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Operations Manual: Vertical Motion Simulator (VMS) S.08

A. David Jones

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NASA

National Aeronautics and
Space Administration

Operations Manual: Vertical Motion Simulator (VMS) S.08

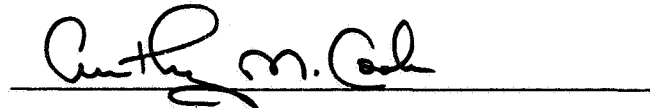A. David Jones, Ames Research Center, Moffett Field, California

PREFACE

This manual describes the operational procedures for the Vertical Motion Simulator (VMS) S.08. This manual may be revised or amended by page changes and additions. A transmittal code is set at the bottom of each page. All pages initially transmitted are coded OMS-08-1 (Operations Manual for Simulator, Number 08, Transmittal Number 1). Revised pages will be coded OMS-08-2, OMS-08-3, etc., and a checklist of pages in force by transmittal codes will accompany each transmittal.
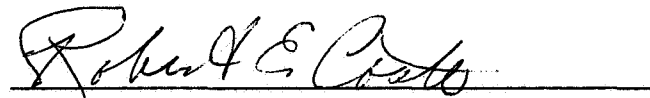
This Operations Manual, setting forth the procedures for implementing and conducting flight research programs on the Vertical Motion Simulator, has been approved by the following officials:

George A. Rathert Jr., Chief
Simulation Sciences Division

Anthony M. Cook, Assistant Chief
(Operations) Simulation Sciences Division

Robert E. Coate, Chief
Simulation Investigations Branch

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1.0 GENERAL DESCRIPTION

The Vertical Motion Simulator (VMS) consists of a two-man cab which can be driven in six degrees of freedom. The VMS was designed to provide extensive cockpit motion to aid in the study of handling qualities of existing or proposed aircraft and helicopters. The simulator is equipped with individual out-the-window color flight displays for both pilot and copilot. Each display has a collimating mirror/beam-splitter system that provides a realistic impression of the flight scene to the simulator crew members. The simulator is equipped with a force-feel system that simulates pilot control (wheel, column, and rudder) forces. To further enhance realism in the cockpit, the cab has a sound system that provides aural cues for simulating such things as forward and reverse thrust for each engine, landing gear locking, and touchdown and runway rumble. Sigma 7 and PDP 11/55 digital computers have been incorporated into the VMS facility. They compute the pilot's control inputs and generate signals which command the visual, audio, and motion generators that provide the various cues to the simulator pilot.

1.1 Description of Vertical Motion Simulator (VMS)

The VMS motion generator (fig. 1) consists of a synergistic hydraulic motion system mounted on a moving platform with large lateral and vertical motion capabilities. The motion generator is located in a tower addition to Building N-243 designed specifically for the motion system. (See figures 2(a) and (b) for a floor plan of Building N-243.) The tower interior dimensions are 36 ft wide x 73 ft long x 120 ft high. To provide adequate stiffness, the poured-in-place concrete tower walls are 2 ft thick.

Vertical motion is the primary degree or freedom and all other modes are built on top of it. A platform spanning the tower is supported by two vertical columns spaced to minimize deflections. Currently, 8 dc servomotors drive the simulator vertically through gear reducers, pinions, and rack which are attached to the columns; however, as a growth factor, 4 additional drives may be added making a total of 12 motors driving the platform.

Four horizontal torque tubes are mounted in bearings at the tower floor and extend out to the vertical columns. The vertical drive racks engage pinions on the ends of the torque tubes, causing them to rotate as the platform moves vertically. The torque tubes synchronize the columns driving the platform and react against roll moments induced when the cab is off the center position. Wheel assemblies at the center and one end of the vertical platform ride on guide rails attached to the tower walls and provide lateral and longitudinal support for the simulator.

An equilibrium ("pneumatic counterweight") system, used to uncouple gravity forces from the vertical drive, applies loads through the vertical drive columns. Seals installed in the ends of the columns ride over pressurized tubes extending to the bottom of the 75-ft-deep shafts. The pressurized tubes are connected to an underground nitrogen storage system. Total volume of the storage system is approximately 1500 ft^3 and the nominal equilibration

AXIS	DISPL.	RATE	ACCEL.
z	30	20	32
y	20	10	24
x	2.5*	2	16
θ	25*	15	50
ϕ	22*	15	50
ψ	29*	15	50

ALL NUMBERS + AND − UNITS: FT; DEG; SEC.

MOTION PERFORMANCE OF VMS
*MAXIMUM INDEPENDENT
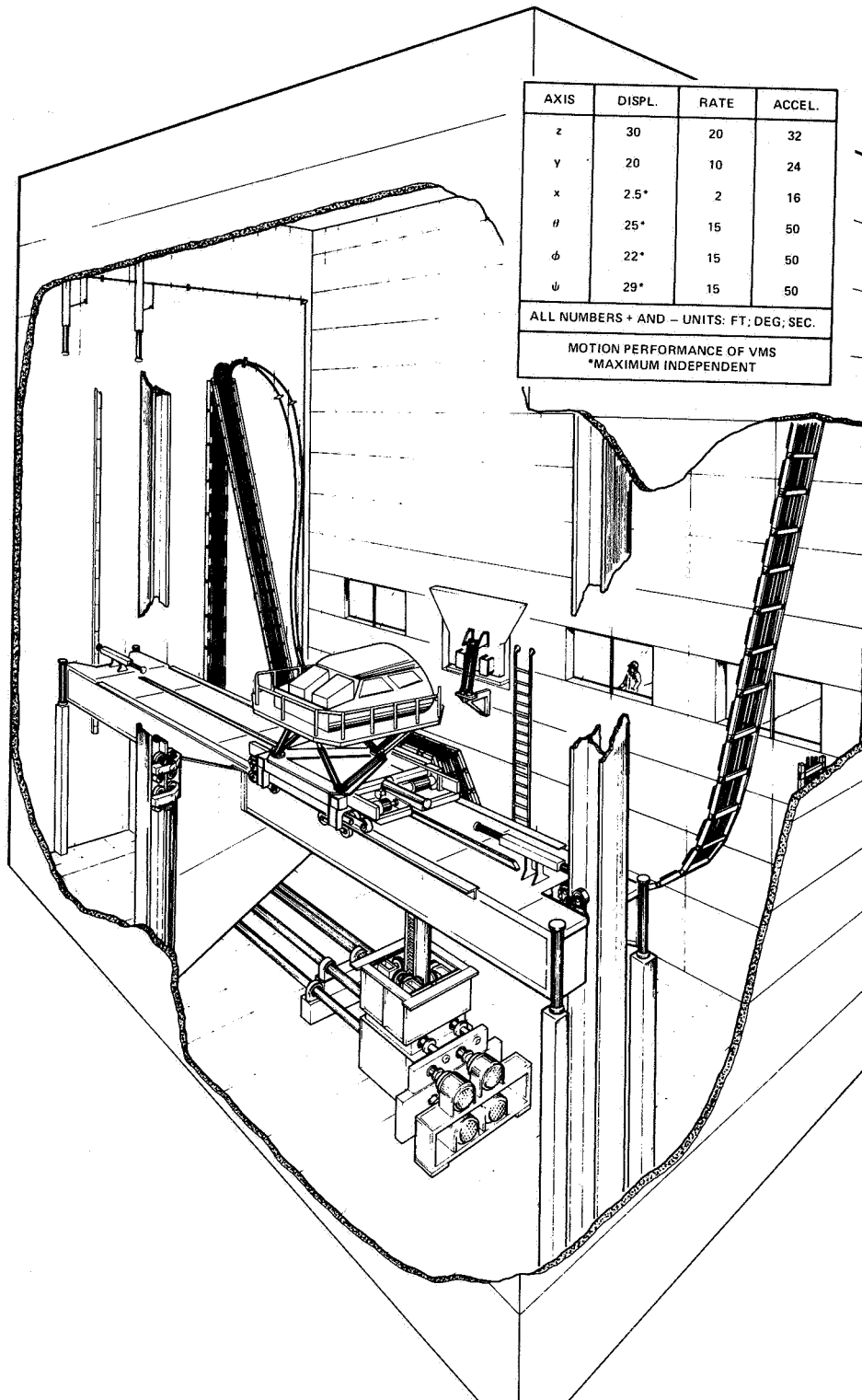
Figure 1. Vertical Motion Simulator.

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FIRST FLOOR

N
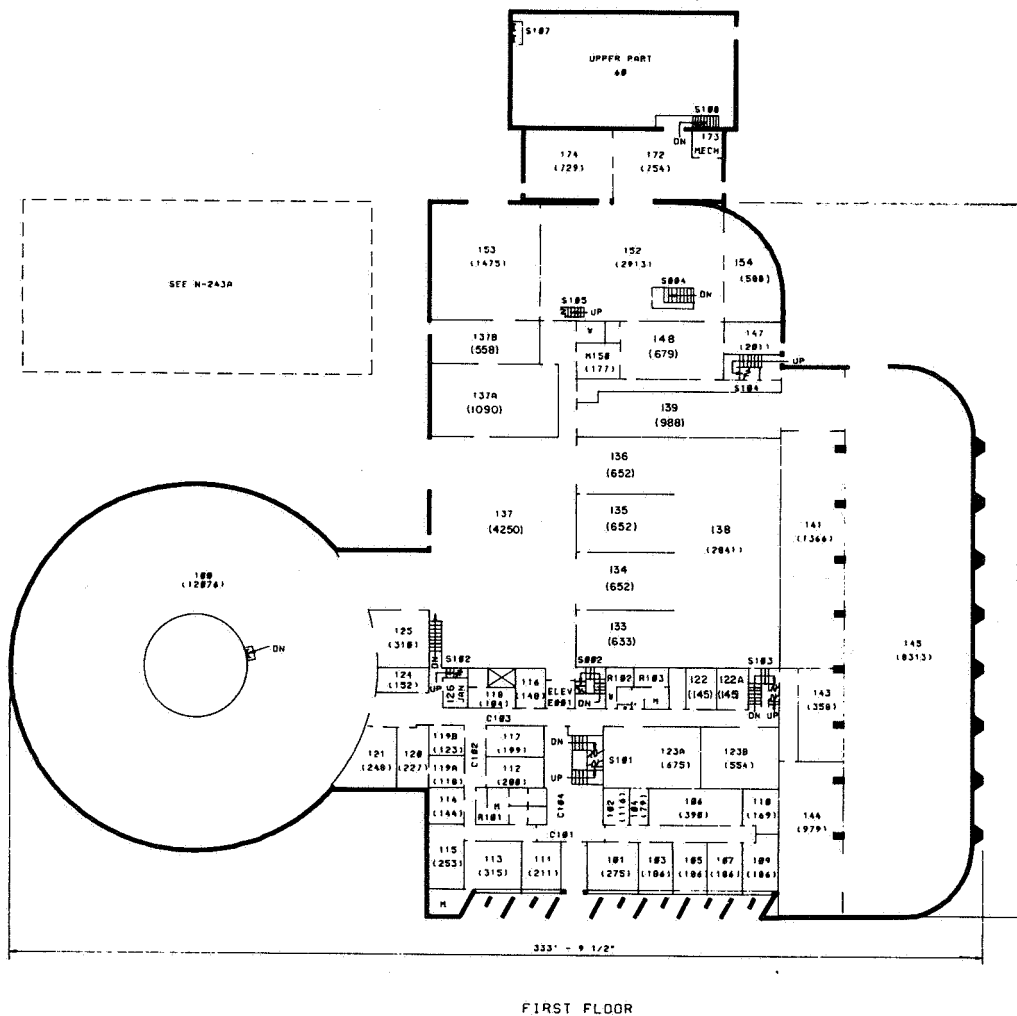
Figure 2. Flight and Guidance Simulation Laboratory Floor
Plan (Building N-243).

