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G LIMITER STATUS

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ABSTRACT

This document is a status report on the pitch acceleration limiter for the AVRO ARROW MH64 Damper. The report analyses the relative merits of two similar systems: (1) The Mass-Spring Accelerometer System and, (2) The Servo Accelerometer System.

The report covers the following subjects:

Note: Section 2.0 contains a condensation of a portion of the material which will appear in the G Limiter Analytical Report. This report is in the process of being prepared.

1.0 SUMMARY AND CONCLUSIONS

In order to fully evaluate the Servo-Accelerometer and Mass-Spring Accelerometer Systems, a fairly large number of factors must be taken into consideration. One must weigh the relative importance of factors as well as the relative worth of each system in accordance with each factor.

In order to summarize their conclusions in measurable parameters MH has found it necessary to assign a relative weighting to the various factors entering into a decision as to which system is the best. Should AVRO have suggestions in this area MH is willing to jointly study the weighting assignment.

The following table presents an overall evaluation of both of the systems under consideratior

TABLE I

AVRO ARROW MH64 DAMPER
G LIMITER EVALUATION

Item		WT	Servo Accelerometer System	Mass-Spring Accelerometer System
1	Size	5	5	5
2	Weight	5	5	3
3	Dev. Cost	10	10	10
4	Prod. Cost	10	7	10
5	Delivery-Time Scale	15	15	8
6	G Limiter Spec Conference			
	(a) Failure Protection	13	13	7
	(b) Freedom From Nuisance Disengage	7	6	3
7	Effect on Damper Performance			
	(a) Stability, Phase Margin, Response	5	2	5
	(b) Flight Envelope Limitations	5	5	2
8	Reliability	5	3	5
9	Fail Safe Provisions	10	6	10
10	Complexity	5	2	5
11	Use of Proven Components	5	4	5
		100	83	78

2.0 ANALYTICAL PROCEDURES AND RESULTS

Scope of Problem

An analogue computer analysis was made of the G Limiter on the CF-105 airplane for thirteen flight conditions to evaluate the performance of two pitch acceleration limiting systems. The two systems are described below:

(a) Servo Accelerometer System

The present pitch axis damper gains and the limit function, $\left(n_{z_{cg}} + \frac{162}{g}\dot{q} \right)$

$$\frac{1 + .02s}{1 + .1s} + 15.75\ \delta_p \frac{.5s}{1 + .5s} + 12.5\ \delta_D \frac{2s}{1 + 2s}$$

, previously developed were used with an accelerometer of 0.1% accuracy to decrease the system error to ±.3g. The accelerometer previously used with this limit function (1% accuracy) gave an error of ±1.2 g which created a serious tolerance problem.

(b) Mass-Spring Accelerometer System

The revised pitch axis gains and a limit function developed during the study,

$$\left(n_{z_{cg}} + \frac{80}{g}\dot{q} \right) + 24\ \delta_p \frac{.5a}{1 + .5a} + 12.5\ \delta_D \frac{2s}{1 + 2s}$$

, were used with an accelerometer of 1% accuracy. The lower $\dot{q}$ gain reduced the system error to ± .6g.

2.2 G Limiter Performance Specification

The Specification for the G Limiter which was prepared during the AVRO-MH Engineering Meeting in Toronto on 10 December 1957 follows:

SPECIFICATION FOR THE PITCH ACCELERATION LIMITER FOR THE CF-105

1.0 Structural Integrity Limit Protection

1.1 The pitch acceleration limiter shall disengage the pitch axis damper to prevent the damper from causing the aircraft to exceed the structural integrity limits of +7.3 and -4.0 g's absolute for c -.g of 28-31% MAC from level flight (except as noted in 1.2).

1.2 For failures which result in simultaneous differential and parallel servo ramp inputs the pitch acceleration limiting system shall meet the requirements of this specificatio if the load factor does not exceed +_____ g's or -____g's absolute.

1.3 The pitch acceleration limiter shall disengage the pitch axis to prevent the damper from causing the aircraft to exceed the structural limits as stated in paragraph 1.1 in event of a failure involving loss of pitch rate while commanding +2g absolute.

2.2 (cont.)

