UNITED STATES ARMY
OPERATIONAL EVALUATION GROUP
LIGHT OBSERVATION HELICOPTER
Fort Rucker, Alabama

REPORT OF EVALUATION

PROJECT NR AVN 2361

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ABSTRACT

1. PURPOSE. To conduct an operational evaluation of Light Observation Helicopter competitive design proposals.

2. SCOPE. Representatives of the Army Aviation School, Army Armor School, Army Artillery and Missile School, Army Infantry School, Army Board for Aviation Accident Research, Army Aviation Board, and the Marine Corps comprised the Army Operational Evaluation Group. Proposals were evaluated separately and then on a comparison basis. The basis for evaluation was the Military Characteristics and Type Specification. The latter took precedence. Liaison was maintained with the Technical Evaluation Group.

3. CONCLUSIONS.

a. A proposal using the T-63 engine will more nearly meet the Army's requirements than will a proposal using any of the alternate engines.

b. The following proposals, listed in order of merit (or desirability), are acceptable.

(1) Bell D-250

(2) Hiller 1100

(3) Boeing-Vertol 131

(4) Sikorsky (Primary)

c. Based on the manufacturer's predicted weight and performance data, and ignoring the Navy's and Army's technical evaluation, the Hughes 369 is the most outstanding proposal.

d. When technically and economically feasible, items listed in Appendix G should be incorporated in the detail specifications of any selected winner(s).

e. Additional requirements, not now specified, exist for the LOH.

f. Development of at least two proposals through user testing prior to selection of a single winner will produce a better LOH.

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a. At least two of the following proposals be developed through user testing prior to selection of a single winner. Proposals are listed in order of merit:

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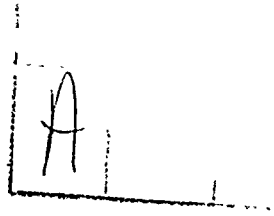
c. The three requirements listed in Appendix I be reconsidered for inclusion on the LOH.



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2. BACKGROUND.

a. The Army Aircraft Development Plan, 1960-1970 (reference 8a), prepared by the Office of Chief of Research and Development, stated that a priority requirement was an aircraft in the light observation area. The L-19, H-13, and H-23 were considered to be obsolete for the missions they perform. The question was posed as to the necessity or desirability of developing a single aircraft to fulfill the entire requirement. An Army Study Requirement, ASR1-60, describing broad development objectives was prepared and presented to industry who, in turn, submitted many design concepts as their solution to the problem. In early 1960, an Army Aircraft Requirements Review Board (Rogers Board) was established to review industry's findings and make recommendations on the courses of action to be followed. The Rogers Board recommended that a design competition be conducted to develop a helicopter to meet the requirement for a light observation aircraft which

would replace the L-19, H-13, and H-23. Further, it was recommended that at least two prototype design proposals be selected and developed through user testing, and then a single winner be selected. This recommendation was approved by the Chief of Staff, United States Army.

b. Military Characteristics for a Light Observation Aircraft were prepared and approved (reference 8d). The US Navy was selected as the developing agency for the Army and Type Specifications were submitted to industry for submittal of competitive proposals.

3. PERSONNEL, ORGANIZATION, AND METHOD.

a. Personnel. The Army Operational Evaluation Group consisted of a representative from the US Army Aviation School, US Army Armor School, US Army Artillery and Missile School, US Army Infantry School, US Army Board for Aviation Accident Research, and US Marine Corps. Other personnel were provided by the US Army Aviation Board. Representatives of the Combat Arms and Aviation School, Marine Corps, and Aviation Board were utilized to consider and analyze those operational concepts and missions envisioned for the LOH by the Combat Arms. Aviation Board personnel were especially selected for their background and experience in specific fields, such as avionics and maintenance, or for Army tactical experience with aviation units. Appendix A lists the names of those individuals assigned to the Army group and a brief background of committee members.

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(1) The committees analyzed each proposal separately and then on a comparison basis. These analyses were based on the information provided by each manufacturer. Significant parameters were established. Each committee established an order of priority of desirability and prepared an analysis indicating the undesirable characteristics of all proposals and the desirable features of those proposals considered high on the priority

list. Additionally, each committee made specific recommendations as to characteristics that should be included in any selected winner.

(2) The committees findings were consolidated and a tentative operational evaluation position was established. This position was then informally discussed with the Navy Technical Evaluation Group.

4. RESULTS.

a. Individual Committee Analysis.

(1) All committees, except the Armament Committee, individually determined that primary and alternate proposals should be evaluated and compared as two separate groups. In this respect, all primary proposals, except Republic's proposals, used the T-63 engine. For the purpose of this analysis, committees considered one of the Republic proposals as a primary and the other as an alternate. This led to a tentative finding that, allowing for a small growth factor for the engine, the Army could satisfactorily meet its requirements with one or more of the primary proposals utilizing the T-63 engine.

(2) Results of a comparison of autorotation characteristics of remaining proposals and known helicopters are shown by Appendix C. The method used and a sample calculation are shown.

(3) Appendix D is a chart which shows the ranking in order of merit assigned by each committee except the Armament Committee. This ranking was not shown because eight of the manufacturers used armament proposals made by General Electric, Burlington, Va., which were basically the same and it was considered that most undesirable features were problems of the armament kit rather than the airframe. It is emphasized that rankings shown for each committee in Appendix D are based entirely on the manufacturers' data without correction.

b. Consolidation of Preliminary Committee Analyses.

(1) Analysis of committee reports resulted in a decision to tentatively eliminate from further consideration all but six of the primary proposals and all but two of the alternates. The following are the proposals eliminated. Appendix E lists undesirable characteristics of each of these proposals.

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Gyrodyne 66

Kaiser KD-161

Kaman K-130

McDonnell 158A

Republic RH-60

Hiller 1099

Hiller 1101

Kaman 130A

(2) The two best alternates (Bell and Sikorsky) were retained because technical input from the Navy was not available to substantiate that the primary proposals still being considered presented realistic weight and performance data or that the sole selection of the T-63 engine was a reasonable and acceptable risk.

(3) Desirable and undesirable characteristics of each remaining proposal are listed by Appendix F.

(4) Specific recommendations as to characteristics that should be included in the detail specifications of any selected winner are contained in Appendix G. Recommendations are essentially for the purpose of clarifying and amplifying the Type Specifications.

c. Analysis Following Coordination With the Navy.

(1) Coordination with the Navy Technical Evaluation Group indicated that both the Navy and Army groups were in agreement as to proposals that could be eliminated from further consideration. However, disagreement was apparent as to the final selection in that the Navy Technical Evaluation Group proposed to recommend only one winner whereas the Army Operational Evaluation Group considered that at least two winners were required to fulfill the approved recommendations of the Rogers Board. Based on the above, a unilateral

decision was made to recommend acceptable winners in order of merit so that a decision could be made by the General and Flag Officers Board.

(2) Based on coordination with the Navy group and a re-examination of remaining proposals, the following decisions were made.

(a) Alternates were eliminated from further consideration. This was primarily due to the excessive cost and weight indicated for alternates and the absence of significantly improved performance resulting from use of an engine other than the T-63. The only apparent significant gain from use of an engine other than the T-63 was in the area of reliability when using a derated engine. Otherwise, alternates, by the manufacturers' figures, were generally critical on meeting endurance or hot day performance requirements or both while utilizing approximately 50% more fuel.

(b) The Hughes 369 proposal was eliminated from further consideration for the following reasons:

1. The Navy group supported the Army group's findings that the performance predicted was comparatively optimistic and did not allow for contingencies.

2. The autorotational characteristics were considered to be borderline. This condition would be further aggravated if this proposal were increased in weight by the amount predicted by the Navy, and would be unacceptable.

3. The avionics installation was considered to be unacceptable due to poor accessibility and the mounting of components in an upside down position (satisfactory operation in this position has not been proven.)

(c) The Lockheed CL-418 was eliminated from further consideration for the following reasons:

1. The proposed rigid rotor system has not been proven.

2. The proposed two-door configuration severely limits access to the cargo/passenger compartment and is not considered acceptable from a tactical viewpoint.

(3) An order of desirability of the remaining proposals was established as follows:

(a) Bell D-250

(b) Hiller 1100

(c) Boeing-Vertol 131

(d) Sikorsky (Primary)

(4) Appendix H is a comparison of the above proposals.

5. DISCUSSION.

a. Choice of Engines.

(1) Prior to the finalization of the Type Specifications, some doubt was expressed as to the capability of the T-63 engine to meet the requirements of the LOH. For this reason, alternate engines were listed by the Type Specification. An analysis of the proposals indicates the following disadvantages when using an engine other than the T-63.

(a) The design gross weight will be increased by approximately 500 pounds with a resultant increase in cost.

(b) The fuel load will be increased from approximately 400-500 pounds to approximately 600-700 pounds indicating an approximate 50% increase in fuel usage and a resulting increased fuel logistical problem.

(c) Even with the increased power, these proposals were generally critical on Army hot day hover performance or endurance or both.

(2) In addition to the above, use of an alternate engine or selection of one proposal using a T-63 engine and another proposal using some other engine would probably result in Army funding of programs for two different engines.

(3) All acceptable proposals using the T-63 engine do not meet the performance requirements of the Type Specification. The Navy Evaluation Group indicates that none of these proposals can meet all performance requirements. It is considered that these requirements

are goals to be strived for if attainable and that the failure to meet such goals does not constitute an unacceptable condition.

(4) The sole selection of one engine for the LOH is a risk such as the Army has taken on the HU-1( ) helicopter and the AO-1( ) airplane. The army evaluation group considers that the risk is reasonable and that although no known growth is now planned for the T-63, some growth of the LOH could be obtained by growth of the T-63.

(5) It is considered that use of an engine other than the T-63 would merely permit the vendors to avoid a part of the engineering effort necessary to achieve the best possible weight and performance with a T-63 engine and increase the Army's cost. Since cost and weight are first priority items, the use of an engine other than the T-63 is considered unacceptable.

b. Selection of One Proposal vs. Two or More.

(1) The Rogers Board's approved recommendation was to select at least two proposals and develop these through user testing prior to selection of a final winner. This position should not require rejustifying; however, there are strong indications that the Navy and certain Army agencies will recommend selection of only one winner with an immediate commitment to production. Reasons justifying this position include:

(a) Reduced cost by reduction of one protytype program, thus allowing full effort on only one program.

(b) An early commitment to production would provide operational aircraft in the field at an earlier date.

(2) The Army Operational Evaluation Group considers that the recommendation to develop at least two proposals through user test prior to selection of a single winner should be fulfilled. Reasons follow:

(a) The direct cost to the airframe manufacturer for developing at least one additional LOH is a very small percentage of the planned program. (This is estimated to be a direct cost of 4-7 million dollars for at least one additional prototype development in an estimated 250 million dollar overall program.)

(b) One of the inputs to the Rogers Board was an analysis of the Army's inventory of light observation aircraft and the predicted LOH requirement. This input indicated that a program which produced production LOH's by 1965 would meet the needs of the Army. It is difficult to believe that this requirement has changed significantly in the last year.

(c) The LOH is programmed into the Army in large numbers (larger by far than any other Army aircraft). For this reason alone, all possible effort must be made to produce the best possible aircraft within the parameters desired by the Army. It is considered that continued competition by at least two reputable manufacturers until Army user testing can be accomplished is a primary method of obtaining the best possible helicopter.

(d) Previous Army experience indicates that when an aircraft is committed to production at an early stage in its development, aircraft reach field units sooner. However, these aircraft are habitually deficient in correctable areas. Corrections when made are much more expensive than if incorporated in production and normally have to be justified on an individual basis. The AO-1( ) "MOHAWK" program is a prime example of the results of a choice of one proposal and early commitment to production. User testing of the AO-1( ) was accomplished on production aircraft and discrepancies exist on this aircraft that make it unsuitable for Army use in its present configuration. This Army airplane was developed under the auspices of the Navy.

c. Additional Requirements. The Army Operational Evaluation Group attempted to evaluate all proposals on requirements as expressed by the Military Characteristics and the Type Specifications. There was obvious variation in opinion as to the validity of all requirements expressed and the lack of certain requirements. However, it was the consensus of the Army group that three requirements exist for the LOH that are not included in the Type Specifications or Military Characteristics and which were previously considered by the Rogers Board. These requirements are listed and discussed in Appendix I.

d. Proposal Validity.

(1) If the Hughes 369 proposal could meet its predicted performance figures and weights, this proposal would be outstanding. In an overall evaluation, using only the manufacturer's data, this proposal

was an unquestionable first choice from a tactical and operational suitability viewpoint. The Hughes 369 proposal was placed second by the Forward Area Maintenance and the Performance/Components Committees. These placements were made notwithstanding the following:

(a) The autorotational characteristic was the poorest of all proposals.

(b) The avionics installation was unsatisfactory.

(c) The predicted performance was optimistic and did not allow for contingencies.

(2) Outstanding and highly desirable features of the Hughes 369 included:

(a) Outstanding with respect to size, weight, and speed.

(b) The small (25') rotor diameter is highly desirable from a tactical viewpoint.

(3) Coordination with the Technical Evaluation Group verified the Operational Analysis Group's findings that performance and weight were considerably optimistic. This then negates the outstanding choice with respect to size, weight, and speed and results in an unacceptable autorotational characteristic. For these reasons and the unsatisfactory avionics proposal, the Hughes 369 proposal was eliminated from acceptable proposals.

6. CONCLUSIONS.

a. A proposal using the T-63 engine will more nearly meet the Army's requirements than will a proposal using any of the alternate engines.

b. The following proposals, listed in order of merit (or desirability), are acceptable.

(1) Bell D-250

(2) Hiller 1100

(3) Boeing-Vertol 131

(4) Sikorsky (Primary)

c. Based on the manufacturer's predicted weight and performance data, and ignoring the Navy's and Army's technical evaluation, the Hughes 369 is the most outstanding proposal.

d. Where technically and economically feasible, items listed in Appendix G should be incorporated in the detail specifications of any selected winner(s).

e. Additional requirements, not now specified, exist for the LOH.

f. Development of at least two proposals through user testing prior to selection of a single winner will produce a better LOH.

7. RECOMMENDATIONS.

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c. The three requirements listed in Appendix I be reconsidered for inclusion on the LOH.

8. REFERENCES.

a. Army Aviation Development Plan, 1960-1970, OCRD, DA, 1 December 1959.

b. ASR 1-60, 1 December 1959, title: "New Light Observation Aircraft Parametric Study, 1965-1970 Time Period."

c. Report of the Army Aircraft Requirements Review Board to the Chief of Staff, US Army, 10 March 1960.

d. Military Characteristics - Light Observation Aircraft, TCTC Item 3408.

e. Type Specification, TS 153, for Light Observation Helicopter (Army), Department of the Navy, BuWeps, 10 October 1960, as amended.

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(b) One of the inputs to the Rogers Board was an analysis of the Army's inventory of light observation aircraft and the predicted LOH requirement. This input indicated that a program which produced production LOH's by 1965 would meet the needs of the Army. It is difficult to believe that this requirement has changed significantly in the last year.

(c) The LOH is programmed into the Army in large numbers (larger by far than any other Army aircraft). For this reason alone, all possible effort must be made to produce the best possible aircraft within the parameters desired by the Army. It is considered that continued competition by at least two reputable manufacturers until Army user testing can be accomplished is a primary method of obtaining the best possible helicopter.