OMS-08-1

233 MECH

DN

MEZZANINE
ABOVE ROOM 231

SEE N243A

UPPER
PART
OF 60

274
(914)

C 206

272
(231)

R203
M

231
(373)

UPPER
PART
OF 153

DN

UPPER
PART
OF 152

232
(362)

229
(1177)

230
(150)

S 104

DN

201
(193)

228
(1386)

202
(195)

UPPER
PART
OF 137

249
(176)

248
(213)

203
(241)

247
(176)

246
(213)

204
(239)

UPPER
PART
OF 136

245
(176)

UPPER
PART
OF 138

243
(176)

244
(213)

205
(249)

C 201

UPPER
PART
OF 145

230A
(650)

241
(176)

242
(213)

206
(330)

230
(150)

DN
UP

S 104

MEZZANINE
(UNDER ROOM 232)

UPPER PART
OF 100

214
(410)

239
(269)

240
(265)

PLAT
FORM

207
(247)

216
(257)

UP S201

DN

223
(91)

224
(67)

W

R202

ELEV
E001

M R201

212
(446)

S 103

DN

C 202

W

208
(194)

S 201

DN

301
MECHANICAL

218
(421)

219
(164)

215
(468)

DN

S101

213A
(500)

211
(1035)

PENTHOUSE

217
(2370)

213B
(1725)

209
(1058)

SECOND FLOOR

N

Figure 2.   Concluded.

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pressure is currently 373 psi, with a growth potential to 420 psi. This provides less than a 10% change in total volume throughout the total travel.

Lateral motion capability of 40 ft is provided by a carriage that is driven across the vertical drive platform. Four carriage-mounted dc servomotors drive through reducers to pinions that engage a fixed rack on the platform. The rotational and longitudinal motions are obtained with the synergistic hydraulic motion system. Six 36-in. stroke actuators operating at 1800 psi produce the actuating forces at a maximum flow rate of 48 gpm.

Hydraulic power and electrical lines (signal and power) are connected to the lateral carriage by two symmetrical catenaries attached to the tower walls. Each catenary joint has provisions for adjustable coulomb damping to eliminate undesirable catenary motions. End-of-travel mechanical stops are provided for the lateral and vertical motions of hydraulic snubbers. In the vertical mode, four constant force snubbers at each travel extreme provide a nominal 1.5-g deceleration when impacted at 15% over the maximum design velocity of 20 ft/s. In the lateral mode, a single snubber at each travel extreme provides a nominal 1.125-g deceleration when impacted at 15% over the maximum design velocity of 10 ft/s.

Vertical parking brakes are provided by disc/caliper assemblies at two locations on each torque tube. The brakes are designed strictly to provide a holding force to keep the platform at any vertical position. Emergency end-of-travel decelerations are provided only by the hydraulic snubbers.

A cockpit boarding ramp is also part of the VMS motion generator. The ramp is installed on the west tower wall and driven electrically to and from the boarding position. When retracted against the tower wall, the ramp is clear of the moving motion generator.

Power to operate the VMS drive system is derived from two sources external to the immediate facility. One source is a 1500 KVA, 13.8-kV/480-V transformer; the other is a Ward-Leonard MG system consisting of a set of two large dc generators driven by a single 13.8-kV, 12,000-hp synchronous motor.

The 480-V ac power is brought to the VMS Electrical Control Center where it is distributed to the various auxiliary control apparatus. Direct-current power from the generators is distributed through the Control Center to the set of dc motors used to drive the vertical axis.

The VMS control system can be divided into three basic drive subsystems: vertical drive, lateral drive, and the synergistic motion platform (termed the hexapod) drive. Both the vertical and lateral drives are powered by electromechanical prime movers whereas the hexapod drive is powered by electrohydraulic means.

The vertical and lateral drive systems are configured to utilize displacement, velocity, and motor current as primary feedback quantities. Correspondingly, three separate inputs from the simulation computer representing displacement, velocity, and acceleration are used. Velocity and acceleration input commands are required to be proportionately adjusted to

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realize the proper feed-forward compensation. The feedback quantities and external signal inputs are summed, preamplified, and conditioned using solid-state discrete, integrated circuit electronic components. The hexapod system utilizes displacement as the primary feedback quantity with velocity feedback used for stabilization. Signals from the computer are displacement commands for each of the six independent actuator servo subsystems on the hexapod.

For the vertical drive system, the output of the electronic preamps are fed to two thyristor controllers rated 100 kW, which separately regulate the current to the control fields of two large dc generators. Each generator in turn is connected to four 150-hp dc drive motors wired so that the two motors on each column are wired in series and the two pairs are wired in parallel.

In the lateral drive system, the output of the electronic preamps are fed to four thyristor controllers, rated 34.8 kW, each of which directly powers a 40-hp dc drive motor. In the hexapod system, the preamplifiers are regulated to control current to the servo valves associated with the respective hydraulic actuators.

1.2 Performance Capability

The current VMS motion generator performance envelope is as follows:

Mode	Maximum displacement	Maximum velocity	Maximum acceleration	Frequency at 30° phase lag
Vertical (Z)	±30 ft	±20 ft/s	±32.2 ft/s^2	1.5 Hz
Lateral (Y)	±20 ft	±10 ft/s	±24 ft/s^2	1.5 Hz
Longitudinal (X)	±2.5 ft	±2 ft/s	±16 ft/s^2	0.7 Hz
Roll (ϕ)	$\pm22^\circ$	$\pm15^\circ$/s	$\pm50^\circ$/s^2	0.7 Hz
Pitch (θ)	$\pm26^\circ$, -24°	$\pm15^\circ$/s	$\pm50^\circ$/s^2	0.7 Hz
Yaw (ψ)	$\pm29^\circ$	$\pm15^\circ$/s	$\pm50^\circ$/s^2	0.7 Hz

These peak motion system capabilities are with a payload that includes all hardware attached to the synergistic motion system with the following characteristics:

$$\text{Weight} = 8,000 \text{ lb}$$
$$I_{xx} = 26,000 \text{ in.-lb-s}^2$$
$$I_{yy} = 31,000 \text{ in.-lb-s}^2$$
$$I_{zz} = 31,000 \text{ in.-lb-s}^2$$

The above moments of inertia are referenced to the center of the top platform on the synergistic system.

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1.3 Computational Capability

The VMS main computational computer is a Xerox Data System Sigma 7 equipped with a 128,000-word memory. Peripheral equipment consists of a card reader (800 cards/min), a line printer (600 lines/min), two tape units (800 bytes/in. at 75 in./s), a random access device (RAD), a disc file, and two electrostatic Versatec printer-plotters.

In addition, there is a Digital Equipment Corporation PDP 11/15 digital computer resident in the Simulation Control Room. This computer is used to communicate between the Sigma 7 and the four remote input/output (I/O) units. The PDP 11/55 is equipped with 48,000 words of memory, 32 digital/analog channels, 32 analog/digital channels, and 64 discrete channels. Two remote I/O units are located in the Simulation Control Room, one in the simulator operator's room and the fourth unit at the simulator cockpit. Each unit is equipped with 256 channels of I/O capability.

2.0 VERTICAL MOTION SIMULATOR OPERATIONS PERSONNEL

The administrative lines of authority and responsibility for operation of the VMS are shown in the VMS Operational Organization Chart (fig. 3). Responsibility for conducting a project on the VMS is as follows:

2.1 Simulation Sciences Division Chief

The Division Chief is responsible for the management, control, and operation of the VMS. Specific operational responsibilities include:

a. Originates and/or approves elements of Division safety policy and procedures.

b. Approves Operational Safety Program, spotchecks operations.

c. Determines need for Operational Readiness Reviews and Man-Rating Reviews; requests these from Chief, Institutional Operations Office; monitors division response to these reviews.

d. Specifies incidents and accident reviews below senior management level; approves response.

e. Serves as Chairman, Human Research Experiments Review Board (AMM 7170-1).

f. Interfaces with senior management and Chief, Institutional Operations Office, on all of the above.

2.2 Simulation Sciences Assistant Division Chief for Operations

Specific operational responsibilities include:

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                    ┌─────────────────────────┐
                    │  AMES RESEARCH CENTER   │
┌──────────────────┐│        DIRECTOR         │
│  INSTITUTIONAL   │├─────────────────────────┤
│ OPERATIONS OFFICE│┤    DEPUTY DIRECTOR      │
└──────────────────┘└─────────────────────────┘
        ┊            ┌─────────────────────────┐
        ┊            │ DIRECTOR FOR AERONAUTICS │
        ┊            │   AND FLIGHT MECHANICS   │
        ┊            └─────────────────────────┘
┌──────────────┐    ┌─────────────────────────┐
│  MAN-RATING  │────│SIMULATION SCIENCES DIVISION│
└──────────────┘    │          CHIEF          │
                    │ ASSISTANT CHIEF, OPERATIONS│
                    └─────────────────────────┘
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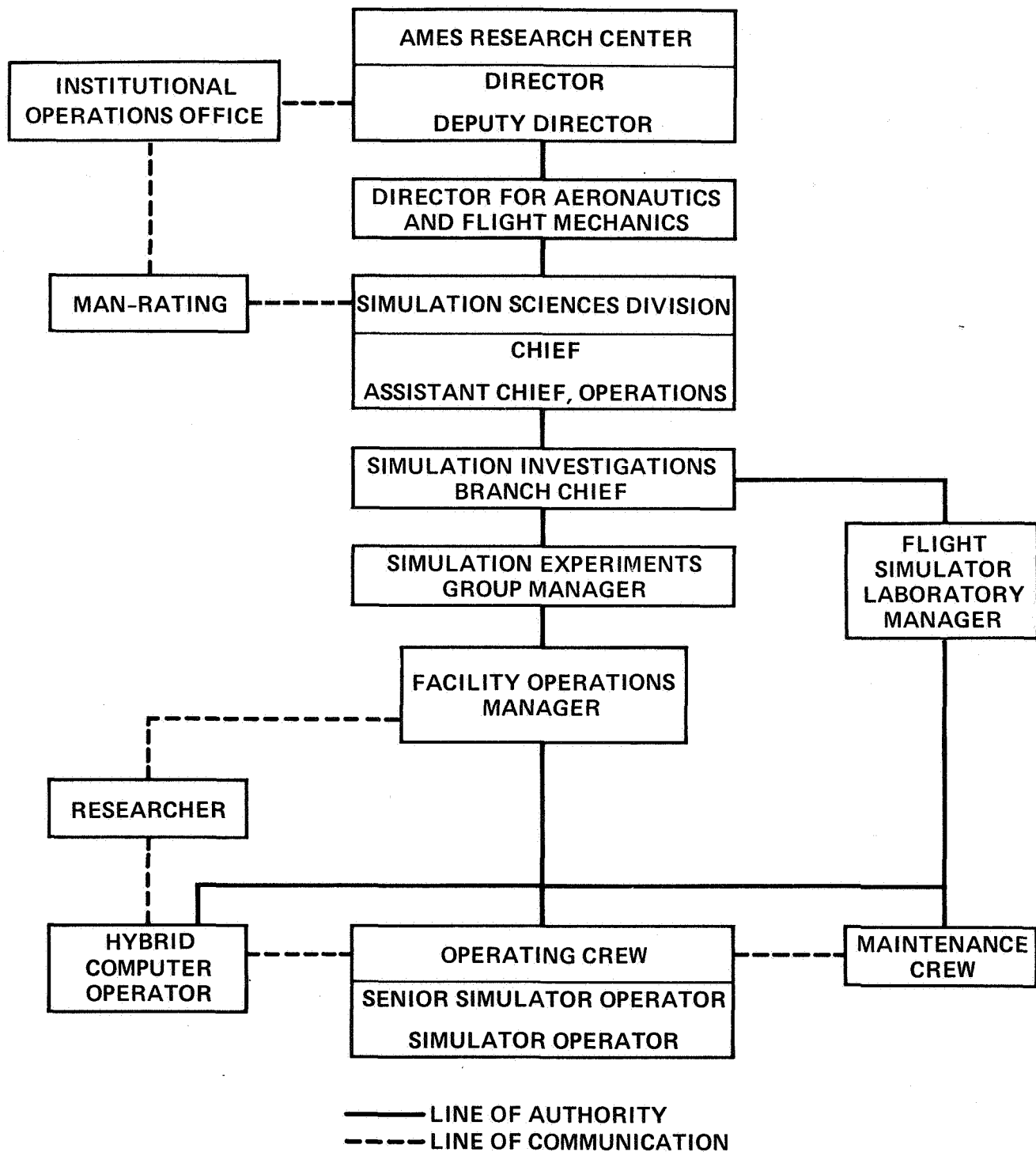
Figure 3. VMS Operational Organization Chart.

