

## 1.0 GENERAL

THESE COMMENTS ARE BASED ON A DETAILED KNOWLEDGE OF THE VEHICLE AND REQUIREMENTS 200 003 011 ECIARD P33-02415A000500390021-0 ART'S AND THE C&J PROPOSAL, A REVIEW OF ROD'S PROPOSAL AND A VERBAL BRIEFING ON T'S PROPOSAL.

AN ATTEMPT IS MADE TO COMPARE THEM USING THE SALIENT POINTS WHICH ARE APPARANT TO ME.

THE COMPARISON IS MADE BY MAJOR COMPONENT OR SUB SYSTEM FIRST, FOLLOWED BY SOME OVERALL COMMENTS.

## 2.0 DETAILED COMPARISON

A BRIEF COMMENT IS MADE WHERE I HAVE OPINIONS OR KNOWLEDGE ON EACH OF THE MAJOR SECTIONS.

### 2.1 OPTICS

ROD'S - 18" F.L. MODIFIED SCHMIDT REQUIRING MIRRORS IN AN APPROXIMATELY 30" LONG BARREL INTRINSIC IMAGE QUALITY IS PROBABLY BEST BUT BOTH MANUFACTURING FOR LIGHT WEIGHT AND MOUNTING DIFFICULTY MAY LIMIT RESULTS SLIGHTLY.

ARTS' - 21" F.L. REFRACTING LENS WITH SCAN MIRROR AND FOLDING MIRROR. IMAGE QUALITY GOOD BASED ON RESULTS OF EXISTING LENS AND BECAUSE OF LONGER FOCAL LENGTH AND LESS DIFFICULT MOUNTING PROBLEMS. RESULTS WILL PROBABLY BE VERY NEARLY EQUAL TO RODS'.

Hy con → T'S - 48" F.L. TELEPHOTO 18"X18" COVERAGE. SINGLE SCAN MIRROR IN FRONT EVEN WITH A CONTOURED PLATEN THE LOW CONTRAST RESOLUTION WILL PROBABLY BE IN THE 35 TO 40 L.P.M. RANGE WHICH MAKES THE POSSIBLE ANGULAR RESOLUTION APPROXIMATELY COMPARABLE TO ROD'S AND ARTS'. THE LENS WILL BE HEAVY.

T'S - 60" F.L. TELEPHOTO 18"X18" THE LOW CONTRAST RESOLUTION WILL PROBABLY BE IN THE 35 TO 40 L.P.M. RANGE. WITH THE LONGER FOCAL LENGTH, THE ANGULAR RESOLUTION COULD BE SLIGHTLY BETTER THAN ROD'S OR ARTS' BUT INDUCED VIBRATION OF FAST CYCLING MAY LOSE ALL THE ADVANTAGE OF INCREASED SCALE.

C&J'S - A 36" F/10 LENS SCAN MIRROR BEHIND LENS HAS GOOD LOW CONTRAST RESOLUTION IN THE 55 LPM RANGE. THE RESULTS WILL BE LIMITED BECAUSE OF THERMAL ENVIRONMENT AND VIBRATION. 18"X18" COVERAGE.

### 2.2 WINDOW

ROD'S THE LARGEST WINDOW AREA IS REQUIRED BECAUSE OF THE CONTINUOUSLY ROTATING FOUR SIDED SCAN MIRROR WHICH CAN'T BE MOUNTED CLOSE AND THUS MINIMIZE WINDOW SIZE. THE LARGE SIZE REQUIRES A THREE LAYER EVACUATED WINDOW SANDWICH WITH A PROPOSED CAPPING SHUTTER SYNCHRONIZED TO THE SLIT TO LIMIT THERMAL INPUT AND THERMAL DISTURBANCE TO THE CAMERA OPTICAL PATH.

ART'S THE SCAN MIRROR PIVOTS NEAR THE WINDOW AND THE TWO PANORAMIC CAMERAS ARE CONVERGENT THUS ALLOWING THE USE OF A SINGLE RELATIVELY SMALL WINDOW. WITH THIS SMALL AREA, A SINGLE THICKNESS WINDOW CAN BE CONSIDERED WHICH WITH A SUITABLE COATING WILL HAVE A TOLERABLE THERMAL INPUT TO THE "Q" BAY. BY ALLOWING THE REFRACTIVE OPTICS TO STABILIZE AT A RELATIVELY HIGH TEMPERATURE THERMAL DEGRADATION FROM GRADIENTS CAN BE AVOIDED USING HELIUM IN THE BAY WILL LIMIT CONVECTION TURBULENCE OPTICAL DEGRADATION TO A LOW VALUE.

