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Operational Procedures for the Eddy Current Metal Integrity/ Cartridge Measurement and Eject System

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PREFACE

This document provides the user with general recommendations for operating and maintaining the Eddy Current Metal Integrity/Cartridge Measurement and Eject System. The descriptions are intended as guidelines for the user to develop more exact procedures, as required, based on operational experience.

CONTENTS

OPERATIONAL PROCEDURES
FOR THE
EDDY CURRENT METAL INTEGRITY/CARTRIDGE MEASUREMENT AND EJECT SYSTEM

1.0 INTRODUCTION

This Cartridge Measurement and Eject System (CMES) is intended to detect internal metal defects, such as slip plane flaws and draw-forming tears, as well as major surface defects, such as splits, dents, and heavy draw scratches, on loaded 5.56-mm cartridge lots previously rejected for split failures on test firings. The Eddy Current Metal Integrity (ECMI) system used on this CMES has the capability to detect metal forming defects that can cause such failures. The system will inspect seven zones in the cartridge case body at a rate of 425 parts per minute.

The basic mechanical handler was originally designed as an online surface flaw inspection system connected to a load and assembly submodule. It has been modified into a stand-alone, bulk-fed, ECMI inspection system. For cost-effectiveness, existing designs and available hardware were used in the system where applicable. An existing Moulins roll-style cartridge feeder was adapted for CMES. The spindle assemblies, ECMI electronics, and most of the system control electronics are identical to those developed for the Cartridge Case Measurement and Eject Systems (CCMES) used on the case line submodules. A reduced data set for ECMI/CMES allowed the onboard microprocessor used on the CCMES system communication card to replace the dedicated minicomputer. Additional software was developed for this microprocessor to provide for CMES cartridge reject control, data handling, and data formats.

This document provides the user with general procedures for operating and maintaining the ECMI/CMES. In Section 2.0 the three basic subsystems comprising the ECMI/CMES unit are described. Section 3.0 outlines procedures for operating the unit. Section 4.0 provides a suggested schedule for performing routine maintenance, as well as general guidelines for timing the wheels and aligning the transfer guides and encoder. Appendixes A through F contain useful supplementary information referred to throughout the text. Appendix G provides lists of drawings for ECMI/CMES components.

2.0 SYSTEM DESCRIPTION

The ECMI/CMES unit consists of three basic subsystems: a bulk feeder, an inspection mechanical handler, and the inspection electronics.

2.1 BULK FEEDER

The subsystem comprises a conveyor to carry cartridges up to a holding bin, a vibratory feed system to transfer the cartridges from the holding bin to the roll feeders, and the roll feeder-to-banana chute mechanism. The banana chute feeds a tilted bevel wheel transfer into the mechanical handling system. The vibrators and rollers are controlled by on/off buttons on an operator station located on the side of the mechanical handler. The conveyor is controlled separately by an on/off station on the conveyor side of the mechanical handler. In addition, a separate remote control is provided to run the rolls only, to allow for initial filling of the banana chute. Compressed air is required for the bulk feed chute vibrators.

2.2 MECHANICAL HANDLER

The mechanical handler system includes the bevel wheel interface, transfer wheel into the examination wheel, ECMI examination wheel with rotary spindles, and exit transfer wheel with a mechanical solenoid-actuated reject finger. The bevel wheel takes cartridges from a horizontal position and reorients them to a bullet-up vertical position. Each of 12 rotary spindles spins cartridges in front of its own ECMI detector coil assembly in order to examine the entire circumference of the cartridge case. As the cartridge travels on the examination wheel, it cams to seven overlapping zones on the case between the shoulder and extractor groove. The exit transfer wheel has two outlet chutes. The reject chute handles the defects diverted out of the wheel by the solenoid-actuated reject finger. The exit chute strips the remaining cartridges out of the exit wheel.

The handler is controlled by two sets of on/off buttons at the operator station. One set controls the handler drive motor that turns the handler wheels. The rotation speed of the handler can be varied by the speed control

at the operator station. Once the system is turning, a speed-sensing circuit automatically turns on the spindle drive motor. The rotation speed of the spindle drive motor is fixed. The spindles will also shut off automatically when the system is stopped. The other set of on/off buttons allows the operator to start only the spindle motor. This allows the static setup and testing of individual inspection stations.

2.3 INSPECTION ELECTRONICS

The inspection electronics consist of the ECMI electronics and the control electronics. The ECMI electronics provide the actual flaw inspection capability. They are identical to those in the system developed for the Cartridge Case Measurement and Eject Systems (CCMES) for the case line submodules. The control electronics provide control of the handler and bulk feeder motion, case inventory information, timing windows for inspection, instrument data handling, case data and operator display, monitoring and display of machine status, and defective case reject control.

Most of the control and ECMI electronics are housed in separate card cages in an air-conditioned instrument rack located beside the mechanical handler. These card cages contain electronics compatible with existing CCMES units. Connecting cables run in a cable tray between the handler and instrument rack. The input end of the mechanical handler has been enclosed to house the electrical controls for the drive and spindle motors as well as the bulk feed system controls. The handler enclosure also contains cartridge present and reject solenoid circuitry.

3.0 OPERATION

General procedures for operating the ECMI/CMES unit, from power up to power down, are outlined in this section.

3.1 POWER UP

3.1.1 Electrical

Electrical power to the entire system, excluding the electronics, is supplied through the main disconnect switchbox located on the mechanical handler above the operator control station. This controls power to the bulk feeder, mechanical handler, and rack air conditioner (see Drawing 601-101). Power to the drive motors for the handler, spindles, rolls, and conveyor is controlled by the on/off key switch on the operator control station. Power to the air and reject solenoids is also controlled by this switch. The electrical power for the electronics is supplied through the electronics (computer) power disconnect switchbox located on the wall behind the instrument rack. For the building source breaker locations, see Remington Arms Company (RAC) Drawing C-SK-1-1908.

The power to the instrument control rack can be left on all the time so long as the air conditioner is operating. The air conditioner will maintain a stable temperature for the rack electronics. The on/off key switch on the operator control station can be used to lock out the system when it is left unattended or when maintenance is required on the handler.

Following a complete power down, the instrument rack power must be reset after the main and electronics power disconnects are turned on during the initial power-up stage. The power reset button is located under the air conditioner to the rear of the instrument rack. When power to the instrument rack is interrupted and then restored, the reset light will be on, indicating a reset is required to restore power to the rack. The reset indicator light will go out when the reset button is pressed. The operating program will also require resetting.

A Qume QVT-102 control terminal and a Hewlett-Packard HP2225D Thinkjet printer have been supplied with the CMES. The terminal is connected to the diagnostics port of the system communication card (Drawing 801-162). The printer is connected to the terminal and will print what is displayed on the terminal when the print key is pressed. Both devices are set to 19.2k baud.

3.1.2 Operating Program

The reset for the operating program after power recycling should occur automatically as a power-up reset. This should result in the CMES startup format on the video monitor. Enter the time and date in numerical form as requested. The screen will default to the HELP format. Select the desired format by pressing the appropriate keyboard key. It may be necessary to manually move the handler one position if the computer E-stop LED will not clear when trying to reset the system from the operator station. The time and date may be entered only in certain instances. When there has been a power-up reset, or a <CTL>D keyboard sequence (initiates diagnostics), the display will restart the initial CMES program introduction that includes the input of day and time. Power-up reset may be accomplished without powering down the entire rack by unplugging and plugging in the system communication card (Drawing 801-162) inside the control card cage in the instrument rack. A program reset can be done by pressing the switch marked reset on the communication card (Drawing 801-162). This will restart the program running with the last totals before reset. This program reset does not allow the setting of time and date.