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a. Ensures compliance with Operational Safety Program in all aspects.

b. Approves long-range schedules of facilities operation.

c. Approves test plans and experiment protocols.

d. Approves operations manuals, facilities manuals, and maintenance schedules.

e. Serves as Facility Manager for Building N-243 and interfaces with managers where Division facilities are co-located.

2.3 Simulation Investigations Branch Chief

The Branch Chief is responsible for all engineering, safety, and operational aspects of projects conducted on the VMS. Specific operational responsibilities include:

a. Assigns the VMS Facility Operations Manager.

b. Develops training standards and certifies qualifications of all operations personnel.

c. Approves minor modifications to the VMS as specified in Paragraph 3.1, Categories 2 and 3.

d. Initiates a formal review board for Category 4.

e. Approves the facility maintenance plan (Paragraph 3.5).

2.4 Facility Operations Manager

2.4.1 Appointment. The Chief, Simulation Investigations Branch, designates a Facility Operations Manager for the VMS. The areas of responsibility of the Facility Operations Manager are the same as those delegated to the Branch:

a. Ensures safety of personnel. This responsibility includes research and operating personnel.

b. Operates the facility within manpower and funding guidelines established by the Chief, Simulation Investigations Branch.

c. Consults with and guides researchers to ensure development of a test plan consistent with the capabilities of the VMS facility.

d. Coordinates simulator maintenance and cockpit reconfiguration to accommodate various research projects.

e. Approves adjustments to the VMS as specified in Paragraph 3.1, Category 1.

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f. Assists the Chief, Simulation Investigations Branch, in long-term and daily scheduling to optimize facility availability.

g. Monitors daily operation of the facility to ensure that it is in compliance with approved test plan and operational procedures.

h. Assures that the facility documentation files are properly maintained (Paragraph 3.1.3).

i. Approves significant departures from the approved test plan after consultation with the researcher.

j. Reviews project log. Its purpose is to record a time history of events, equipment failures, and project interruptions pertinent to the project.

k. Conducts a postsimulation critique, as described in Paragraph 3.6.

l. Prepares final documentation for files. The contents will contain the following as a minimum:

   (1) Request for SSD support (Form FL-3).

   (2) Project requirements and schedule.

   (3) Operational procedures.

   (4) General coverage photographs.

   (5) Results of critique.

   (6) Any later comments by the researcher, including published papers or reports.

2.5 Senior Simulator Operator

2.5.1 Appointment. The Flight Simulator Laboratory Group Manager will assign a Senior Simulator Operator for the VMS. The Senior Simulator Operator is under the direct supervision of the Facility Operations Manager during operation. His primary responsibilities include the following:

a. Assists the Operations Manager whenever possible, especially during project runs.

b. Obtains new instrument dial face scales when necessary.

c. Directs the simulator cab electrical configuration, modification, and documentation.

d. Directs the instrument to remote I/O unit assignments.

e. Adjusts the engine sound system in the cab.

f. Maintains and calibrates linear and angular accelerometers.

g. Monitors contractor's work on cab interior changes such as removing or replacing center and side consoles or control loaders, CRT monitors, etc.

h. Programs the intercom nets and assures that the intercom audio recorder is operating properly.

i. Assures that the VMS is operated safely to achieve the objectives stated in the approved operational procedures; he is directly responsible for implementing the following operating procedures concerning the VMS operation:

   (1) Operating procedures (Paragraph 3.3).

   (2) Emergency procedures (Paragraph 3.4).

   (3) Preflight checklist (Paragraph 3.5).

   (4) Major inspection checksheet (Paragraph 3.5).

2.6 Alternate Simulator Operator

The Alternate Simulator Operator is assigned by the Flight Simulator Laboratories Group Manager and is under the direct supervision of the Senior Simulator Operator. He assists the Senior Operator whenever possible and is qualified to operate the VMS.

3.0 ADMINISTRATIVE PROCEDURES FOR THE VERTICAL MOTION SIMULATOR

3.1 Maintenance of Procedures for Operating Man-Rated Simulators

3.1.1 General. This section prescribes the manner in which procedures governing the management, control, operation, and maintenance of man-rated simulators will be maintained to avoid compromising the basis on which the simulator was man-rated.

3.1.2 Changes to Operational and Maintenance Procedures

a. Initiation. Any cognizant official requesting changes to established procedures governing the management, control, and operation of man-rated simulators will send a memorandum to the Simulation Sciences Division Office. This memorandum will set forth the specific change desired and the reason for proposing the change.

b. Proposed changes to the procedures governing operation of a man-rated simulator shall be reviewed and evaluated by the Chief, Simulation Investigations Branch, to determine the effects of the change(s) on the man-rated status of the simulator. For this purpose, reference will be

made to the recommendations and final report of the Man-Rating Review Board.

3.1.3 Configuration Control

a. General. The configuration of a man-rated simulator, as delineated in the drawings, specifications, or other documentation, may not be altered without a review to assure that the safety of the system is not degraded. Modifications, including the addition of equipment on the VMS, shall be reviewed by the Simulation Sciences Division in accordance with these procedures. The official file of drawings and related documentation for man-rated simulators shall be controlled by the Simulation Investigations Branch. The master drawing will be maintained in the Engineering Information Center in Building N-213. Electrical site drawings will be in Building N-243, Rooms 272 and 174. Mechanical site drawings will be in Room 232. The site drawings will be red-lined whenever changes are made and then the master drawings will be updated. This will be the responsibility of the Facility Operations Manager.

b. References. The review of proposed changes or modifications to man-rated simulators shall include:

   (1) Drawings and specifications approved by the Man-Rating Review Board.

   (2) Failure mode and effects analysis.

   (3) Final report of Man-Rating Review Board.

c. Review and approval. Proposed modifications shall be reviewed for their effect on the man-rated status of the VMS, for the possibility of introducing new or hazardous failure modes, and to assure the safety of personnel. Work to be performed on the VMS shall be assessed prior to starting the work. The categories for efforts expended on the VMS, and the approval authority, is shown below. In the event that the designated approval authority deems the action to exceed his responsibility, he routes the action for approval to the next higher category modification.

   Category 1. Adjustments, physical arrangements, or installation of test apparatus as indicated in the operational procedures. Approval rests with the Facility Operations Manager.

   Category 2. Minor modifications that include, for example, modifications to increase safety, replace components with more reliable ones, strengthen the system, or introduce redundancy; modifications that limit or restrict performance but do not change the system beyond the limits imposed by the Man-Rating Review Board; replacement of components on any basis other than one-for-one (change in rating of electrical and electronic devices, change in material, change in physical properties). Approval rests with the Chief, Simulation Investigations Branch.

   Category 3. Major modifications that do not affect the man-rating criteria or introduce critical failure modes. Examples are modifications

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that introduce new control devices or systems; modification to the structure; installation of an improved or superior braking or other system for energy absorption or attenuation; and introduction of a new communication or energy transmission system. Approval rests with the Chief, Simulation Investigations Branch.

Category 4. Major modifications requiring interdisciplinary assessment, but not introducing critical failure modes. The assessment will be made by a panel, established by action of the Chief, Simulation Investigations Branch. Membership of the panel will include the disciplinary competence appropriate to the problems created by the proposed modification. The panel shall submit an analysis, with recommendations in writing, to the Branch Chief. Examples are modifications that introduce new or exotic materials; energy transmission systems that could interfere with signal or communication networks; and systems or devices that might generate adverse effects on pilots or operating personnel. The panel assessment will be evaluated and approved by the Chief, Simulation Investigations Branch.

Category 5. Modifications that introduce critical modes of failure, whether or not these are controllable, or that change the basis for man-rated status. Examples are modifications that extend the performance capabilities of the VMS beyond that for which it was man-rated; and modifications that introduce critical failure modes, even though they are protected by backup or redundant systems or are controlled by procedures. The Chief, Simulation Sciences Division, shall request that the Institutional Operations Office, Code DO, establish a new Man-Rating Review Board for the purpose of evaluating these modifications.

The control of the work to be performed is accomplished in two ways. For work being done by Simulation Sciences Division personnel, a Shop Work Order form FL-022 (fig. 4) must be filled out and approved before shop personnel will begin work. For work being performed by other Ames Research Center organizations, a Service Request, ARC Form 73, must be used. This form has a block for Simulation Modification Approval and must be signed off by the Chief, Simulation Investigations Branch. It is the responsibility of the Facility Operations Manager and the Senior Simulator Operator to assure that no unauthorized work is performed on the VMS. This work will be inspected by the Simulation Investigations Branch.

3.2 Experiment Control Procedures

3.2.1 General. The VMS is used primarily for aeronautical research, where the pilots or researchers are a part of the investigative procedure and are not themselves the object of study. Projects that constitute human research shall be subject to the safeguards, procedures, and controls as outlined in AMM 7170-1.

A number of events must occur before the formal operation of a flight simulation project can begin. These events occur in the following sequence and the individual responsible is identified in parentheses.

SHOP WORK ORDER

\#_____ - _____

DESCRIPTION OF WORK REQUIRED _____

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_____

REQUESTED BY _____

CONTACT FOR DETAILS _____ **PHONE NO.** _____

JOB ORDER #_____ **DATE** _____/_____/_____   **DATE NEEDED**_____/_____/_____

SIMULATOR MODIFICATION LEVEL	APPROVALS	INITIALS	DATE
NOT APPLICABLE	CONTRACT MONITOR		
CATEGORY 1	FACILITIES MANAGER		
CATEGORY 2, 3, 4	BRANCH CHIEF, FLI		
CATEGORY 5	DIVISION CHIEF, FL		

Figure 4.   Shop Work Order (FL-022).

FLI-022(AUG 79)

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(1)   Prepare and submit for approval by the Assistant Chief,
        (Operations) Simulation Sciences Division, a Request for SSD
        Support as stated in Paragraph 3.2.2 (researcher).