T'S 48" & 60" REQUIRE MULTIPLE WINDOWS WITH A SHUTTER ON EACH WINDOW. THE "Q" BAY WILL BE CONSIDERED A LIGHT TIGHT BOX IN THIS DESIGN. THE THERMAL INPUT SHOULD BE LOW TEMPERATURE GRADIENTS IN AND AROUND THE WINDOW WILL HAVE TO BE CONSIDERED IN THE DESIGN. PROBABLY SHUTTER, WINDOWS AND Q BAY AREAS WILL HAVE TO HAVE CONSIDERABLE EMPERICAL WORK TO AVOID IMAGE DEGRADATION. I BELIEVE IT CAN BE DONE WITH CONSIDERABLE EFFORT INVOLVING FULL SCALE MOCK UP AND THERMAL TESTING WITH SIMULATED OPTICAL TARGETS.

C&J THE FIVE SMALL WINDOWS ARE PLANNED AS A TWO LAYER VACUUM PACK AND DO NOT REPRESENT A CRITICAL PROBLEM. THE CONVECTION IMAGE DEGRADATION FROM THE HOT INNER WINDOW SURFACES WILL NOT BE ANY MORE SERIOUS IN THIS UNIT THAN IN THE OTHERS PARTICULARLY IF HELIUM IS USED.

### 2.3 STEREO ANGLE

ROD'S FORWARD OVERLAP ON VERTICAL CAMERAS APPROX 10 DEGREES  
ART'S CONVERGENT STEREO APPROX 20 DEGREES

T'S FORWARD OVERLAP STEREO APPROX 10 DEGREE FOR 48" F.L.,  
APPROX 8 AND 1/2 FOR 60" F.L.

C&J FORWARD OVERLAP STEREO APPROX 14 DEGREES. THE HIGHER STEREO ACUITY AVAILABLE WITH ANGLES LARGER THAN 10 DEGREES IS A VALUABLE TOOL.

### 2.4 FILM TRANSPORT

RODS THE DESIRE FOR ABSOLUTELY SMOOTH AND CONTINUOUS MOTION THROUGH OUT THE FILM TRANSPORT, TOGETHER WITH THE SPACE USED BY THE 30" LENS PATH LENGTH FORCES A MOST COMPLEX AND DIFFICULT FILM TRANSPORT ON ROD'S CAMERA. A SINGLE STRIP OF FILM GOES PAST BOTH SLITS WITH ONE SLIT INTERPOSING ITS IMAGE BETWEEN SCAN SWEEPS OF THE OTHER CAMERA. BECAUSE OF SPACE LIMITATION AND THE DESIRE TO HAVE ZERO FILM C.G. SHIFT A COAXIAL REEL IS PLANNED. ALL OF THESE REQUIRE AT LEAST SIX FILM TWISTERS WHICH AT BEST ARE HAZARDOUS. THE INTERNAL TIMING BETWEEN CAMERAS IS BEING HANDLED ENTIRELY BY SERVO MEANS WITH NO MECHANICALLY LOCKED PHASING BETWEEN CAMERAS. THUS IT IS THE SAME FILM STRIP. THIS IS ALSO DIFFICULT AND HAZARDOUS. AT BEST THE FILM TRANSPORT IS A

DIFFICULT AND LEGTHY DEVELOPMENT. BECAUSE OF THE LONG  
FILM PATHS INVOLVED THE PROCESS OF PROVIDING AN ISOLATED CHAMBER  
WITH APPROVED FOR RELEASE 2001/03/01 : CIA-RDP83-02415A000500390021-0  
DIFFICULT TO DESIGN AND ALMOST IMPOSSIBLE TO MAKE A REASONABLE  
OPERATIONAL DEVICE FOR SERVICING.