2.0 Assurance against nuisance disengagement.

2.1 There shall be no disengagements upon the application of a 30 ft./second vertical gust during positive steady state accelerated flight equivalent to 70% of flight envelope g's or +4.5 g's absolute whichever is less. (Flight envelopes as delineated by P/Control/105 dated July 1957).

2.2 There shall be no disengagements due to the pitch acceleration limiter for a commanded negative step of 1 g incremental.

2.3 There shall be no disengagement due to the pitch acceleration limiter for step inputs of +4 incremental g's or the flight envelope whichever is less.

2.4 There shall be no disengagement due to the pitch acceleration limiter for a step input through a $\frac{1}{1 + .25s}$ lag to 5.5 g's absolute.

3.0 Failure Philosophy

No single failure or no one known failure plus an unknown failure in the MH-64 damper shall cause the aircraft to exceed the structural integrity limits of section 1.0 providing the known failure is not in the pitch acceleration limiter."

AVRO in agreeing to the above specification pointed out that MH should advise AVRO of all failure peak g's which fall outside of +6.5 g's and -2.7 g's since for a 60,000 lb. gross weight the structural limits are somewhat compromized by the specification.

AVRO also stated that in the event there are sufficient failure disengagements near the +7.3 or -4 g limits, such as to compromise the 60,000 lb. gross weight, AVRO may request that MH lower CSS and AFCS maximum g commands by 1 incremental g allowing both the failsafety and nuisance disengage limits to be moved in closer to level flight.

2.3 <u>Summary of Studies</u>

Thirteen critical flight conditions were analyzed on the analogue computer to evaluate the system performance. The transient responses were studied for three types of failure inputs: simultaneous parallel and differential servo failure, double differential failure, and parallel failure only. Also, stick command inputs and vertical gust inputs to check for nuisance disengage were made. The transient trace of normal acceleration at the c.g. was examined to give predicted peak g's for the failures. The bulk of the analogue computer studies were made for $\dot{\delta}_{e_{max}} = 20\ ^{\circ}/sec$. A few critical flight conditions were studied for $\ddot{\delta}_{e_{max}} = 30^{\circ}/sec$ and $40^{\circ}/sec$ to evaluate the effects of elevator rate.

2.4 Analogue Computer Simulation

The details of the simulation will be apparent from a study of figures 1 and 2.

2.4.1 Basic Airframe and Pitch Damper

The CF-105 pitch airframe was simulated by the angle of attack and pitch rate equations of motion. Airspeed variations were neglected. Second order networks simulated the dynamics of pitch rate gyro and normal accelerometer; and first order lags approximated the dynamics of the differential and parallel servos and the actuator. Authority and rate limits were used where necessary.

2.4.2 Limit Function

The mag-amp, pre-amp dynamics in the g-limiter calibrator were represented by a second order network. The servo accelerometer dynamics were neglected (since f_n = 100 cps, ζ = .6), but the mass-spring accelerometer dynamics were included as a second order on the accelerometer signal (f_n = 9 cps, ζ = .6 nominal). The total system dead time of 50 milliseconds was simulated by use of relays in conjunction with suitable first order lags.

The limit function was set to trip at +6.0 g's and -1.5 g's absolute (nominal values). The accelerometer errors for each limiting system were added to peak g's for both positive and negative failures and subtracted from the maximum command g's for nuisance checks.

2.5 Results of Simulation

The results for the Servo Accelerometer System and Mass Spring System are given in table II and III, respectively.

2.6 Discussion of Results

It will be noted that the Servo Accelerometer System does a better job both in terms of failure protection and freedom from nuisance disengage. If one considers the 60,000 lb gross weight flight envelope the Servo Accelerometer System is providing ore protection than the Mass-Spring Accelerometer System. The Mass-Spring Accelerometer System would also require a reduction in the level of the present maximum AFCS and Stick commands by 1 incremental g in order to assure reasonable freedom of nuisance disengagements.

2.6 (cont.)

This would impose a performance limitation on the ARROW.