(2)   Conduct a presimulation conference and develop a project
        description as stated in Paragraph 3.2.3 (Operations Manager).

(3)   Prepare and submit project requirements as stated in Paragraph
        3.2.4 (researcher).

(4)   Review test plan as stated in Paragraph 3.2.5 (Operations Manager).

(5)   Review operational procedures as stated in Paragraph 3.0
        (Operations Manager).

(6)   Assign personnel and their responsibilities for simulator
        operations as stated in Paragraph 2.0 (Simulation Investigations
        Branch Chief).

(7)   Program computer (Simulation Experiments Group Manager).

(8)   Outfit simulator and train and certify operational personnel
        (Flight Simulator Laboratory Manager).

(9)   Final simulator checkout—The VMS is flown to check out flight
        instruments, visual displays, control forces, computer program, and
        motion washout system to minimize any discrepancies before the
        pilots are scheduled to fly (Simulation Experiments Group Manager).

(10)   Train and certify pilots and passengers (researcher and Simulations
        Sciences Division).

3.2.2 Request for SSD support. A Request for SSD Support Form FL-3 (fig. 5)
shall be submitted to the Simulation Sciences Division Office at the earliest
possible date to expedite planning and facility preparation.

3.2.3 Presimulation Conference. Developing a plan for conducting research
on the VMS requires that a detailed project description (fig. 6) be
obtained. This document summarizes project conditions and objectives,
project requirements, special instrumentation, emergency procedures, and
manpower and facility requirements, and is prepared by the Facility
Operations Manager. This information would normally be obtained during the
first presimulation conference. Additional conferences will be held as
required to resolve problems, establish status, etc.

3.2.4 Project Requirements. Once a presimulation conference has been
conducted with members of the Simulation Sciences Division, the researcher
must provide other detailed information.

a. Schedule. Appendix A is a good example of a well-planned schedule for a
    flight simulation project. Sometimes a tight schedule cannot be adhered
    to strictly. To ensure maximum utilization of the VMS, the operating

REQUEST FOR SIMULATION SCIENCES DIVISION SUPPORT

PROJECT TITLE: _____ JOB ORDER: _____

REQUESTOR: _____ PHONE #: _____ ORG. CODE: _____

SIGNATURE REQUESTING DIVISION CHIEF: _____ DATE: _____

SIMULATOR REQUESTED: _____ VFA REQUESTED: _____ COMPUTER REQUESTED: _____

DATE SIMULATION DATA PACKAGE TO BE DELIVERED:

    PRELIMINARY: _____ FINAL: _____

DESIRED SIMULATION DATES: FROM: _____ TO: _____

DESCRIPTION OF PROJECT: _____

_____

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_____

FLI ☐   ACCEPTED: _____   ASSIGNED TO: _____
FLS ☐
FLT ☐   DECLINED: _____   DATE: _____

COMMENTS: _____

_____

PROJECT NO: _____

APPROVED: _____   DATE: _____
        SIMULATION SCIENCES DIVISION

(PLEASE TYPE OR USE BLACK INK)

FL-3 (REV. 1/77)

Figure 5. Request for Simulation Sciences Division Support (FL-3).

        OMS-08-1

PROJECT DESCRIPTION

Project No. FLI_____   Date_____

1. Purpose of Project.

2. Objectives and Job Order Identification.

    a. Basis for conducting the project.
    b. Outside interest in the project.
    c. Job Order that covers costs and time incurred on the project.

3. Technical Plan

    a. Facility Plan

        1) Equipment to be used and description of required modifications
            and their category, including physical adequacy of the mounting
            devices for project apparatus.
        2) Data acquisition system.
        3) Displays and instrumentation required.
        4) Standard operating procedures to be used.
        5) Equipment and materials required and their suitability for the
            proposed environment.

    b. Project Test Plans

        1) Identity of events, decision points, and order of action for
            conducting the project.
        2) Plan for acquiring the data desired by the researcher.
        3) Contingency plans.
        4) Criteria for holds, aborts, and termination of the run.
        5) Manpower requirements. The manpower and job requirements of all
            personnel necessary for conducting the project. Use Form
            FL-017 (fig. 7) for cockpit staffing.
        6) Environments to be employed in the project. It shall include the
            range of values and rates of onset in which the project is to
            be conducted.
        7) Emergency procedures. Identify the specific operational
            emergencies or hazards known to be associated with the project
            and its environment. Emergency procedures shall be written
            describing the means of overcoming or containing each emergency
            or hazard.

Figure 6. Project Description.

AUTHORIZATION
SIMULATION SCIENCES DIVISION MOTION SIMULATORS

THE FOLLOWING PERSONS:

ARE AUTHORIZED TO PARTICIPATE IN MOTION OPERATIONS ON THE:

☐ S.10   (FSAA)

☐ S.08   (VMS)

☐ S.01   (6°)

☐ PILOT   ☐ PASSENGER

FOR THE DATES OF _____ TO _____ . FIRST-TIME

PILOTS ARE TO BE CHECKED OUT BY: _____ AND

(CHECK PILOT)

DEMONSTRATE PROFICIENCY IN FIXED-BASE MODE BEFORE FLYING WITH MOTION.

CHECK PILOT INITIALS: _____

PASSENGERS ARE NOT TO BE PERMITTED TO OPERATE CONTROLS.

_____

Anthony M. Cook
Assistant Chief, Operations
Simulation Sciences Division

FL-017 (9/79)

Figure 7. Authorization for Simulation Sciences Division Motion Simulators (FL-017).

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personnel should have a contingency plan prepared by the researcher. In compiling a schedule, it is necessary for the operating personnel to know the tasks to be performed and the means for accomplishing them. Information regarding planned takeoffs, landings, high- or low-altitude flights, etc., ensures that the proper instrumentation will be made available. Criteria and decision points where project conditions may change should be indicated.

b. Project information. Figure 8 outlines the information required by the Simulation Sciences Division. This information is required before a final commitment to a proposed research project and its attendant schedule. Appendix B contains the specific information required.

3.2.5 Review Test Plan. The Facility Operations Manager will assess the research goals of the proposed program and advise the Simulation Investigations Branch and the Simulation Sciences Division as to whether this facility should be committed to this program and that the motion provided by the VMS facility is truly relevant to the proposed program. The Facility Operations Manager will also review and concur with the proposed research test plan to assure that the scope and amount of experimental data required is consistent with the time that the researcher has scheduled on the facility.

3.3 Operational Procedures

The following sections outline the procedures used for normal operation.

3.3.1 Simulator Operator Preflight Inspection. This will be performed by the Senior Simulator Operator and will consist of the following items.

a. Verify mechanical preflight has been completed and all systems are safe for operation. This inspection is performed by simulator mechanics using forms FLI-021A and FLI-021B (see Appendix D, figs. D1 and D2). The performing individual must sign both the Preflight Inspectional Sheet (FLI-021A) and the VMS Preflight Log Book which is located in Room 272.

b. Verify that all nitrogen valves are properly set and equilibrator pressure correct (373 psi).

c. Servo room and hydraulic room walk-through and general readiness check.

d. General area security.

3.3.2 Pilot-Task Briefing. Before the initiation of piloted motion operation, the Senior Simulator Operator will conduct a preflight briefing. This briefing will verify the cockpit occupant's familiarity with normal operational procedures, emergency procedures, and with the location and operation of all safety-related items.

Each first-time pilot or passenger will receive a complete copy of the Pilot-Task Briefing, including the emergency procedures. This briefing will be signed and kept on file. It will be the responsibility of the Senior

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I. Information For Simulation Management

    A. Research Goals

    B. Test Plan

    C. Personnel Staffing Plans

II. Hardware Information

    A. Cockpit requirements

    B. Display requirements

III. Math Model Information

    A. Vehicle Characteristics

    B. Aerodynamic Math Model

    C. Control System

    D. Stability Augmentation Systems

    E. Guidance and Navigation

    F. Engine Math Model

    G. Landing Gear Math Model

    H. Atmospheric Disturbance Model

    I. Math Model Validation

    J. Data Acquisition

Figure 8. Required Project Information.

Simulator Operator to verify that there is a signed form on file for each occupant prior to initiating motion operation. The Senior Simulator Operator will also verify that the Authorization Form (FL-017, fig. 7) is on file. The complete Pilot-Task Briefing is attached as Appendix C.

3.3.3 Equipment Startup Procedures. These will be performed by the Simulator Operator and will consist of the following items.

a. Select axis to be used using key A1 and clutches using key B1. Return key B1 to main key bar.

b. Verify that mode controls show "Docked"; if not, push "Dock Request." Check manual pots for setting of 500; adjust as needed.

c. Verify CAE power switches on.

d. Verify all keys are in main key block except dock key C1.

e. Clear annunciator and check for any obvious problems before starting auxiliaries; correct as needed.

f. Start auxiliaries using key A1.

g. Close and lock loading gates using key C1A.

h. Put gate key C1A in dock control box; rotate and raise dock.

i. Remove key C1 from dock control box and place in main key bar.

j. Key bar should now rotate, freeing key D1 and securing all other keys.

k. Check annunciator panel:
   (i)   All systems should be clear with the exception of hydraulics fault; this is normal as hydraulic fault will not clear until "Emergency Stop" is reset.
   (ii)   MG set brushes down on vertical generators. This takes approximately 3 min from time auxiliary start is initiated. WAIT!!
   (iii)   Verify that all colored lights at bottom of annunciator panel show correct readings.
l. Reset Emergency Stop.

m. Clear annunciator hydraulics fault; should now clear.

n. System should now be ready to operate.

3.3.4 Operating Procedures. These procedures will be performed by the Simulator Operator and will consist of the following items.

a. Close main disconnects by rotating wheel approximately four turns clockwise.

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b. Verify that all selected axes show closed at selection panel and on annunciator.

c. Meters should now be balanced on vertical and lateral axes. If not, WAIT! Pots should not be moved from 500 reading as this will slow balancing. When meters are balanced, ready lights should be on.

d. If the cab is manned, refer to Appendix C for the terminology used during motion operation for e, f, and g below.

e. Close loops using key D1.
   (1) CAE should move up approximately 1 ft.
   (2) Lateral and vertical may move very slightly but should generally be stable.
   (3) "Brakes On" light should be off, but "Brakes Off" light should not come on. This is a normal function showing vertical brakes are in an automatic mode and will not come on again until button is pushed at time of docking. If brakes come on at any time loops are closed, loops will automatically open.

f. On initial startup each day, press predock at this time. CAE and lateral should remain stationary and vertical will move up approximately 4 ft. This is a system check. If operation is smooth, proceed to center position. On subsequent startups, proceed directly to CP from dock.

g. Perform tests as required.

3.3.5 Docking Procedures. When motion operation is complete, the following procedures will be used to return the cockpit to the loading dock. If the cockpit is manned, the simulator operator will tell the cockpit when each button is pressed.

a. Press predock. This may be done from any other mode at any time.
   (i)   CAE will move down to approximately 1 ft above rest position.
   (ii) Lateral will move to dock position.
   (iii) Vertical will stop approximately 4 ft above dock position.
   (iv) Predock achieved light should come on when position and velocity are proper. This automatically removes the first set of lower travel limits, allowing the simulator to move into dock position.

b. Press dock button when predock light comes on.
   (i) CAE and lateral should remain stationary.
   (ii) Vertical should move slowly through stops to dock position.

c. Check visual marks on lateral and vertical structures. Adjust position with manual pots, if needed.

d. Press "Brakes On" button and hold approximately 2 seconds or until loops open. NOTE: If loops are opened without brakes being held, vertical will probably move up slightly due to equilibrator pressure. If this happens, transfer key D1 to jog and reposition simulator.