ARTS' THESE CAMERAS HAVE SEPARATE PRESSURIZED AND COOLED FILM  
CASSETTES FOR EACH CAMERA. THE TWO CAMERAS SPOOL IN OPPOSITE  
DIRECTIONS AND THUS AVOID ANY LARGE C.G. SHIFT OF THE FILM. THE  
FILM TRANSPORT IS STRAIGHT THROUGH AND THE INTERMITTENT FILM MOTION  
IS PROVIDED BY MERELY STOPPING THE FILM AND LETTING IT LIFT  
OFF AND DE-COUPLE FROM THE CONTINUOUSLY ROTATING PLATTEN ROLLER.  
AS THE ONLY INTERMITTENCY IS THE PLATEN METERING ROLLERS AND THE  
SHORT LENGTH OF FILM ON THE PLATEN, NO SIGNIFICANT VIBRATION IS  
EXPECTED FROM THE FILM TRANSPORT. IT IS ESSENTIALLY A SIMPLE  
SMOOTH FILM ACTION WITH CONSTANT SPEED SPOOLING. ACCURATE  
PHASING BETWEEN THE CAMERAS TO PROVIDE A FIXED ANGLE BETWEEN SCANS  
IS ACHIEVED BY A SINGLE MOTOR DRIVE. THIS IS DONE TO PROVIDE A  
POWERFUL PHOTOGRAMMETRIC TOOL. IT IS NOT REQUIRED FOR FILM HANDLING.

T'S THE 48" & 60" FILM TRANSPORTS MUST BE EXTREMELY  
FAST CYCLING (APPROXIMATELY TWO PER SECOND). THIS IS  
DIFFICULT AND WILL CAUSE SEVERE INTERNAL VIBRATION AND PROBABLY  
IMAGE DEGRADATION. TWO PER SECOND IS THE FASTEST  
FEASIBLE 18" FILM TRANSPORT DEVELOPED TO DATE AND IT WAS NOT  
SATISFACTORY FROM AN INTERNAL SHOCK AND VIBRATION VIEWPOINT.  
ACHIEVING HIGH GROUND RESOLUTION WITH A LARGE FAST CYCLING FRAME  
CAMERA IS A DIFFICULT AND POSSIBLY  
UNSUCCESSFUL DEVELOPMENT. NO GOOD FAST CYCLING (2 PER SECOND OR  
FASTER) LARGE (18") FRAMING CAMERAS HAVE EVER BEEN DEVELOPED  
THOUGH SEVERAL HAVE BEEN ATTEMPTED.

C&J THE EXISTING "B" UNIT WILL BE USED ESSENTIALLY AS IT IS  
WITH THE CYCLING PERIOD ABOUT 70 PERCENT FASTER - IE - 1 AND 1/4  
SECONDS BETWEEN EXPOSURES VERSUS THE PRESENT 2 AND 1/5 SECONDS BETWEEN  
EXPOSURES. THIS CAN BE READILY ACHIEVED WITHOUT MAJOR CHANGE IN THE  
CAMERA. THIS CAMERA A RELIABLE AND FULLY DEVELOPED UNIT WITH  
THE LOWER GROUND RESOLUTION EXPECTED. THE FILM TRANSPORT DISTURBANCES  
WILL NOT LIMIT THE RESULTS.

2.5 IMC

ROD'S CAMERA PROPOSES TO ACHIEVE IMC BY SHIFTING THE FILM  
SIDEWAYS ALONG THE SLIT BY MEANS OF SERVO CONTROLLED "TOE-IN" ROLLERS.  
AS IT IS IMPOSSIBLE TO GUIDE OR PUSH THIN BASE FILM BY EDGE GUIDES  
OR FLANGES, THE ONLY MEANS OF ACHIEVING PROPER IMC  
VELOCITY IS TO CONTROL THE RATE OF "TOE-IN" OF ROLLERS SO THAT THE  
FILM WILL MOVE AXIALLY ALONG THE ROLLERS AT THE PROPER RATE.  
THIS APPEARS TO BE A MOST DIFFICULT TECHNIQUE WHICH WILL BE SUBJECT  
TO ALL THE VAGARIES OF FILM TENSION, FILM CONDITION AND TRANSPORT  
SMOOTHNESS. IT DOES NOT APPEAR TO BE PRACTICAL FOR REASONABLE  
IMC ACCURACY.