Studies with $\dot{\delta}_{e_{max}}$ of 20 °/sec and higher have shown no appreciable change in peak g's as $\dot{\delta}_{e_{max}}$ is increased to 40 °/sec. However, beyond this point peak g's increase appreciably. This can be explained as follows: As $\dot{\delta}_{e_{max}}$ is increased the anticipation term $K\dot{q}$ causes the limit function to build up more rapidly thus offsetting the increased g's pulled during the operational dead time. As $\dot{\delta}_{e_{max}}$ approaches 40 °/sec however, the limit function is reaching its peak almost instantaneously. Thus a further increase in $\dot{\delta}_{e_{max}}$ causes more g's to be pulled during the operational dead time than can be compensated for by the anticipation term $K\dot{q}$.

2.7 Conclusions

The servo accelerometer system has the advantage of providing a wider g range of normal performance, free of nuisance disengage, while still adequately protecting the aircraft for combat gross weight. The servo accelerometer system also affords a large part of the extra protection required for the 60,000 pound gross weight configuration.

The advantage of the mass-spring accelerometer system is that the pitch damper gains associated with it provide a more inherently stable airplane - damper system.

Elevator rates from 20 °/sec to 40 o/sec are acceptable. However, under no environmental condition shall $\dot{\delta}_{e_{max}}$ be allowed to exceed 40 o/sec.

3.0 SYSTEM ERRORS

A summary of System Error is presented as follows:

Symbol	Source	Servo Accelerometer	Mass-Spring Accelerometer
E_a	Accelerometer Linearity	0.2	0.5
E_T	Temperature Variations	+0.18	+0.19 (-.03)
E_V	Voltage Variations	+.03	±.05
E_c	Calibration	±0.1	±0.1

3.1 Mass-Spring Accelerometer System Error

$$E_{Total} = -.03 \pm \sqrt{(.5)^2 + (.19)^2 + (.05)^2 + (0.1)^2}$$

$$E_{Total_{max}} = \pm 0.6 \text{ g's}$$

3.2 Servo Accelerometer System Error

$$E_{Total} = \pm \sqrt{(.2) + (.18)^2 + (.03)^2 + (0.1)^2}$$

$$E_{Total} = \pm 0.3 \text{ g's}$$

4.0 HARDWARE CONSIDERATIONS

4.1 Reliability and Failsafety

Basically the Mass-Spring Accelerometer System is a more reliable and failsafe mechanization than Servo Accelerometer System. This is due to a number of factors:

(a) The Mass-Spring accelerometer is a simpler device than is the Servo accelerometer and has therefore better inherent reliability.

(b) The Servo accelerometer has a plus and minus voltage output about 0 g's. The Mass-Spring accelerometer has a single polarity output with a large quiesent at 1.g. Thus the Mass-Spring accelerometer will automatically cause disengagement of the damper for accelerometer failures to either zero or full output. The Servo Accelerometer System does not have this feature for zero output.

It would be possible however, to build a bias power supply which would add in series with the output of the servo accelerometer so that it would effectively have a undirectional voltage output. This, however, would involve considerable complexity as such a bias power supply would have to have an accuracy of 0.1% over the temperature range in order to preserve accelerometer accurateness.

(c) The servo accelerometer is more easily adaptable to a push to test feature. It would be necessary to have a cockpit push button switch to check out G Limiter operation. It is felt by MH that this feature in addition to duplicate channel operation offsets the disadvantages delineated in (b), above.

4.1 (cont.)

(d) It is the firm conclusion of MH, however, that the Servo accelerometer has sufficiently less inherent reliability than the Mass-Spring accelerometer so as to require two forward accelerometers and two aft accelerometers per system. However, the transistorized servo accelerometer is small enough so that two can be packaged in the space of a GG47E.

4.2 Complexity Versus Accuracy

The main difference in system complexity between the Servo Accelerometer and the Mass-Spring Accelerometer System lies in the complexity of the accelerometers themselves. The increase in accuracy by a factor of 10 of the Servo Accelerometer over the Mass-Spring Accelerometer seems to warrant the additional complexity, however.

5.0 ESTIMATED DELIVERY SCHEDULE

The following delivery schedule is predicated on authorization from AVRO during the 21 - 22 January coordination meeting to proceed with one or the other of the two systems proposed.

5.1 Servo Accelerometer System

The Servo Accelerometer System can be delivered as follows:

One "System" 1 June 1958, and one system every two weeks thereafter. Each "System" consisting of:

1 - BG67E - Calibrator G Limiter

2 - GG75A - Accelerometer - Servo G Limiter

*1 - LG16K - Position Transmitter

Note: Each GGXX has two sensing units.