(d) Previous Army experience indicates that when an aircraft is committed to production at an early stage in its development, aircraft reach field units sooner. However, these aircraft are habitually deficient in correctable areas. Corrections when made are much more expensive than if incorporated in production and normally have to be justified on an individual basis. The AO-1( ) "MOHAWK" program is a prime example of the results of a choice of one proposal and early commitment to production. User testing of the AO-1( ) was accomplished on production aircraft and discrepancies exist on this aircraft that make it unsuitable for Army use in its present configuration. This Army airplane was developed under the auspices of the Navy.

c. Additional Requirements. The Army Operational Evaluation Group attempted to evaluate all proposals on requirements as expressed by the Military Characteristics and the Type Specifications. There was obvious variation in opinion as to the validity of all requirements expressed and the lack of certain requirements. However, it was the consensus of the Army group that three requirements exist for the LOH that are not included in the Type Specifications or Military Characteristics and which were previously considered by the Rogers Board. These requirements are listed and discussed in Appendix I.

d. Proposal Validity.

(1) If the Hughes 369 proposal could meet its predicted performance figures and weights, this proposal would be outstanding. In an overall evaluation, using only the manufacturer's data, this proposal

was an unquestionable first choice from a tactical and operational suitability viewpoint. The Hughes 369 proposal was placed second by the Forward Area Maintenance and the Performance/Components Committees. These placements were made notwithstanding the following:

(a) The autorotational characteristic was the poorest of all proposals.

(b) The avionics installation was unsatisfactory.

(c) The predicted performance was optimistic and did not allow for contingencies.

(2) Outstanding and highly desirable features of the Hughes 369 included:

(a) Outstanding with respect to size, weight, and speed.

(b) The small (25') rotor diameter is highly desirable from a tactical viewpoint.

(3) Coordination with the Technical Evaluation Group verified the Operational Analysis Group's findings that performance and weight were considerably optimistic. This then negates the outstanding choice with respect to size, weight, and speed and results in an unacceptable autorotational characteristic. For these reasons and the unsatisfactory avionics proposal, the Hughes 369 proposal was eliminated from acceptable proposals.

6. CONCLUSIONS.

a. A proposal using the T-63 engine will more nearly meet the Army's requirements than will a proposal using any of the alternate engines.

b. The following proposals, listed in order of merit (or desirability), are acceptable.

(1) Bell D-250

(2) Hiller 1100

(3) Boeing-Vertol 131

(4) Sikorsky (Primary)

c. Based on the manufacturer's predicted weight and performance data, and ignoring the Navy's and Army's technical evaluation, the Hughes 369 is the most outstanding proposal.

d. Where technically and economically feasible, items listed in Appendix G should be incorporated in the detail specifications of any selected winner(s).

e. Additional requirements, not now specified, exist for the LOH.

f. Development of at least two proposals through user testing prior to selection of a single winner will produce a better LOH.

7. RECOMMENDATIONS.

a. At least two of the following proposals be developed through user testing prior to selection of a single winner. Proposals are listed in order of merit:

(1) Bell D-250

(2) Hiller 1100

(3) Boeing-Vertol 131

(4) Sikorsky (Primary)

b. Items listed in Appendix G be incorporated, where technically and economically feasible, in the detail specification of any selected winner(s).

c. The three requirements listed in Appendix I be reconsidered for inclusion on the LOH.

8. REFERENCES.

a. Army Aviation Development Plan, 1960-1970, OCRD, DA, 1 December 1959.

b. ASR 1-60, 1 December 1959, title: "New Light Observation Aircraft Parametric Study, 1965-1970 Time Period."

c. Report of the Army Aircraft Requirements Review Board to the Chief of Staff, US Army, 10 March 1960.

d. Military Characteristics - Light Observation Aircraft, TCTC Item 3408.

e. Type Specification, TS 153, for Light Observation Helicopter (Army), Department of the Navy, BuWeps, 10 October 1960, as amended.

APPENDIX A

PERSONNEL AND EXPERIENCE
(Administration Personnel Not Included)

1. PERSONNEL AND EXPERIENCE. Following is a brief synopsis of the personnel and accumulated experience represented by the Army Operational Evaluation Group:

a. Evaluation Personnel.

(1) 16 officers.

(2) 1 enlisted specialist.

(3) 5 DA civilians.

(4) Above represents:

(a) 19 Army pilots.

1. 3 Master Army Aviators.

2. 11 Senior Army Aviators.

3. 3 Army Aviators.

4. 2 civilian test pilots.

(b) 1 Naval Aviator.

(c) 2 non-rated specialists.

b. Accumulated Experience.

(1) Fixed wing time - 61,700 hours.

(2) Helicopter time - 19,400 hours.

(3) Military aviation experience - 270 years.

(a) Represented by background in:

1. Naval aviation experience.

2. Marine aviation experience.

3. Army aviation experience.

(b) Represents qualifications in all Army aircraft (fixed and rotary) and many Navy and Air Force aircraft including jets.

(4) Scientific degrees:

(a) 3 Masters of Aeronautical Engineering.

(b) 8 Bachelors of Science.

(5) Combat experience. 18 of 22 individuals with combat experience in World War II or Korea.

2. BACKGROUND (of individua's).

a. Chairman - COL J. L. MARINELLI, Arty, 034331. Pres, USAAVNBD. MAA; rated 1943. 4300 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, YAC, T-28, T2V (jet), G-91 (jet). 200 hrs rotary wing; qualified in H-13, H-34, HU-1A&B. Sp inst FW. Arty Officers Adv Crs, C&GSC. Combat experience WW II and Korea.

b. Project Officer - LT COL C. M. NEUFELD, Arty, 0981221. Dir, DG Div, USAAVNBD. SrAA; rated 1941. 5000 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, T-28, T2V (jet). 200 hrs rotary wing; qualified in H-13, H-23, H-19, HU-1. Sp inst FW. Arty Officers Adv Crs, C&GSC. Combat experience WW II and Korea.

c. Advisor - MR. M. J. FORTNER, DAC, Aero Engr, USAAVNBD. AA; rated Ln Pilot 1942. 1500 hrs fixed wing during WW II. BS, Aero Engr.

d. Liaison Officer - MAJ L. K. SOLT, Arty, 060200. Ch, Equip Br, Test Div, USAAVNBD. MAA; rated 1944. 5400 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, U-1A, AO-1, C-47. 600 hrs rotary wing; qualified in H-13, H-19, H-34. Inst ex and sp inst FW. Arty Officers Adv Crs, C&GSC. Combat experience WWII. BS, Business Adm.

e. Operational and Tactical Suitability Committee.

(1) Chairman - MAJ G. J. BOYLE III, TC, 071450. Proj Officer, Test Div, USAAVNBD. SrAA; rated 1950. 1500 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, YAC, YAO. 1800 hrs rotary wing; qualified in H-13, H-19, H-21, H-23, H-34, H-37, HU-1A&B, YHO-1, YHO-2, YHO-3. Std inst FW and RW. Abn Officers Crs, Arty GM Officers Adv Crs, Trans Officers Adv Crs, C&GSC. Combat experience WW II and Korea.

(2) LT COL H. L. DANIEL, USMC, 014515. Marine Corps LnO, USAAVNBD. Naval Aviator; rated 1942. 3500 hrs fixed wing; qualified in R4D, R5D, F2H-2, F9F-8, FJ, T2V, T-28, AD-5, OE-2, L-26, L-23, YAC, AO-1, U-1A, L-20. 1900 hrs rotary wing; qualified in HUP-2, HRS-3, HR2S-1, HUS, HOK, HO5S, H-23, Allouette, H-21. Sp inst (Navy) FW & RW. Amphib Warfare Sch, Quantico, Va. Combat experience WW II and Korea.

(3) MAJ D. E. CHAMBERLAIN, Arty, 060823. CDO, USAAMS. SrAA; rated 1944. 3500 hrs fixed wing; qualified in L-19, L-20, U-1A. 800 hrs rotary wing; qualified in H-13, H-19, H-23. Std inst FW. Arty and GM Officers Adv Crs. Combat experience WW II and Korea.

(4) MAJ O. B. BUTLER, Inf, 050507. CDO, USAIS. SrAA; rated 1946. 2000 hrs fixed wing; qualified in L-19, L-20, L-23, U-1A. 500 hrs rotary wing; qualified in H-13, H-23, H-19, H-34. Sp inst FW. Inf Officers Adv Crs, C&GSC. Combat experience WW II and Korea.

(5) MAJ C. E. HARGETT, CE, 01182377. Proj Officer, Test Div, USAAVNBD. SrAA; rated 1951. 2000 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, YAC, YAO, U-1A. 1000 hrs rotary wing; qualified in H-13, H-19, H-21, H-23, H-34, HU-1A&B. Inst ex FW &RW, sp inst FW and std inst RW. Engr Officers Adv Crs. Combat experience WW II and Korea.

(6) CAPT E. P. LUKERT JR., Inf, 063915. CDO, USAAVNS. SrAA; rated 1952. 1800 hrs fixed wing; qualified in L-19, L-20, L-23, U-1A. 500 hrs rotary wing; qualified in H-13, H-19, H-23. Sp inst FW. Inf Officers Adv Crs, Abn & Rngr Officers Crs. Combat experience Korea. BS Mil Science, BAE and MS Aero Engr.

(7) CAPT C. K. STEELE, TC, 084676. Opns Officer, 90th Trans Co (Med Hcptr). SrAA; rated 1952. 1000 hrs fixed wing; qualified in L-19, L-20. 1000 hrs rotary wing; qualified in H-13, H-19, H-23, H-37. Std inst FW. Trans Officers Adv Crs.

f. Performance/Components Committee.

(1) Chairman - MAJ J. I. SCOTT, Arty, 063319. Aero Engr, DG Div, USAAVNBD. Arty & GM Officers Adv Crs. Combat experience Korea. BME; BS & MS Aero Engr. Professional Engr in Trng of Ga., License No. 1201.

(2) CAPT W. E. CROUCH JR., Arty, 064002, Proj Officer, DG Div, USAAVNBD. AA; rated 1960. 500 hrs fixed wing; qualified in L-19, L-20, L-23, U-1A, Glider Pilot. Std inst FW. Arty & GM Officers Adv Crs, Abn Officers Crs. Combat experience Korea. BS Mil Science; MS Aero Engr.

(3) MR. R. J. FOLLOWILL, DAC. Proj Officer, Test Div, USAAVNBD. Civilian test pilot 19 years. 6000 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, YAC, YAO. 3500 hrs rotary wing; qualified in H-13, H-19, H-21, H-23, H-34, H-37, HU-1A&B, YHO-1, YHO-2, YHO-3. Std inst FW. Participated in user testing of all helicopters presently assigned to Army.

g. Avionics, Electrical Systems, Instruments Committee.

(1) Chairman - MAJ J. C. RIKE, Arty, 0936352. Proj Officer, DG Div, USAAVNBD. SrAA; rated 1944. 4000 hrs fixed wing; qualified in L-19, L-20, U-1A, T2V (jet). 400 hrs rotary wing; qualified in H-13, H-23. Std inst FW. Combat experience WW II and Korea.

(2) MR. J. H. GRAY, DAC, (Maj, Ret). Electronics Advisor, DG Div, USAAVNBD. SrAA; rated 1952. 3500 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, U-1A. 300 hrs rotary wing; qualified in H-13, H-23, H-19, HU-1A. Std inst FW. Combat experience WW II and Korea. As aviation electronics advisor, flies test projects to evaluate installed equipment.

(3) MR. C. L. MARTIN JR., DAC. Proj Officer, Test Div, USAAVNBD. Civilian test pilot 18 years. 6000 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, U-1A, YAO. 3000 hrs rotary wing; qualified in H-13, H-19, H-21, H-23, H-34, HU-1A&B, YHO-1, YHO-2, YHO-3. Std inst FW. Participated in user testing of all helicopters presently assigned to Army.

h. Forward Area Maintenance Committee.

(1) Chairman - MR. A. A. HALL, DAC, (Maj, Ret). Dep Dir, Log Div, USAAVNBD. SrAA; rated 1946. 2300 hrs fixed wing; qualified in L-19, L-20, U-1A. 1000 hrs rotary wing; qualified in H-13, H-19, H-21, H-23, H-34. Combat experience WW II and Korea. As military and civilian maintenance test pilot, participated in testing of all helicopters at Aviation Board since 1956.

(2) MAJ J. H. STEBBINS, TC, 0936305. Maint Officer, Log Div, USAAVNBD. MAA; rated 1944. 4400 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, YAO, R4D. 1500 hrs rotary wing; qualified in H-13, H-19, H-21, H-23, H-34, H-37, HU-1A&B, YHO-1, YHO-2, YHO-3. Sp inst FW. Combat experience WW II and Korea.

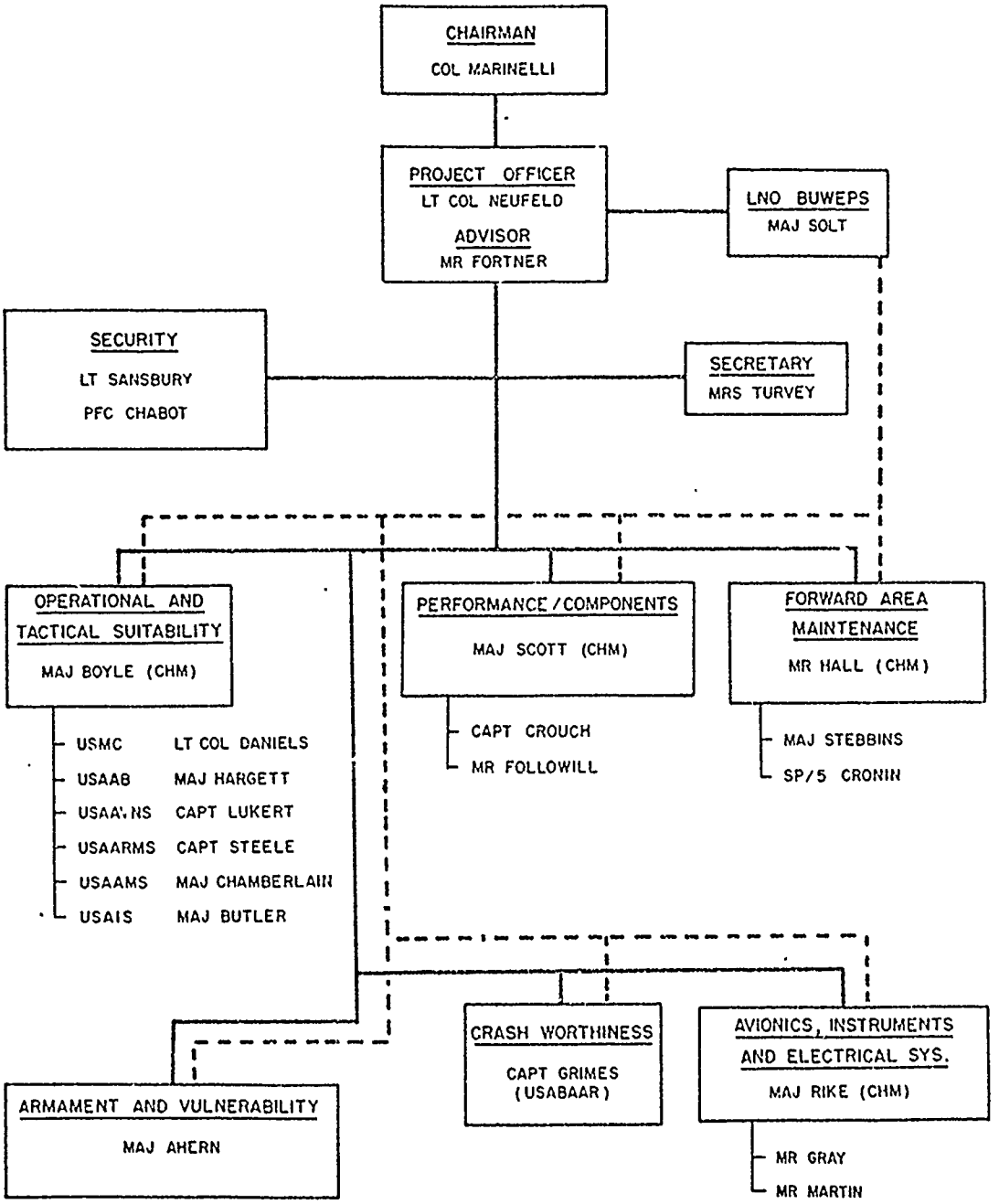
(3) SP/5 J. W. CRONIN III, RA51372489. Sr Avn Mechanic, Log Div, USAAVNBD. Qualified to perform all echelons of maintenance on L-19, L-20, L-23 FW acft, H-13, H-23, H-19, H-21, HU-1A&B hcptrs. USA Avn Sch Maint Crs, Sikorsky Factory Sch H-37, Bell Factory Sch HU-1, Vertol Factory Sch H-21. Has 10 years civilian A&E experience. Combat experience Korea.

i. Armament and Vulnerability Committee. MAJ J. R. AHERN, Arty, 059918. Ch, Armament Br, Test Div, USAAVNBD. SrAA; rated 1943. 3000 hrs fixed wing; qualified in L-19, L-20, L-23, L-26, T-28, T2V (jet). 200 hrs rotary wing; qualified in H-13, H-23. Std inst FW. Arty & GM Officers Adv Crs. Combat experience WW II and Korea. BS Biology.

j. Crashworthiness Committee. CAPT C. H. GRIMES, MSC, 078667. Crash Injury Analyst, USABAAR. AA; rated 1953. 500 hrs fixed wing; qualified in L-19, U-1A. 1000 hrs rotary wing; qualified in H-13, H-23, H-19. Std inst FW. Avn Safety Officers Crs, Med Svc Officers Crs. Combat experience WW II. BA in Science, MA Education.