3.2 STARTUP

The system startup procedures for normal daily operation assume that the system was stopped by the on/off key switch and that parts remain in the banana chute. The following sequence is recommended for startup:

1. Turn the operator station key switch to the on position.
2. Press the reset button. The reset button light should come on. If it does not, check the status panel on the front of the instrument rack for stop conditions.

3. When starting the system in motion, first start the bulk feeder to ensure that the rolls will be full. Then start the handler drive motor. The system can be started with the speed set at maximum. Start the system moving before the rolls become too full and parts begin to stack in the transfer chute between the hopper chute and the rolls.

4. Make sure that the roll feed is begun at the proper rate. The roll feed rate is critical for continuous operation of the system. A constant, steady flow of parts to the rolls results in optimal performance. Overfilling the rolls causes jams at the top of the banana chute. Underfilling the rolls creates jams within the banana chute.

A closed loop option is available for use when captive closed loop operation is desired for instrument testing. This option is described in Appendix A.

3.3 ALARMS AND STOPS

During system operation various alarms may appear on the 'overall status' video format. The alarms and their meaning are described below. Those preceded by an asterisk (*) cause a computer E-stop. Further explanation may be found in Appendixes B and C.

- CMES DATA SYNC ACHIEVED - The system encoder has been synchronized with the microprogram to provide part location and verification.
- HIGH REJECT RATE SP # xx - This is a segment percentage alarm that is itemized by spindle number. The limit is set in operating parameter (6).
- CONSECUTIVE REJECT LIMIT SP # xx - This is itemized by spindle number. The limit is set in operating parameter (2).
- SHORT TERM TOTAL RJ RATE LIMIT - This is a short-term percentage alarm based on the short-term reset total set in operating parameter (7). The limit is set in operating parameter (10).

- ECMI REJECT LIMIT SP # xx ZN # xx - This is based on rejects in short term and itemized by both spindle and zone. The limits are set in operating parameters (8) and (9) in two zone categories.
- SPINDLES NOT ROTATING - The sensing circuitry indicates the upper or lower spindles are not rotating. There is also a no spindle rotation indicator on the instrument rack.
- CASE PRESENT MALFUNCTION - This indicates no transmission between cartridge positions from light source to detector at either input or output part detectors. This would suggest either blockage of the light path or a component failure.
- ECMI ZONE x MALFUNCTION SP # xx - The ECMI system has signaled a malfunction indicating hardware problems with the individual zone signal processing cards or their interfaces. Cases will be rejected if a zone malfunction is detected and that zone is not overridden.
- ECMI MICRO MALFUNCTION SP # xx - The ECMI system has signaled a malfunction as determined by software diagnostics indicating difficulty with the system controller card. Cases will be rejected if a micro malfunction is detected and Zone 5 is not overridden.
- CASE LOST AT FINAL CP SP # xx - If a case is not present at the final case present but should have been, this alarm will be displayed.
- *EXTRA CASE AT FINAL RJ SP # xx - This message is displayed if a case that was not detected at the system input is found at the final case present. A computer E-stop will occur.
- *REJECT FAILURE - This message is displayed if a case that should have been rejected is found at the final case present. A computer E-stop will occur.
- *SPINDLE TIP xx IS STUCK - This alarm is generated if a spindle tip does not retract after the case exits the spindle. A computer E-stop will occur.
- SYNC LOST ON SPINDLE NUMBER xx - If the index pulse is not received at the correct spindle increment count, or if a data block collision

is detected, then a system loss of sync is forced. All parts will be purged from the system until synchronization can be re-established. The last valid spindle number is displayed for diagnostic purposes.

- DATA COLLISION - This indicates data is being input to the data processor too quickly. A data collision occurs if cartridge data processing is not completed by the time the next part arrives. This will also generate a sync lost condition as previously described.
- ENCODER CARD SYNC LOST SIGNALED - This message does not force a sync lost. It indicates the encoder circuitry has sensed a system backup.
- NONVALID INTER - This message indicates a nonvalid internal interrupt in the control software.

The ECMI/CMES has various sensors to guard against possible malfunctions and is set up to stop for any conditions that may indicate problem areas. Each stop has an LED indicator on the system status panel in the CMES instrument rack. These stops and their causal conditions include:

- NO SPINDLE ROTATION - The spindles stopped turning while the system was running. The spindle rotation sensors monitor motion of the upper and lower spindle idler pulleys with proximity detectors (for signal tracing, see Drawing 601-101, sh. 2). The spindles should start and stop automatically when the handler is run by the drive motor. By stopping the system with the E-stop button, the spindles will stop turning before the handler comes to rest. The spindles may back-drive the handler before it stops completely if the drive motor stop is used. If the reset light does not remain on after pressing the operator station reset button, and the no spindle rotation and operator E-stop LEDs will not clear from the instrument rack status panel, move the system manually one full revolution. This should clear the no spindle rotation bit from the motor control card. Alternatively, the motor control card, 801-167, can be reset inside the control card cage.
- COMPUTER E-STOP - The microprogram has alarmed a stop condition. These alarms appear on the 'overall status' video format and are

distinguished by an asterisk (*). For further details see the preceding list of computer alarms. If this alarm does not clear when the operator station reset button is pressed, move the handler manually one position and try the reset again. This may be necessary to clear the stop bit.

- OPERATOR E-STOP - The E-stop button on the operator station has been pushed.
- BULK FEED HUB - The over-torque clutch on the drive shaft for the bevel transfer wheel has become disengaged. This clutch is located on the bevel wheel drive shaft between the wheel and the base plate. The clutch will disengage when a jam occurs at the bevel wheel transfer points. Take care to clear the area and cartridge path of all parts that may have fallen out of the banana chute onto the bevel wheel and/or the small horizontal transfer wheel. To re-engage the clutch, turn the wheel in the forward direction, being careful to remove parts before they reach the transfer out of the bevel wheel, until the lower clutch plate snaps back up into position.
- MOTOR OVERLOAD - The electronic shear pin contacts in the drive motor control electronics have been tripped, indicating an excessive load on the drive motor. Check that the handler is free to turn manually before starting the drive motor. At very slow speeds or when the spindles turn on automatically at startup, the system drive may jerk and sometimes trip the overload.

3.4 MISCELLANEOUS SYSTEM STATUS INDICATORS

In addition to the stop conditions indicated by the instrument rack status panel, four LEDs denote the operating condition of the handler and instrument rack:

- INSTRUMENT OVERTEMP - The instrument rack temperature has exceeded 80°F. This is a warning indication. If the temperature reaches 90°F, the power to the instrument rack will be shut off automatically.

These two temperature sensors are located inside the top back of the instrument rack (for signal tracing, see Drawing 601-102).

- DRIVE MOTOR ON - The drive motor has been activated by the start button on the operator station.
- SPINDLE MOTOR ON - The spindles are rotating.
- FAULT OVERRIDDEN - At least one of the stop conditions has been overridden.

3.5 DISPLAYS

The keyboard provided with the video monitor allows the operator to select various data displays. The operating parameters format allows the operator to set various limits to help monitor system status. The main user displays are identified in Table 3.1 according to key and title. A scope mode format is also available to help troubleshoot specific data bits to the processor. For further explanation of a specific display, see the software description in Appendix B.

TABLE 3.1. Frequently Used Display Formats

Key	Format
V	Overall Status - count summaries, alarms
A	Total Flaws - defect breakdown by zone and spindle
S	Total Reject - inputs and rejects by spindle
X	Daily - selects daily totals for above flaws and reject formats
C	Segment - selects segment totals for flaws and rejects
Z	Short Term - selects short-term totals
J	Operating Parameters - allows operator input
K	Reject Override - allows operator input
G	Alarm Reset - reset alarms in overall status

3.6 SHUTDOWN

The power to the instrument control rack can be left on all the time so long as the air conditioner is on. This allows the air conditioner to maintain a stable temperature for the rack electronics. The on/off key switch on the operator control station can be used to lock out the system when it is left unattended or when maintenance is required on the handler. The on/off key switch removes power from the handler drive motor, spindle drive motor, conveyor feed motor, hopper vibrator motor, air solenoids, and reject solenoids.