ARTS' IMC IS PROPOSED TO BE ACHIEVED BY A SKEWING OF THE PRIMARY  
SCAN MIRROR AXIS TOGETHER WITH A COORDINATED IMAGE DE-ROTATION  
MOTION OF THE FOLDING MIRROR. ALTERNATELY IT MAY BE PLANNED TO  
SWEEP THE STABILIZED MOUNT IN PITCH. EITHER METHOD WILL PROVIDE  
GOOD RESULTS THOUGH THE MIRROR SYSTEM WILL HAVE LESS WEIGHT.

T'S PROPOSAL IS TO ACHIEVE IMC BY MIRROR MOTION ABOUT A  
HORIZONTAL AXIS WHICH IS IN ADDITION TO THE SCAN MOTION. THIS IS  
PRACTICAL AND STRAIGHTFORWARD AND WORKED WELL IN THE ORIGINAL "C".  
CAMERA ACCURACY SHOULD BE GOOD.

C&J CAMERA ACHIEVES IMC BY ROCKING THE OPTICAL STRUCTURE AROUND  
A HORIZONTAL AXIS BY CAM DRIVE. EVEN WITH A X3 INCREASE IN RATE  
THE MOTION IS VERY SLOW AND GOOD IMC AND SMOOTH MOTION SHOULD  
RESULT. A CHANGE IN CAM AND STIFFENING OF FOLLOWERS AND SHAFTS  
WILL BE NECESSARY BUT RELATIVELY SIMPLE.

3.0 ESTIMATE OF GROUND RESOLUTION POSSIBLE

BASED ON EXPERIENCE WITH THE ORIGINAL "C" UNIT AND UTILIZING  
ESTIMATES FROM DATA AND METHOD IN NIELSON'S REPORT ON OPTICAL  
DEGRADATION THROUGH SHOCK AND BOUNDARY LAYER, FOLLOWING IS MY  
ROUGH ESTIMATE OF THE POSSIBILITIES UNDER PLANNED OPERATIONAL ENVIRONMENT  
USING ANGULAR RESOLUTION AS THE BASIS OF COMPARISON ORIGINAL "C"  
BEST RESULTS WERE 30 LPM WHICH RESULTED IN 6" GROUND RESOLUTION AND  
ANGULAR RESOLUTION OF .0073 MIL RADIUS USING NIELSON'S METHOD  
IT IS ESTIMATED THAT RESULTS IN THE "Q" BAY THROUGH BOUNDARY LAYER  
AND SHOCK WARE WILL BE LIMITED TO .01 MIL RADIUS ANGULAR RESOLUTION.  
THEREFORE THE "Q" PROJECT RESULTS CAN PROBABLY NOT BE PUSHED BEYOND  
A GROUND RESOLUTION OF APPROXIMATELY 9 TO 10 INCHES

ROD'S CAMERA IS PLANNED FOR 1 FOOT

ART'S CAMERA IS PLANNED FOR 1 AND 1/2 FOOT

ARTS IS LESS THAN RODS ONLY BECAUSE OF THE LONGER SLANT RANGE  
BECAUSE OF CONVERGENT STEREO. IT IS BELIEVED THAT THE HIGHER STEREO  
ACUITY IS A BETTER TOOL THAN THE 1 FOOT WITH POORER STEREO.

T'S CAMERAS ARE LIMITED TO 9 TO 10 INCHES BY EXTERNAL  
DEGRADATION SO THE ADVANTAGES IN SCALE OF THE LONG FOCAL LENGTHS  
ARE LOST. THERE IS A GREAT DEAL OF DOUBT THAT EVEN THIS

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RESOLUTION CAN BE ACHIEVED DUE TO INTERNAL VIBRATION DIFFICULTIES  
 BECAUSE OF FAST CYCLING REQUIRED BY LONG FOCAL LENGTH.  
 DEGRADATION IS EXPECTED TO PRODUCE 3.3 FEET GROUND RESOLUTION WHICH IS  
 AN ANGULAR RESOLUTION OF .027 MIL RADIUS THE LENS ITSELF IS CAPABLE  
 OF BETTER THAN .02 MIL RADIUS AT LOW CONTRAST AND AT HIGH  
 CONTRAST GOES TO .01 MIL RADIUS APPROXIMATELY. THEREFORE  
 THE LENS IN THIS CAMERA IS A GOOD ONE.

