



MEMORANDUM

• DIVISION OF BENDIX AVIATION CORPORATION

TO: All Field Service Representatives

FROM: M. S. Thomson

SUBJECT: Changes to the G-15 -- Effective
Serial #309

DATE: April 12, 1960

As you are aware, the G-15 has experienced several changes since #209 came off the line. So far, you have received information outlining the changes imposed by ECO's 970-1053. These became effective on machines with serial #'s 241 and above.

The material you should have received on the subject so far is as follows:

1. Subject: G-15 ECO's
1/7/60, Norman Love to J.R. Campbell (cover
memo: 2/4/60, Norman Love to Frank Adair.)
2. Subject: G-15 ECO's -- Logical Explanation
2/16/60, M.S. Thomson to J.R. Campbell
3. Subject: The OUTPUT "Link"
3/23/60, M.S. Thomson to All Customer Engineers

Additional ECO's have been approved since that time, the latest major one being ECO 1096. It is expected that machines starting with serial #309 will incorporate the latest changes.

In general, ECO 1096 "cleans up" preceding ECO's to yield the same results with less hardware and greater reliability. It is the purpose of the attached to indicate what will be in the #309+ machines in terms of how they differ from #'s 241-308.

M.S. THOMSON

mc
encl.

Changes in logic will be discussed in terms of the memo "G-15 ECO's -- Logical Explanation" dated February 16, 1960.

Page 1 This is not a change but an additional note. Item 10, "PHOTO READ, AUTO-RELOAD" will address the built-in photo-reader provided no PR-1's are installed. If PR-1's are installed, CHARACTERISTIC will select the reader, while the S/D bit, if = 1, will call for auto-reload. $(CH = 0) \cdot (S/D = 1)$ must be avoided as it sets OH, resulting in chaos if any MINUS codes exist on a tape on the built-in photo-reader. In general, Item 10 is of academic interest only.

THE FOLLOWING EQUATIONS HAVE BEEN CHANGED:

Pages 2-4

- 1b Is now $\langle E \rangle \cdot \langle SA \rangle$ -- improves reliability.
- 2a,b Replaced by READY -- reduces hardware, simplifies operating rules.
- 4c Is now $TYPE \cdot AS \cdot OY \cdot TO$ -- renders OH inert in numeric type-outs, simplifying logic and reducing hardware.
- 6c Is now $AUTO \cdot OG \cdot TF \cdot OA3$ -- $\overline{OF3}$ was unnecessary.
- 6d Is now $AUTO \cdot OG \cdot TF \cdot M23$ -- $\overline{OF3}$ was unnecessary.
- 6f Is now $SLOW\ OUT \cdot \overline{HC} \cdot \overline{OS} \cdot \overline{OH} \cdot \overline{OY} \cdot TO$ -- applying $\overline{OH} \cdot \overline{OY}$ to this equation in conjunction with the change to eq. 4c permits deletion of equations 8a and 8b, reducing hardware and simplifying logic.
- 7a Is now $TYPE \cdot \textcircled{F} \cdot OY$ -- hardware reduction.
- 8a,b Removed (see 6f).
- 9a Is now $SLOW\ OUT \cdot OY \cdot \textcircled{G}$ as in original G-15 -- the \overline{OH} term was unnecessary.
- 9b Is now $SLOW\ OUT \cdot OH \cdot \textcircled{G}$ -- hardware reduction permitted by change to 4c.
- 10c Is now $\overline{OC4} + \overline{OC3} + \overline{AS} + \overline{OY}$, which is still $= \overline{AUTO \cdot OY}$ -- the SLOW IN term was unnecessary.
- 11a Is now $AUTO \cdot OG \cdot TF \cdot OA3$ -- $\overline{OF3}$ was unnecessary.
- 11b Is now $AUTO \cdot OG \cdot TF \cdot M23$ -- $\overline{OF3}$ was unnecessary.
- 11c The hardware has been re-arranged to save diodes and improve reliability, but the equation remains unchanged.

