Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

COLOSSUS Memo # 210
LUMINARY Memo # 106

TO: Distribution
FROM: A. Engel, B. McCoy
DATE: August 14, 1969
SUBJECT: RTCC Compatibility Testing at MIT, current understanding of scope, responsibilities, etc.

This memo represents a compilation of miscellaneous documentation and statements concerning the RTCC/AGC compatibility testing which MIT will undertake beginning with Mission H. Little attempt has been made to organize the thoughts in any coherent pattern. Daily conversations with NASA and TRW people continually add new dimensions or correct erroneous ones, so that at best, this document is current as of the preparation date. Other memos will undoubtedly follow this one.

BRIEFING CHARTS

Attached hereto is a set of briefing charts prepared for the joint NASA/MIT Development Plan Meeting #48, held on 10 July, 1969. A benchmark in many senses, it presents the then-current thinking (with some obvious updating indicated) concerning RTCC/AGC compatibility testing -- purpose, history, the MIT role for future missions, sample data packages, and to some extent, impacts due to testing simulator and edit changes.

Material for the briefing was collected from a number of sources, notably phone conversations with Gunter Sabionski and Ken Leach of MSC and with Tom Fujawa of TRW. A limited set of data packages and sample TRW digital printouts had already been received. (See COLOSSUS Development Note #28 for samples).

The briefing charts still stand. No major errors have been detected, but much additional information (especially details of compatibility testing implementation) has been obtained.

RTCC Compatibility Testing Meeting

On 30 July, 1969, a meeting was held at MIT to discuss RTCC compatibility testing. MIT, TRW, LEC, and MSC were represented as follows:

(a) MSC: Gunter Sabionski, Tom Price, Ken Leach

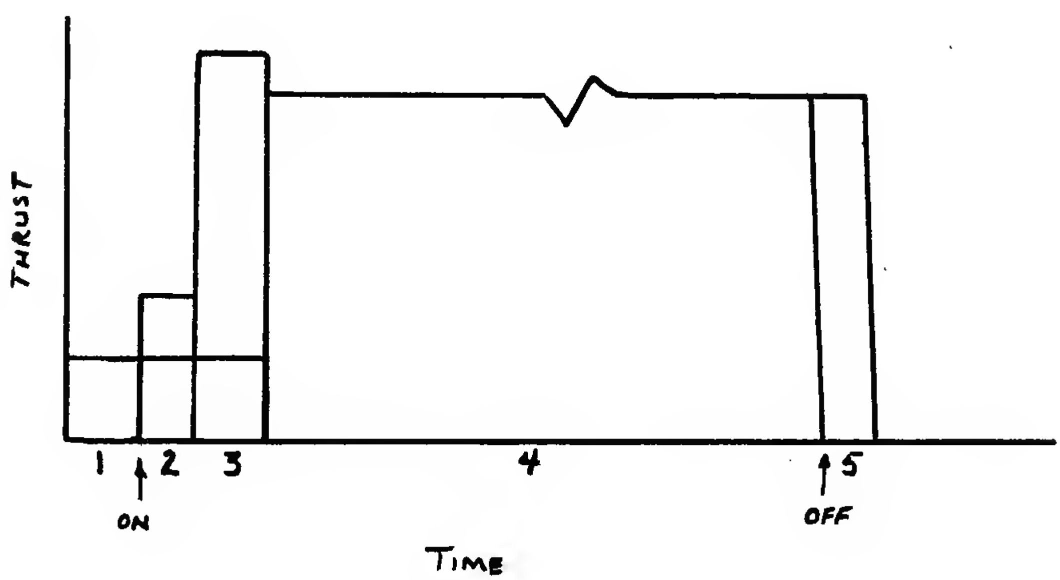
(b) TRW: Tom Fujawa, Jim Hill

(c) LEC: Jim Vinson

(d) MIT: Al Engel, Bruce McCoy, Bill Ostanek, Pete Volante

Discussion covered all phases of the original MIT briefing charts (hence the updating) and provided many details theretofore missing. Some of these are discussed below, followed by a somewhat random collection of miscellaneous pieces of information.