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e. Remove key D1 from console and replace in main key bar.

f. Open main disconnect by rotating wheel approximately four turns counterclockwise.

g. Rotate main key bar and remove dock key C1.

h. Verify that all axes have opened by checking selection panel.

i. System is now safe for entry to cab or machinery area. If additional runs are to be made, skip to item m.

j. Turn off auxiliaries. NOTE: Vertical generators will continue running approximately 1 min. This is a normal function to allow changes in axis selections during operation without waiting 3 min for generators to restart.

k. Deselect all axes at selection panel.

l. Turn off CAE power switches.

m. Using key C1 rotate dock control box and lower dock.

n. Remove key C1A from dock control box and unlock and open gates.

3.3.6 Changes in Test Operations. All required changes in normal test operations will be accomplished through the Facility Manager.

3.3.7 Termination of Testing. Termination of testing by the pilot researcher or facility manager will be accomplished by telling the Simulator Operator to "return the cab to dock."

3.4 Emergency Procedures

3.4.1 General. To report any emergency, day or night, including fire, ambulance, emergency crew, equipment failure, guards, etc., Ames Emergency Control Center should be notified at Ext. 5555.

Appendix C covers specific operational plans and procedures for the various types of emergencies listed below.

a. Simulator hardware failure
b. Injured personnel
c. Fire

3.4.2 Training. Regular practice in the performance of emergency procedures is necessary to ensure the readiness of the VMS operational staff to cope with the various types of emergencies. It will be the responsibility of the Facility Manager to conduct these practice emergency drills every 3 months.

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3.4.3 Emergency Equipment. The following equipment is located in the following rooms that are associated with the VMS Facility.

Room 272, Control Room:
    CO_2 fire extinguisher

Room 274, Experiment Control Room:
    CO_2 fire extinguisher (2)

Loading Dock Entrance:
    CO_2 fire extinguisher
    Ansul dry chemical fire extinguisher
    Stokes litter
    Fire blanket

Room 104, MG Set (N-243A):
    CO_2 fire extinguishers (2)
    Ansul dry chemical fire extinguisher
    Fire blanket

Room 174, Servo Rack and Motor Control Center:
    CO_2 fire extinguishers (2)

Room 60, VMS Tower:
    Ansul dry chemical fire extinguishers (3)
    CO_2 fire extinguisher

Room 172, Shop:
    Stokes litter
    First-aid kit
    Fire blanket
    CO_2 fire extinguisher

3.4.4 Notification List for a Major Facility Emergency. The following offices are to be notified in case of a major facility emergency after the condition has been brought under control.

Responsible for Notification	Office to be Notified
Facility Manager	Chief, Simulation Sciences Division (ext. 5168)
	Assistant Chief (Operations), Simulation Sciences Division (ext. 5162)
	Chief, Simulation Investigations Branch (ext. 5164)

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Responsible for Notification	Office to be Notified
Chief, Simulation Sciences Division	Director, Aeronautics & Flight Systems (ext. 5066)
	Institutional Operations Office (ext. 5107)
Director, Aeronautics & Flight Systems	Center Director (ext. 5111)
	Public Affairs Office (ext. 5091)

3.5 Facility Maintenance

3.5.1 Electrical Systems Maintenance. The electrical maintenance program is defined by maintenance schedule sheets in a computerized program managed by the Facilities Services Branch (Code RST). To avoid unsafe interference with research programs, electrical maintenance work may be performed only with the permission of the Facility Operations Manager, who may assign someone to review the work actually performed.

3.5.2 Mechanical Systems Maintenance. The mechanical maintenance program is defined by maintenance schedules managed by the Simulation Investigations Branch. An outline of the maintenance plan and preflight checklist is attached as appendix D.

3.5.3 Safety Systems Maintenance. Verification of safety system operation is critical to the safe and reliable use of the VMS. The verification takes two forms: (1) proper operation of the sensor and (2) proper system response to the sensor. Appendix E contains an outline of the safety systems verification plan.

3.6 Postsimulation Critique

3.6.1 Policy. To evaluate the success of the test program operation and develop changes which would make it more successful on the next test. A critique shall be held for the following purposes:

a. Establish the causes and take necessary corrective action on equipment failures.

b. Strengthen procedures.

c. Improve training.

d. Update equipment.

e. Improve operational efficiency.

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3.6.2 Participation. The participants in the critique shall be the senior personnel in the test program. Individuals who can contribute to the critique may be called participants. The Facility Operations Manager will be the Chairman. The minimum number of participants shall be the Facility Operations Manager, Senior Simulator Operator, and the researcher.

3.6.3 Distribution. Copies of a final report of the critique shall be distributed as determined by the Facility Manager.

APPENDIX A

EXAMPLE TEST SCHEDULE AND TEST PLAN

SCHEDULE FOR OCTOBER/NOVEMBER
STOL CERTIFICATION SIMULATION

A. Pilot schedule

The schedule for the four subject pilots is given in figure A1. Each task indicated in the figure is described below.

B. Nominal Approach and Landing

The six days scheduled for this task are to be divided between the transparency-in and transparency-out configurations -- testing transparency out first.

Day 1:   Familiarization flights (table A1) plus training runs (table A2)

Days 2, 3: Formal testing, i.e., evaluation of different approach speeds by using the 10 runs of table A3 for each speed

Days 4, 6: Repeat of 1-3, but with transparency in

C. Approach and Landing with a Display

The four days scheduled for this task are to be divided between the transparency-in and transparency-out configurations, testing transparency in first.

Day 1:   Training runs (table A2) plus one formal test sequence (table A3)

Day 2:   Formal testing (table A3) at different approach speeds

Days 3, 4: Repeat of 1-2, but with transparency out

D. Steep Approach and Landing

The 9.5° approaches will only be done with the transparency-in configuration.

Day 1:   Training runs (table A2) plus one formal test sequence (table A3)

Day 2:   Formal testing (table A3) at different approach speeds

E. Takeoff Performance

The complete schedule for this task is given in table A4.

F. Takeoff Speed

At the beginning of this two-day task, each pilot will be given a set of familiarization runs (table A5). This will be followed by evaluation of different V_R and V_2 combinations using the test sequence of table A6 for each combination.

Figure A1. Pilot Schedule.

NAL   Nominal approach and landing
SAL   Steep approach and landing
TP   Takeoff performance demonstration
TS   Takeoff speed evaluation
+   Stick shaker activated
−   Stick shaker disconnected
α   Approach and landing with α display

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TABLE A1.   FAMILIARIZATION

Run	Ceiling (ft)	Engine cut, ft
a. Approach and Landing*		
1	500	None
2	250	None
3	250	h = 300
4	250	h = 100
5	0	None
6	0	h = 200
7	0	h = 300
b. Minimum Speed Demonstration**		
Run	N_C,[†] percent	Initial airspeed,[†] knots
1,2	100	$60^+/55^-$
3,4	$92^+/85^-$	$65^+/70^-$
5,6	75	$70^+/75^-$

Disturbances: no wind or turbulence.

*Initial conditions: Standard approach (V = 80 knots, h = 1600 ft, γ = 0, δ_{flap} = 45°; 45° heading relative to localizer, alternately right and left of localizer).

**Initial conditions: h = 5000 ft, δ_{flap} = 95°; trim to appropriate rate of descent.

[†]+ Values for transparency in; – Values for transparency out

TABLE A2. TRAINING–APPROACH AND LANDING

Run*	Surface Wind		Wind Shear				Ceiling (ft)	Engine Cut (ft)
	Magnitude (knot)	Direction (deg)	Gradient 1h (knot/100 ft)	(ft)	Gradient 2h (knot/100 ft)	(ft)		
1	5	90	0	–	0	–	250	None
2	15	45	0	–	0	–	300	None
3	15	135	8	100	0	–	250	None
4	5	90	0	–	0	–	250	None
5	10	270	-15	100	-5	200	300	None
6	15	45	0	–	0	–	250	h = 400
7	5	90	0	–	0	–	250	None
8	5	90	-5	100	0	–	0	None
9	15	135	-15	100	0	–	0	h = 200
10	5	90	0	–	0	–	250	None

*To be done sequentially; runs 1, 4, 7, and 10 are repeats for checking the training effect.

Turbulence: O_{u_g} = 5 ft/s.

Initial conditions: Standard approach (V = 80 knots, h = 1600 ft, γ = 0; δ_{flap} = 45°; 45° heading relative to localizer, alternately right and left of localizer).

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TABLE A3. FORMAL TESTS—APPROACH AND LANDING

Case*	Surface Wind		Wind Shear				Ceiling (ft)	Engine Cut (ft)
	Magnitude (knot)	Direction (deg)	Gradient 1h (knot/100 ft)	(ft)	Gradient 2h (knot/100 ft)	(ft)		
1	5	90	-5	100	0	–	0	None
2	15	135	-15	100	0	–	0	h = 200
3	15	45	-15	100	0	–	0	h = 400
4	15	45	0	–	0	–	250	h = 400
5	10	270	-15	100	-5	200	300	None
6	10	270	-4	500	0	–	250	None
7	5	90	15	100	5	200	300	None
8	5	90	0	–	0	–	250	None
9	15	45	0	–	0	–	300	None
10	15	135	8	100	0	–	250	None

*To be done in a random sequence.

Turbulence: O_{u_g} = 5 ft/s.

Initial conditions: Standard approach (V = 80 knots, h = 1600 ft, γ = 0; δflap = 45°; 45° heading relative to localizer, alternately right and left of localizer).

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TABLE A4. TAKEOFF PERFORMANCE

Task	Approximate Number of Runs
1. Practice takeoffs; terminate after stabilizing on climb speed.	4
2. V_{MU} demonstration	2*
3. Establish V_2 and distance to 35 ft for various V_R; range of V_R to cover all practical values.	10*
4. Establish accelerate - stop distance as function of speed; accelerate to specified speed, cut engine, stop.	10*
5. Takeoff at selected nominal V_R and V_2 with engine cuts at initial speed and at 0.5 V_1.	4*

*These estimates allow for one repeat run for each specific task.

Disturbances: No wind or turbulence

Initial conditions: Standard takeoff (minimum speed, airplane at runway threshold, weight = 52,000 lb, δ_{flap} = 45°).

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TABLE A5. FAMILIARIZATION—TAKEOFF

Run	Engine cut	Task
1,2	None	Straight-out climb to 1000 ft
3,4	V_1	Same as above
5,6	h = 35 ft	Same as above
7,8	None	Straight-out climb to 500 ft Demonstrate minimum power-on Speed and recovery
9,10	V_1	Same as above

Disturbances: No wind or turbulence

Initial conditions: Standard takeoff (minimum speed, airplane at runway
threshold, weight = 52,000 lb δ_{flap} = 45°).