- 11d Is now $\textcircled{M} \cdot \text{OH} \cdot \overline{\text{OA1}}$ -- hardware reduction; AS is not necessary as a result of change to eq. 4c.
- 11e,f Are now replaced by $\text{DS} \cdot \text{SO} \cdot \textcircled{U}$; i.e. the circuit has been returned to its original form for reasons to be discussed later.
- 13a Is now $\text{AUTO} \cdot \text{OY} \cdot \text{TE} \cdot \overline{\text{CF}}$ -- OG was unnecessary.
- 17a Is now $\text{AUTO} \cdot \text{OG} \cdot \text{TF} \cdot \text{OA3} \cdot \text{OH} \cdot \text{OS}$ -- $\overline{\text{OF3}}$ was unnecessary.
- 18a Is now $\text{SLOW IN} \cdot [\text{STOP}]_{\text{OB}} \cdot \overline{\text{OF2}} \cdot \overline{\text{OD}}$ -- $\overline{\text{OG}}$ was unnecessary.
- 18c Is now $\text{AUTO} \cdot \text{OH} \cdot \text{OF3} \cdot \textcircled{F}$ -- hardware reduction.
- 18d Is now $\textcircled{M} \cdot \text{OH} \cdot \overline{\text{OA1}}$ -- hardware reduction, AS is not necessary as a result of change to eq. 4c.
- 19a Is now $\text{SLOW OUT} \cdot \text{OG} \cdot \overline{\text{AS}} \cdot [\text{STOP}]_{\text{OB}}$ -- $[\text{STOP}]_{\text{OB}}$ was added for reasons discussed later.
- 20 Delete -- $\overline{\text{OH}}$ is not necessary and has been removed.
- 22 Is now $\text{OB5} \cdot \overline{\text{AS}} + \text{OB5} \cdot \text{OH} \cdot \overline{\text{OY}}$ -- AS, in the second term was unnecessary.
- 23 Is now $\langle \text{E} \rangle \cdot \langle \text{SA} \rangle$ -- improves reliability.
- 24,25 These equations have not been changed, but do warrant further explanation. They are "effective" equations which means that terms which logically "drop out" are not shown. The attached drawing of "PR-2 CONTROL" should clarify this.

Attached you will find three revised TRAINING PRINTS as follows:

45A	ALPHANUMERIC IN/OUT CONTROL
48A	ALPHANUMERIC INPUT
52A	ALPHANUMERIC SLOW OUT

These are supplements to your present drawings #'s 45, 48, and 52. The new prints show the hardware to be found in machines affected by ECO 1096 (presumably starting with machine #309). The three drawings exhibit the hardware forming all of the new IN/OUT equations except 9c, 24, 25.

Your copy of drawing #60 should be marked-up to indicate that $\overline{\text{AS}}$ has been added to the $\text{FAST OUT} \cdot \text{OD} \cdot \textcircled{G}$ gate which sets OE -- this will take care of eq. 9c. Eqs. 24 and 25 are handled on the "PR-2 CONTROL" drawing mentioned above.

Essentially the logic write-up, "G-15 ECO's -- Logical Explanation", remains valid although minor items have been changed. Below are some alterations to the text to up-date it:

P5, A-1, line 2 -- ...ECO's 970-1096 ...

P5, A-4, line 5 -- ...(e.g. "Eq. 1a" means AS_s includes $DS \cdot \overline{CV} \cdot Cl$)...

P5, A-5 -- Add: "SLOW OUT·OH implies ALPHA TYPE-OUT" since OH_s is conditioned by AS in SLOW OUT operations.

P6, B-6, line 2 -- Should read "... $DS \cdot \overline{CV}$, SLOW IN· $\overline{OC1} \cdot \overline{[STOP]}_{OB}$, and ① are ...". The omission of $\overline{[STOP]}_{OB}$ was an error in the text and does not reflect a recent ECO.

P7, B9 -- Additional information: Eq's 13a and 14a are active and control OAl whether or not they are needed for the "RAPID" case. This is of no consequence in the non-"RAPID" case since the state of OAl while OY is up^{is} of no consequence. (A new code will be placed in the OA's prior to the next OA's \leftrightarrow M23 precession.)

P8, B-15, line 2 -- "... (SLOW IN appears inverted in the PR-2 stop equation and is ...". This is not a new change but a correction.

P12, D-3 -- Substitute the following for the entire paragraph:

"In the ALPHA mode, OY and OH may be thought of in terms of a counter having four states. The relaxed state is $OY \cdot OH$ (#4 or #5). In order to advance to the #1 state, $OY \cdot OH$, OY must be set. The OY_s equation is:

$$SLOW\ OUT \cdot TO \cdot \overline{OY} \cdot \overline{OH} \cdot \overline{HC} \cdot \overline{OS}$$

The $\overline{OY} \cdot \overline{OH}$ terms in the equations allow the #1 state of this counter to arise only after the #4 or #5 state, while the $\overline{HC} \cdot \overline{OS}$ portion can prevent advancement as a function of external control. HC stops advancement as a function of typewriter feedback, while OS is used for a special purpose outlined in sec. D-15."