For the end of daily operation and to empty only the mechanical handler portion of the system, the system may be stopped with parts remaining in the banana chute and rolls. This eliminates the tedious task of having to empty and refill the chute and rolls. To empty the mechanical handler, insert the metal retainer into the bottom of the banana chute to prevent any cartridges from entering the system. Carefully move the system forward, making sure that the last few parts below the inserted retainer in the banana chute do not fall out of the transfer from the chute and onto the transfer wheels. Always check to ensure that no parts have fallen into the transfer wheel case path.

3.7 POWER DOWN

To power-down the entire system, including the instrument rack, pull down the electronics power disconnect lever located behind the instrument rack; then pull down the main power disconnect lever located above the operator station. This can be done during extended shutdown periods. The main power disconnect removes all power from the bulk feeder, handler, and air conditioner. The electronics power disconnect removes power from the instruments.

4.0 MAINTENANCE

This section presents general guidelines for the routine and special maintenance actions associated with ECMI/CMES operation. A daily log book should be used in which to document any maintenance performed on the unit, along with a record of the daily general system operating condition, unusual circumstances, or any changes made to the system.

4.1 ROUTINE MAINTENANCE

Certain routine maintenance actions should be performed at regularly scheduled intervals. These actions and their frequency are listed in Table 4.1.

More detailed guidance on calibration procedures is presented in Appendix D. Related information on use of the CCMES/ECMI tester for CMES inspections and the ECMI standards is contained in Appendixes E and F, respectively.

4.2 SPECIAL MAINTENANCE

Certain key CMES maintenance procedures are very similar to the procedures used in CCMES maintenance. The following explanations are intended as a guideline for the user to develop more exact procedures based on operational experience. Use the CCMES manuals for additional information.

4.2.1 Wheel Timing

The examination wheel, both large (entry and exit) transfer wheels, and the smaller input transfer wheel all use tapered bushings to lock the center wheel shafts to the driven gears below the base. When the transfer points into and out of the exam wheel are being aligned, the wheels must be held in place while the bushings are tightened.

The carrier nubs of the small input wheel have been modified to accommodate the transfer interface to the bevel wheel. Every other lower set of nubs has been cut down to allow for the incoming angle of the part off the bevel wheel. Take care to align these modified positions from the bevel wheel to the examination wheel. Every other possible spindle position is empty. Obviously the parts must arrive at the exam wheel where the spindles are located. The

TABLE 4.1. Suggested Schedule for Routine Maintenance Actions

Frequency	Action
Daily	Check the ECMI probe faces for damage and severe misalignment. Verify proper alignment, liftoff, and null signal on any suspect probes. Check associated spindles for excessive wobble, sticky upper shafts, or worn tips.
Daily	Lightly lube the spindle shafts. This will increase bearing life and prevent upper shafts from sticking.
Daily	Lightly lube the bulk feed rolls. This will help parts feed into the banana chute at a constant rate.
Daily	Clean the handler of all loose cartridges on the base, wheels, covers, floor, etc., throughout the day. Stray parts are an indication of improper parts handling, which could lead to serious problems.
Daily	Check the reject station for loose or misaligned items.
Weekly	Check the critical ECMI zone calibrations (Zones 5-7). This is a static check with minimal defects to ensure that ECMI will detect all critical defects.
Weekly	Check all spindles for loose tips, loose setscrews, excessive shaft wobble, sticky shafts, excessive tip wear, and any visually obvious anomalies.
Weekly	Lubricate bearings at the upper and lower ends of the feed rollers.
Weekly	Check spindle belt wear.
Weekly	Check transfer guide settings.
Weekly	Check and clean air filter.
Twice Monthly	Check the noncritical ECMI zone calibrations.
Monthly	Lubricate gears.
Monthly	Check spindle tip heights and runout.

nubs have been removed in an unused section of the small input wheel to allow for easy removal when necessary. The clearance was required due to the overlapping nature of the wheel transfer.

The bevel wheel is chain-driven from the exit transfer wheel. Its timing is adjustable with a slotted timing hub located above the torque-limiter hub. Always check that the torque-limiter hub is engaged before beginning any alignment. The spring-loaded plate of the torque hub assembly should be nearly flush with the upper assembly piece. The bulk feed hub indicator light on the instrument rack status panel should be clear (light off) when the operator station reset button is pressed. The timing between the bevel wheel and the small input wheel is critical and should be adjusted to provide a smooth transition from wheel to wheel. The transfer may appear loose at various points, but the angles involved in the area of transfer require a certain degree of part freedom to make the wheel-to-wheel transition.

4.2.2 Transfer Alignments

The transfer guide alignment into and out of the examination wheel is similar to that for the CCMES. The guides must be set to bring the parts smoothly on and off the lower spindle tips. An alignment guide is also provided on the exam wheel just after the input transfer. Parts that do not seat fully into the lower tip at the entry transfer are nudged into place as they spin past this guide around the outside of the exam wheel. If the spindles are not rotating when parts are transferred onto the spindle tips, the parts often do not seat completely in the lower tip.

The interface ends of the bevel guide surrounding the bevel wheel and the input guide for the small input wheel are basically cut-to-fit sections because of the complex angles at this transfer point. The actual transfer point may appear to be very loose, but adequate clearance is required for the angled approach of the part. The rubber skirt around the bevel guide keeps the cartridge in the bevel wheel at the slower speeds during startup. The rubber bumper piece attached to the incoming end of the input wheel guide is to help place the lower portion of the cartridge into the lower wheel nubs.

The feed adapter wedge located at the output end of the banana chute completes the arc to the bevel wheel. It should be adjusted to provide a smooth part transition from the banana chute to the bevel wheel. The rotating bevel wheel motion removes the cartridges from the banana chute. The weight of the cartridges in the chute provides the insertion force into the bevel wheel. A full chute is necessary when adjusting the transfer. Shims may be required beneath the interface wedge to properly fill the space between the chute and wheel. A retainer has been provided to keep parts in the chute from entering the system. When moving the system after inserting the retainer, always ohserve the transfer of the final parts out of the chute. Without the full weight from the chute part queue, these last few parts may not transfer correctly and could possibly lodge in undesirable places in the system.

4.2.3 Encoder Alignment

The CMES encoder is located under the ECMI inspection turret. It generates timing signals used to track the position of the mechanical handler. Correct alignment of the encoder is necessary for the CMES to function properly.

To check encoder alignment, connect a CCMES remote encoder LED display to the connector under the control front panel on the instrument rack. Place the display where it can be easily read when standing in front of the ECMI inspection turret. Manually turn the ECMI inspection turret in the forward direction, taking care not to let the turret slip backward, especially when crossing the cam positions. Turn the turret at least one complete revolution to ensure synchronization. Continue turning the turret forward until ECMI spindle #11 enters the Zone 2 inspection position. At this point monitor the encoder LED display while slowly turning ECMI spindle #13 into the Zone 1 position. The display should read ".0.0" when spindle #13 is at the midpoint of the cam incline entering the Zone 1 position (decimals may be either to the right or left of the zeros). This is the only position in the turret's revolution at which the decimals should be displayed. If the decimals are not displayed or if the position is not 00 at this point, the encoder is misaligned and needs to be adjusted.