TABLE A6. FORMAL TESTS—TAKEOFF

Run	$^{0}u_g$ (ft/s)	Surface Wind		Engine cut	Rotation
		Magnitude (knot)	Direction (deg)		
1	0	0	-	None	Nominal rate at V_R
2	0	0	-	h = 35 ft	Nominal rate at V_R
3	0	0	-	V_1	Nominal rate at V_R - 5 knots
4	0	0	-	V_1	Nominal rate at V_R - 10 knots
5	0	0	-	None	Maximum practical rate at V_R
6	5	10	0	None	Nominal rate at V_R
7	5	10	0	h = 35 ft	Nominal rate at V_R
8	5	10	0	V_1	Nominal rate at V_R - 5 knots
9	5	10	0	V_1	Nominal rate at V_R - 10 knots
10	5	10	0	None	Maximum practical rate at V_R

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APPENDIX B

PROGRAMMING INFORMATION AND REQUIREMENTS NEEDED TO USE
SIMULATION SCIENCES DIVISION FACILITIES AT AMES RESEARCH CENTER

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I. DESCRIPTION OF AMES COMPUTER SIMULATION LABORATORY:

1. The basic kinematics of a rigid body (airframe) are already programmed.

2. The executive software necessary to control, time, and monitor a true-time digital simulation is in use and available.

3. Functions of one, two, and three independent variables with completely arbitrary argument breakpoints can be programmed.

4. The "basic" kinematic program at Ames integrates the rotary derivatives (torques) in body axis (since we are dealing with a rigid body, no other axis is really practical); and the vehicle's translational forces are integrated in an inertial axis system. The rotary as well as translational aerodynamic force data may be presented in either body or stability axis systems. (We have complete latitude here.)

5. There is a wide variety of data-gathering capability at Ames.

   a. Analog strip-chart recordings.

   b. Analog X-Y plots (one normally -- more can be arranged).

   c. Digital tape recordings up to 100 variables. All variables are digitized using time as the independent variable. These tapes are useful for postrun analysis and can be used as input to any postrun processing program.

   d. Electrostatic printer-plotter output. These devices can produce time histories as well as function as a line printer. They can be used to print out initial condition information or postrun data such as aircraft performance information. Also, means and variances of several variables can be taken during a piloted run without seriously compromising our computational iteration rate. (That is the sampled data interval of the digital simulation.)

   e. The electrostatic printer plotter can be used to output plots of all the aerodynamic functions. This can be very useful when there are several hundred of them.

II. INFORMATION FOR SIMULATION MANAGEMENT FURNISHED BY RESEARCHER

A. Research Goals

   1. Reasons for simulation (including justification for use of VMS for this experiment)

   2. Relationship to previous or future simulations

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3. Relationship to organizations outside Ames

4. Relationship of SSD hardware and software capabilities to simulation goals

5. Time-critical elements of simulation program

B. Test Plan

1. List of test conditions

2. Estimate of required number of runs

3. Estimate of required hours of simulator time

C. Personnel Staffing Plans

1. Name of principal researcher

2. Name of principal pilot

3. Organization chart for simulation including all researchers, engineers, and pilots

4. Plan for staffing of all simulation test periods

III. HARDWARE INFORMATION FURNISHED BY RESEARCHER

A. Cockpit Requirements

1. Instrument panel

a. Location, dimension, and function[*] of all instruments

b. Location and function of all switches

c. Location and function of all lights

2. Controls

a. Types of all controls

b. Travels of all controls

c. Location of all controls

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[*]This should include all information necessary to program and check out the function of each instrument.

    d.   Information on any special requirements, i.e., friction levels, servoed controls, etc.

   3.   Documentation of user-provided equipment

    a.   Power requirements

    b.   Voltage input and output characteristics

    c.   Weight, size, and structural requirements

    d.   Connector specifications

    e.   Any other information necessary to completely specify the hardware

B.   Display Requirements

   1.   Redifon-generated displays

    a.   Runway requirements, i.e., length, width, scale, etc.

    b.   Runway lighting requirements

    c.   Performance requirements

    d.   Special effects -- refueling, night scene, etc.

   2.   Computer-generated displays

    a.   Specification of desired display, i.e., symbology, perspective, movement, labeling, etc.

    b.   Cockpit requirements -- location, type, color, etc.

IV. MATH MODEL INFORMATION FURNISHED BY RESEARCHER

A.   Vehicle Characteristics

   1.   Definition of all wing areas, span, chord, etc.

   2.   Weights and inertias -- variable or fixed

   3.   Pilot location as function of C.G. position

   4.   Tail position as function of C.G. position

   5.   Landing gear position as function of C.G. position

   6.   Tail strike point

   7.   Engine location and inclination

8. Any other data necessary to specify the physical characteristics of the vehicle

B. Aerodynamic Math Model

1. Equations for coefficient buildup

2. Plots and tables for any empirical data that might be required (functions of up to three independent variables are possible).

3. Define coefficient axis systems (equations or figures).

4. Definition of any special abilities required during the simulation, e.g., variable aerodynamic functions, different aero configurations, etc.

C. Control System

1. Block diagrams

2. Tables of gains and plots of any nonlinearities required

3. Specifications for control travels, force gradients, breakouts, damping, moments of inertia, and any other properties required for cockpit controls.

4. Definition of any special abilities required during the simulation, i.e. gains that will be varied during or between runs, additional loops that might be added between runs, failure modes, etc.

D. Stability Augmentation System

1. Block diagrams.

2. Tables of gains and plots of any nonlinearities required.

3. Specifications of any cockpit switches required.

4. Definition of any special abilities required during the simulation, i.e., gains that will be varied during or between runs, additional loops that might be added between runs, failure modes, etc.

5. Methods of initialization and limiting.

E. Guidance and Navigation

1. Block diagrams.

2. Tables of gains and plots of any nonlinearities required.

3. Any special cockpit display requirements, i.e., two-segment approach, curved approach, etc.

4. Description of any special guidance laws required, i.e., two-segment approach, curved approach, etc.

5. Definition of any special abilities required during the simulation, i.e., gains that will be varied during or between runs, noise that should be impressed upon guidance signals, failure modes, etc.

F. Engine Math Model

1. System block diagram.

2. Tables of gains.

3. Plots and tables for any nonlinear functions.

4. Definition of any special abilities required during the simulation, i.e., failures, etc.

G. Landing Gear Math Model

1. System block diagram.

2. Tables of oleo characteristics.

3. Definition of physical characteristics (location of tires, length of struts, etc.).

4. Definition of nosewheel steering system.

5. Definition of braking system.

H. Atmospheric Disturbance Model

1. Specification of any special nonsteady wind profiles required.

2. Specification of any gust required.

3. Specification of turbulence model (if different from BASIC model).

I. Math Model Validation

1. Static checks for each major subsystem. These should be in sufficient detail to allow verification of all possible logic paths. Enough terms should be provided to allow the isolation of all programming errors.

2. Trim points for several typical areas of the flight envelope to be investigated. This should be in sufficient detail to allow the isolation of any errors made in combining the subsystems into the total system.

3. Dynamic checks for each major subsystem and the total aircraft. Again, they should be in sufficient detail to allow verification of all elements of a simulation. However, minimum reprogramming, if any, should be required to run the necessary dynamic checks.

J. Data Acquisition

1. I.C. (static) printout which closely resembles the format that check data will be supplied in.

2. Real-time data-taking schemes, e.g., plots, digital tape, end of run statistical printouts, etc.

3. Brush recorder requirements (variable scaling, recycling).

4. Researcher-controlled simulation input requirements at the Project Engineer's Control Station (PEC), e.g., special switches for failures, etc.

V. SIMULATION SCIENCES DIVISION REQUIREMENTS RELATED TO PROGRAMMING

1. All simulation programming will be done at Ames by our staff personnel. The simulation laboratory is a closed shop operation.

2. The program for any simulation that is going to use an Ames Motion Device must be in our computers and checked out 2 weeks before the simulator schedule is to start. This requirement is essential to conserve simulator time as well as the time of programming and other support personnel. How much in advance of that date the complete program specifications outlined in II above must be furnished to Ames personnel is determined by the complexity of the program. Actual dates for this will be the subject of negotiation.

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APPENDIX C

PILOT-TASK BRIEFING INCLUDING COMPLETE
OPERATIONAL PLANS AND PROCEDURES FOR
VARIOUS EMERGENCIES

I. PILOT-TASK BRIEFING

A pilot and passenger entering the VMS cab will comply with all the following procedures and note the location and operation of all safety-related items. Each first-time pilot or passenger will receive a copy of the complete Pilot-Task Briefing, including all emergency procedures. The pilot-task briefing will verify the cockpit occupant's familiarity with these procedures.

1. Seat belts and shoulder straps to be used during motion runs.

2. Fire extinguisher, mounted rear of pilot's position above sound system speaker box.

3. Five-minute Air Capsule, located above the side consoles beside the pilot's and copilot's seats.

4. Flash lights, located in pouch at the rear of pilot's and copilot's seats.

5. Both pilot and copilot side windows are pop-out type and can be used for emergency exit.

6. All emergency procedures for exiting the cab will be controlled by the Simulator Operator.

7. Motion drive circuit lights are mounted in the overhead console.

   Green light -- motion drive circuits open. If cab door is closed, remain seated until the door is opened unless otherwise instructed by the Simulator Operator.

   (Simulator Operator will remind the pilot and crew before each docking.)

   Amber light -- motion drive circuits energized. Remain seated with seat belt fastened.

8. Control loader system (on-off) switch is on a panel located in each side console. A red light indicates the system is energized.

II. MODE CONTROLS

There are standard simulation mode controls that the simulator pilot must learn. The following are the controls, their location, and the function that they serve:

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Control	Location	Function
CP (center position)	Lighted push-button on center console and button on the wheel or trigger on the stick.	Simulator resets by moving the cab to the center position (cab level) and the displays are returned to initial conditions
H (hold)	Light pushbutton on center console	Freezes the programmed air-craft dynamics, instruments, and visual displays, but returns the motion drives to center position. <u>CP must be initiated prior to restarting the task.</u>
OP (operate)	Lighted push-button on center console	Activates computer program and data recording only for fixed-base operation
Tape recorder	Pushbutton on wheel	Activate, voice recording

III. SIMULATOR PILOT COMMUNICATIONS

The simulator pilot communicates with the computer and/or simulator operators with his microphone/headset. This system will automatically switch over to battery operation if the building electrical power fails.

IV. SIMULATOR FIXED-BASE OPERATION

The simulator pilot may request to "fly" the task in a fixed-base mode before closing the cab door and preparing for motion operation. The hybrid computer operator will configure the system for fixed-base and the simulator operator will stand by.

V. SIMULATOR MOTION OPERATION

When the simulator is ready for motion, the simulator operator will inform the pilot that the cab door will be closed and preparations for motion operation will commence. He will verify that the cockpit personnel are in their seats with seatbelts on and that the cab is safe for motion operation. The following terminology will be used during the sequence of providing motion for the simulator researcher and/or pilot.

Note: The following procedure will be omitted if the cab
is at the center position

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Initiator	Receiver	Statement
Researcher/pilot	Computer operator/ Simulator operator	Would like to operate with motion.
Simulator operator	Computer operator/ pilot	Are you ready for closing servo loops?
Computer operator	Simulator operator	Computer is ready!
Pilot	Simulator operator	Cockpit is ready!

(Simulator operator proceeds to close the servo loops and notifies new pilots that they will experience some vertical motion of the hexapod.)

Simulator operator	Computer operator/ Alt.	Loops closed
Simulator operator	Computer operator/ Pilot	Are you ready to go to center position?
Computer operator	Simulator operator	Computer is ready!
Pilot	Simulator operator	Cockpit is ready!

(Simulator operator proceeds to initiate center position (CP) mode and notifies new pilots that they will experience some lateral and vertical motion when going to the center position.)

Simulator operator	Computer operator/ Pilot	Center position
Computer operator	Pilot	These are your trim settings
Pilot	Computer operator	I have trim settings.