P14, D-8 -- Substitute the following for the entire paragraph:

"The TYPE PULSE is generated during the #1 state ($OY \cdot \overline{OH} \cdot \overline{OE}$). The maximum rate at which the OY-OH counter can cycle is once every 4 drum cycles, or approximately 8 times per second, hence the maximum ALPHA type-out rate is limited to approximately 8 characters per second. This will be slowed down by (1) Typewriter feedback via HC and (2) OS.

During the course of the #4 cycle ($\overline{OY} \cdot \overline{OH}$), OE will be high for the sake of the second extraction. This, as a by product, enables a ONE in M19.107's sign position to set OS at T1·CN time of the #4 cycle; if set, OS will then be reset at T1 of the following word 00. There will be a ONE in the sign position of M19.107 at this time until M19 is almost exhausted of compacted ALPHA characters, with the result that until an M19 ALPHA type-out is almost concluded OS will prevent the #1 state from directly following the #4 state, slowing down ALPHA type-outs from M19 to a maximum of one character every 5 drum cycles regardless of feedback.

This slow-down could be eliminated by applying [SIGN]_{OF} to the (T)·T1·CN·M19 gate which sets OS; however, feedback from the typewriter usually slows the type-out rate to one character per 5 drum cycles anyway and the OS slow-down feature merely keeps the rate constant from key to key.

Typewriter feedback will slow type-out down considerably more in the event of a TAB or CARRIAGE RETURN. "CARRIAGE" SHIFT will not slow the type-out down except when associated with special characters discussed in the next paragraph (D-9)."

P16, D-13 -- Substitute the following for the entire paragraph:

"There is practically no change to original NUMERIC type-out system; the ALPHA circuits which were added will simply be inert since AS will be low. If anything, NUMERIC type-out is simpler than it was in the earlier G-15's since the "phony feedback" circuit involving OF3 has been removed. (The new typewriter is faster than the old one and one character per 3 drum cycles can be tolerated.) The cycle is now as follows:

#1	$\overline{OY} \cdot \overline{OE}$	(send TYPE pulse for previous character to ANC-1)
#2	$\overline{OY} \cdot \overline{OE}$	M19 \longleftrightarrow OA's (the only extraction)
#3	$\overline{OY} \cdot \overline{OE}$	code placed in OB's
(#4	$\overline{OY} \cdot \overline{OE}$	kill time in case of feedback)
#1	$\overline{OY} \cdot \overline{OE}$	send TYPE pulse to ANC-1 for code just obtained

Feedback from the typewriter can only exist when TAB, CARRIAGE RETURN, or SPACE functions are performed. In such cases advancement from #3 state to #1 is delayed and the inactive #4 state will exist until feedback is over. The OH and OS terms will have no effect on delaying \overline{OY} since OH remains reset all through a NUMERIC type-out and OS cannot be high at the end of the #3 drum cycle.

P17, E-1 -- This entire change is being removed, reverting the circuit to its original form for the sake of standardization. Programmers have learned to live with the old system while the new one, though cleaner, could cause incompatibility between old programs and new machines.

P18, E-4 -- In addition to the features outlined here, provisions for two additional commands are contemplated as follows:

LOWER PEN:	DS·S5·SX·①	(1 23 31)
RAISE PEN:	DS·S5·SX·②	(2 23 31)

It is not expected that these commands will be built into all new machines. Certain machines might be modified in the field to include the feature for the sake of expanding the capabilities of the PA-3 accessory. (At this time the feature is outlined in ENGINEERING MEMORANDUM #693.)

THE FOLLOWING CONSTITUTES AN ADDENDUM TO SECTION E

E-5 "Logical Sum" command -- ECO 1074

DS·S7·SX·②·M18 has been added to M20w

This creates a command in the Form:

M18 + M20 → M20

which is programmed as a "2 31 31" during the desired word time or series of word times.

The purpose of the command is to permit easy logical summing of input data received from a CA-2 when multiple-formatting is employed. (A companion modification to the CA-2 is desirable to further reduce programming complexities in connection with multiple-format input operations -- this would only be of concern to CA-2 installations employing 402's as card readers.)

