers, but shall preserve and keep the same available for audit and inspection at any time.

28. Foreign Exchange

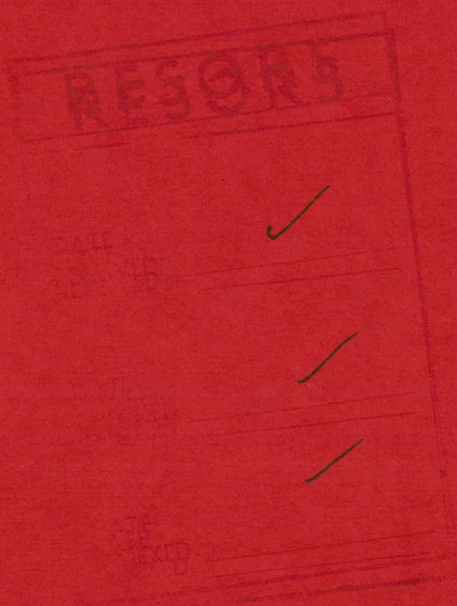
Unless otherwise provided in the contract or agreed to by the Minister, the Contractor shall not be entitled to any increase in the contract price by reason of foreign exchange fluctuations.

29. Increased Taxes and Duties

(1) In the event of any change in any tax imposed under the Excise Act, the Excise Tax Act, the Old Age Security Act or any duties imposed under the Customs Act or the Customs Tariff Act after the date of the contract and which affects the cost to the Contractor of the work, the contract price shall be adjusted to reflect the increase or decrease in the cost to the Contractor.

(2) As a prerequisite of payment the Contractor shall forward to the Minister a certified statement showing the increase or decrease in cost to the Contractor that is directly attributable to the change in tax or duty. Any price revision under this section may be verified by government audit.

(3) For the purpose of determining the adjustment in price referred to in paragraph 2 of this section resulting from any change in tax or duty described in paragraph 1 of this section, where such tax or duty is changed after the date of submission of the Contractors tender or price proposal but public notice of such change has been given by the Minister of Finance before the date of submission thereof, the change of such tax or duty shall, for the purposes of this section, be deemed to have occurred before the date of submission of such tender or price proposal.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