(The following are all the procedures required to repeat runs.)

Pilot	Simulator operator	Cockpit ready for a motion run.
Simulator operator	Computer operator	Computer ready?
Computer operator	Simulator operator	Computer ready!
Simulator operator	Pilot	Pilot ready?
Pilot	Simulator operator	Pilot or cockpit "ready"

Initiator	Receiver	Statement
Simulator operator	Pilot	"Initiating IP" (initiates required Initial Position motion conditions -- commands are washed out to zero when cab is in the proper starting position). "IP" after reaching Initial Position.
Simulator operator	Pilot	"OPERATE" (Initiate after receiving OP. READY LIGHT). Complete simulation started. Pilot terminates run when tests are completed or any time he feels he has lost control of the aircraft or for <u>any</u> other reason! This is done by pushing the CP button.

VI. EMERGENCY PROCEDURES

Assumptions for All Emergency Procedures

1. There will always be two simulator motion operators. Operator #1 will be located in room 272 during motion operation. (Operator #2 can have other temporary duties but must be in intercom contact with Operator #1.) Both will have had first aid and CPR training. There will always be one hybrid computer operator located in room 274.

2. A stokes litter will be stored on the wall next to the loading dock.

3. When the emergency number (ext. 5555) is called, an ambulance will be sent to the back of building N-243. During the day shift, a doctor may also be sent from the Ames Health Unit.

4. The overhead crane will be stored during motion operation at the northeast corner of the tower so that the controls reach the floor and the hook is also fully extended.

5. An emergency basket capable of carrying two people and a stokes litter will be located on the floor at the northeast corner of the tower.

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A.   Simulator Hardware Failure

CASE A-1   Loss of communication: Wherever there is a loss of communication
               with the cab, the Simulator Operator will return the cab to the
               dock position, maintaining communication to the cab in the event
               the transmission failure might be from the cab only.

CASE A-2   Loss of building electrical power: When a building power
               failure occurs, the Facility Operations Manager will assess the
               situation, consult with the researcher, and issue appropriate
               directions to delay the run or to terminate for the day.
               Battery-powered emergency lights and communications are provided
               and will be used when this failure occurs. There are
               flashlights (see Pilot-task Briefing item 4) inside the cab for
               the pilot's use. Removal of the cab occupants, when the cab is
               not at the dock position, is accomplished by the procedures
               outlined in Case A-4 or A-5.

CASE A-3   Procedure for a situation when the vertical cannot be
               electrically driven but is not jammed. The lateral is still
               operative.

               (1)   Operator #1 will notify operator #2 and the cockpit of the
                     situation. He will then bring the cab to the dock position
                     by means of the lateral jog mode, lock the brakes, and
                     configure the servosystems to a safe condition (all drives
                     off, etc.).

               (2)   Operator #2 will then descend the back stairs, go through
                     the shop, and enter the tower through the lower door.
                     After putting on a headset, the operator will lower the
                     vertical drive platform to the dock position by reducing
                     nitrogen pressure in the equilibrators.

               (3)   After the vertical drive platform is at the dock position,
                     Operator #2 will secure the vertical brakes and inform
                     Operator #1 of the situation.

               (4)   Operator #1 will lower the boarding ramp and advise cockpit
                     personnel that it is safe to exit.

CASE A-4   Procedure when lateral cannot be driven, but the vertical is
               operational.

               (1)   Operator #1 will notify operator #2 and the cockpit of the
                     situation. He will then bring the vertical platform to the
                     dock position by means of the jog mode, lock the brakes,
                     and configure the servosystem to a safe condition (all
                     drives off, etc.).

               (2)   Operator #2 will then descend the back stairs, go through
                     the shop, and enter the tower through the lower door. He

will then climb the emergency ladder system or the platform access ladder, depending on the cab location, to the top of the vertical drive platform, cross over to the cab and deploy the cab ladder. He will then enter the cockpit and lead the personnel across the vertical platform and down the ladder system.

CASE A-5   Procedure when vertical is "locked" and the lateral is operative.

(1) Operator #1 will notify operator #2 and the cockpit of the situation. After moving the lateral as far north as possible, the operator will lock the brakes and configure the servosystem to a safe condition (all drives off, etc.).

(2) Operator #2 will use the same procedures as in step #2, Case A-4, except that the platform access ladder cannot be used.

CASE A-6   Procedure when vertical and lateral cannot be moved.

(1) Operator #1 will notify operator #2 and the cockpit of the situation. He will then lock the brakes and configure the servosystem to a safe condition (all drives off, etc.).

(2) Operator #2 will then descend the back stairs, go through the shop, and enter the tower through the lower door. He will then climb the emergency ladder system or the platform access ladder, depending on the cab location, to the top of the vertical platform, cross over to the cab and deploy the cab ladder. He will then enter the cockpit and lead the personnel across the vertical platform and down the ladder system.

CASE A-7   Procedure when hexapod does not settle to its normal level position.

(1) Operator #1 will notify operator #2 and the cockpit of the situation. He will turn off the hydraulic supply and bring the cab to the dock position.

(2) Operator #2 will then descend the back stairs, go through the shop, enter the tower through the lower door, and hook up the basket to the overhead crane. Riding the basket, operator #2 will position it next to the cab and direct the egress of personnel from the cockpit. All parties will ride the basket to the floor level.

B. Injured Personnel

CASE B-1   Procedure when simulator is operational and someone is injured or disabled in the cockpit.

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(1) Operator #1 will notify operator #2 of the situation in the VMS cockpit.

Operator #2 will then call 5555 and inform the emergency personnel that there is an injured person in the VMS cockpit. The ambulance will be directed to go to the south side of the VMS tower attached to the east side of Building N-243. Operator #2 will direct the hybrid computer operator to meet and direct the ambulance personnel.

(2) Operator #1 will bring the simulator to the dock position and lower the boarding ramp.

(3) If there is no danger to the injured person by allowing him to remain in the cockpit, operators #1 and #2 will give first aid to the injured person and wait for the ambulance. They will assist as necessary in removing the injured person from the cab. He will then be transported to the waiting ambulance.

(4) If there is a danger to the injured person by leaving him in the cockpit, operators #1 and #2 will remove the injured person using the Stokes litter. The litter will be moved into a safe environment to wait for the ambulance.

CASE B-2   Procedure when simulator is NOT operational and someone is injured or disabled in the cockpit.

(1) The procedure will vary depending on what part of the VMS is not operational. See CASES A-3 through A-7 for obtaining access to the injured personnel.

(2) The medical personnel will follow the pathway as used by operator #2; the hybrid computer operator will meet and direct the ambulance personnel.

(3) Should the overhead crane be required to remove the injured, operator #1 will operate the crane.

C. Fire

CASE C-1   Procedures when simulator is operational and there is a fire.

(1) Operator #1 will bring the simulator to the dock position, lock the brakes, and configure the servosystem to a safe condition. He will then notify operator #2 and the cockpit personnel, and lower the boarding ramp.

(2) Operator #2 will trip the fire alarm in the hallway outside the Control Room and then direct the hybrid computer operator to go to the back of Building N-243 to direct the emergency personnel.

(3) Depending on the location of the fire, operator #1 will instruct cockpit personnel on the best route to exit either through the boarding ramp or down the emergency ladder system.

(4) After the cockpit personnel are safe and before the emergency personnel arrive, operator #1 will direct firefighting activities if it is deemed appropriate.

(5) Should the simulator become inoperable, operator #1 will assess the situation and instruct the cockpit personnel either to exit via the emergency ladder system or stay in the cockpit until the situation is cleared.

I have received a copy of the VMS Pilot-Task Briefing, including the complete emergency procedures (pages 42 through 50). I have read it and understand it.

_____   _____
            Signature   Date

APPENDIX D

MECHANICAL MAINTENANCE PROGRAM AND PREFLIGHT CHECKLIST

The vertical motion simulator (VMS) requires regular mechanical maintenance for the following items:

I.   Vertical Drive

        A. Gear reducers
        B. Pinion carrier assemblies
        C. Pinions and racks
        D. Inner columns and vertical shafts
        E. Vertical couplings
        F. Torque tube assemblies
        G. Equilibrium system

II.   Vertical Platform

        A. Wheel track assemblies
        B. Platform structure
        C. Column clevises

III.   Lateral Drive

        A. Pinions and rack
        B. Planetary reducers
        C. Cam followers

IV.   Lateral Carriage

        A. Wheel truck assemblies
        B. Carriage structure
        C. Lateral rack

V.   Shock Absorbers

VI.   CAE Motion System

        A. Hydraulic power pack
        B. Motion system
        C. Hydraulic lines

VII.   Catenary Assemblies

VIII.   Boarding Ramp

XI.   Drive Motor Instrumentation

(See maintenance schedules for frequency and details of inspection.)

CAE MOTION SYSTEM MAINTENANCE SCHEDULE

Weekly

1. Lubrication of bearings as required by CAE Maintenance Schedule (3-2, page 1).

Monthly

1. Lubricate all bearings and shafts as required by CAE Manual (3-2, page 4).

2. Check torque (70 $\pm$5 ft/lb) on 24 anchor bolts.

3. Clean magnetic trap on power pack reservoir.

4. Check pressure in accumulators by method given in CAE Manual (3-2, page 5).

5. Clean water strainer on hydraulic power pack.

6. Check oil from hydraulic pressure and return lines for discoloration (change if brown).

7. Check screws on split-flange fittings on main hydraulic loop (fitting 6 - 500 in./lb; fitting 7 - 650 in./lb).

Quarterly

1. Remove and clean or replace 6 filters on motion base.

2. Sample hydraulic fluid for analysis (3-2, page 25 in CAE Manual).

Semi-Annually

1. Check and replace, if necessary, all filters on hydraulic power pack.

2. Check upper bearing bolts; torque to 23 ft/lb.

Yearly

1. Lubricate pump motors on power pack.

2. Check calibration on all pressure gauges.

Biannual

1. Check alignment of all motor shafts couplings.

2. Overhaul motion system as prescribed in CAE Manual (4-3, page 1-6).

3. Check lower bearing belts; torque to 60 in./lb.

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GENERAL MAINTENANCE

Monthly

Vertical Drive:

1. Inspect racks and pinions; lubricate if necessary (Aeroshell #17 grease).

2. Inspect disk brakes for wear and fluid leaks.

3. Inspect inner columns and vertical shaft.

Lateral Drive:

1. Inspect lateral drive racks and pinions; lubricate if necessary.

Quarterly

Vertical Drive:

1. Check gear reducer oil and add if necessary (SAE 30).

2. Inspect all Aerol wheels on pinion carriers; adjust for snug fit.

3. Inspect vertical couplings for slippage.

4. Clean strain-gage slip rings on torque tubes.

Vertical Platform:

1. Inspect Aerol wheels and adjust if necessary.

2. Inspect column clevises for cracks or monoball damage.

3. Inspect tension bars for breakage.

Lateral Drive:

1. Check oil level on planetary reducers; fill to 2 in. below centerline (with Mobile DTE-25 Med.).

2. Inspect cam followers and lube with Aeroshell #17 grease.

Lateral Carriage:

1. Inspect aerol wheels and adjust if necessary.

2. Check lateral rack hold-down screws for backout.

Shock Absorbers:

1. Check fluid and fill with Dynoil-A-1 fluid.

2. Check lateral accumulator pressure fill with nitrogen (70-80 psi).

Boarding Ramp:

1. Inspect cables for fraying and wear.

2. Check limit switch and smoothness of operation.

Drive Motor Instruments:

1. Check timing belts and adjust to eliminate backlash.

Semiannually

Vertical Drive:

1. Lubricate bearings on pinion carriers (use high-temperature aircraft grease).

2. Racks and pinions; replace lubricant and clean with solvent.

3. Fill seal reservoir on inner columns with recommended oil.

4. Lube S.K.E. bearings on torque tubes with high-temperature aircraft grease.

5. Check pinion backlash on torque tubes (within 0.015 to 0.030 in. at pitch line).

Lateral Drive:

1. Racks and pinions; replace lubricant and clean with solvent.

Drive Motor Instruments:

1. Lubricant cartridge bearings with high-temperature aircraft grease.

General:

1. Check all cables (stop-lock, emergency basket, etc.) for fraying, loose sweg fittings, etc.

Annually

Vertical Drive:

1. Measure pinion backlash (within 0.015 to 0.030 in.).

2. Retorque vertical couplings as follows:

	Disk pack	Central member
All pinion couplings	200	130
Motor couplings	130	95
Shear pins in motor couplings (torques in ft/lb)	- 24	

3. Inspect vertical tracks on walls for weld cracks, etc.

4. Visually inspect equilibration system.

Vertical Platform:

1. Make a complete inspection for cracks, loose fasteners, and inspect internal members for damage.

Lateral Carriage:

1. Make a complete inspection for cracks and loose fasteners.

Lateral Drive:

1. Measure pinion backlash (within 0.015 to 0.030 in.).

Catenary Assemblies:

1. Inspect friction disks and replace when 0.050 in. thick or less.

2. Adjust friction torque to assure adequate damping.

3. Inspect shock mounts at ends of catenaries for damage.

General:

1. Check calibration on all pressure gauges.

10 years

1. Recertify equilibrium system.

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VERTICAL MOTION SIMULATOR
PREFLIGHT INSPECTION SHEET

LEGEND:
- ✓ PM COMPLETE
- ◯ OUT OF SPECIFICATIONS AND PM COMPLETE
- Ⓥ CORRECTED AND PM COMPLETE

TASK DESCRIPTION

CAE UNIT HYDRAULIC ROOM

TASK No.	Description
1	FLUID LEVEL
2	COOLING WATER ON
3	HYDRAULIC LINE VALVES OPEN
4	MAGNETIC DIP STICK
5	GENERAL CLEANLINESS AND LEAKS
6	STOKES LITERS (2)
7	NOTE RUN TIME

DRIVE MOTOR

TASK No.	Description
1	DRIVE BELTS
2	AIR HOSES
3	ELECTRONIC INTERLOCK

VERTICAL DRIVE SYSTEM

TASK No.	Description
1	FLOOR AND EQUILIBRATOR PIT
2	EQUILIBRATOR PRESSURE AND VALVES
3	MAIN DRIVE RACK
4	HYDRAULIC BUFFERS
5	REDUCTION GEAR BOXES
6	PARKING BRAKE SYSTEM
7	GUIDE WHEELS
8	SHAFT COUPLINGS
9	MECHANICAL FUSES
10	BLEED AIR LINE
11	BRAKE LOCKS AND RACKS

LATERAL PLATFORM

TASK No.	Description
1	SUPPORT AND GUIDE WHEELS
2	DRIVE RACK AND PINIONS
3	GEAR DRIVE BOXES
4	SHOCK ABSORBER SYSTEM LIMIT SWITCHES
5	CLEAN UP HYDRAULIC FLUID
6	TACH., ACC., F.U., AND DRIVE BELTS

NOTES (explain on reverse side)

MECH. INITIALS

FREQ.

DATE

VERTICAL MOTION SIMULATOR PREFLIGHT INSPECTION SHEET

LEGEND:
✓ PM COMPLETE
○ OUT OF SPECIFICATIONS AND PM COMPLETE
⊘ CORRECTED AND PM COMPLETE

Group	Task No.	TASK DESCRIPTION
CATANARY SYSTEM	1	GENERAL SECURITY AND CONDITION
	2	CONDITION AND SECURITY OF WIRING
	3	HYDRAULIC LINES
CAE UNIT	1	ACCUMULATOR PRE-CHARGE 900 psi
	2	CYLINDER ATTACH POINTS
	3	HYDRAULIC FITTINGS
	4	CHECK RUN TIME/LUBE SCHEDULE
	5	CYLINDER WIPER SEEPAGE
LOADER HYDRAULIC SUPPLY	1	OIL AND CHANGE
	2	CHANGE FILTERS AS PER SCHEDULE
	3	PUMPS AND SYSTEM COMPONENTS
	4	LEAKS AND OPERATION
	5	SEEPAGE BOTTLES
	6	FLUID LEVEL IN RESERVOIR
CAB	1	CLEANLINESS
	2	SEATS, SHOULDER HARNESS, SEAT BELTS
	3	ELECTRICAL WIRING
	4	INSTRUMENT PANEL
	5	LOADER SYSTEM
	6	SAFETY RAILINGS, LADDERS
	7	FIRE EXTINGUISHER
	8	FLASHLIGHTS, 5 MIN. AIR UNIT
	9	CRANE POSITION AND LOCATION OF EMERGENCY BASKET
BUILDING	1	ROLL-UP DOORS SHUT
	2	

TASK No.
FREQ.
MECH. INITIALS
DATE
NOTES (explain on reverse side)

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SIMULATION INVESTIGATIONS BRANCH
VERTICAL MOTION SIMULATOR
PREFLIGHT CHECKLIST

DATE:

ITEM	AREA OF INSPECTION
	CAE UNIT HYDRAULIC ROOM
1.	Verify that fluid level is in operational range — adjust as needed.
2.	Verify cooling water is on.
3.	Verify hydraulic line valves are open.
4.	Check magnetic dip stick for signs of excessive metal particles.
5.	Check for general cleanliness and signs of leaks — repair as needed.
6.	Check availability of Stokes Litters (2).
7.	Note CAE unit run time.
	DRIVE MOTOR Check:
1.	Condition of all drive belts — change as needed.
2.	Condition and security of air hoses.
3.	Condition and operation of electronic interlock switches in cooling air plenum
	VERTICAL DRIVE SYSTEM Check:
1.	Floor and equilibrator pit for loose and interfering objects and for cleanliness.
2.	Equilibrator pressure — adjust as needed (373 lbs.). Log any changes. Verify that Nitrogen Valves are properly set
3.	Main drive rack for cleanliness, lubrication, general condition.
4.	Hydraulic buffers for security (oil leaks), air supply, condition of pistons, and reset switches.
5.	Reduction gear boxes for oil level. Fill as needed.
6.	General condition of parking brake system.
7.	Condition and security of all guide wheels.
8.	All shaft couplings for signs of slippage and general condition.

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SIMULATION INVESTIGATIONS BRANCH
VERTICAL MOTION SIMULATOR
PREFLIGHT CHECKLIST

DATE:

ITEM	AREA OF INSPECTION
	VERTICAL DRIVE SYSTEM (Cont.)
9.	Condition of all mechanical fuses. Change all 6 if any are cracked.
10.	Bleed shop air line on West wall to remove water
11.	Brake locks and racks.
	LATERAL PLATFORM
	Check:
1.	Condition and security of all support and guide wheels.
2.	Check drive rack and pinions for cleanliness, lubrication and general condition.
3.	Oil leakage under gear drive boxes — fill as needed and report excess leakage.
4.	General condition of shock absorber system and reset limit switches.
5.	Clean up any hydraulic fluid under CAE unit.
6.	Check Tachometer, accelerometer, follow-up, and drive belts
	CATANARY SYSTEM
	Check:
1.	For general security and condition.
2.	For condition and security of wiring.
3.	Hydraulic lines for general condition and signs of any wear.
	CAE UNIT
1.	Verify accumulator pre-charge 900 psi pressure side 50 psi return side.
2.	Check security of all cylinder attach points.
3.	Check for leaking hydraulic fittings — tighten or repair as needed.
4.	Check run time/lube schedule — lube as required.
5.	Wipe down cylinder wiper seepage.

SIMULATION INVESTIGATIONS BRANCH
VERTICAL MOTION SIMULATOR
PREFLIGHT CHECKLIST

DATE:

ITEM	AREA OF INSPECTION
	LOADER HYDRAULIC SUPPLY
	Check:
1.	Oil and change as per schedule.
2.	Change filters as per schedule.
3.	Pumps and system components for condition and security.
4.	System for leaks and operation.
5.	Empty seepage bottles as needed (report excess).
6.	Fluid level in reservoir.
	CAB
	Check:
1.	For cleanliness, loose items, and foreign objects.
2.	Security and safety of seats, shoulder harness, and seat belts.
3.	Security and condition of electrical wiring.
4.	Security and condition of instrument panel and instruments.
5.	Loader system for leaks, security and condition.
6.	Monitors, safety railings, ladders, for security and condition.
7.	Check fire extinguisher system.
8.	Flashlights, 5 min. air unit, gen. safety equip.
	BUILDING
	Check:
1.	Crane position and location of emergency basket
2.	Roll-up doors are shut

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APPENDIX E

SAFETY SYSTEMS VERIFICATION PLAN

I. Monthly

Vertical Drive:

1. Verify that low equilibration pressure switches trip out at 300 psi.

2. Verify that low equilibration pressure locks the vertical brakes.

3. Verify that all position sensors are operational.

4. Verify that tripping the position sensors opens the loops.

5. Verify that low brake pressure switches trip out at 800 psi.

6. Verify that tripping the break low-pressure sensors opens the loops.

7. Verify that the buffer-extended sensors are operational.

8. Verify that tripping the buffer-extended sensors opens the loops.

9. Verify that the buffers are operational by hitting them at 50% rated velocity (10 ft/s).

Lateral Drive:

1. Verify that all position sensors are operational.

2. Verify that tripping the position sensors opens the loops.

3. Verify that buffers are operational by hitting them at 50% rated velocity (5 ft/s).

4. Verify that tripping the buffer-extended sensors opens the loops.

CAE:

1. Verify that all position limits are operational.

II. Semiannually

Vertical Drive:

1. Verify that velocity sensors (centrifugal and electronic overspeed) are operational.

2. Verify that tripping the overspeed sensors opens the loops.

3. Verify that velocity limits are operational.

Lateral Drive:

1. Verify that velocity sensors (centrifugal and electronic overspeed) are operational.

2. Verify that tripping the overspeed sensors opens the loops.

3. Verify that velocity limits are operational.

III. Yearly

Vertical Drive:

1. Verify operation of the torque tube strain gauges.

2. Verify that strain gauge out of limits will open the loops.

3. Verify that overcurrent sensors are operational.

4. Verify that overcurrent sensors open the loops.

5. Verify that 425 overpressure valve is operational.

Lateral Drive:

1. Verify that overcurrent sensors are operational.

2. Verify that overcurrent sensors open the loops.

CAE:

1. Verify operation of the low hydraulic pressure sensor.

2. Verify that low hydraulic pressure shuts off the hydraulic pumps.

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15. Supplementary Notes

16. Abstract

The Ames Research Center Vertical Motion Simulator (VMS) is described in terms useful to the researcher who intends to use it. A description of the VMS and its performance are presented together with the administrative policies governing its operation. The report addresses the management controls over its use, including data requirements, user responsibilities, and scheduling procedures. This information is given in a form that should facilitate communication with the NASA operations group during initial simulator use.

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