E-6 Application of $\overline{\text{STOP}}$ to ② -- ECO 1096

This has been indicated earlier in this write-up as a change to eq. 19. Addition of this term has nothing to do with the ALPHA feature of SLOW OUT, but constitutes the correction of a logical flaw which has always existed in the G-15 SLOW OUT system.

In brief, the three bits which follow an END code in an output format (NUMERIC) are not ignored. They are of no consequence in the case of an M19 output since the only effect they can have is that of shifting M19 left after it is empty. However, should a 101 configuration follow the END code of an AR format, an M19 \longleftrightarrow MZ precession will occur after AR is typed out. This would resemble a machine trouble, but is actually a design flaw. $\overline{[STOP]}_{OB}$ "locks" the END code in the OF's so that the following three bits will never be interrogated. (Note: This disorder has no connection with the TYPE AR - SET READY sequence used by programmers to purposely cause a M19 \longleftrightarrow MZ precession.)

E-7 <P> Key Interlock -- ECO 1096

The TAPE START signal is now:

$$\langle P \rangle \cdot \langle SA \rangle \cdot \overline{AS} + \text{AUTO TAPE START}$$

instead of:

$$\langle P \rangle \cdot \langle SA \rangle + \text{AUTO TAPE START}$$

Application of \overline{AS} to the $\langle P \rangle \cdot \langle SA \rangle$ combination renders $\langle P \rangle$ key initiation of a PHOTO-TAPE READ impossible if the INPUT system is set up for ALPHA input. For instance, should the operator fail to strike the $\langle \textcircled{S} \rangle$ key after an ALPHA TYPE-IN, he will obtain no reaction if he strikes the $\langle P \rangle$ key.

Should an ALPHA TYPE-IN followed by a manually initiated PHOTO-TAPE READ be desired, the operator should follow this sequence:

1. $\langle E \rangle \cdot \langle SA \rangle$ -- set up for ALPHA TYPE-IN.
2. TYPE-IN the ALPHA information.
3. Option (A) $\langle \textcircled{S} \rangle \cdot \langle SA \rangle$ -- set READY without terminal M23 normalizing, etc.
 Option (B) $\langle \textcircled{S} \rangle \cdot \overline{\langle SA \rangle}$ -- set READY with terminal M23 normalizing, etc.
4. $\langle P \rangle \cdot \langle SA \rangle$ -- start PHOTO-TAPE READ (numeric).

If step (3) is skipped, step (4) will cause no reaction.

Historical information: Machines starting with #241 had the $\langle P \rangle \cdot \langle SA \rangle + \text{AUTO TAPE START}$ combination applied to AS_r to shut off the ALPHA circuits in case

step (3) was skipped in the above sequence. This, however, did not assure reset of OH. With OH set, numeric inputs would lose control when the first MINUS code reached the input system. Hence $\langle P \rangle \cdot \langle SA \rangle + \text{AUTO TAPE START}$ was applied to OH_r . (TECO #146 - Change 2 applied this combination to OH_r ; ECO #1084 made the change permanent. ECO #1096 removes it from both OH_r and AS_r since the $\overline{\text{AS}}$ qualifier on the $\langle P \rangle \cdot \langle SA \rangle$ gate renders it unnecessary.)

E-8 Special provisions for MTA-2 control -- ECO 1096

There has been a demand for the following features in programming MTA-2's:

- (1) REVERSE-SEARCH (7 1/2 ips) for STOP code.

$L : L_{50} L_{50} C 4 31$
 $L_{50} : L_{52} N C 12 31$
N. G.

- (2) FORWARD-SEARCH (7 1/2 ips) for STOP code.

$L : L_{50} L_{50} C 5 31$
 $L_{50} : L_{52} N C 13 31$
N. G.

Sequences similar to the above have been used on unmodified G-15's with marginal results. The following changes have been introduced to render the operations "solid":

- (A) \textcircled{K} , which resets the OB's, now includes $\text{FAST IN} \cdot \textcircled{E}$ as a substitute for $\text{PHOTO-TAPE REVERSE} \cdot [\text{STOP}]_{\text{OB}} \cdot \textcircled{E}$,
 See Dwg. 48A - bottom.
- (B) MAG TAPE STOP is now $[\text{STOP}]_{\text{OB}} \cdot \textcircled{S} \cdot \text{OCI} + \text{READY}$ instead of $[\text{STOP}]_{\text{OB}} \cdot \textcircled{S} + \text{READY}$. This should be noted on your copy of Dwg. 47 - lower right.