To realign the encoder, block the mechanical handler in the position described above (ECMI spindle #13 cam follower at the midpoint of the cam incline entering the Zone 1 position). Extend the motor controller board (see Drawing 801-167) and connect a scope to test point TP5. To help locate the index pulse, set the scope to trigger on a low to high transition at TP5. Minor adjustments can be made using the lever under the ECMI inspection turret. Loosen the two bolts holding the lever in place. While monitoring the scope display, slowly move the lever to the right or left until the scope triggers. Tighten the two bolts on the lever while holding it in the position where TP5 is at a high (~4-volt) level. At this position the remote encoder LED display should again display the decimals.

If the encoder alignment cannot be accomplished with this adjustment, tighten the two bolts on the lever with the lever in the center position (perpendicular to the face of the mechanical handler). Loosen the setscrews holding the belt pulley to the drive shaft, which is centered under the ECMI inspection turret. This enables the encoder to be turned while the mechanical handler remains stationary. Turn the encoder pulley in the forward direction (counter-clockwise looking up from underneath the pulley) until the scope triggers (still monitoring TP5 on the motor controller board). Turn the encoder pulley slowly backward or forward to the position where TP5 is high (~4 volts). At this position the decimals should again appear on the remote encoder display. While holding the encoder at this position, tighten the set-screws on the belt pulley to the drive shaft. Test the tightness of the set-screws on the encoder belt pulley. Also check the belt tightness. It need be only tight enough so as not to slip around the pulley teeth. As a final test, recheck the encoder alignment as described above.

APPENDIX A

CLOSED LOOP OPTION

APPENDIX A

CLOSED LOOP OPTION

The option is provided for captive closed loop operation of the unit where parts remain on the exam wheel and do not transfer on or off. Dynamic testing of individual inspection stations can be done in this configuration.

To change the normal bulk feed configuration to operate in a captive recirculation mode:

1. Remove both entry and exit transfer guides into and out of the exam wheel.
2. Remove the spacer caps from the top of the ECMI spindles. These spacers can be removed by sliding them up off the long spindle caps and off the shaft through the slit in the spacer. Check to see that the lower position of the upper tips clears both large transfer wheels.
3. Place a cartridge in each spindle position to be tested.
4. Visually check the parts for at least one slow revolution around the wheel for clearance. Also check that the parts remain in the spindles around the back side of the wheel.

To restore the system to the normal bulk feed mode:

1. Replace the spacer caps on top of the spindles.
2. Replace the entry and exit transfer guides into and out of the exam wheel. Carefully adjust the guides to provide a smooth transition on and off the lower spindle tips.
3. Check the transfers at slow speed before operating at normal speeds.

APPENDIX B

CMES SOFTWARE DESCRIPTION

APPENDIX B

CMES SOFTWARE DESCRIPTION

This appendix contains a description of the software contained in the COMM system (801-162 and 801-169 card). The COMM card was originally designed to read data blocks from CCMES and transfer this data to the PDP 11/44 by way of the DMA system (801-187 card). The COMM card contains control software for the CMES inspection and rejection system and the operator interface software to display data formats and control the CMES system.

Data received by the COMM board is collected from the ECMI instrument and the system case presents. This information is used to track cases through the inspection system and to reject defective parts. Operator interface is provided through an ASCII terminal; a printer is attached to the terminal to provide hard copies of the system data.

The CMES system uses a Zilog Z80 microcomputer, PIOs (parallel input/output) and SIOs (serial input/output) for all interfaces. All software was developed at Battelle using the Battelle cross assembler.

FILE STRUCTURE

This section outlines the file structure and directories used for source development and maintenance. The root directory for CMES is called CMES. This directory contains all files used to create the CMES control software programmed into EPROM and placed in the COMM card.

The files found in CMES are listed below, along with a description for each file.

EQUATE.ASM	This file contains constants used by CMES system.
RESTART.ASM	This file contains the power-up start vector and all restart vectors.
TABLES.ASM	TABLES contains all ASCII messages and tables used by CMES.

SUBRTN.ASM	This file contains all the general purpose subroutines used by CMES.
RAM.ASM	The RAM file contains all the memory allocation for variables and data buffers.
MAIN.ASM	This file contains the main processing loop of the system. In the main loop only operator terminal output and limit testing is performed. All operator input and data input/output is interrupt-driven.
NMI.ASM	The NMI file contains diagnostics software to print all registers in the event of an NMI interrupt.
MACRO.ASM	This file contains all macros used in the system.
BOARD.ASM	The BOARD file contains equates that are specific to the CMES system.
INIT.ASM	This file performs all system initialization.
DEVICE.ASM	DEVICE.ASM contains data tables used by the initialization program to configure the I/O devices.
INTJPT.ASM	The Z80 is used in interrupt mode 2, and the INTJPT file holds all the system interrupt vectors.
DIAGN.ASM	The DIAGN file contains the diagnostics software used by the system during the self-test mode.
INTSER.ASM	This file contains all the interrupt service routines.
DOCUM.ASM	This is the documentation file containing only comments describing the system structure.
AN.COM	This is a command file, which is invoked by typing the following command: @AN. The result of executing this command file is the concatenation of all the files discussed and then their assembly. Three files are produced: CMES.ASM, CMES.LIS, and CMES.OBJ. The OBJ file contains the object code to be burned into EPROM. The

AN.COM file is listed below to illustrate the order in which files are combined.

```
$ DELETE COMM.*;*/LO
$ APPEND DOCUM.ASM    CMES.ASM/NEW_VERSION
$ APPEND MACROS.ASM   CMES.ASM
$ APPEND EQUATE.ASM   CMES.ASM
$ APPEND BOARD.ASM    CMES.ASM
$ APPEND RSTART.ASM   CMES.ASM
$ APPEND NMI.ASM      CMES.ASM
$ APPEND INTJPT.ASM   CMES.ASM
$ APPEND DEVICE.ASM   CMES.ASM
$ APPEND TABLES.ASM   CMES.ASM
$ APPEND INIT.ASM     CMES.ASM
$ APPEND MAIN.ASM     CMES.ASM
$ APPEND DIAGN.ASM    CMES.ASM
$ APPEND INTSER.ASM   CMES.ASM
$ APPEND SUBRTN.ASM   CMES.ASM
$ APPEND RAM.ASM      CMES.ASM
$ ASMZ80VAX
CMES
N
```

AY.COM — This command file performs the same function as AN.COM, with the added feature of producing a cross-reference as part of the listing file.

If program modifications are performed, AN.COM or AY.COM must be executed to produce CMES.OBJ to be burned into EPROM. The utility INTEL is used to convert the OBJ file into an Intel hex format file, which is then downloaded to the series four and burned into EPROM. When the program is assembled, the check sum locations are set to OFF hex. This enables these locations to be programmed after CMES.OBJ is transferred to EPRDM.

After programming, the check sums must be found and programmed in EPROM 0000 at locations 2,3, 4, 5, 6, and 7. The check sum for EPRDM 0000 must be calculated from 0008 to 1FFF. This 16-bit check sum is then entered low byte

in 2 and high byte in 3. The 16-bit check sum for EPROM 2000 and 4000 is found over their entire range (0000 to 1FFF). Then this value is entered low byte in 4, high byte in 5 for EPROM 2000, and low byte in 6, high byte in 7 for EPROM 4000 of EPROM 0000. Thus, all check sums are stored in the first EPROM.

OPERATION

The CMES software is interrupt-driven. CMES receives an interrupt from the TXMIT signal in control. This signals CMES to read data from CONTROL and ECMI instruments and build a data block. The data is gathered and processed. The rejects are controlled as a result of the input data. Total counts are maintained of inputs, outputs, and rejects, and can be displayed by operator command. The operator can monitor and adjust system variables through the user console.