APPENDIX B

UNITED STATES ARMY OPERATIONAL EVALUATION GROUP
LIGHT OBSERVATION HELICOPTER



APPENDIX C

RELATIVE AUTOROTATIVE LANDING INDEX (AI)*

1. The relative autorotative landing index (AI) constitutes a quick and readily available criteria for evaluating the autorotational landing characteristics of a new helicopter design. The indices of helicopters of known autorotational landing characteristics are compared with the index of a proposed helicopter. The comparison yields a preliminary estimate of the capabilities of the proposed helicopter as compared to known values.

2. The basic factors affecting the autorotational landing are:

a. Energy factor - This is the ratio of the kinetic energy of the rotor to the energy of the falling aircraft.

b. Time factor - The rate of loss of rotor speed is related to the amount of time for pilot control correction and to the rate of loss of rotor energy being used.

c. These factors may be expressed as:

$$\text{Index} = \text{energy factor} / \text{time factor}$$

or

$$\text{Index} = (I_R / W) \div (W/A)$$

Where I_R / W = rotor inertia available per pound of aircraft. The greater this value, the better the landing characteristics.

W/A = disc loading, indicative of sinking velocity. The lower this value, the less the sinking velocity and resultant aircraft energy to be dissipated.

γ = rotor mass factor, which is the ratio of the air to mass forces. The lower this value, the less the rotor tends to decelerate.

*Katzenberger, E. F., and Rich, M. J., "An Investigation of Helicopter Descent and Landing Characteristics Following Power Failure," Journal of Aeronautical Sciences, April 1956.

3. A sample calculation and comparison of the autorotative index of the H-13H is shown below:

a. $$\gamma = \frac{b\rho acR^4}{I_R}$$

Where b = number of blades
ρ = .00238 slug per ft^3
a = lift slope, 5.73 constant
c = blade chord, ft
R = rotor radius, ft
I_R = rotor inertia, slug - ft^2

$$= \frac{(2)\ (.00238)\ (5.73)\ (.916)\ (17.56)^4}{550}$$

$$\gamma = 4.31$$

$$\text{Index} = \frac{I_R / W \times 1000}{W/A\ \gamma}$$

$$= \frac{(.216)\ (1000)}{(2.64)\ (4.31)}$$

Index = 19.0

b. This index value of 19.0 can be compared with the index value of 5.5 for the YHO-2HU. Based on these values, it would be expected that the autorotative landing characteristics of the H-13H would be appreciably better than for the YHO-2HU. Flight experience with both aircraft has shown the H-13H has much better autorotative landing characteristics in comparison with the YHO-2HU.

4. The autorotational characteristics, as reflected by the autorotational index (AI), of the top six primary proposals and the top two alternate proposals are shown in Figure 1. As a basis of comparison, the AI of three known helicopters are also shown. Figure 2 is a chart of the factors used and each value. By this method of evaluation and comparison, all proposals are acceptable with the possible exception of Hughes which would be considered a borderline case.

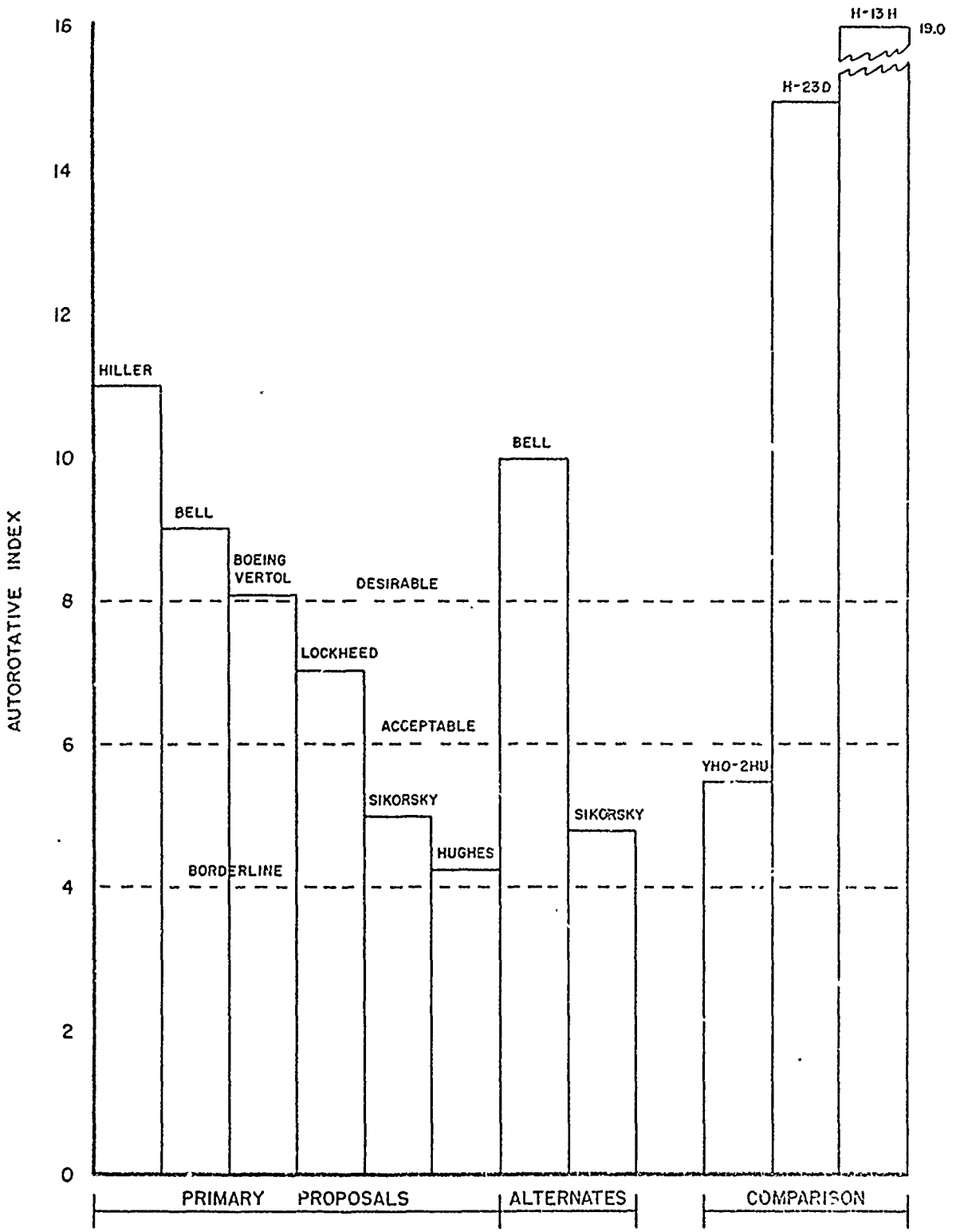


FIG I AUTOROTATIONAL CHARACTERISTICS

AIRCRAFT MFGS	FACTORS									
	b	c	R	I_R	γ	A	W	I_R/W	W/A	INDEX
	PRIMARY PROPOSALS									
HILLER	2	.852	17.5	381	5.74	962	2410	.158	2.51	11.0
BELL	2	1.167	16.0	380	5.49	804	2450	.156	3.05	9.31
BOEING - VERTOL	3	.946	17.5	426	8.53	962	2432	.175	2.53	8.1
LOCKHEED	3	.667	16.5	315	6.43	855	2440	.129	2.85	7.04
SIKORSKY	3	.925	15.75	300	7.8	780	2450	.12	3.14	5.0
HUGHES	4	.563	12.5	165	4.54	490	2050	.081	4.18	4.24
	ALTERNATE PROPOSALS									
BELL 251	2	1.37	16.0	516	4.75	804	2950	.175	3.67	10.0
SIKORSKY	3	1.02	15.75	390*	6.6	780	3104	.126	3.97	4.8
	COMPARATIVE HELICOPTERS									
YHO-2 HU	3	.563	12.5	124	4.56	490	1550	.08	3.16	5.5
H-23 D	2	.946	17.71	492	2.59	985	2550	.193	2.59	14.4
H-13 H	2	.916	17.56	550	4.31	966	2550	.216	2.64	19.0

* SCALED FROM PRIMARY PROPOSAL

FIG 2 AUTOROTATIONAL CHARACTERISTICS INDEX (AI)

RANKING BY COMMITTEE

PARAMETERS	PRIMARY PROPOSALS													ALTERNATES						
	BELL D-250	BOEING-VERTOL 131	CESSNA CH-4	GYRODYNE 66	HILLER 1100	HUGHES 369	KAISER KD-161	KAMAN K-130	LOCKHEED CL-418	Mc DONNELL 158A	SIKORSKY (PRIMARY)	REPUBLIC RH-60 (T-72)	REPUBLIC RH-60 (T-74)	BELL D-251 (T-72)	HILLER 1099 (T-72)	HILLER 1099 (T-74)	HILLER 1101 (T-74)	HILLER 1101 (T-72)	KAMAN 130A	SIKORSKY (T-74)
Tactical & Operational Suitability	2*	4	9	12	6	1	5	10	7	8	2*	11	A6	A1	A4	A4	A3	A3	A5	A2
Forward Area Maintenance	1	9	12	10	8	2	5	7	6	4	3	11	A5	A1	A6	A6	A4	A4	A3	A2
Performance/Components	1	3	8	12	4	2	9	11	5	7	10	A4	6	A1	A7	A8	A6	A5	A2	A3
Avionics/Electrical Systems/ Instruments	4	5	3	7	2	6	11	8	1	9	12	10	A4	A3	A2	A2	A1	A1	A5	A6
Crashworthiness	1	10	7	12	5	4	8	6	9	3	2	11	A6	A1	A5	A5	A3	A3	A4	A2

*Tie for second place. No third place assigned.

NOTE: When two alternates are assigned the same ranking, there is no significant difference in these proposals from the committee viewpoint.

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APPENDIX E

Following is a list of proposals eliminated from further consideration and the significant undesirable characteristics of each proposal. All comments are based on data provided by the manufacturer.

a. CESSNA CH-4.

(1) The two-door configuration is not optimum for passenger and cargo loading and is considered to be unacceptable.

(2) The cargo compartment configuration, coupled with the sliding two-door configuration, limits the width of lateral straight-thru loads to 12 inches. The transmission utilizes space between passengers in the cargo area.

(3) The cargo compartment floor is excessively high above the ground (28 inches). A step is not provided to the cargo area.

(4) The proposal does not meet the Army hot day hover requirement.

(5) Proposal utilizes a combustion type heater, and an extensive winterization kit is required as compared to other proposals.

(6) Roof design limits upward visibility.

(7) Pilot visibility is limited to the left and down by the radio compartment.

(8) Blade track and balance is accomplished by trial and error which is considered pre-state-of-the-art.

(9) The free-wheeling unit is an integral part of the transmission (if the free-wheeling unit malfunctions, the entire transmission must be changed).

(10) The routine servicing system proposed is too complex. Additionally, lubrication is required every fifty hours using two different types of grease and three different types of oil.

(11) Proposal utilizes movable and controllable horizontal stabilizing surfaces.

(12) Tail rotor control cables are difficult to rig and are considered pre-state-of-the-art.

(13) The man-hour requirements for scheduled and unscheduled maintenance are considered excessive.

(14) Proposal indicates use of H-41 helicopter components which are considered pre-state-of-the-art.

(15) The main rotor blade has a complex component structure and poor weight distribution. During folding operations, the flight control system can be undesirably loaded.

(16) The high mean blade lift coefficient will restrict any weight growth by penalizing altitude performance.

(17) The CG travel is comparatively limited.

(18) Engine air intakes are located low in the fuselage resulting in probable high foreign object ingestion.

(19) Hydraulic boost is provided for all three flight controls and auto-stabilization is required. This is considered to create excessive increases in cost, weight, and maintenance.

(20) The UHF/VHF antenna location is not considered optimum.

(21) Anti-collision light provisions appear inadequate to meet the field of view requirement as stated in MIL-L-006730A(Aer).

(22) The dimensions of space allotted to the Battlefield Identification System could not be verified from data supplied in proposal.

(23) Electrical system overvoltage protection is not provided.

(24) An 11 amp/hr battery is proposed for use at 20°F and above. A 22 amp/hr battery is proposed for use from 20°F down to -25°F. (Does not meet Type Specification with 11 amp/hr battery.)

(25) Adequate information, or sufficient detail, not provided to permit thorough evaluation of avionics portion of proposal. (In some instances, information is so meager that proposed location of major components cannot be determined.)

(26) Crew seats have insufficient tie-down strength with safety belt and shoulder harness attached to the seat structure and the seat attached to the floor by quick-release attachments.

(27) Proposed armament installation blocks the left door and chuting appears excessively long.

b. GYRODYNE 66. Proposal exhibits a lack of understanding by the manufacturer of the Army's tactical environment and the intended use of the LOH.

(1) Proposal exceeds the specified maximum height. Additionally, the lower blades are considered to be too low.

(2) Design fails to meet speed requirement for normal rated power. Rate of climb is below average.

(3) Proposal does not provide for replaceable skid shoes.

(4) Major disassembly is required for air transport in C-130 type aircraft.

(5) The ferry range is least of all proposals submitted.

(6) Proposal has a very small cargo compartment with small through-load capability because of transmission hanging in area. Additionally, CG travel is comparatively limited.

(7) The blade folding is complex.

(8) In the event of a crash, the flailing action anticipated from the counter-rotating rotor blades and the additional mass of the rotor system is considered undesirable. The proximity of the transmission to the occupants is an added hazard during crash sequence.