SPS Thrust/Time Profile (typical values)



Step #	Purpose	Duration (sec)	T Thrust Level (lb)	$\dot{\omega}$ Flow Rate (lb/Hr)
1	ullage	14 sec (total ullage = 15)	179.02	2671.2
2	thrust buildup during ullage	.533	424.015	4847.42
3	mainstage thrust during ullage	.467	21215	242534.14
4	main stage thrust	--- (switchover at Ws)	---	---
5	thrust tailoff impulse	12300 lb. sec at final T,W	---	---

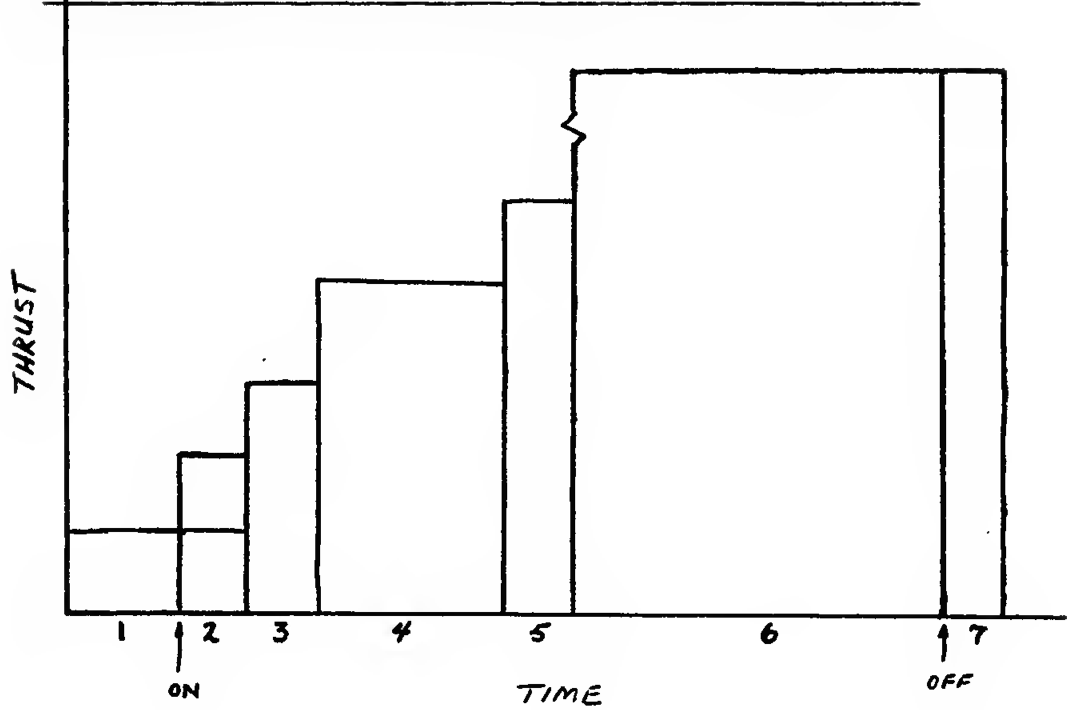
Notes: RTCC ullage is colinear with thrust, which is aligned exactly with VG - no RCS deadband, computer truncation errors, etc. - thus for a "perfect" burn, mainstage thrust and flow are extracted from a table lookup routine f(w); for TRW compatibility testing a single constant level thrust was used; for MIT testing pre- and post-tank-switchover thrusts and switchover weight will be specified.

(a) MIT will trim residuals to 0.4 fps 2 jet nominal thrust. MIT will use real ullage (as did TRW) and will provide RTCC with the average thrust level observed (rotational control during ullage reduces effect ullage thrust).

MIT will adjust its' thrust buildup delay (TONDEL) to provide the same buildup impulse (lb. sec.) over the 1 second interval. (MIT is investigating the hardware termination of ullage at 1 second; currently all MIT knows about is the software termination at 2 seconds). Thus: T(TONDEL) = .533 (424.015).

MIT will adjust its' thrust tailoff delay (TOFFDEL) and its' AGC pad-load counterpart (ETDECAY) to achieve the RTCC tailoff impulse at the main stage terminal thrust and flow rate . Thus: T(ETDECAY) = 12300 lbs sec.

DPS (DOI) Thrust/Time Profile (typical values)