Item (A), in conjunction with the recommended command sequences, eliminates the "false STOP code" problem associated with starting tape in the midst of data. (This has been previously referred to as "Hugh Bell's problem".)

Item (B) delays tape stop by 30-60 ms. when reverse-reading for STOP codes in order to allow a minimum of 2/10" of tape "overshoot" for the sake of a subsequent "FORWARD-SEARCH (7 1/2 ips) for STOP code" sequence. (The problem introduced by insufficient "overshoot" has previously been referred to as the "'C.D.C.' or 'Mac Haufe' problem".)

This ECO renders two TEMPORARY ECO's (TECO #146 and TECO #147) permanent. TECO #146 deals with the ALPHANUMERIC INPUT system while TECO #147 deals with the PR-1 and PTP-1 accessories.

(Item 1) TECO #146, change 1:

This portion of ECO 1084 inserts the B28CF-S cathode-follower in series with the $[\text{AUTO} \cdot \text{OG} \cdot \text{TF} \cdot (\text{OA3} \cdot \overline{\text{OF3}} + \text{M23} \cdot \text{OF3})]$ combination (found on LOOP) which is applied to both OD_S and OY_S .

ECO 1096 will still apply the output of this cathode-follower to OD_S and OY_S , but the combination feeding it will be changed to $[\text{AUTO} \cdot \text{OG} \cdot \text{TF} \cdot \text{OA3} + \text{AUTO} \cdot \text{OG} \cdot \text{TF} \cdot \text{M23} + \overline{\text{OB5}} \cdot \text{OB3} \cdot \overline{\text{OB2}} \cdot (\text{S}) \cdot \overline{\text{AS}}]$. This constitutes no change in logic -- just a re-arrangement of hardware which releases several diodes and the D28DE-UV cathode follower.

(Item 2) TECO #146, change 2:

This portion of ECO 1084 connects the $\langle \text{P} \rangle \cdot \langle \text{SA} \rangle + \text{AUTO TAPE START}$ combination (found on K13J) to OH_r via the C17R-E diode. (For discussion see sec. E-7). ECO 1096 will remove it.

(Item 3) TECO #147, changes for PR-1:

This changes the control of the built-in PHOTO-TAPE READER such that an external signal can inhibit its activity if a PHOTO-TAPE operation is initiated by a command containing a non-zero CHARACTERISTIC. The inhibiting action will only be effective if a PR-1 is installed.

Two "and" gates have been installed in series with the signals which control the relay puller tube in the PHOTO-TAPE READER as follows:

$(\text{PHOTO TAPE FORWARD}) \cdot (\overline{\text{OC6}} \cdot \overline{\text{OC5}})$ feeds the FORWARD triode.

$(\text{PHOTO TAPE REVERSE}) \cdot (\overline{\text{OC6}} \cdot \overline{\text{OC5}})$ feeds the REVERSE triode.

The $(\overline{\text{OC6}} \cdot \overline{\text{OC5}})$ combination originates in the "MASTER PR-1" and indicates a PHOTO-TAPE operation with CHARACTERISTIC = 0. If no PR-1

is installed the ($\overline{OC6 \cdot OC5}$) combination will be "floating" and cannot disqualify the above-mentioned "and" gates.

The above is not a complete description of the PR-1 change; its purpose is to indicate what has been done to original G-15 internal logic. More details on the PR-1 facilities should be mentioned in literature on the subject of the PR-1 itself.

(Item 4) TECO #147, changes for PTP-1:

This deals with the installation of wiring and logic to control the PTP-1. Such wiring and logic is only of interest in connection with the PTP-1 accessory and should be documented in literature dealing with the PTP-1.

SUGGESTION

It is suggested that you place the attached copies of Dwgs. 45A, 48A, and 52A in your copy of TECHNICAL MANUAL - REV. #1 following Dwgs. 45, 48, and 52. It is also suggested that you place your copy of "THE OUTPUT LINK" (which you should already have) in the manual directly after Dwg. 62. A detailed version of "THE OUTPUT LINK" is being prepared and will be known as Dwg. 63A; it will be sent to you later.