The control software for CMES is modeled after the CCMES system software both in internal structure and operator interface design. Input case data is placed in a shift register, and the shift register is advanced each time a case position interrupt is received. The CMES system allows cases only in odd spindle case positions, but the software gets case position interrupts for all positions (CCMES has 24 spindles per exam wheel; CMES uses every other possible spindle position and therefore has 12 spindles per exam wheel). Instrument data and case present data from a data block apply to various physical case positions in the system. This is represented in the software by the shift register referred to as the inventory system. This inventory system is two words (32 bits) for each case position in the CMES system from the input case present to the final case present.

Each time a case position is advanced, an interrupt is received; then all instrument data is collected. A subroutine is then called for each instrument, case present, and reject station on the CMES system. These routines update the inventory system and use data in the inventory to control case rejection and counting. The software design allows for addition of other instruments to the system so long as computer resources exist to process the information before the next case position interrupt.

System alarms are displayed on the user console when in the overall status mode. Five pages of alarms can be stored in the system memory. A page clear key is provided to clear an existing page of alarms and advance to the next page. After all five pages of alarms are filled, new alarms are lost.

A diagnostic testing mode is designed into the system to allow system hardware testing. Running the diagnostic software will force an E-stop of the CMES system.

Counter timers are used to generate an 8-Hz clock to be used as a real-time clock to maintain time of day and to allow calculation of system rates. The counter timers generate this clock by dividing the high speed system clock down to 8 Hz. The real-time clock has no battery backup and must be set each time the power is reapplied to the system.

Additional signals force interrupts in the COMM system. The MRESET signal indicates that the master reset button has been pressed. This will clear all reject outputs asynchronously. A RECENC interrupt is used by the system to ensure that data blocks are processed in time; any errors found are reported in the alarm system. If the data blocks are not processed in time, then sync lost is forced and the system is purged of cases.

DATA BLOCKS

The formats of the data block from CMES are listed below. This is the data seen in the scope display.

BYTE # 1	START
BYTE # 2	UNUSED
BYTE # 3	UNUSED
BYTE # 4 - # 7	CASE PRESENT ETC & STATUS
BYTE # 8	UNUSED (SOFTWARE WILL COMPUTE SPINDLE # & OUTPUT IT)
BYTE # 9 - #28	PROFILE
BYTE #29 - #31	SURFACE FLAW
BYTE #32	EC FLAW
BYTE #33 - #34	ECMI
BYTE #35	UNUSED
BYTE #36	CHECKSUM

The format of the reject data block is shown below. This reject data is also shown on the scope display.

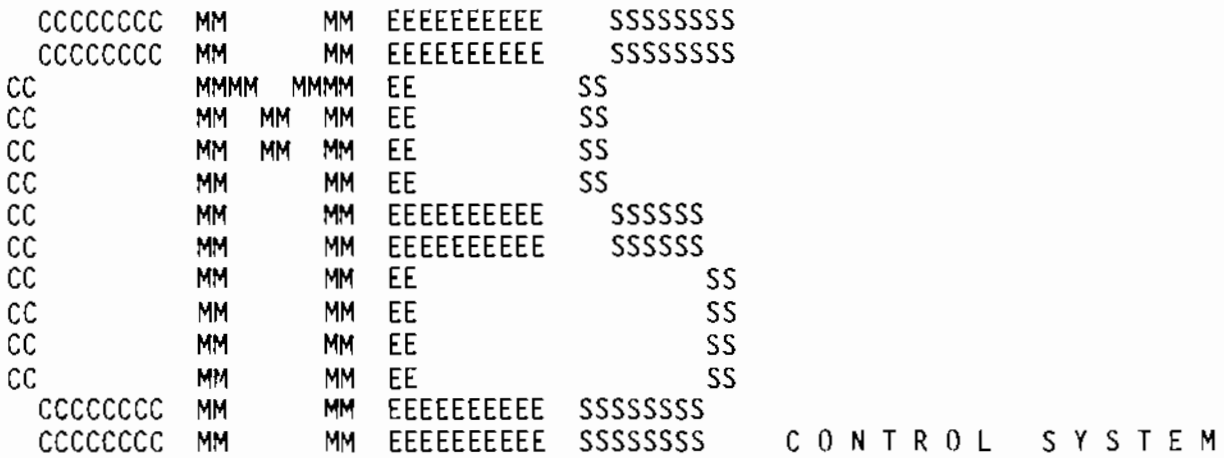
BYTE #1	START
BYTE #2	REJECT DATA LOW BYTE
BYTE #3	REJECT DATA HIGH BYTE
BYTE #4	CHECKSUM

DISPLAY MODES

This section discusses the features that are available on the user console. A terminal set for 19.2k baud should be plugged into the diagnostics terminal port. The valid keys are

sp	--	TRIGGER DISPLAY ON NEXT VALID CONDITION
P	--	SET TO SCOPE DISPLAY MODE
B	--	SET DISPLAY RADIX TO BINARY
H	--	SET DISPLAY RADIX TO HEXIDECIMAL
O	--	SET DISPLAY RADIX TO OCTAL
D	--	DECREMENT THE DISPLAY SPINDLE NUMBER
I	--	INCREMENT THE DISPLAY SPINDLE NUMBER
F	--	FORCE DISPLAY OF ANY CURRENT DATA
Y	--	TOGGLE COMMAND/CONTINUOUS-TRIGGER FLAG
R	--	RESET THE BLOCK COUNT
V	--	OVERALL SYSTEM STATUS DISPLAY MODE
A	--	TOTAL FLAWS DISPLAY MODE
S	--	TOTAL REJECT DISPLAY MODE
X	--	DAILY DISPLAY TYPE SELECTION
C	--	SEGMENT DISPLAY TYPE SELECTION
Z	--	SHORT TERM DISPLAY TYPE SELECTION
E	--	TRIGGER ON ANY SYSTEM ERROR
G	--	RESET ALARM PAGE
J	--	OPERATING PARAMETERS MODE
K	--	RE-ROUTE AND OVERRIDE MODE
?	--	DISPLAY HELP SCREEN
<CTL>D	--	TOGGLE DIAGNOSTICS TESTING MODE

When the system is powered up, the following display will be seen.



Gordon Anderson
Development Engineer
Battelle Northwest
Phone 509-375-2319

ENTER TIME OF DAY, HH:MM:SS

The time of day is entered at this time. If the return key is pressed without any time data entered, then the time will be set 12:00:00. If hours only are entered, then the minutes and seconds are set to zero. Likewise, entering only the hours and minutes will force the seconds to zero. A 24-hour clock setting ensures proper date increment (e.g., 1:00 pm = 13:00). After the time is entered, the user will be prompted to enter the date as shown below:

ENTER DATE, MM/DD/YY

If the return key is pressed without any date entered, the date will be set to January 1, 1985. If month only is entered, then the day is set to 1 and the year to 1985. Likewise, entering only month and day will force the year to 1985. The month is entered as a number indicating the month of the year but it is displayed as three letters. After the time and date are successfully entered, a listing of the valid keys will appear. The system power must be cycled to allow the operator to reenter the time and date. If the system reset button is pressed, the system will restart by performing a warm boot and will

try to save all counters and restart the system in the same mode as it was. The function of each of these commands will be discussed.

V - Overall Status Mode

Pressing the "V" key on the keyboard will force the system into the overall status display mode. A typical display is shown below:

```
OVERALL STATUS              CMES    JLY-18-85 11:21:55  SEG 1-11:03

PARTS COUNT              INPUT  RJ-ABLE REJECTED OUTPUT   RATE
   DAILY TOTAL             429     108        0      0      25  AVERAGE
   THIS SEGMENT            429     108        0      0      25  SEGMENT
   SHORT TERM              429     108        0      0      25  CURRENT

ECMI MICRO MALFUNCTION SP # 19
*REJECT FAILURE
CCMES DATA SYNC ACHIEVED
```

This mode displays system total counts for daily, segment, and short term, as well as all system alarm and information messages. The daily and segment counters are reset through the operating parameters display mode by operator command only. The short-term length is selected by the operator using the same display. This length is in number of turret revolutions (possible number of inputs per spindle). The short-term counters will automatically reset after this number is achieved.