5.2 Mass-Spring Accelerometer System

The Mass-Spring Accelerometer System can be delivered as follows:

One "System" 1 June 1958, and one system every two weeks thereafter. Each System consisting of:

1 - BG67E - Calibrator, G Limiter

2 - GG47E-2 - Accelerometers

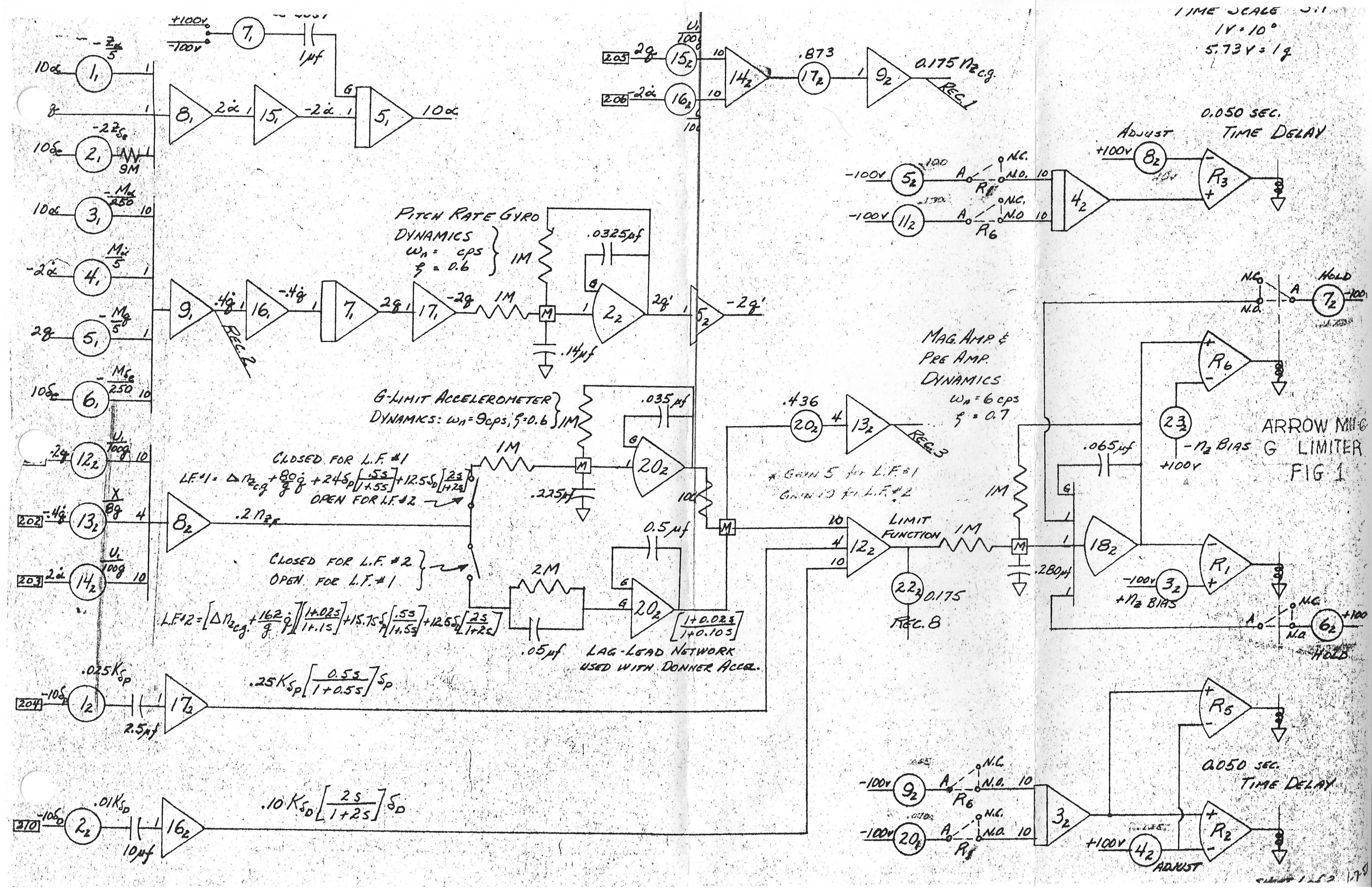
*1 - LG16K - Position Transmitter

*3 of the LG16K Position Transmitters have already been shipped.