(9) Counter-rotating coaxial rotors present complex tracking problems.

(10) An indeterminate number of push-pull tubes organic to the transmission and mast assembly terminating in vast numbers of rod end bearings requiring checking and servicing indicates undesirable forward area maintenance problems.

(11) A three-stage complex transmission is proposed upon which lubrication and maintenance requirements cannot be determined. An excessive number of replacement man-hours (10) is required for this item.

(12) An overrunning clutch is integral to the transmission and requires tear-down of transmission in case of failure.

(13) The replacement time on most major components and scheduled and unscheduled maintenance man-hour requirements are considered excessive.

(14) Drive train component replacement appears to be beyond capabilities of forward area maintenance.

(15) The reliability factor and the maintenance man-hour ratio data are not available.

(16) The main rotor blade is a composite complex structure. Use of aluminum for doubler plates is questioned. The one-piece injection molded fiberglass production techniques are questioned.

(17) The rotor system is complicated and contains a poor bearing system. The autorotative characteristics are poor (AI* = 3.81).

(18) The engine intake air is inadvertantly heated by flowing around the transmission. The transmission is complicated. Accessory power losses are not stated.

(19) Visibility is poor due to the large, high instrument panel and the cabin structure.

(20) Ventilation provisions through the heater system are inadequate. Defrosting is proposed for the pilot's side only.

(21) The construction description specified maximum use of magnesium castings and forgings which is considered undesirable.

(22) The electrical system presented is considered unsatisfactory as compared to other proposals.

(23) A steering pointer instrument is not provided for display of FM homer data.

*See Appendix C

(24) Provisions are not shown for installation of ADF dynamotor.

(25) Overhead position proposed for switch panel is considered undesirable.

(26) FM communication antenna orientation is not considered optimum.

(27) Anti-collision light provisions appear inadequate to meet the field of view requirement of MIL-L-006730A(Aer).

(28) No indication is made of the type battery proposed.

(29) The proposed heavy and complex 3-phase rotary inverter is excessive to the requirement, and not optimum.

(30) Flight instrument arrangement is not the approved Army "T".

(31) Engine instruments are placed at random, following no known established pattern.

c. KAISER KD-161. Proposal is somewhat sketchy in some areas and indicates a lack of understanding by the manufacturer of the Army's tactical environment and intended use of the LOH.

(1) Proposal utilizes servo boost and artificial feel in the control system.

(2) The proposed design has a relatively high disc loading (4 lbs/sq ft).

(3) Not enough information is furnished to determine the number of fully assembled helicopters that can be air transported in C-130 type aircraft.

(4) Proposal has restricted rearward visibility.

(5) The main rotor blade folding does not appear to incorporate maximum safety in design.

(6) The tail rotor control cables are considered to be pre-state-of-the-art.

(7) Transmission location between passengers' heads is poor crashworthiness design.

(8) The tapered main rotor blade structure possesses poor mass distribution and grip design. Gross lack of information precluded the determination of autorotative characteristics.

(9) The rotor head is a clever but complicated design. Ball bearings are used to take the oscillating blade thrust loading.

(10) The performance data reported is high because of an estimated 10%-30% low flat plate estimate.

(11) The engine air filtration, fuel filter, and by-pass provisions are not stated in sufficient detail. The four fuel tank configuration is too complex.

(12) Visibility is poor because of a large instrument panel and overhead cabin structure.

(13) A steering pointer instrument is not provided for display of FM homer data.

(14) Only one C-1611 control panel is provided in the AN/AIC-12 intercom system.

(15) Space provided for Battlefield Identification System is inadequate.

(16) Proposal has poor accessibility to avionic components.

(17) The overhead position of the proposed circuit breaker and control panel is undesirable.

(18) FM and UHF/VHF communication antenna locations are not considered optimum.

(19) A transmission oil pressure warning light is mentioned, but location is not specified. Same situation exists with volt-ammeter switch.

(20) Anti-collision light provisions appear inadequate to meet the field of view specified in MIL-L-006730A(Aer).

(21) Intensity control is not provided for panel lighting.

(22) Installed avionics equipment (BIS) is located in troop/cargo compartment which conflicts with the use of this location for its primary purpose, i.e., payload.

(23) An unidentified 36 amp/hr battery (45 lbs.) is proposed.

(24) No logical pattern is followed in arrangement of engine instruments.

(25) Flight instrument arrangement is not the approved Army "T".

(26) Shoulder harness and safety belt attached to separate seat structure does not give sufficient tie-down strength for occupant.

(27) Armament proposal mounts weapon on same side as the pilot which will probably cause a lateral CG problem.

d. KAMAN K-130.

(1) Does not provide a free-wheeling clutch for autorotation. This results in a high rate of autorotative descent. The tail rotor control power is low.

(2) Does not meet speed requirement for normal rated power.

(3) Proposal has low main rotor ground clearance (5 feet 5.4 inches).

(4) Passenger area is comparatively small with limited head room.

(5) Visibility is limited rearward.

(6) Only two helicopters could be transported in C-130 aircraft without major disassembly as compared to up to four by other proposals.

(7) Sufficient information is not presented to determine ferry range.

(8) Proposal indicates excessive man-hour requirement for blade folding and replacement.

(9) Interchangeability is not provided for the tail rotor drive shafting (3 segments).

(10) Small metal discs bonded to skids, are used in place of shoes for abrasion wear.

(11) Tail rotor control cables are considered pre-state-of-the-art.

(12) Cables used for engine power controls are considered unsatisfactory.

(13) Periodic inspection man-hour requirements are considered excessive.

(14) Rigging procedures and special tools required are considered excessive.

(15) Reliability factor and maintenance man-hour to flight-hour ratio were not available.

(16) The blade structure requires a large number of components and is complicated by the servo flap configuration. Aluminum is used for retention plates.

(17) Blade folding procedures are not simple although a pilot warning device is incorporated and would be desirable.

(18) Cockpit and cabin floor is 30 inches from the ground. A step is not provided.

(19) Combustion heating and bleed-air defrosting systems are not optimum. Outlets are inadequate.

(20) A steering pointer instrument is not provided for display of FM homer data.

(21) Proposal has poor accessibility to avionics components.

(22) The overhead position proposed for the switch panel is undesirable.

(23) FM and VHF/UHF antenna locations are not considered adequate.

(24) Anti-collision light provisions appear inadequate to meet the field of view requirements of MIL-L-006730A(Aer).

(25) Adequate information, or sufficient detail, not provided to permit thorough evaluation of avionics portion of proposal. (In some instances, information is so meager that proposed location of major components cannot be determined.)

(26) Shoulder harness and safety belt attached to separate seat structure does not give sufficient tie-down strength for occupant.

(27) The armament proposal indicates an excessive chuting requirement.

e. McDONNELL 158A.

(1) Proposal exceeds the maximum specified height unless the tail rotor is positioned horizontally.

(2) Design fails to meet the three-hour endurance requirement with the proposed fuel. Apparently will not meet the Army hot day hover requirement if three hours of fuel are provided. Rate of climb and radius of action is below average.

(3) Head room for passengers is limited.

(4) Aft and rearward visibility is limited.

(5) The partition between front and rear area of cabin is a deterrent to oral and visual communication.

(6) The intermediate gear box proposed requires additional maintenance and service.

(7) Cable control tail rotor is considered pre-state-of-the-art.

(8) The blade structure utilizes composite aluminum, steel, and plastic construction together with poor mass distribution and grip design.

(9) Blade folding procedures can undesirably load the controls with attendant cuff assembly complications.

(10) Proposal has poor autorotative characteristics (AI = 5.5).

(11) The tail rotor control power is comparatively low.

(12) Heating and defrosting system outlets are poorly designed and ineffectively located.

(13) Landing gear configuration is poor because cross-members join skids at a shallow angle and do not allow satisfactory ground clearance.

(14) Proposal indicates poor accessibility to electrical system components.

(15) The proposed location of the switch and circuit breaker panel to the rear and between the pilot and observer seats is undesirable.

(16) Anti-collision light provisions appear inadequate to meet the field of view requirement of MIL-L-006730A(Aer).

(17) Eyebrow type instrument panel lighting not considered optimum.

(18) Location of certain items is poor in that good engineering principles are violated by the excessive distances between battery and starter, and ADF receiver and its dynamotor locations.

(19) Avionics components are not grouped, but are scattered throughout the fuselage.

(20) Overvoltage protection for the electrical system is not provided.

(21) The proposal provides a DC electrical or vacuum power rather than AC for gyro instruments. This is considered less desirable than AC operated instruments.

(22) Non-MIL-STD DC operated engine and vacuum powered flight instruments are proposed.

(23) The flight instrument arrangement is not the approved Army "T".

(24) Adequate information, or sufficient detail, not provided to permit thorough evaluation of avionics portion of proposal. (In some instances, information is so meager that proposed location of major components cannot be determined.)

(25) The armament proposal indicates excessively long ammunition chuting. Proposal provides less ammunition than some of the other proposals.

f. REPUBLIC RH-60 (T-72 and T-74). Proposal exhibits a lack of understanding by the manufacturer of the Army's tactical environment and the intended use of the LOH. Proposal is sketchy and not complete in some areas. (Comments apply to both proposals.)

(1) Proposal exceeds the desired maximum design gross weight of 2450 pounds by 600 or more pounds (approximately 25%).

(2) Proposal does not meet the 3-hour endurance requirement. Apparently will not meet the Army hot day hover requirement with three hours of fuel.

(3) Proposal utilizes power boost on the controls.

(4) The two-door configuration is not optimum for passenger and cargo loading.

(5) The cargo compartment configuration, coupled with the sliding two-door configuration, limits the width of lateral straight-thru loads to 15 inches.

(6) The engine is exposed with no IR suppression indicated.

(7) The left door will not open with the proposed armament installed.

(8) The ferry range is significantly less than other proposals.

(9) Proposal did not provide sufficient data to evaluate air transportability.

(10) Numerous Zerk fittings require extensive use of a grease gun.

(11) The balancing and tracking requirement for the tail rotor compromises the maintenance work load.

(12) The shock mounted landing gear is undesirable from a maintenance viewpoint. (Feature is desirable from a pilot's viewpoint.)

(13) The tail rotor cable control is considered pre-state-of-the-art.

(14) Scheduled and unscheduled maintenance requirements and rigging procedures are considered excessive. Approximately 400 man-hours are required for the 1200-hour overhaul inspection.

(15) The main rotor blade has a poor mass distribution, folding and grip design. Blade retention is accomplished by taper pins which will eventually gall and bind.

(16) The rotor system is complicated.

(17) Disc loading is relatively high.

(18) Visibility is relatively poor due to cabin overhead structure, eight-section bubble, and poor downward vision angle.

(19) A combustion heater is utilized for heating. Heating controls are excessive in number and complicated.

(20) Two large hydraulic shock struts are necessary for damping rotor oscillations during takeoff and landing.

(21) The tail skid ground clearance (25") is considered insufficient, indicating that the tail skid would contact the ground frequently during landings, particularly autorotative landings.

(22) A steering pointer instrument is not provided for display of FM homer data.

(23) Only one C-1611 control panel is provided in the AN/AIC-12 intercom system.

(24) Proposal indicates poor accessibility to electrical system components.

(25) The FM and UHF/VHF communication antenna locations are not considered optimum.

(26) Good engineering principles are violated by the excessive distance between battery and starter.

(27) Overvoltage protection for the electrical system is not provided.

(28) Electrical system distribution not shown in sufficient detail to permit a thorough evaluation.

(29) The flight instrument arrangement is not the approved Army "T".

(30) Adequate information, or sufficient detail, not provided to permit thorough evaluation of avionics portion of proposal. (In some instances, information is so meager that proposed location of major components cannot be determined.)

(31) Shoulder harness and safety belt attached to separate seat structure does not give sufficient tie-down strength for occupant.

(32) The unsupported extended cockpit area creates a problem of roof collapse in roll-over.

(33) The armament proposal indicates excessive ammunition chuting.

g. HILLER 1099 (T-72 and T-74). (Comments apply to both proposals.)

(1) The proposal is essentially a product improvement of the H-23H and is considered to be a second generation helicopter. (Does not meet current state-of-the-art.)

(2) Helicopter exceeds the maximum specified rotor diameter and height.

(3) Proposal exceeds the desired design gross weight of 2450 pounds by 500 or more pounds (approximately 20%).

(4) Helicopter does not meet the 3-hour endurance requirement with the proposed 675 pounds of fuel. Does not meet the required maximum speed at normal rated power.

(5) Helicopter requires major disassembly for transport in C-130 aircraft.

(6) The overhead location of fuel tanks, battery, and engine are considered unsatisfactory from a crashworthiness viewpoint.

(7) By relying heavily upon existing product components where practical, i.e., main and tail rotor systems, transmissions, and rotating controls of the present H-23D, this proposal represents second generation machinery. The helicopter fails to meet Type Specifications qualifications for an easily maintained helicopter to be employed in forward areas and that will be expected for extended periods of time to operate with only such support as may be provided by one mechanic with hand tools. For example, 1200-hour component life, which is an important qualification, cannot be met. Further, the 300-hour inspection period requirement would not remain valid if these components were used. Lastly, man-hour and special tool requirements would remain extensive, thereby invalidating the proposal from a maintenance standpoint.

(8) Visibility is unsatisfactory in the lateral and vertical planes (110° and 68°) and poor in the horizontal plane (too many obstructions from structure).

(9) The collective friction knob and collective down-stop knob may be confused in flight.

(10) A steering pointer instrument is not provided for display of FM homer data.

(11) The overhead position proposed for switches, circuit breakers, and control knobs is considered undesirable.

(12) The UHF/VHF antenna locations are not considered optimum.

(13) Separate intensity controls are not provided for flight instruments and engine instruments.

(14) The circuit breaker panel rear access door mounted on the top surface of the cabin opens to the outside of the airframe. This will likely result in maintenance problems due to moisture.

(15) Location of certain avionic items is poor in that good engineering principles are violated, i.e., excessive distance is proposed between battery and starter.

(16) The battery is located in an area which is difficult to reach.

(17) Shoulder harness and safety belt attached to separate seat structure does not give sufficient tie-down strength for occupant.

h. HILLER 1101 (T-72 and T-74). (Comments apply to both proposals.)

(1) Proposal exceeds the maximum desired design gross weight by 400 pounds (approximately 16%).

(2) Helicopter will not meet the 3-hour endurance requirement with design gross weight fuel.

(3) Helicopter requires major disassembly for transport in C-130 aircraft.

(4) Proposal has one of the highest silhouettes of all proposals.

(5) The main gear box has a separate oil tank with a dip stick involving lines and fittings susceptible to leakage.

(6) The overrunning clutch (free-wheeling unit) is integral to the transmission drive bevel pinion. In case of malfunction, the transmission is lost in that the clutch cannot be replaced separately at user level.

(7) Lubrication requirements include use of a grease gun with high temperature grease.

(8) Cable controls for the tail rotor are considered pre-state-of-the-art.

(9) Scheduled maintenance man-hour requirements are considered excessive.

(10) The engine and transmission do not have sight gages. Dip sticks are used instead.

(11) Rigging requirements are considered excessive for forward area maintenance.

(12) Reliability and maintenance flight hour ratio could not be determined.

(13) The large instrument panel restricts visibility.

(14) The collective pitch down-stop adjustment knob and the collective pitch friction control knob are located adjacently between the seats and may be confused in flight.

(15) The landing gear cross-members join the skids at a shallow angle with undesirably low ground clearance.

(16) A wrench or similar tool is required to raise and lower the ground handling wheels.