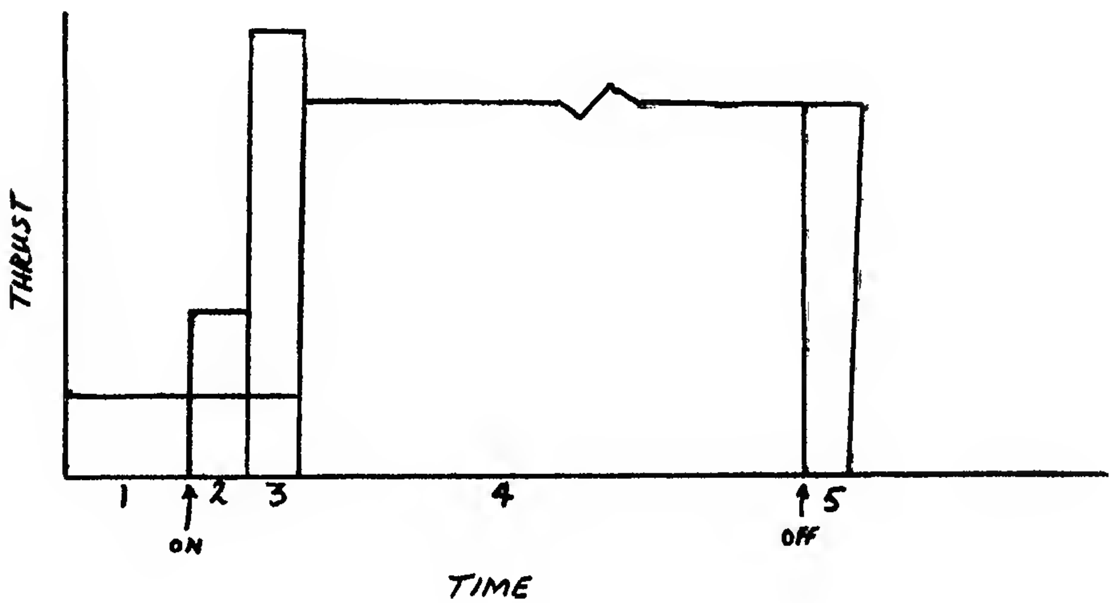
Legend	ΔT (sec)	Thrust (#)	$\dot{\omega}$ (#/hr)
(1) Ullage	T - 0.5	200	-
(2) Buildup to 10% during ullage	0.5	1	1
(3) Buildup to 10% from ullage end	3.1	467.7	55,93.75
(4) 10% FTP	26	1180	14,112.96
(5) Buildup from 10% to FTP	0.4	4326.5	51,745.5
(6) Full Thrust	X	10,500	125,581.4
(7) Tailoff	-	2300 # . sec Impulse equiv- -alent	

DPS (PDI) Thrust/Time Profile

See DPS(DOI) for throttle-up times

Throttable region will be as the Digital Simulator's existing exponential curve: The DPS thrust is an exponential function of the number of pulses sent to the DECA.

APS Thrust/Time Profile (typical values)



Legend	ΔT(sec)	Thrust (#)	$\dot{\omega}$ (#/hr)
1. ullage	T - .5	200	---
2. Buildup during ullage	0.308	155.8	1818.1
3. End of Buildup to Ullage end	0.192	3476	40562.72
4. Full Thrust	X	3476	40562.72
5. Tailoff		299# .sec impulse equivalent	

Notes: As for the SPS thrust model, the DPS and APS will have TOFFDEL (Tailoff delays) adjusted for the Impulse equivalent given by RTCC: 2300 # .sec for DPS and 299 # .sec for APS.

RCS ullage is colinear with the desired thrust direction, thus a "perfect burn". MIT will use real ullage and will provide RTCC with the average thrust level observed.

The center of gravity for the LM is reference to the Standard Apollo Reference System (in the Stacked pre-launch configuration). (true for CSM along X axis only; y and z cg locations in s/c coordinates. Some questions here, so still an open item.

Miscellaneous

all RTCC derived from s/c Operational Data Handbook

RTCC compatability is not an attempt to validate one environment model or another; it merely verifies the mechanization of matching the RTCC model as closely as possible.

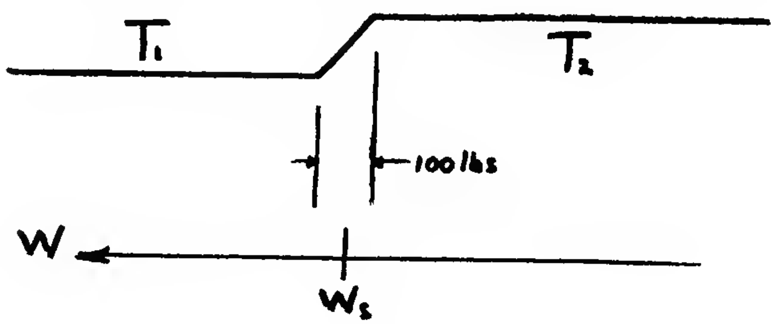
the simulator should remain constant throughout the 3-4 month testing period prior to the flight; hence the necessity to "freeze" certain environment files and programs.

post burn trimming by component to within a 1.4 fps deadband (as the MIT ASTRNAUT now performs) is acceptable, but +.1 fps would be desirable. Note: 1 PIPA pulse = .? fps, therefor unresolved.

each type of pad uplink must be tested at least once via V71E (P27) octal load. Other tests can then use octal or decimal load, whichever is most convenient.

DPS and APS thrust changes due to throat erosion are not implemented - constant thrust

RTCC implement the tank switchover thrust level change as a linear change over a 100 lb. vehicle weight differential



For sample date packages see COLOSSUS DEVELOPMENT NOTE #28

For Mission # RTCC test requirements and schedule see COLOSSUS Memo # 209