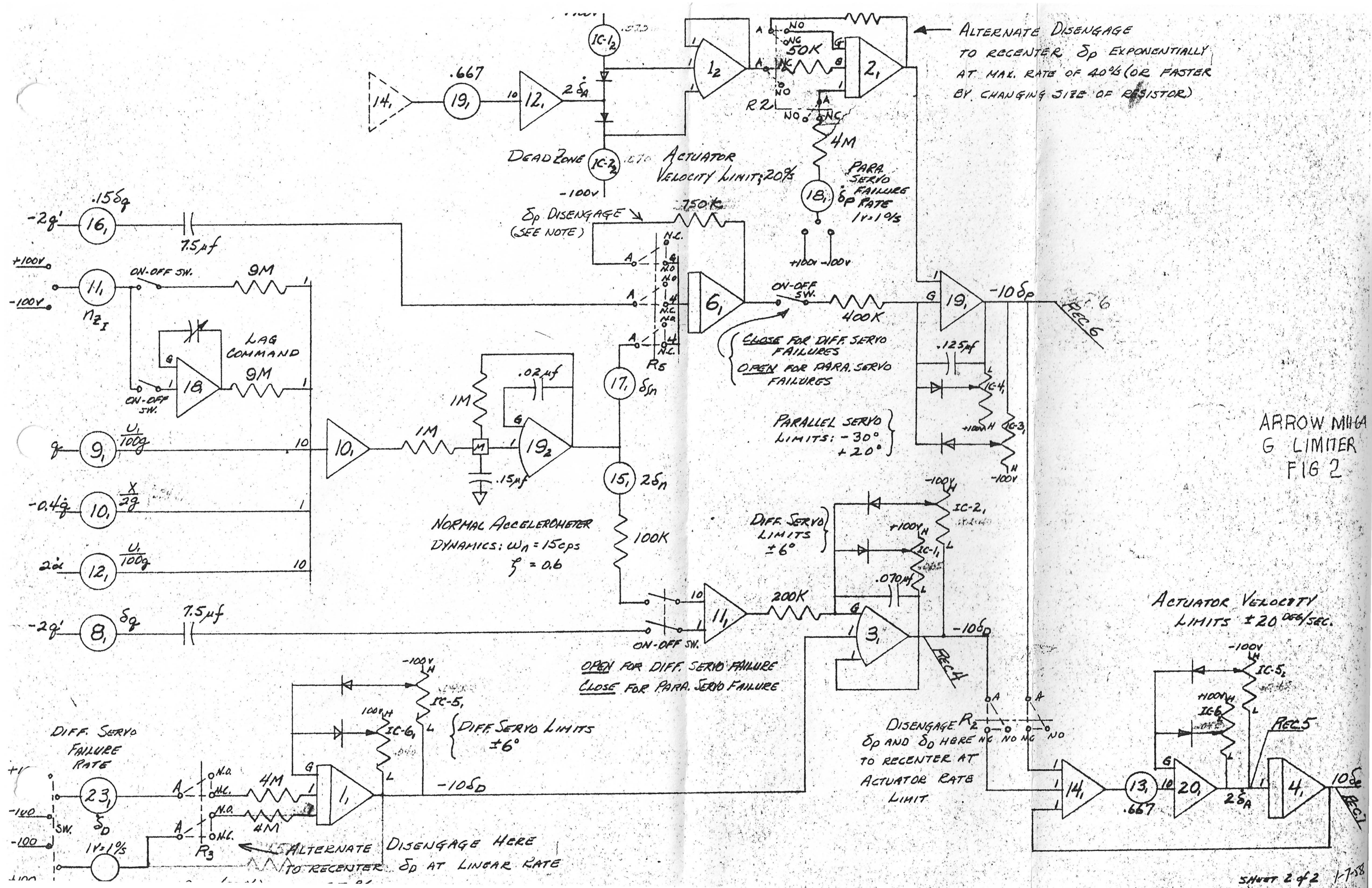
5.2 (cont.)