(17) Extensive use is made of rotor bearings which include the use of ball bearings to take oscillating blade thrust loads.

(18) A steering pointer instrument is not provided for display of FM homer data.

(19) The overhead position proposed for switches, circuit breakers, and control knobs is considered undesirable.

(20) The UFH/VHF antenna locations are not considered optimum.

(21) Separate intensity controls are not provided for flight instruments and engine instruments.

(22) The circuit-breaker panel rear access door mounted on the top surface of the cabin opens to the outside of the airframe. This will likely result in maintenance problems due to moisture.

(23) Location of certain avionic items is poor in that good engineering principles are violated, i.e., excessive distance is proposed between battery and starter.

(24) Cockpit structure is inadequately supported to prevent collapse during roll-over. The close proximity of the main transmission to the rear seat occupants is extremely hazardous in a crash sequence.

i. KAMAN 130A. Manufacturer does not present enough information for a reasonable analysis. Alternate proposal seems to be an afterthought.

(1) Proposal exceeds the desired maximum design gross weight by over 400 pounds (approximately 17%).

(2) Excessive man-hours are required for blade folding and replacement.

(3) Interchangeability of tail rotor drive shafting (3 segments) is not provided.

(4) Small metal discs bonded to skids are used in place of shoes for abrasion wear.

(5) Tail rotor control cables are considered pre-state-of-the-art.

(6) Cables used for engine power controls are considered unsatisfactory.

(7) The periodic inspection man-hour requirement is considered excessive.

(8) Rigging procedures and special tools required are considered excessive.

(9) Reliability factor and maintenance man-hour to flight-hour ratio was not available.

(10) A steering pointer instrument was not provided for display of FM homer data.

(11) The overhead position proposed for the circuit breaker panel is considered undesirable.

(12) FM communication antenna location and orientation is considered unsuitable.

(13) Anti-collision light provisions appear inadequate to meet the field of view required by MIL-L-006730A(Aer).

(14) The space allocated for relocation of battery is considered unsuitable.

(15) Shoulder harness and safety belt attached to separate seat structure does not give sufficient tie-down strength for occupant.

APPENDIX F

Following is a list of proposals remaining after elimination of all but 6 primary proposals and two alternates from further consideration. Desirable and undesirable characteristics of each proposal are listed. The characteristics are based on the information provided by the manufacturer.

a. BELL D-250. This proposal indicates the manufacturer's understanding of the Army's requirements and the intended use of the LOH.

(1) Attributes.

(a) Helicopter is designed for 312 h.p. to allow for growth of the T-63 engine. (Allows for a helicopter growth contingency of 25 pounds.)

(b) Design proposes a means to the pilot for selecting maximum stability or controllability as desired.

(c) Helicopter uses sliding doors that may be opened in flight.

(d) Performance analysis is a conservative approach and allows for contingencies.

(e) Manufacturer proposes a longitudinally adjustable cyclic stick grip to position the grip for various sizes of pilots.

(f) Relatively good visibility is provided from all seats. However, rearward visibility is limited.

(g) A flat cargo area is provided on fold-down seat backs.

(h) Proposal incorporates a tail landing skid designed for safer landings.

(i) Design permits emergency evacuation of a litter patient.

(j) Design has comparatively excellent ferry range.

(k) Design permits carrying of three troops plus a pilot and observer.

(l) A relatively indiscriminate cargo area loading is provided.

(m) Proposal has a comparatively low silhouette.

(n) Only one type of oil is used throughout (7808).

(o) The prepared fixed length measurements with a built-in fixture results in a simple fool-proof rigging provision.

(p) The reliability factor and maintenance man-hour/flight-hour ratio are considered outstanding.

(q) The main rotor blade is considered to be outstanding with respect to composition, simplicity, and mass distribution.

(r) The aircraft will have good autorotational characteristics (AI* = 9.3).

(s) The mean blade lift coefficient is low which will permit weight growth without penalizing altitude performance.

(t) The rotor system is considered to be outstanding with respect to simplicity, bearings, and overall design.

(u) See-saw restraint and pitch lockout are provided during main rotor blade folding operation.

(v) Manufacturer proposes to meet the -65° requirement without a winterization kit.

(w) Avionic and electrical components are easily accessible.

(x) Installation environment of the electronic components appears good.

* See Appendix C

(y) The space and locations provided for internal avionic and electrical components are good.

(z) The approved Army "T" arrangement of flight instruments is proposed.

(aa) The proposed use of a combination UHF/VHF antenna appears highly desirable.

(bb) Integration of crew and passenger seats into the basic structure and utilization of aluminum honeycomb material in seats give outstanding crashworthiness and energy absorption properties.

(cc) Shoulder harness and safety belts are attached to the basic airframe.

(dd) A roll-over structural support has been integrated into the area between crew and cargo area that should minimize "crushing" during a crash sequence.

(ee) The fuel system incorporates outstanding properties to prevent crash fire. (Aluminum honeycomb material.)

(ff) Reduction of noise in the cabin has been considered throughout the design with Fiberglas sound proofing used in critical areas.

(2) Undesirable Characteristics.

(a) Proposal has poor rearward visibility.

(b) The arrangement of crew and passengers is not optimum for in-flight oral and visual conversation.

(c) Helicopter fails to meet the Army hot day hover requirement.

(d) Proposal fails to meet the speed requirement at normal rated power.

(e) Horizontal stabilizer must be removed to transport three helicopters in a C-130 aircraft.

(f) The main rotor blade can flex down to 5' 4" above the ground reference line.

(g) The blade tracking requirement and method used (flag) is time consuming trial and error and is considered pre-state-of-the-art.

(h) A grease gun requirement every 300 hours exists for seven Zerk fittings.

(i) The tail skid clearance (15") is small; however, this is supposedly nullified by the tail skid which is designed to contact the ground on landing and create a beneficial pitching-forward action.

(j) The method of counteracting blade erosion by using an epoxy coating rather than a replaceable item is questioned.

(k) A steering pointer instrument is not provided for display of FM homer data.

(l) The overhead position proposed for the circuit-breaker panel is considered to be unsuitable.

(m) The anti-collision light provisions appear inadequate to meet the field of view requirements specified by MIL-L-006730A(Aer).

(n) The post type instrument panel lighting recommended is not optimum.

(o) Separate intensity controls are not provided for flight instruments and engine instruments.

(p) An 11 amp/hr battery is proposed. This is considered inadequate for reliability in low temperature (-25°F) operation.

(q) Proposal indicates inability to meet the radar reflectivity and IR requirement.

b. BOEING-VERTOL 131.

(1) Attributes.

(a) The basic design considers use of any of the engines listed by the Type Specification.

(b) Consideration is given to the installation of the artillery visual airborne target location system (VATLS) AN/UVS-1 (XE-2) and an aerial wire dispenser.

(c) Proposal has outstanding all around visibility.

(d) By the folding arrangement of the left front seat, a prostrate casualty can be transported.

(e) Provisions are made for dual ground handling wheels when required.

(f) Three passengers can be carried in the cargo compartment.

(g) One type of oil is used throughout (7808).

(h) The low mean blade lift coefficient will permit growth without penalizing altitude performance.

(i) Proposed helicopter has a low disc loading (2.53).

(j) The rotor head simplicity, bearing system, and general design is good.

(k) Design permits relatively indiscriminate cargo loading.

(l) Passengers have option of forward or rearward seating.

(m) Proposal meets the -65°F requirement without a winterization kit.

(n) The avionic components are easily accessible.

(o) Antennas (except FM homer and UHF/VHF) are well located.

(p) The installation environment of avionic components is satisfactory.

(q) Adequate internal space is provided for avionic components.

(r) The approved Army "T" arrangement of flight instruments is proposed.

(2) Undesirable Characteristics.

(a) The narrow rear doors do not allow rapid and easy entry and exit from the passenger area. Rear seat design presents an obstacle to passenger entry and exit. The cockpit and cabin floors are excessively high above the ground (30"); a step is not provided.

(b) The overall length is comparatively longer than most proposals.

(c) The main rotor mast utilizes space in the cargo-passenger area.

(d) The main rotor head, hub, and flight controls have a self-contained lubrication system, however, an excessive number of oil reservoirs indicate major servicing requirements.

(e) The aircraft contains an intermediate gear box which increases maintenance and servicing requirements.

(f) Scheduled and unscheduled maintenance man-hour requirements are excessive.

(g) The cable tail rotor control is considered pre-state-of-the-art.

(h) The landing gear has dampening struts requiring a maintenance and servicing requirement over that which is considered necessary.

(i) The hydraulic control system is considered too complex for forward area maintenance, i.e., use of a hydraulic mule is required for servicing the 1500 psi hydraulic system.

(j) The hydro-mechanical stability augmentation system, using the same hydraulics as boost actuators, increases the complexity of maintenance requirements.

(k) Rigging procedures and required accoutrements appear to be excessive.

(l) The design has poor blade mass distribution.

(m) The composite blade does not contain an abrasion strip and has exposed doublers.

(n) The proposed use of a Fiberglas blade is questioned.

(o) Tail rotor thrust is comparatively low.

(p) A steering pointer instrument is not provided for display of FM homer data.

(q) Proposal makes no provision for installation of FM homing antenna AT-764.

(r) Avionic components are not easily accessible.

(s) The overhead position proposed for the circuit-breaker panel is considered undesirable.

(t) The anti-collision light provisions appear inadequate to meet the field of view specified by MIL-L-006730A(Aer).

(u) Suitability of the specified location of the Battlefield Identification System (BIS) and ADF is questioned in view of the expected ambient temperature in this area (aft deck, under glass, over engine hot-spot).

(v) Conflict exists of the utilization of space allotted for BIS and ADF installation vs. stowage of rear doors.

(w) An 11 amp/hr battery proposed, but bidder states battery is inadequate for prescribed low temperature operation without supplementary battery heating. An accessory JP-4 burning heater is proposed.

(x) Proposal does not indicate that the radar reflectivity and IR requirement will be met.

(y) Shoulder harness and safety belt attached to separate seat structure does not give sufficient tie-down strength for occupant.

(z) A possible fire hazard exists with the location of the engine exhausts only 3 feet from ground level.

(aa) The armament proposal indicates that the M-73 gun will not clear the ground when fully depressed.

c. HILLER 1100.

(1) Attributes.

(a) The helicopter has good all around eye level visibility.

(b) The pilot seat is adjustable fore and aft.

(c) The proposed speed and Vmax are higher than required.

(d) The basic design considers provisions for one of the larger engines.

(e) A flat cargo loading area is provided, although some space is lost by the folding rear seats.

(f) Helicopter has superior autorotational characteristics (AI = 10.97).

(g) Proposal has a low disc loading (2.5).

(h) Blade mass distribution and grip design is good.

(i) Avionic and electrical components are easily accessible.

(j) The exterior lighting proposed is considered comparatively excellent.

(k) The installation environment of avionic and electrical components appears good except for access to the rear of the circuit-breaker panel.

(l) The space and weight provisions for internal avionic and electrical components are good.

(m) The electrical distribution system is very good.

(n) The approved Army "T" arrangement of flight instruments is proposed. Torque and RPM gages are in desired locations.

(o) The instrument panel is edge lighted.

(p) Proposal indicates that IR requirement will be met.

(2) Undesirable Characteristics.

(a) Design proposes power operated cyclic and collective controls, and SAS for stability and control.

(b) Design requires major disassembly for transport in a C-130 aircraft. (Rotor and mast or skids must be removed to transport one in a C-130. It is questionable that two can be transported without further disassembly.)

(c) Proposal has one of the highest silhouettes of all proposals.

(d) The main gear box has a separate oil tank with dip stick involving lines and fittings susceptible to leakage.

(e) An overrunning clutch (free-wheeling unit) is integral to the transmission. In case of malfunction, the transmission is lost in that clutch cannot be replaced separately at user level.

(f) Lubrication requirements include use of a grease gun with high temperature grease.

(g) Cable controls for the tail rotor is considered pre-state-of-the-art.

(h) Scheduled maintenance man-hour requirements are considered excessive.

(i) The engine and transmission do not have visual exterior sight gages.

(j) Rigging requirements are considered excessive for forward area maintenance.

(k) The large instrument panel proposed restricts forward and downward visibility.

(l) The collective pitch down-stop adjustment knob and the collective pitch friction control knob are located adjacently between the seats and may be confused in flight.

(m) The landing gear cross-members join the skids at a shallow angle with undesirably low ground clearance.

(n) A wrench or similar tool is required to raise and lower the ground handling wheels.

(o) Extensive use is made of rotor bearings which include the use of ball bearings to take oscillating blade thrust loads.

(p) A steering pointer instrument is not provided for display of FM homer data.

(q) The overhead position proposed for the circuit-breaker panel is considered undesirable.

(r) The UHF/VHF antenna location is not considered optimum.

(s) Separate intensity controls are not provided for flight instruments and engine instruments.

(t) The circuit-breaker panel rear access door opens to the outside of airframe, and is mounted on the top surface of the cabin indicating maintenance problems from moisture.

(u) Proposal will not meet the radar reflectivity requirement.

(v) The location of certain avionic items is poor in that good engineering principles are violated by the excessive distances between battery and starter, and the ADF receiver and its dynamotor locations.

(w) Cockpit structure is inadequately supported to prevent collapse during roll-over. The close proximity of the main transmission to the rear seat occupants is extremely hazardous in a crash sequence.

d. HUGHES 369.

(1) Attributes.

(a) Proposal is outstanding with respect to size, weight, speed, and Army hot day hover requirements.

(b) Helicopter has a small (25') rotor diameter which enhances tactical suitability.

(c) The multi-blades (4) could reduce vibration during cruise flight as compared to proposals with 2 or 3 blades.

(d) Antennas are flush or buried - no external antennas are proposed.

(e) The proposal indicates an optimum maintenance man-hour to flight-hour ratio.

(f) The design has excellent entrance and exit locations and sizes.

(g) The pod armament proposal is considered to be highly desirable.

(h) The design utilizes two fuel tanks which reduces vulnerability.

(i) The design has a comparatively large flat cargo loading area (14.7 sq. ft.).

(j) Five passengers plus a pilot may be transported.

(k) The design permits the emergency evacuation of one litter patient.

(l) The design provides for an external cargo sling.

(m) Four helicopters can be loaded in C-130 aircraft without disassembly.

(n) A hydraulic boost system is not requ[illegible], lowering man-hour and maintenance requirements.

(o) The design incorporates maximum use of lightweight components which are highly desirable from a maintenance and logistical viewpoint.

(p) A grease gun is not required.

(q) The reliability factor and maintenance man-hour/flight-hour ratio are considered outstanding.

(r) The proposed slope landing capability is outstanding (15^{o}/).

(s) The rearward tip-over angle is very good (14^{o}) and combined with the spring-shock gear configuration allows advantageous tail low landings from autorotations as well as normal touchdowns (do not have to hover momentarily).

(t) The ground handling wheels mounted on the front of the skids has proved to be a very good feature.

(u) The strap type flexures afford full articulation and eliminate centrifugally loaded bearings.

(v) The switches, knobs, control panels, and circuit breakers are all well located; none are overhead or to the rear of the pilot.

(w) The approved Army "T" arrangement of flight instruments is proposed.

(x) The instrument panel size and shape will permit an optimum instrument arrangement.

(y) Proposal indicates that the IR requirement will be met.

(2) Undesirable Characteristics.

(a) The design has the poorest autorotative characteristics as compared to other proposals (A^{T} = 4.24).

(b) The proposed flush antenna installation must be proven.

(c) The rear canvas doors proposed are questionable.