The INPUT cases are the number of cases detected by the input case present. The RJ-ABLE cases are those that have been tagged in the inventory system to be rejected. The REJECTED cases are the ones that are actually rejected out the reject chute. The RJ-ABLE and REJECTED counters will not always be equal; if a reject is overridden, then a case will be counted as rejectable and not as rejected because it will pass through the system. Also, a loss of system sync will force all cases in the system to be purged and all counting to stop until the system sync is reachieved. Sample cases with flaws will he counted as rejectable and rejected. Sample cases without flaws will be counted as rejected. Rejectable counters are always advanced before the reject

counters, so a short-term reset or any counter reset with the system running may cause the two counters to be off. The OUTPUT counters track the total number of cases that have passed through the output of the system.

The rest of the display area under the overall status counters is reserved for alarm and status message display. Up to 16 messages can be displayed on the terminal. Pressing the "G" key will reset the alarm page and allow display of the next page. Up to five pages of alarms can be stored in the system. The alarm display is updated only at case position interrupts and therefore will not indicate new alarms if the system is not turning (to perform a page reset, the system must be turning). The page reset key will function only in the overall status mode. If the alarm system is full, additional alarms will not be displayed, and all trace of the alarm will be lost. Most alarms will not be duplicated in the alarm system. A list and description of each message is given below, and the alarms that will be repeated are indicated. If the alarm message is preceded by an asterisk, then the alarm condition also forces a computer E-stop.

- SYNC LOST ON SPINDLE NUMBER XX -- If the index pulse is not received at the correct time, or if a data block collision is detected, then a system loss of sync is forced. This indicates the system is not sure of the present spindle number, and all cases will be purged from the system. The last valid spindle number will be displayed for diagnostic purposes.
- DATA COLLISION -- This alarm is generated if a data block collision is detected. This will also force a sync lost alarm. A data collision occurs if case data processing is not completed by the time the next case arrives.
- NONVALID INTER -- If a nonvalid internal interrupt is detected by the control software, this message is displayed.
- ECMI ZONE X MALFUNCTION SP # XX -- This message indicates that the ECMI system has signaled a zone malfunction. Cases will be rejected if a zone malfunction is detected and that zone is not overridden.

- ECMI MICRO MALFUNCTION SP # XX -- This message indicates that the ECMI system has signaled a micro malfunction. Cases will be rejected if a micro malfunction is detected and Zone 5 is not overridden.
- *REJECT FAILURE -- This message is displayed if a case is found at the final case present and the same case was to be rejected. This alarm will also E-stop the system.
- *EXTRA CASE AT FINAL RJ SP # XX -- This message is displayed if a case is found at the final case present that was not detected at the system input. This alarm will force an E-stop.
- CASE LOST AT FINAL CP SP # XX -- If a case is not present at the final case present but should have been, this alarm will be displayed.
- CONSECUTIVE REJECT LIMIT SP # XX -- The operator can input a consecutive reject limit through the operating parameters display. If the value is exceeded on a per spindle basis, then this alarm will indicate the spindle on which the alarm occurred. This is based on any reject case flaw.
- CMES DATA SYNC ACHIEVED -- The message informs the operator that the system has achieved sync. This alarm will be repeated for each occurrence.
- ECMI REJECT LIMIT SP # XX ZN # XX -- The operator can enter short-term reject limits using the operating parameters mode. If the limit is exceeded, then this alarm will identify the spindle and zone on which the alarm occurred. This alarm is based on rejectable flaw case counters.
- HIGH REJECT RATE SP # XX -- This is a segment percentage alarm that is itemized by spindle number. The limit is user-definable using the operating parameters display.
- SHORT TERM TOTAL RJ RATE LIMIT -- This is a short-term percentage alarm based on short-term totals. This limit is also user-definable.

- CASE PRESENT MALFUNCTION -- This alarm indicates that a case present malfunction was signaled by the control hardware. This only informs the operator of a malfunction and will not force a reject.
- *SPINDLE XX TIP IS STUCK -- This alarm is generated if a spindle tip does not retract after the case exits the spindle. This alarm will force a system E-stop.
- SPINDLES NOT ROTATING -- This alarm indicates that a spindle not rotating signal was detected by the control hardware. If this condition exists, then no ECMI zone or micro malfunctions will be displayed until the spindles are rotating. The parts will be rejected due to the ECMI zone and micro malfunctions, even without that message displayed.
- ENCODER CARD SYNC LOST SIGNALED -- This message does not force a sync lost. It indicates only that the encoder card has signaled a loss of sync.

A - Total Flaws

Pressing the "A" key on the keyboard will force the system into the total flaws display mode where the system total flaw counters for all odd spindles will be displayed. A typical total flaw display is shown below:

TOTAL FLAWS CMES JLY-18-85 11:25:19 DAILY

LINE	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6	ZONE 7	REJ-ABL
1	1	3	0	15	21	21	1	21
3	0	0	0	4	1	0	0	4
5	0	0	0	3	1	0	0	3
7	1	1	3	5	19	17	0	24
9	0	1	0	4	1	0	0	6
11	0	1	0	2	0	0	0	3
13	6	0	0	9	4	0	3	13
15	2	0	0	2	1	0	1	4
17	1	0	2	4	2	0	0	5
19	2	0	0	2	1	2	1	5
21	2	1	5	7	1	0	3	8
23	1	4	3	2	6	1	1	12
OVERRIDDEN								
	N	N	N	N	N	N	N	

The total flaws display shows rejectable cases itemized by spindles and zones. This display format can display daily, segment, or short-term counters. The counters displayed are selected by the single key command as listed below:

- X -- daily counters
- C -- segment counters
- Z -- short-term counters.

The upper right-hand corner of the display indicates the counters that are displayed at the current time. The counters can be changed by pressing one of these keys on the keyboard at any time.

The right-hand column holds the total rejectable cases per spindle. The flaws per spindle will not necessarily add up to the rejectable count because a case can have multiple flaws. ECMI micro and zone malfunctions are counted only in the rejectables column and not in the flaw area.

The current status of the override flags is displayed for each zone along the bottom of the display. This informs the user of the current status only, and gives no information about the history of these flags.

S - Total Rejects

Pressing the "S" key on the keyboard will force the system into the total reject display mode. This display will show a history of rejected cases itemized by spindle. A typical total reject display is shown below:

```
TOTAL REJECT              CMES     JLY-18-85 11:25:19   DAILY
INPUT:     429   REJECTABLE:     108    REJECTED:     212   OUTPUT:       0
LINE     INPUT    RJ #1                    TOTAL

 1          36       19                       19
 3          36       16                       16
 5          36       13                       13
 7          36       16                       16
 9          36       15                       15
11          36       15                       15
13          36       21                       21
15          36       17                       17
17          35       17                       17
19          35       17                       17
21          35       23                       23
23          36       23                       23

TOTAL
            429      212                      212
```

As with the total flaws display, this display can show counts from daily, segment, and short-term counters and arrays. The counters are selected as was discussed above in the total flaws section.

This display will show the operator the total cases input by spindle against the total cases rejected by spindle. Both rejected cases and sampled cases will show up here. Only cases rejected due to a sync lost condition will not show up on these counters.