In order to utilize the Mass-Spring accelerometer system it is also necessary to make a change in pitch axis gains which are effected by changes to the BG92 Amplifier Calibrator. The following schedule is proposed for shipping the BG92:

Unit 1 (Flt Test)	20 April (Retrofit at AVRO)
Unit 6	1 April
Unit 7	8 April
Unit 8	Dependent upon whether used as Flt. Test or Development Model.
Units 2 - 5	Retrofit at AVRO during period 20 April to 20 Aug dependent upon availability.



ARROW MII G LIMITER FIG 1



ARROW MK 64 G LIMITER FIG 2

[illegible]REAC RESULTS OF SERVO ACCELEROMETER SYS[illegible]

$$LF = (n_z [illegible] + \frac{162}{g}\dot{q})\ \frac{1 + 0.02s}{1 + 0.1s} + 15.75\ \delta_p \frac{0.5s}{1 + 0.5s} + 12.5\ \delta_D \frac{2s}{1 + 2s}$$

$$\dot{\delta}_{e\ max} = 20\ °/sec$$

NOTES:
(1) G Values given in absolute peak G's (±0.3g error included)
(2) F.E.L. - Flight Envelope Limited
(3) * Values Out of Spec.

POSITIVE G FAILURE CHECKS		FLIGHT CONDITION													
		0-.4	0-.7	0-1.09	10-.7	10-1.0	10-1.15	10-1.3	20-.7	20-.9	20-1.15	30-.8	40-1.0	50-1.4	60-1.8
Simultaneous & Differential	Parallel Failure	3.9	4.3	4.55	4.3	5.3	4.8	4.5	3.8	4.3	4.3	3.7	3.7	3.8	-
Parallel Servo Failure Rates	80°/sec	4.3	4.8	4.3	4.3	5.0	4.8	4.7	4.3	3.9	4.5	3.8	3.6	5.5	-
	35 °/sec	4.8	5.8	4.3	5.4	5.9	4.9	5.5	5.3	5.3	5.0	5.8	4.3	5.3	-
	20 °/sec	5.3	6.3	5.8	5.8	6.5	6.3	5.9	5.8	5.7	6.1	6.0	5.3	5.3	-
	10 °/sec	6.3	6.8	6.1	6.3	6.6	6.3	6.3	6.8	6.3	6.1	6.3	6.3	5.5	-
	5 °/sec	6.5	6.8	6.1	6.8	6.5	6.3	5.8	6.8	6.8	6.1	6.3	6.3	5.8	-
Differential Servo Failure Rates	30 °/sec	2.3	3.8	3.6	3.3	4.55	4.3	3.8	2.8	3.8	3.5	2.3	2.4	2.3	-
	20 °/sec	2.8	4.3	3.6	3.9	4.6	4.8	4.5	3.3	4.3	3.9	2.8	2.8	2.3	-
	10 °/sec	2.8	3.3	3.6	3.7	3.0	3.3	3.3	3.1	3.3	3.3	2.3	2.5	2.3	-
NEGATIVE G FAILURE CHECKS															
Simultaneous & Differential	Parallel Failure	-0.3	-0.8	-1.1	-0.6	-1.8	-1.55	-0.8	-0.3	-0.7	-1.0	-0.3	-0.3	0.0	-
Parallel Servo Failure Rates	80 °/sec	-0.3	-0.8	-1.1	-0.3	-1.5	-	-0.8	-0.3	-0.4	-1.0	-0.3	-0.3	0.0	-
	35 °/sec	-0.3	-0.55	-0.8	-0.5	-1.1	-	-0.8	-0.3	-0.3	-0.8	-0.3	-0.3	-0.3	-
	20 °/sec	-0.8	-1.8	-0.8	-1.3	-0.8	-	-0.8	-1.3	-1.5	-1.3	-1.3	-1.3	-1.0	-
	10 °/sec	-1.7	-2.3	-1.8	-2.0	-1.8	-1.8	-1.8	-1.8	-2.3	-1.8	-1.8	-2.2	-1.3	-
	5 °/sec	-1.9	-2.55	-2.0	-2.3	-2.0	-1.9	-1.8	-2.3	-2.3	-1.9	-1.9	-2.3	-1.8	-
Differential Servo Failure Rates	30 °/sec	-0.3	-0.8	-1.1	-0.4	-1.8	-1.3	-0.8	0.55	-0.8	-0.9	-0.3	-0.3	0.0	-
	20 °/sec	-0.3	-0.8	-1.1	-0.5	-1.5	-1.3	-0.8	0.55	-0.7	-0.8	-0.3	-0.3	0.0	-
	10 °/sec	-0.6	-1.3	-1.1	-1.1	-1.3	-1.1	-1.3	0.9	-1.3	-0.8	-0.3	-0.3	0.0	-
NUISANCE CHECKS															
Positive G's															
Max G Step		5.5	5.5	5.5	5.5	5.6	5.0	5.6	5.5	5.5	5.4	5.5	4.5FEL	4.3FEL	FEL
Lagged Step		5.5	5.5	5.5	5.5	5.6	*5.4	5.6	5.5	5.5	5.4	5.5	4.5FEL	4.3FEL	FEL
Step + Gust		4.7	*4.4	*4.3	4.5	*4.2	*3.9	*4.0	4.7	4.7	*4.3	4.7	4.5	4.3FEL	FEL
Negative G Step		-1.7	-1.7	-1.7	-1.7	-1.7	-1.2	-1.7	-1.7	-1.7	-1.7	-1.7	-1.7	-1.7	-1.3