(d) The performance analysis is optimistic - does not provide for contingencies.

(e) The four-bladed rotor will present tracking problems. The only method provided is by flag. Experience with the YHO-2HU during the service test substantiates this statement.

(f) A free-wheeling unit (overrunning clutch) is incorporated in the main gear box. Failure of clutch requires a main gear box change.

(g) The tail rotor blades are not interchangeable. The tail rotor must be replaced as a unit. Experience with the YHO-2HU during service test indicates susceptibility of Fiberglas blades to abrasive effect of dust and sand.

(h) Landing gear shock struts combined with coil springs establishes an additional maintenance and service requirement (this item is highly desirable from a pilot viewpoint).

(i) The periodic inspection man-hour requirement is considered excessive in comparison to other proposals.

(j) Rigging procedures require special tools and above average man-hour requirements.

(k) A more realistic drag estimate (estimated to be 25%-50% low) will penalize high speed performance and increase fuel required and gross weight.

(l) The four-bladed system increases the complexity, maintenance, statistical failure conditions, and reduces the inherent blade resistance to damage.

(m) The high disc loading will cause a comparatively large recirculation of vegetation and debris.

(n) A steering pointer instrument is not provided for display of FM homer data.

(o) Avionic components are not easily accessible.

(p) The landing light location inside of the bubble is questionable.

(q) The proposed installation of the BIS in the troop/cargo compartment conflicts with the use of this location for its primary purpose.

(r) The proposed Sonotone CA-10H (self-heating) Nickel-Cadmium battery is FAA approved, but is not BuWeps approved. An alternate self-powered heating system is proposed.

(s) The electronic components are mounted in an inverted position which is considered unsatisfactory. Advise from the US Army Signal Corps indicates that the development items involved (ARC-51, ARC-54, ARR-49) have not been tested in the inverted position and this mounting is not recommended prior to such testing. It appears that it may be impossible to mount the electronic components in an upright position in the space provided; in any event, some weight increase may be expected.

(t) A possible grass fire hazard exists with the location of the engine exhaust only three feet from ground level.

(u) Design apparently will not meet the radar reflectivity requirement.

e. LOCKHEAD CL-418.

(1) Attributes.

(a) Proposed design has outstanding Army hot day performance and exceeds the speed requirement for normal rated power.

(b) The proposed rigid rotor system, though unproven, offers a possible "break-thru" in flying and maintenance simplicity.

(c) Three fully assembled helicopters can be transported in a C-130 aircraft.

(d) Blade mass distribution and grip design are good.

(e) The rotor system has minimum bearing requirements.

(f) Copilot's seat is removable for additional cargo space.

(g) The avionic and electrical components are easily accessible and are well grouped within their respective categories.

(h) Switches, knobs, control panels and circuit breakers are all well located; none are overhead or to rear of pilot.

(i) All antennas, except UHF/VHF, are well located.

(j) Exterior lighting should exceed the requirements.

(k) Installation environment of the avionic components appears good.

(l) The space and locations provided for internal avionic and electrical components are good.

(m) The approved Army "T" arrangement of flight instruments is proposed.

(n) Combined temperature and pressure indicating instruments are proposed.

(o) The armament design was considered to be one of the better proposals submitted.

(p) Proposal indicates that IR requirement will be met.

(2) Undesirable Characteristics.

(a) The rigid rotor system proposed must be proven. It is possible that a slope landing and takeoff may not be satisfactorily accomplished with the proposed design.

(b) Anti-torque drive shafting (3 segments) is not interchangeable.

(c) Cables for the tail rotor are considered pre-state-of-the-art.

(d) Scheduled maintenance man-hour requirement is considered excessive.

(e) Rigging procedures and requirements for special tools are considered excessive.

(f) Pressure lubrication of the overrunning clutch is required. Three "V" bands and "O" rings are subject to leakage.

(g) Lubrication requires a grease gun.

(h) The reliability factor was not provided from printed data.

(i) Downward and rearward visibility is limited.

(j) The two-door configuration is not optimum tactically, and is considered to be unacceptable.

(k) The controls utilize a spring-force coupling. Control reactions are a function of spring forces and not control stick displacement.

(l) Tapered blade retention bolts will eventually gall and bind.

(m) Description of flight characteristics indicates there will be an undesirable sideward movement of the cyclic with forward displacement to initiate forward flight.

(n) Forward visibility is restricted by the high instrument panel and 8" wide windscreen divider at knee level.

(o) Ventilation provisions consist of opening doors which cannot be locked in intermediate positions.

(p) The narrowed front portion of the landing gear will "plow in" on sliding rough terrain landings.

(q) A steering pointer instrument is not provided for display of FM homer data.

(r) Only one C-1611 control panel is provided in the AN/AIC-12 intercom system.

(s) The proposed post-type instrument panel lighting is not considered optimum.

(t) Separate intensity controls are not provided for flight instruments and engine instruments.

(u) A nickel cadmium battery of 11 amp/hr capacity is proposed. Bidder asserts this is an inadequate capacity and proposes a self-powered internal heating system to make the battery suitable for -25°F. operation.

(v) Shoulder harness and safety belt attached to separate seat structure does not give sufficient tie-down strength for occupant.

(w) Proposal does not indicate that the radar reflectivity will be met.

f. SIKORSKY (PRIMARY).

(1) Attributes.

(a) Design has good all around visibility.

(b) Three helicopters can be transported in a C-130 aircraft without disassembly.

(c) Rear doors can be latched open for flight (doors open at front and for this reason are considered unsatisfactory).

(d) A pre-rigged control system is proposed.

(e) A uniflex rotor hub suspended on a spherical self-aligning teflon bearing has no maintenance or lubrication requirement.

(f) Tracking is not normally required on the blades. Pre-tracked blades have track value stenciled on the butt end and employ calibrated pitch change rods. This method is practical and simple.

(g) The tail rotor control method employs a controlex remote control mechanism that appears to be maintenance free, simple, and reliable.

(h) Only one oil (7808) is used and a grease requirement does not exist.

(i) The main rotor blade grip and folding design are outstanding.

(j) Control system locked out is provided during blade folding operations.

(k) The "spar crack detection system" proposed is unique and merits further study.

(l) The avionics compartment appears to be above the average with respect to weather proofing and ventilation.

(m) The approved Army "T" arrangement of flight instruments is proposed.

(n) Integration of crew and passenger seats into the basic structure and utilization of aluminum seat pans in seats give outstanding crashworthiness and energy absorption properties.

(o) Shoulder harness and safety belts are attached to the basic airframe.

(p) A roll-over structural support has been integrated into the design.

(2) Undesirable Characteristics.

(a) Proposal does not meet the requirement for three hours of fuel for speed for best range with a resultant inadequate fuel supply. Will not meet the Army hot day hover requirement with a 3-hour fuel supply.

(b) The rear doors open at front - are hinged at rear. This is considered unsatisfactory and a possible safety-of-flight item.

(c) Passenger door sills are excessively high above the ground (34") - highest of all proposals. A step is not provided.

(d) Ventilation appears unsatisfactory (through heating system).

(e) Design utilizes power boosted controls.

(f) A magnetic dip stick is used in lieu of magnetic plug and sight gage on the main gear box.

(g) Proposal has a relatively high disc loading (3.14).

(h) Proposal has a poor autorotational characteristic (AI = 5).

(i) The skid design is poor in that 32" of the forward end of the skid is upturned at a comparatively sharp angle, most of this length being dead weight. A curved tip would have been considered optimum.

(j) A steering pointer instrument is not provided for display of FM homer data.

(k) Only one C-1611 control panel is provided in the AN/AIC-12 intercom system.

(l) Adequate space is not shown for the Battle Field Identification System.

(m) The overhead position proposed for the circuit-breaker panel is considered undesirable.

(n) An overvoltage protection to the electrical system is not provided.

(o) The electrical distribution system is not shown, thus precluding a detailed evaluation.

(p) An 11 am/hr battery is used with shorting-type heating provisions. (This battery is too small for low temperature requirements without a supplementary source of heat; the proposed technique of battery heating should be proven.)

(q) Adequate information, or sufficient detail, was not provided to permit a thorough evaluation of the avionics portion of proposal. (In same instances, information is so meager that proposed location of major components cannot be determined. Apparently, some items must be removed to gain access to other components.)

(r) Armament proposal indicates excessive ammunition chuting.

(s) Proposal indicates inability to meet radar reflectivity and IR requirements.

g. BELL D-251.

(1) Attributes.

(a) Proposal has outstanding maximum speed for normal rated power (131K).

(b) Good growth potential is indicated.

(c) Design has high cruise speed (115K).

(d) Proposal has good visibility from all seats.

(e) A flat cargo area on fold down seat backs is provided.

(f) Design proposes a means to the pilot for selecting maximum stability or controllability as desired.

(g) Proposal incorporates a tail landing skid designed for safer landings.

(h) Design permits emergency evacuation of a litter patient.

(i) Helicopter uses sliding doors that may be opened in flight.

(j) Proposal has comparatively excellent ferry range.

(k) Performance analysis is a conservative approach and allows for contingencies.

(l) Relatively good visibility is provided from all seats. However, rearward visibility is limited.

(m) Design permits carrying of 3 troops plus a pilot and observer.

(n) Manufacturer proposes a longitudinally adjustable cyclic stick grip to position the grip for various sizes of pilots.

(o) Relatively indiscriminate cargo area loading is provided.

(p) Proposal has a comparatively low silhouette.

(q) Only one type oil is used throughout (7808).

(r) The installation environment of the electronic components appears good.

(s) Avionic and electrical components are easily accessible.

(t) The space and locations provided for internal avionic and electrical components are good.

(u) The approved Army "T" arrangement of flight instruments is proposed.

(v) The proposed use of a combination UHF/VHF antenna appears highly desirable.

(w) The fixed length measurements with a built-in fixture results in a simple fool-proof rigging provision.

(x) The reliability factor and maintenance man-hour/flight-hour ratio are considered outstanding.

(y) The aircraft will have good autorotational characteristics (AI = 10).

(z) A low mean rotor blade lift coefficient is provided.

(aa) The rotor system is outstanding with respect to simplicity, bearings, and overall design.

(bb) See-saw restraint and pitch lockout are provided during folding operation.

(cc) Integration of crew and passenger seats into the basic structure and utilization of aluminum honeycomb material in seats give outstanding crashworthiness and energy absorption properties.

(dd) Shoulder harness and safety belts are attached to the basic airframe.

(ee) A roll-over structural support has been integrated into the area between crew and cargo area that should minimize "crushing" during a crash sequence.

(ff) The fuel system incorporates outstanding properties to prevent crash fire.

(gg) Reduction of noise in the cabin has been considered throughout the design with Fiberglas sound proofing used in critical areas.

(hh) Proposal meets the -65°F. requirement without winterization kit.

(2) Undesirable Characteristics.

(a) Proposal exceeds the desired maximum design gross weight of 2450 pounds by 500 pounds (approximately 20%).

(b) Design does not meet the 3-hour endurance requirement with the proposed fuel.

(c) Proposal has poor rearward visibility.

(d) Proposal has a relatively high disc loading (3.67).

(e) Design requires removal of horizontal stabilizer to transport three helicopters in C-130 aircraft.

(f) The main rotor blades can flex down to 5' 4" above the ground reference line.

(g) A steering pointer instrument is not provided for display of FM homer data.

(h) The overhead position proposed for the circuit-breaker panel is considered undesirable.

(i) Anti-collision light provisions appear inadequate to meet the field of view requirement specified by MIL-L-006730A(Aer).

(j) The post type instrument panel lighting proposed is not considered optimum.

(k) Separate intensity controls are not provided for flight instruments and engine instruments.

(l) An 11 amp/hr capacity battery is proposed. This is considered inadequate for reliability in low temperature (-25°F.) operation.

(m) Good engineering principles are violated by the excessive distance between battery and starter.

(n) The tail skid clearance (15") is small; however, this is supposedly nullified by the tail skid which is designed to contact the ground on landing and create a beneficial pitching-forward action.

(o) The method of counteracting blade erosion by using an epoxy coating rather than a replaceable item is questioned.

(p) The blade tracking requirement and method used (flag) is time consuming, trial and error and is considered pre-state-of-the-art.

(q) A grease gun requirement every 300 hours exists for seven Zerk fittings.

(r) Proposal indicates inability to meet the radar reflectivity and IR requirement.

h. SIKORSKY (ALTERNATE).

(1) Attributes.

(a) Proposal indicates excellent growth potential.

(b) Design has good all around visibility.

(c) Three helicopters can be transported in C-130 aircraft without disassembly.

(d) Rear doors can be latched open for flight. (However, doors open at front and for this reason are considered unsatisfactory.)

(e) A pre-rigged control system is proposed.

(f) A uniflex rotor hub suspended on a spherical self-aligning teflon bearing has no maintenance or lubrication requirement.

(g) Tracking is not normally required on the blades. Pre-tracked blades have track value stenciled on butt end and employ calibrated pitch change rods. This method is practical and simple.

(h) The tail rotor control method employs a controlex remote control mechanism that is considered to be maintenance free, simple, and reliable.

(i) Only one oil (7808) is used and a grease requirement does not exist.

(j) The main rotor blade grip and folding design are outstanding.

(k) Control system locked out is provided during blade folding operations.

(l) The "spar crack detection system" proposed is unique and merits further study.

(m) The avionics compartment appears to be above the average with respect to weather proofing and ventilation.

(n) The approved Army "T" arrangement of flight instruments is proposed.

(o) Integration of crew and passenger seats into the basic structure and utilization of aluminum seat pans in seats give outstanding crashworthiness and energy absorption properties.

(p) Shoulder harness and safety belts are attached to the basic airframe.

(q) A roll-over structural support has been integrated into the design.

(2) Undesirable Characteristics.

(a) The proposal exceeds the maximum desired design gross weight by more than 650 pounds (approximately 27%).

(b) The rear doors open at front - are hinged at rear. This is considered unsatisfactory and a possible safety-of-flight item.

(c) The passenger door sills are excessively high above the ground (34"), highest of all proposals. A step is not provided.

(d) Ventilation appears unsatisfactory.

(e) A magnetic dip stick is used in lieu of magnetic plug and sight gage on the main gear box.

(f) Proposal has relatively high disc loading (3.98).

(g) Proposal has poor autorotational characteristics (AI = 5).

(h) The skid design is poor, in that 32 inches of the forward end of the skid is upturned at a comparatively sharp angle, most of this length being dead weight. A curved tip would have been considered optimum.

(i) A steering pointer instrument is not provided for display of FM homer data.

(j) Only one C-1611 control panel is provided in the AN/AIC-12 intercom system.

(k) Adequate space is not shown for the Battlefield Identification System.

(l) The overhead position proposed for the circuit-breaker panel is considered undesirable.

(m) Overvoltage protection for the electrical system is not provided.

(n) The electrical distribution system not shown.

(o) An 11 amp/hr battery is used with shorting-type heating provisions. (This size battery is too small for low temperature requirements without a supplementary source of heat; the proposed technique of battery heating should be proven.)

(p) Adequate information, or sufficient detail, are not provided to permit a thorough evaluation of the avionics portion of proposal. (In some instances, information is so meager that proposed location of major components cannot be determined. Apparently some items must be removed to gain access to other components.)

(q) Armament proposal indicates excessive ammunition chuting.

(r) Proposal indicates inability to meet radar reflectivity IR requirement.