4.0 ROUGH RELIABILITY COMPARISON BY SYSTEM COMPLEXITY  
 ROD'S CAMERA SYSTEM IS X MOST COMPLEX AND HAS MOSTLY  
 ACTIVE ELECTRONIC ELEMENTS DETERMINING ITS INTERNAL SYNCHRONIZATION,  
 PHASING AND ACCURACY AND HAS A MOST DIFFICULT FILM PATH. THE  
 DEVELOPMENT PROCESS WILL BE A LENGTHY AND DIFFICULT ONE TO ACHIEVE  
 RELIABILITY.

ARTS CAMERA SYSTEM EMPLOYS PASSIVE INTERNAL SYNCHRONIZATION  
 AND PHASING (MECHANICAL LOCK) AND HAS A SIMPLE STRAIGHT FILM PATH.  
 THE DEVELOPMENT IS PRIMARILY APPLICATION OF GOOD DESIGN PRACTICE TO  
 ACHIEVE RELIABILITY.

T'S CAMERAS ARE SIMPLE AND EXCEPT FOR THE FAST CYCLING WOULD  
 BE STRAIGHTFORWARD. ACHIEVING RELIABILITY AND GOOD RESULTS WILL BE  
 A DIFFICULT AND LENGTHY PROCESS.

C&J CAMERA IS OF PROVEN RELIABILITY. THE FASTER CYCLING REQUIRES  
 MINIMUM MODIFICATION. THE CYCLING RATE IS MODERATE AND SHOULD NOT  
 REPRESENT A RELIABILITY PROBLEM.

5.0 VIBRATION ISOLATION & STABILIZATION

ALL PROPOSALS EXCEPT C&J PLAN TO USE A C.G. FREE-FREE MOUNTING  
 WITH STABILIZING TORQUERS REFERENCED TO INERTIAL SPACE. ROD PLANS  
 TO USE FLYWHEEL REACTION TORQUES RATHER THAN PUSH-PULL SOLENOIDS.  
 A SLIGHTLY BETTER STABILIZATION QUALITY CAN BE ACHIEVED BUT THERE IS  
 DOUBT THAT THE EXTRA WEIGHT IS WARRANTED AS THE ORIGINAL "C"  
 UNIT ACHIEVED A CONSIDERABLY BETTER ANGULAR RESOLUTION THAN IS NOW  
 PLANNED. THE ONLY DETAILED VIBRATION ISOLATION SYSTEM PROPOSED  
 WAS IN ARTS' PROPOSAL IN WHICH THE VIBRATION DAMPERS ARE REFERENCED  
 TO INERTIAL SPACE. THIS SYSTEM SHOULD AVOID MANY OF THE VIBRATION  
 DIFFICULTIES EXPERIENCED WITH THE ORIGINAL "C" UNIT. THE C&J  
 CAMERA IS NOT PLANNED FOR EITHER DYNAMIC VIBRATION ISOLATION OR  
 STABILIZATION. THE EXPECTED QUALITY OF RESULTS DOES NOT WARRANT IT.  
 THE VEHICLE IS VERY SMOOTH.

SUMMARY

RODS CAMERA HAS INTRINSIC POSSIBILITY OF HIGHEST QUALITY RESULTS  
 BUT THE PROBABILITY IS THAT EXTERNAL CONDITIONS LIMIT THE RESULTS.  
 THE PRICE PAID IN COMPLEXITY AND DIFFICULTY OF DEVELOPMENT FOR AVOIDING  
 ANY INTERMITTENT MOTIONS WHATSOEVER (EXCEPT IMC) IS EXTREME.

ARTS CAMERA WILL PROBABLY PRODUCE THE SAME INFORMATION CONTENT  
 AS RODS AND IS A MUCH SIMPLER AND ACHIEVABLE DESIGN.

T'S CAMERAS CANNOT BE USED TO THEIR FULL ADVANTAGE IN THIS  
 VEHICLE BECAUSE OF CONSEQUENT FAST CYCLING AND EXTERNAL RESOLUTION  
 LIMITATIONS.

C&J CAMERA IS A QUICKLY AVAILABLE INTERIM UNIT WHICH WILL  
 PRODUCE USEFUL RESULTS.

THE COVERAGE OF RODS, ARTS, AND C&J CAMERAS ARE ROUGHLY THE  
 SAME. T'S CAMERAS ARE PROBABLY WEIGHT LIMITED IN COVERAGE.