TABLE III

REAC RESULTS OF MASS-SPRING ACCELEROME SYSTEM

$$L.F \quad n_{z_{c.g.}} + \frac{80}{g}\dot{q}) + 24\,\delta_p \frac{0.5s}{1 + .05s} + 12.5\,\dot{\delta} \frac{2s}{1 + 2s}$$

$\dot{\delta}_{e_{max}} = 20$ °/sec

NOTES:
(1) G Values given in absolute peak G's (+0.6 g error included)
(2) F.E.L. - Flight Envelope Limited
(3) * - Values Out of Spec.

POSITIVE G FAILURE CHECKS		FLIGHT CONDITION													
		0-.4	0-.7	0-1.09	10-.7	10-1.0	10-1.15	10-1.3	20-.7	20-.9	20-1.15	30-.8	40-1.0	50-1.4	60-1.8
Simultaneous & Differential	Parallel Failure	5.6	7.2	7.1	6.7	7.1	7.0	6.6	5.1	5.6	6.1	5.1	5.1	4.6	-
Parallel Servo Failure Rates	80 °/sec	5.1	6.1	6.1	5.6	6.1	5.8	5.6	4.6	4.6	5.6	4.2	4.85	3.8	-
	35 °/sec	4.8	6.2	6.1	5.9	6.2	6.1	5.8	4.6	4.6	5.6	4.6	4.6	4.6	-
	20 °/sec	6.1	6.8	6.7	6.8	6.8	6.2	6.1	5.3	6.1	6.0	5.1	5.6	4.6	-
	10 °/sec	6.5	6.8	6.2	7.0	6.6	6.2	5.8	6.6	6.6	5.8	5.6	5.8	4.8	-
	5 °/sec	6.6	6.8	6.1	6.9	6.6	6.2	6.1	6.6	6.6	6.1	5.1	6.1	5.3	-
Differential Servo Failure Rates	30 °/sec	2.85	4.1	6.1	4.5	5.6	4.6	4.3	3.7	4.6	4.1	2.85	3.1	3.1	-
	20 °/sec	3.3	5.1	7.1	5.6	6.2	5.6	5.1	4.6	5.8	4.8	3.1	3.6	3.1	-
	10 °/sec	3.6	4.6	5.8	5.7	4.3	4.3	4.4	4.6	5.3	4.4	3.1	3.2	2.8	-