APPENDIX G

Following are specific recommendations for characteristics that should be included, as appropriate, in the detail specifications of any selected winner. These recommendations are based on experience gained by the Army Operational Evaluation Group in analyzing each manufacturer's interpretation of the Type Specifications. Recommendations are essentially for the purpose of clarifying the Type Specifications; however, in some instances, the Type Specification is amplified. Explanations, where considered necessary, follow the suggested change as a parenthetical statement.

a. Add to Paragraph 3.2.4.2 MAINTENANCE AND REPAIRS:

(1) Four flight hours per day utilization within an arbitrary thirty-six months service tour indicates that the maintenance overall man-hour to flight-hour ratio, in order to be acceptable, can be no greater than .5 hours maintenance per each flight hour. Scheduled maintenance man-hour requirements should be .75 hour to 1.0 hour for daily inspections; 5.0 hours to 7.5 hours for 300-hour periodic inspections; and 125 hours to 150 hours for 1200-hour overhauls (component replacement and inspection only). Unscheduled maintenance requirements should not exceed .20 man-hours per flight hour.

(2) Consideration should be given to using integral helicopter components as special tools or assists in maintenance operations.

(3) Add to paragraph (1)(e): It is desired that there shall be no lubrication requirement other than a minimum number of self-contained oil reservoirs and lifetime type bearings, e.g., Teflon, Fabroid, etc.

(Testing results to date in the HU-1( ) series helicopter have indicated the successful use of these type bearings in applicable areas.)

(4) Maximum use shall be made of simple flexible couplings (Thomas or equivalent) that minimize servicing and alignment requirements.

(5) There shall be adequate, substantial hand holds, steps, hinged work platforms, inspection panels, and work decks in applicable areas.

(6) There shall be maximum use of hinged inspection plates, access panels and covers incorporating hand operated quick disconnect fasteners.

(7) The design shall provide for mounting a lightweight, portable hoist to assist in component removal if applicable. Consideration shall be given toward utilization of this "maintenance assist" by one mechanic in forward areas.

(It is considered that in the time frame of this helicopter, forward area mechanics will be required to accomplish component changes without the aid of field maintenance and without the assistance of additional manpower.)

(8) Maximum utilization shall be made of quick-disconnects on all electrical and fluid terminus points.

b. Add Paragraph 3.2.15. SINGLE ENGINE OUT REQUIREMENTS. An engine failure warning system will be provided.

(OCR&D, based on USCONARC recommendations, has requested OCofT to study this problem and make recommendations.)

c. Add to Paragraph 3.5.1.8 BLADE TRACKING. It is desired that the main rotor system utilize pretracked blades with predetermined stenciled (or scribed) values and calibrated pitch change rods.

d. Add Paragraph 3.6.1 TAIL ROTOR. It is desired that there be no requirement for tail rotor tracking and balancing. The tail rotor should utilize pretracked and balanced assemblies using fixed predetermined lengths for control rods and using simplified control systems.

e. Add to Paragraph 3.7.1 FUSELAGE.

(1) The crew and cargo-passenger doors shall be jettisonable or be provided with kick-out panels (24" X 31").

(2) All side windows shall be able to be opened during flight or be provided with a sliding port operable during flight for ventilation.

f. Add to Paragraph 3.8.2.1 DESCRIPTION.

(1) The cross-members of the alighting gear shall join the skids at a nearly vertical angle with respect to the lateral axis in order to provide the maximum clearance to ground surface obstructions such as rocks and vegetation. The bottom surface of each skid shall be protected with a removable and replaceable anti-abrasion shoe(s) of a suitable hard material.

(2) Ground handling wheels shall be provided to facilitate movement of the aircraft on rough ground. Consideration will be given to mounting the ground handling wheels on the forward end of the skid for use as a ground bearing surface to minimize the possibility of aircraft tip-over while executing forward movement takeoffs and landings on uneven terrain. Provisions will be made in the gear design to permit installation of a second set of ground handling wheels from another aircraft as a dual wheel arrangement to increase flotation and ease of ground handling over rough or unstable ground.

g. Add to Paragraph 3.10 FLIGHT CONTROL SYSTEMS.

(1) Control cables will be utilized in only a minimum essential capacity. Engineering advances indicate acceptable utility of push-pull systems in lieu thereof.

(YHO-2HU testing revealed successful design adaptation of a push-pull system with no recorded faults.)

(2) Intermediate gear boxes utilized for speed reduction and direction changes shall not be considered as first choice requisites where other design proven couplings can be utilized.

(3) Simplified rigging procedures shall be used throughout, using fixed length measurements combined with a built-in rigging fixture or fixtures.

(HU-1( ) series helicopters utilize this feature successfully. Testing has indicated an overall simplification of maintenance techniques when incorporated.)

(4) Consideration shall be given in the design or location of the cyclic and collective controls to prevent or protect items of clothing, shoulder harness, safety belts, etc., from inadvertently restricting full movement of controls.

h. Add to Paragraph 3.12.9 FUEL SYSTEM.

(1) The fuel filter system will be designed to remove reasonable contamination from fuel and eliminate, as much as possible, fuel contamination problems such as is being currently experienced with Army turbine aircraft.

(2) A dc operated float-transducer system is considered optimum. The system used shall be calibrated in pounds to indicate zero-level at the zero-usable-fuel level. A separate, independent, float-operated low-level warning system shall be included.

i. Revise Paragraph 3.12.15 TRANSMISSION SYSTEM to include a requirement for a cockpit warning light in conjunction with the specified magnetic chip detector plug.

j. Add to Paragraph 3.14.1 INSTRUMENTS.

(1) A combination engine oil temperature-engine oil pressure gauge is desired.

(2) A combination transmission oil temperature-transmission oil pressure gauge is desired.

(3) A single fuel quantity gauge, with a totalizer if necessary, shall be provided.

(4) A low fuel quantity warning light is required.

(5) The magnetic standby compass and the free air temperature gauge shall be installed in locations selected by the manufacturer; however, the magnetic compass shall not be mounted adjacent to the directional gyro indicator.

(6) The airspeed, altitude, attitude, and heading indicators shall be mounted in the instrument panel in the approved Army "T" arrangement as illustrated in Figure 3. The altimeter and the attitude, heading, and airspeed indicators shall be of standard three-inch size.

(7) The Ball-and-race bank indicator portion of a turn-and-bank indicator shall be provided as a feature integral to the attitude indicator. See Figure 4. (NOTE: Delete turn-and-bank indicator from paragraph 3.14.1.)

(8) A deviation indicator shall be provided, suitable for display of navigation information from the AN/ARC-54 FM Radio Set Homing System. This instrument shall be located as indicated in Figure 5.

(9) Engine instrument arrangement shall be in general accordance with Figure 5. Locations of engine instruments not shown in Figure 5 shall be subject to approval by the Mock-up Board.

(10) A combination heading-bearing indicator is desired. See Figure 6.

(11) Orientation of all appropriate indicator pointers shall provide normal operating (velocity for best range) indications at identical relative positions. The six or twelve o'clock positions shall not be used.

(12) Add an 8-day type clock to the list of GFE.

(13) Integral lighting of instruments and edge lighting of instrument panel is desired.

k. Add to paragraph 3.16 ELECTRICAL.

(1) Single-phase 400-cycle 100-VA, 115-volt, static-type inverter(s) shall be installed.

(2) A Nickel-Cadmium type storage battery of 22 amp/hr capacity shall be provided.

(3) A single 450-watt light on a ground adjustable mount, shall be installed.

(4) Provisions shall be made for use of any Army type-classified 28-volt dc auxiliary power unit used in the same time frame as is the LOH, to include dc power sources mounted on automotive vehicles. A current limiter device may be used in meeting this requirement, if appropriate.

1. Revise Paragraph 3.17.2.2 INTERPHONE SYSTEM to indicate: The AN/AIC-12 interphone system shall consist of two C-1611 control panels, mounted in such a manner as to provide access to one by the pilot, and access to the second by the observer.

m. Add to Paragraph 3.17.6 ANTENNAS: A combination UHF/VHF communications band antenna is desired. The antenna should be mounted in a location determined by the contractor to be optimum.

(Such an antenna is now being tested by the Signal Aviation Test and Support Activity at Fort Rucker, Alabama.)

n. Add to Paragraph 3.18 ARMAMENT.

(1) Consideration will be given to keeping the length of ammunition chutes to a minimum.

(2) Weapon installation will not exceed the time required for normal combat refueling service of the helicopter.

(3) Weapons will be installed in such a manner that moments created about the aircraft aerodynamic center will be minimized.

o. Add to Paragraph 3.19 FURNISHINGS AND EQUIPMENT.

(1) An annunciator (caution) panel shall be provided. Provisions shall be made to include, if appropriate, but not limited to, the following:

Low fuel quantity

Low engine oil pressure (or quantity)

Low transmission oil pressure

Fuel filter by-pass indicator

Generator out

Magnetic chip detector

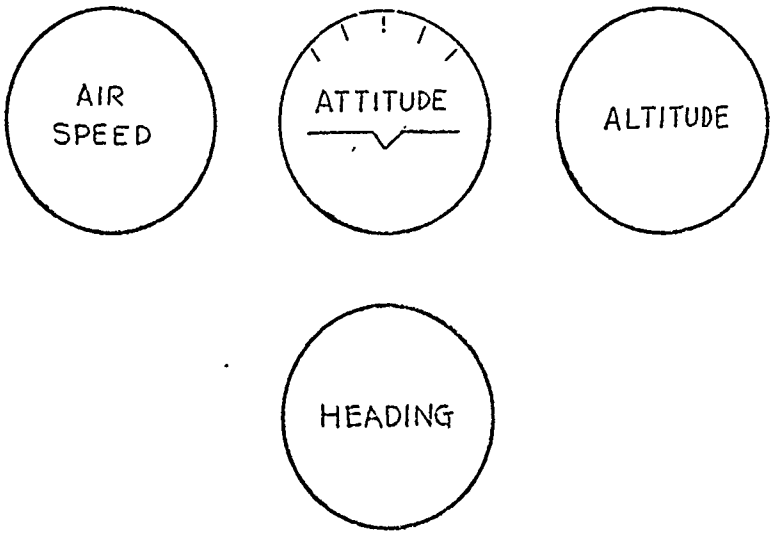
(Provisions of an annunciator panel will be an added cost as compared to caution lights placed at random in the cockpit. Random placement of caution lights is not recommended. The HU-1( ) and AO-1( ) use annunciator panels.)

(2) Energy absorbing material or other means are desired in the design of seat cushions to help minimize spinal-type injuries in accidents having considerable vertical forces. The use of aluminum honeycomb, or other similar material, is recommended for use in construction of the seat-well.

(3) It is desired that seal belts and shoulder harnesses be attached to the basic airframe in lieu of the seats, if compatible with the design.

(4) One (1) GFE Type CF3Br hand fire extinguisher shall be provided in the pilot's compartment readily accessible to operating personnel.

(5) One (1) GFE first aid kit shall be installed.



ARMY STANDARD "T" PANEL

Figure 3

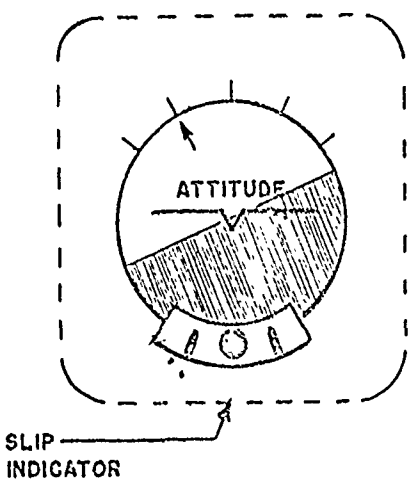
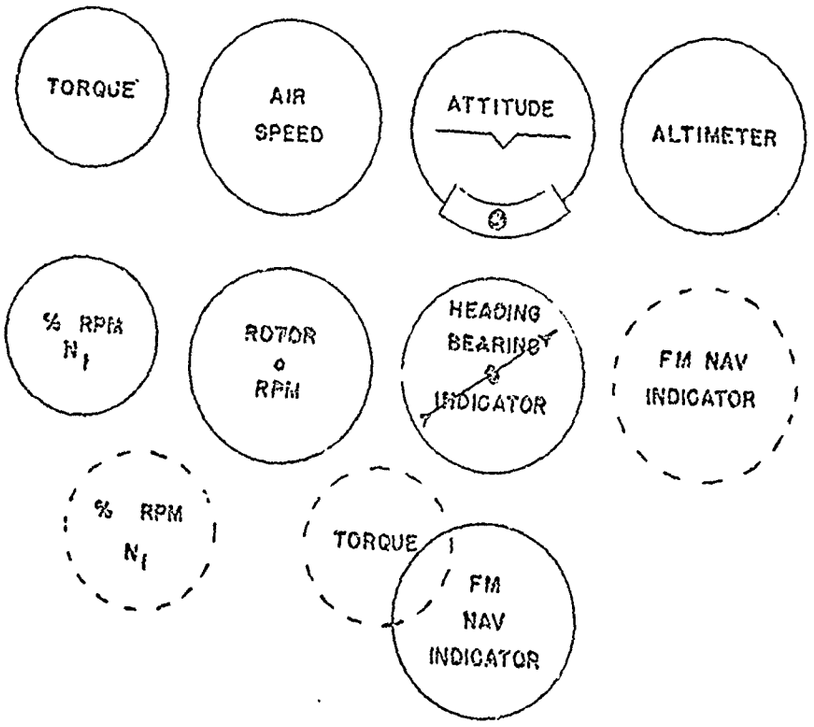
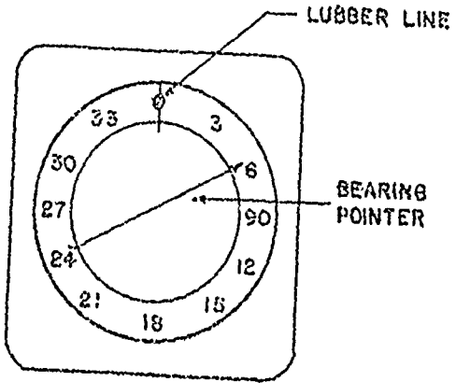


Figure 4



1. SOLID LINES INDICATE DESIRED ARRANGEMENT
2. DOTTED LINES INDICATE ACCEPTABLE ALTERNATE

Figure 5



HEADING BEARING INDICATOR

Figure 6

APPENDIX H

COMPARISON OF ACCEPTABLE PROPOSALS

PARAMETERS	COMPARISON				NOTES
1. Acceptable Proposals	Bell (D250)	Hiller (1100)	Boeing-Vertol (131)	Sikorsky (Primary)	
2. Order of Merit	First	Second	Third	Fourth	
3. Dimensions (Note 1)					1. Dimensions to nearest inch.
Height	8'8"	9'5"	8'7" (Note 2)	8'10" (Note 2)	2. Tail rotor not considered.
Skid width	5'10"	7'5"	5'	6'6"	
Length (rotors turning)	37'	41'1"	41'2"	37'8"	
Length (rotors folded) (Note 3)	27'10"	29'5"	29'4"	27'2"	3. Tail rotor vertical.
Main rotor dia	32'	35'	35'	31'6"	
Overall	Smallest	Largest			4. Must remove horizontal stabilizer and tail skid for 3. No removal required for 2.
4. Air Transportability					
Nr that can be transported in C-130 without major disassembly (see Figures 7 thru 11)	3 (Note 4)	0 (Note 5)	2	3	5. Must remove main rotor & mast. Does not meet MC. It is questionable that re-assembly can be accomplished in 1 hour for Phase II reqmt. Will meet Phase III reqmt.
5. Weights					
Empty (lbs.)					
By mfg's data	1375 (Note 6)	1345	1444	1512	6. Allows for 125 lbs growth contingency

	Bell	Hiller	Boeing-Vertol	Sikorsky
Navy estimate	1450	1460	1519	1512
Design gross (lbs.)				
By Mfg's data	2450	2410	2432	2450
Est increase (Navy)	+75	+115	+75	+50 (Note 7)
Navy design gross	2525	2525	2507	2500
6. Performance				
Hover ceiling (ft) (Army Hot Day)				
By mfg's data	4500	6000	6800	6000
Navy estimate	2670	4350	4830	3150
Speed				
Vmax, NRP (kts)				
By mfg's data	104	113	111	110
Navy estimate	102	110.5	108	101.5
V for max rg (kts)				
By mfg's data	96	102	90	93 (Note 8)
Navy estimate	98.5	101	96.5	92.5
Flat plate area (sq ft)				
By mfg's data	8.38	6.84	6.47	6.5
Navy estimate	9.24	7.35	7.75	9.06

7. Sikorsky ignored the reqmt for 3 hrs end @ V for max rg. The Navy added 50 lbs. of fuel to Sikorsky's proposal and increased gross weight by 50 lbs.