J - Operating Parameters Mode

Pressing the "J" key on the keyboard will force the system into the operating parameters display and data entry mode. This mode allows the user to adjust key system parameters. A typical operating parameters display is shown below:

```
OPERATING PARAMETERS              CMES        JLY-18-85 11:20:37    SEG 1-11:03

SEGMENT RESET          CONSECUTIVE REJECTS      SAMPLE CASE CONTROL
(1)  1 :ID#            (2) 50 :NO. LIMIT        (3)  1 :ID# (25=ALL)
                                                (4)  0 :DELAY (SEC)
TOTAL RESET            HIGH REJECT RATE
(5)  0 :99=RESET       (6) 75 :% LIMIT          SHORT TERM RESET
                                                (7)  0 :TERM LENGTH (MAX=255)
SHORT TERM REJECT                                      (IN # OF SPINDLE 1s)
LIMITS
(8)  1 :DEFECT #(2-3)                           TOTAL SHORT TERM REJECTS
(9) 50 :REJECT LIMIT(MAX=255)                   (10) 50 :% LIMIT

DEFECT #   DEFECT TYPE   REJECT LIMIT
  1
  2          ECMI Z5Z7        50
  3          ECMI Z1Z4        50


SELECT PARAMETER NUMBER
```

From this point the user selects the parameter of interest, enters the number in parentheses to the left of the parameter desired, and then presses the return key on the terminal to make the selection. If the number entered is not valid, the user will be reprompted for a selection. Pressing the return key without entering a parameter selection will return the user to the overall status mode. After a parameter is successfully selected, the user will be

prompted for that specific input. At any prompt point the user can return to the overall status display by pressing the return key with no parameter selection numbers entered. Each of the parameter types is outlined in more detail below.

(1) segment reset - Advancing the segment number will reset all of the segment counters and the short-term counters. The user must enter a new segment number higher than the present number to reset the segment. Entering a lower number will produce an error message and the user will be reprompted for input.

(2) consecutive reject limit number - This input defines the number of consecutive rejects per spindle required to generate an alarm.

(3) sample case control ID number - This input defines the sample case type to be taken. If the input is 25, then a case will be rejected from each spindle in the CMES system for a total of 12 cases. Any valid odd spindle number will result in a sample of only the selected spindle. The sample output will not start until the delay time is entered.

(4) sample case control delay - This input defines the delay until the sample rejection is to start. If the sample is all, then this delay will exist between each of the sample cases rejected.

(5) total reset - This input is used to reset all system counters. Entering a 99 will force this reset as well as resetting the segment number to 1.

(6) high reject rate - This is a percentage value input by the operator to monitor reject rate in the segment counters on a per spindle basis.

(7) short-term reset - This value determines the number of case positions in a short term. The value input is in number of turret revolutions, where each turret revolution is 12 case positions.

(8) short-term reject limit defect number - This selects the reject limit type to be changed by entry of the reject limit. A cross reference

of defect number to defect type is listed on the display along with the present limit value for reference.

(9) short-term reject limit - The limit data entered here is stored for the defect number selected in (8) above. If this short-term reject limit is exceeded, an alarm message is printed, itemizing the alarm by zone and spindle.

(10) total short-term rejects - The value entered here is a percentage of total short-term rejects. An alarm is generated if this limit is exceeded.

K - Reject Override

Pressing the "K" key on the keyboard will force selection of the reject override data entry mode. In this mode the operator can override rejects of his choice. A typical override display is shown below:

```
OVERRIDE                    CMES      JLY-18-85 11:21:20  SEG  1-11:03

                                          REJECT  OVERRIDE
                                     (4)   2:DEFECT # (2-8)
                                     (5)   0:OVERRIDE (1=YES)

DEFECT #   DEFECT TYPE                RJ OVERRIDE

    1
    2       ECMI Z1                        N
    3       ECMI Z2                        N
    4       ECMI Z3                        N
    5       ECMI Z4                        N
    6       ECMI Z5                        N
    7       ECMI Z6                        N
    8       ECMI Z7                        N

SELECT PARAMETER NUMBER
```

The selection of a parameter and the return to overall status modes is the same here as in the operating parameters modes. For a discussion of parameter selection refer to the operating parameters section of the manual. The following list describes each of the parameters in the override display:

(4) reject override defect number - This allows selection of the reject defect type of which you wish to affect the status. A cross

reference of defect type numbers to defect description is included on the display, as is the present status of all defects.

(5) reject override - Entry of a 1 will override the selected defect; entry of a zero will remove the override condition from the selected defect.

P - Scope Mode

Pressing the "P" key on the keyboard will force the system into the scope mode. A typical scope display is shown below:

```
                SPINDLE #  7 BLOCK COUNT      576              OPER MODE
                DATA BLOCK                                      SCOPE

  1  AA                        2  00
  3  00                        4  00
  5  00                        6  00                           RADIX HEX
  7  00                        8  00
  9  00                       10  00                           TRIG ANY
 11  00                       12  00                           TRIG CONT
 13  00                       14  00                           ECMI SP# 13
 15  00                       16  00
 17  00                       18  00
 19  00                       20  00
 21  00                       22  00
 23  00                       24  00
 25  00                       26  00
 27  00                       28  00
 29  00                       30  00
 31  00                       32  00
 33  00                       34  00
 35  00                       36  55

                REJECT DATA

  1  AA                        2  00
  3  00                        4  55
```

In the scope mode, data blocks are displayed in binary, octal, or hexidecimal formats. The operating mode radix and trigger mode are displayed on the right side of the display.

The display radix is selected by pressing "B" for binary, "H" for hex, or "O" for octal.

After a display has been printed, it will be updated on the next valid trigger condition, and reprinted. The trigger modes will be discussed later. A new display can be forced by pressing the "F" key.

Trigger Modes

In this section the different trigger modes for the scope display update will be outlined. By default, the trigger on any code is selected. In this mode the display will be updated with the next data block regardless of its spindle number.

I and D Keys

Triggering on a user-selected spindle number is done using the "I" and "D" keys. If the "I" key is pressed when in trigger on any mode, the system will advance to trigger on spindle 1. If "I" is pressed again, the system will advance to spindle 2. The "I" key advances the spindle number for trigger until spindle 24. After spindle 24, the system will return to trigger on any.

The "D" key function is similar to the "I" key, except it moves backward through the spindle numbers. If in trigger on any mode and "D" is pressed, the system enters trigger on spindle 24. If in trigger on spindle 1 and "D" is pressed, the system enters trigger on any.

The profile and scope display will show the selected trigger spindle number on the right side of the display.

Y and Space Keys

The "Y" key is used to toggle the command/continuous trigger mode. In the continuous mode, the display is updated by the next valid trigger condition. In the command mode, the display will be updated by the next valid trigger condition only after being commanded. Pressing the space bar will command a new display. This display will be updated only one time, each time the space bar is pressed.

The system will indicate the selected mode under the operating mode display on the right side of the CRT. The operating mode is displayed in the scope mode only.

E Key

A trigger on any system error mode can be selected by pressing the "E" key. In this mode, the scope display will update only on error conditions. To exit the trigger on error mode, press the "E" key again. As always, the operating mode display will show the trigger mode when in the scope display mode.

R Key

The "R" key is used to reset the block count to 0.

? Key

The "?" key is used to display the listing of valid commands on the CRT.

Additional System Modes

<CTL>D

The diagnostics testing mode is entered by holding down the control key and then pressing the "D" key. Starting the diagnostic testing of the CMES control system will issue an E-stop to the control system.

The diagnostics testing display is shown below:

```
                              DIAGNOSTICS MODE
=============================================================================
RAM TESTS                          ----                          ERRORS
                                                                      0
                                                                      0

EPROM TESTS                        ----                          ERRORS
                                                                      0
                                                                      0
                                                                      0

COUNTER TIMER TESTS                ----                          ERRORS
                                                                      0

PIO TESTS                  ----------------BITS----------------ERRORS

DATA BUS OUTPUT                                                       0
DATA BUS INPUTS AND BUFFERS                                           0

                                                          PASS NO.  172
```

The diagnostics testing mode is exited by the same input (<CTL>D) used to enter the testing loop. Once diagnostics testing is started, the system will remain in the loop until stopped. Once diagnostics mode is stopped, the system will restart as if the power had been cycled.