NEGATIVE G FAILURE CHECKS															
Simultaneous & Differential	Parallel Failure	-1.3	-2.6	-2.6	-2.0	-2.4	-3.1	-2.3	-1.1	-1.2	-1.8	-0.8	-1.1	-0.8	-
Parallel Servo Failure Rates	80 °/sec	-0.6	-2.1	-2.3	-0.9	-2.1	-2.0	-1.6	-0.6	-0.7	-0.8	-0.6	-	-0.4	-
	35 °/sec	-0.6	-2.2	-2.1	-1.0	-1.6	-2.0	-1.3	-0.6	-0.8	-0.8	-0.6	-0.6	-0.4	-
	20 °/sec	-0.85	-2.85	-1.6	-1.1	-1.6	-1.6	-1.3	-0.6	-0.7	-0.8	-0.6	-0.6	-0.6	-
	10 °/sec	-1.6	-3.1	-2.1	-2.1	-1.8	-2.1	-1.8	-1.6	-2.0	-1.6	-1.6	-1.6	-1.1	-
	5 °/sec	-2.2	-3.0	-2.2	-2.2	-2.2	-2.1	-1.3	-2.1	-2.35	-1.6	-1.7	-2.1	-1.6	-
Differential Servo Failure Rates	30 °/sec	-1.0	-2.1	-2.6	-2.1	-2.6	-2.3	-2.1	-1.8	-1.6	-1.6	-0.6	-1.1	-0.6	-
	20 °/sec	-1.6	-2.35	-2.3	-2.1	-2.6	-2.3	-2.1	-1.1	-1.4	-2.1	-1.1	-1.6	-0.6	-
		-1.85	-2.6	-2.8	-2.6	-2.2	-2.6	-1.8	-1.6	-2.0	-1.6	-1.0	-1.4	-0.6	-

NUISANCE CHECKS														
Positive G's														
Max G Step	5.15	5.15	5.15	5.2	5.3	5.15	5.3	5.0	5.15	5.3	5.25	4.5FEL	FEL	FEL
Lagged Step	*5.15	*5.15	*5.15	*5.2	5.3	*5.15	*5.3	*5.0	*5.15	*5.3	*5.25	4.5FEL	FEL	FEL
Step + Gust	*4.0	*4.4	*3.4	*3.6	*4.15	*4.0	*4.0	4.6	4.6	*4.2	4.7	4.5	*4.0	FEL
Negative G Step	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.1	*-0.8

APPENDIX TO MINUTES

Preliminary Specification for the Rudder Monitor

The following specification is intended to delineate maximum requirements. Should analytical studies yield marginal performance relative to these specifications MH and AVRO will re-evaluate the specifications.

The specification has no specific protection requirements relative to maneuvering flight at this time. However, MH will evaluate maneuvering flight failures during the study phase of development. The reason for non-inclusion at this time of such requirements is due to lack of information.

1.0 Design Objective

Under any accumulation of static and dynamic conditions, means shall be provided to prevent the damper or AFCS from applying control to the aircraft which will cause the aircraft to exceed the rudder load limit of 36,500 lbs. in less than 5 seconds.

2.0 Specific Requirements

2.1 Protection

The monitor shall prevent the damper or AFCS from applying control to the aircraft which will cause the aircraft to exceed a rudder load of 36,500 lbs. in less than 5 seconds for the following specific conditions.

2.1.1 Loss of Yaw Rate to Damper, then apply 30 ft./second gust or a gust which produces an initial tail load of 10,000 lbs., whichever is less at each static condition.

2.1.2 Rudder hardovers at representative rudder ramp rates from 0 to the limiting velocity limit of the rudder from straight and level flight at each flight condition.

2.2 Nuisance Disengagements

The monitor shall not cause a nuisance disengagement under the following conditions.

2.2.1 Coordinated 4g turns at each flight condition.

2.2.2 Roll from level flight at the maximum roll rate that CSS can command at each flight condition.

2.2.3 Roll from wings level or ϕ = 90 deg. at the maximum roll rate that CSS can command at each flight condition while pulling a plus 3 incremental g's.

2.2.4 Same as 2.2.3 except a minus 1.5 incremental g's

2.2.5 Roll at 60 deg/second while pulling a plus 3 incremental g's then apply 30 ft/second lateral gust at each flight condition.

3.0 Failsafety

One failure of the damper, AFCS or monitor or one failure unknown to the pilot plus a second failure, shall not cause exceeding the rudder load limit in less than 5 seconds providing the unknown failure is not in the rudder monitor.

Note: 1.0 and 3.0 were added by MH as proposed additions subsequent to the meeting.