8. Adjusted from 80 kt proposed to calculated V for max rg. (See Note 7.)

	Bell	Hiller	Boeing-Vertol	Sikorsky
Endurance (hrs) (Note 9)				
By mfg's data	3	3	3	2.7 (Notes 7 & 8)
Navy estimate	2.90	2.94	2.55	2.52
Range (NM) (Note 9)				
By mfg's data	288	306	270	261
Navy estimate	286	297	246	233
Autorotational index (Note 10)	9.31	11.0	8.1	5.0
Min maneuverability time (sec) (Note 11)	2.23	1.48	1.68	.45
Min rate autorotative descent (ft/min) (Note 12)	1620	1375	1340	1320
7. Rating by Committees (Notes 13 & 14)				
Operational & Tactical Suitability				
Field operations	E	S	E	E
Tactical missions				
Visual observation	E	E	O	O
Target acquisition	E	E	O	S
Reconnaissance	E	S	S	S
Command control	E	E	S	S

9. At speed for max range.

10. From mfg's data uncorrected by Navy estimates. See Appendix C.

11. Time available for landing following autorotation & pulling pitch for flare. (From mfg's data.)

12. From mfg's data.

13. Ratings considered in order of merit are as follows:
    O - Outstanding
    E - Excellent
    S - Satisfactory

14. Some items evaluated, such as performance, weight, and air transportability, are reported above and not included here. The four LOH proposals are compared with each other.

	Bell	Hiller	Boeing-Vertol	Sikorsky
Radiation survey	S	E	E	S
Suppressive fire	E	S	S	S
Co level tasks	E	E	S	S
Flying ease and comfort	0	E	S	S
Forward Area Maintenance				
Component life	0	E	E	0
Maintainability (Note 15)	0	E	S	0
Scheduled inspections	0	E	S (Note 16)	E
Servicing & lubrication	E	E	E	0
Maint man-hr to flight-hr ratio	0	E	S (Note 16)	E
Performance/Components (Note 14)				
Rotor system				
Structure	0	E	E	0
Aerodynamics	0	E	E	S
Mechanical design	0	E	0	E
Power system				
Power plant	E	E	S	S
Tail rotor	E	E	S	S

15. Forward area maintainability at user level.

16. Periodic inspection and overhaul times considered excessive.

	Bell	Hiller	Boeing-Vertol	Sikorsky	
Airframe					
General	E	E	E	E	
Landing gear	E	S	E	S	
Visibility	E	E	0	0	
Access-exit	E	E	S	S	
Heating/ventilation	E	E	E	S	
Control system	E	S	E	E	
Avionics, Electrical, & Instruments					
Maintainability (Note 17)	0	0	E	S (Note 18)	
Configuration	E	E	E	S (Note 18)	
Compliance with Table "E" reqmts	E	E	S	S	
Lighting	E	E	E	S (Note 18)	
Environment (Note 19)	0	E	E	0	
Provisions for internal components (Note 20)	E	E	E	S (Note 18)	
Electrical system	E	0	E	S (Note 18)	

17. As a function of component accessibility.
18. Proposal too vague to permit detailed evaluation.
19. Weather protection and ventilation.
20. Space, weight, & location.

	Bell	Hiller	Boeing-Vertol	Sikorsky
Instruments (Note 21)				
Engine	O	O	O	O
Flight	E	E	E	E
Crashworthiness				
Safety belt, shoulder harness & reel	O	E	S (Note 22)	O
Structural integrity & fuel system	O	S	S	E
Noise	E	S	S	E
Emergency exits	E	E	E	E
Grass fire prevention	E	E	S (Note 23)	E

21. Adequacy and arrangement.

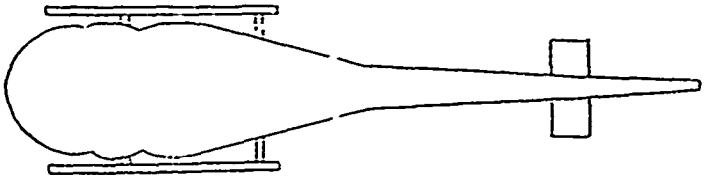
22. Belt & harness attached to seat rather than structure.

23. Exhaust 3' above ground. Will cause grass fires in uneven grassy terrain.

TRANSPORTABILITY IN C-130 CARGO AREA

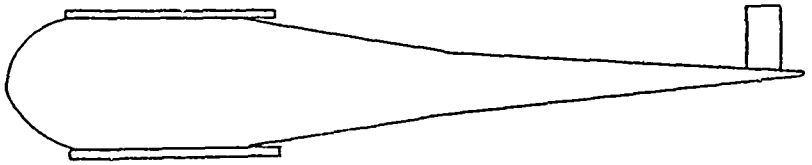
C-130 LENGHT 41.1' WIDTH 10.3' HEIGHT 9.1'

BELL



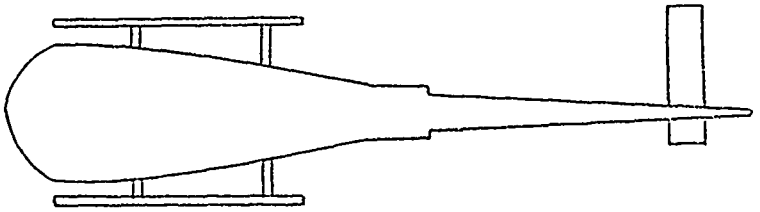
LENGTH 25.5' WIDTH 5.8' HEIGHT 8.8'

BOEING - VERTOL



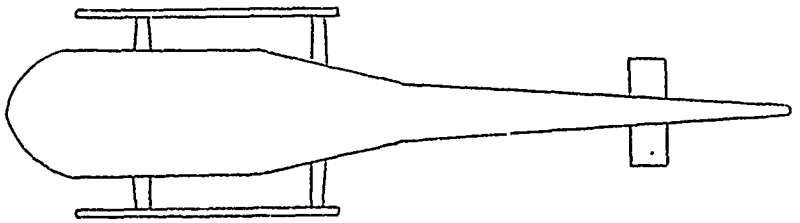
LENGTH 29.3' WIDTH 5.0' HEIGHT 8.8'

SIKORSKY



LENGTH 27.3' WIDTH 6.5' HEIGHT 8.9'

HILLER



LENGTH 29.0' WIDTH 8.4' HEIGHT 9.7'

FIG 7 SIZE COMPARISON

C 130 A & B (CARGO COMPARTMENT)

LENGTH 41.4' HEIGHT 9.1'

WIDTH 10.3'

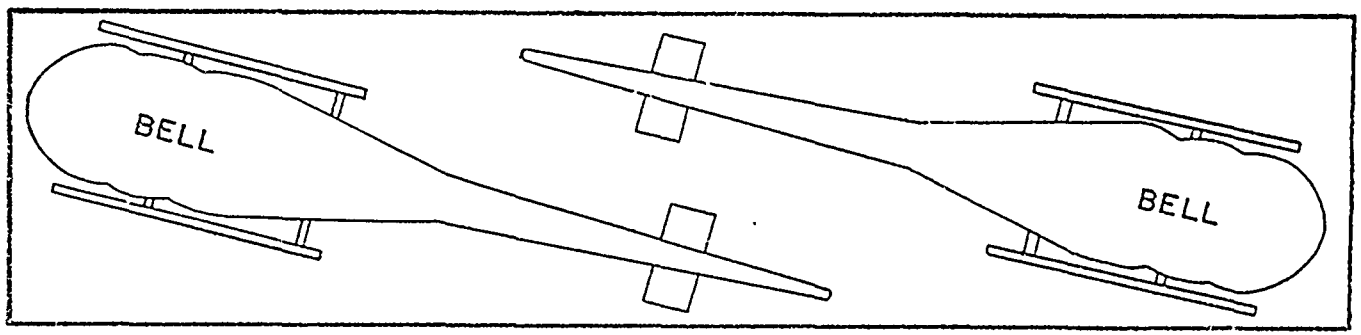


FIG 8 (NO COMPONENTS REMOVED)

BELL D-250

LENGTH 41.4' HEIGHT 9.1'

WIDTH 10.3'

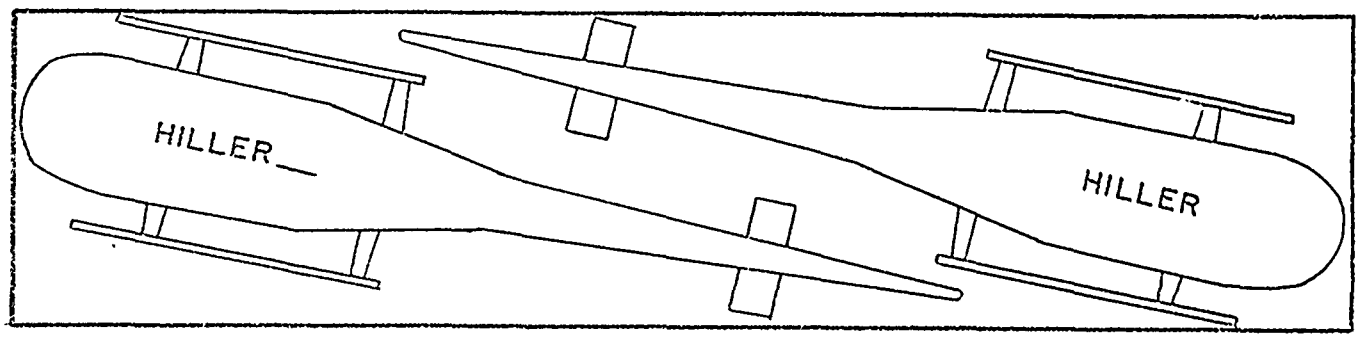


FIG 9 (REQUIRES REMOVAL OF ROTOR & MAST)

HILLER 1100

C 130 A & B (CARGO COMPARTMENT)

LENGTH 41.4' HEIGHT 9.1'

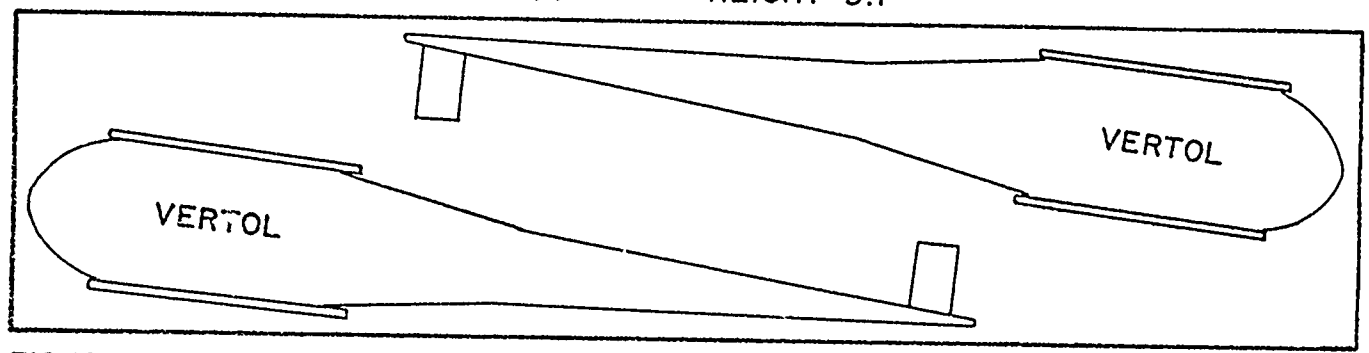


FIG 10 (NO COMPONENTS REMOVED)

BOEING - VERTOL 131

LENGTH 41.4' HEIGHT 9.1'

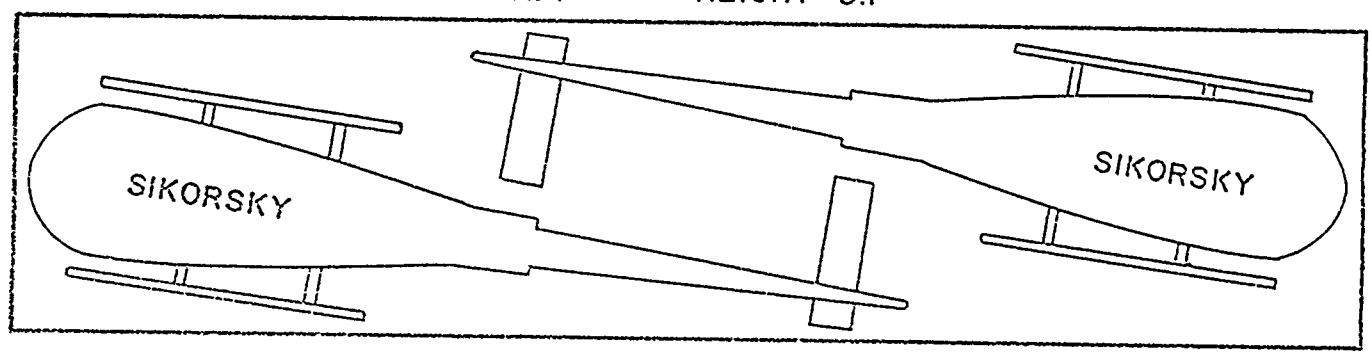


FIG 11 (NO COMPONENTS REMOVED)

SIKORSKY (PRIMARY)

APPENDIX I

It was the consensus of the Army Operational Evaluation Group that the following three requirements, listed in order of merit, should be included in the detail specifications for the LOH. These items were previously considered by the Rogers Board and were eliminated from the LOH requirements:

a. Consideration for installation of the visual airborne target locator system, AN/UVS-1( ). This is basically an Artillery position. It is recognized that present models of the AN/UVS-1, weighing over 200 pounds, are not practical for installation in the LOH. However, if this system meets expectations and can be reduced in weight, it is a logical and needed supplement to the LOH for Artillery use. Therefore, the manufacturer of any LOH should be appraised of the possible future requirement for this equipment. At this time, this essentially means the ability to cut an approximate six-inch hole in the floor of the LOH near the center rear of the observer's seat, and possibly the ability to remove the observer's seat.

b. The ability to transport one prostrate casualty. It is considered that with the number of LOH's planned for Army use the ability to transport one prostrate casualty is a firm requirement. There is no intent to provide any brackets or fittings for this specific purpose nor to expand this requirement to a litter configuration. Such a requirement, at most, may necessitate the removal of the observer's seat.

c. Capability for installation of a simple external cargo hook. It was considered that such a requirement could be met with a kit and that a simple, lightweight external cargo sling hook is obtainable and would greatly enhance the tactical suitability of the LOH.