NMI Display

The COMM board is provided with an NMI switch. Cycling this switch will cause the system to execute the NMI program and halt the processor. To restart the system, a reset must be performed.

When the NMI program is executed, the registers and stack values will be displayed on the right side of the CRT as shown below. This will be displayed in any of the system modes.

```
PC    10DF
SP    F7F0
AF    7F3E
BC    2CA1
DE    D0E1
HL    117E
IX    700A
IY    137E
      STACK
LO    107E
      17FF
      6500
      77EE
HI    CCDC
```

The display will not be cleared before writing the NMI data. The NMI code will be executed as a result of executing any of the restart instructions, as well as using the NMI switch.

This feature is useful for system debugging to indicate where the processor is in the code and its register values. Once this display is seen, the power must be cycled to restart the controller.

The Status LEDs

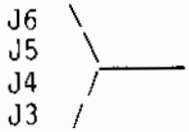
The COMM board has nine status LEDs. A halt LED is on whenever the processor has stopped. After executing the NMI code, a halt instruction is issued.

A group of eight LEDs communicates system status to the user. Those LEDs are labeled RESTART, 64, 32, 16, 8, 4, 2, and 1. If the RESTART LED is on, then a restart instruction has been executed. The restart instruction type can be found by adding the number corresponding to the remaining seven LEDs that are on. If a restart 7 has been executed, the RESTART LED and LEDs 1, 2, and 4 will be on.

The LED labled 1 is turned on when the case present interrupt processing is started, and is turned out after the processing is completed. This allows testing of the software system performance. During normal operation, LED 1 blinks as the system is run. The other LEDs are off.

Jumper Settings

This section indicates the jumper selection used for the present DMA card configuration.



The baud rate table below shows the jumpers to install for a given baud rate.

J3	J4	J5	J6	baud rate	
				110	
			*	150	
		*		300	
		*	*	2400	
	*			1200	
	*		*	1800	
	*	*		4800	
	*	*	*	9600	
*				2400	
*			*	600	
*		*		200	
*		*	*	134.5	
*	*			75	
*	*		*	50	
*	*	*		19.2k	
*	*	*	*	19.2k	(default)

J2 _____ Data link baud rate jumper, UNUSED ON CMES
J1 /

Install J2 for 153.6k baud (default)
Install J1 for 76.8k baud

J1,J4 and J7 Installed to enable U1,U2 and U3 for 2764 EPROMS.
J11 and J14 Installed to enable U4 and U7 for 2k static ram.

CMES also requires a new memory decoder chip to replace a PAL in the present COMM card. This is done using an Altera EP-300. A hardware modification is also performed to install 28 pin sockets in place of U1,U2, and U3, thus allowing for 2764s. Replacing the EP-300 with the original PAL and replacing the EPROMs with the latest COMM PROMS (bottom justified in the 28 pin sockets) would return the card to a COMM configuration.

MODIFICATION HISTORY

This section lists all modifications performed to the CMES software.

V1.0	8-29-85	original version.

APPENDIX C

CMES DATA BLOCK IDENTIFICATION

APPENDIX C

CMES DATA BLOCK IDENTIFICATION

The data bits in the data transmission block sent from the instrument data bus to the data communication card, 8D1-162, are located as shown below. Overall location is in the same format as CCMES. Only CMES-related bits are shown here. This information is useful when testing continuity of data from the instruments to the data control program in conjunction with the scope format display.

Xmit	8	7	6	5	4	3	2	1	Byte No.
	1	0	1	0	1	0	1	0	1 Start
	CP in	-	-	hi tip	-	-	-	-	4 Case Present
	-	-	-	-	-	-	CP out	-	5 Case Present
	indx	-	spin	-	-	BF	sync	stop	7 System Status
	malf uP	malf Z7	malf Z6	malf Z5	malf Z4	malf Z3	malf Z2	malf Z1	33 ECMI
	malf uP	flaw Z7	flaw Z6	flaw Z5	flaw Z4	flaw Z3	flaw Z2	flaw Z1	34 ECMI

Rcv	8	7	6	5	4	3	2	1	Byte No.
	-	rej	-	-	-	-	-	-	2 Receive

APPENDIX D

ECMI/CMES CALIBRATION PROCEDURES

APPENDIX D

ECMI/CMES CALIBRATION PROCEDURES

Calibration of the ECMI/CMES should be checked periodically to ensure that each spindle is inspecting the seven zones with the proper sensitivity. This procedure can be accomplished in about 2 hours.

1. Clear machine of cartridges.

   Insert the retainer in the bottom of the banana chute of the feeder to prevent any cartridges from entering the system. Remove any cartridges on the turret or transfer wheels. Check for stray cartridges in the case path around the first small transfer wheel.

2. Connect ECMI diagnostics to terminal.

   Unplug the RS-232 connector on the back of the electronics rack and plug into the RS-232 port above the ECMI front panel. After turning on power to the terminal, the ECMI diagnostics should be viewable. This will let you know when the ECMI system is unsynchronized.

3. Check probe alignment and liftoff.

   Rotate the inspection turret to locate spindle 1 in the Zone 4 inspection station. Place the alignment jig in spindle 1 and measure the liftoff between the jig and the probe with a feeler gauge. The 0.007-inch gauge should drag lightly when inserted and removed. Check the alignment of the probe. The probe should be centered on the vertical line on the jig when the face of the probe and jig are parallel. The top of the probe should line up with the horizontal line of the jig. As a final check, insert the Zone 4 cartridge used to measure liftoff on the ECMI bench tester in the Zone 4 inspection station. The 0.016-inch blade of the feeler gauge should drag slightly when inserted and removed. If the probe needs to be adjusted, refer to the instructions for this in the CCMES/ECMI wheel electronics setup procedures.

Note: Probe brackets for CMES and CCMES are not interchangeable. Replacement of CMES brackets with CCMES brackets or vice versa will result in damage to the probe assembly.

Repeat this step for the other eleven spindles.

4. Synchronize ECMI.

   Press the Master Reset button and turn the inspection turret forward manually until the monitor no longer shows the unsynchronized alarm. Take care that the turret does not move backward, especially when crossing the cam steps. The ECMI system should become synchronized as spindle 13 comes into the Zone 1 inspection position.

5. Start calibrating.

   Move spindle 13 to the Zone 5 inspection position. Insert the pin in the hole behind spindle 15 so as to block the turret from turning backward. Insert the Zone 5 calibration standard in spindle 13 and the Zone 7 calibration standard in spindle 11. Turn on the spindle drive while holding spindle 15 against the pin. Monitor Zone 5 scope signals EC Data and EC Digital. EC Digital should be high at each peak of EC Data. If no signal is present, the system is probably out of sync. Repeat the synchronization procedure and try again. To set the probe gain to the correct sensitivity, decrement the gain until EC Digital is low at some or all of the EC Data peaks. Increment the gain one step at a time until EC Digital is high at every EC Data peak. Due to spindle wobble, the signal may increase and decrease while you monitor it. Set the probe gain so that EC Digital is high at the EC Data peak when the EC Data signal average is minimum. Note the new probe gain setting on the calibration record form. Monitor the Zone 7 scope signals and adjust the probe gain for spindle 11, Zone 7 in the same manner. Move the standard in spindle 13 to spindle 15 and the standard in spindle 11 to spindle 13. Rotate the turret ahead two positions and again monitor Zone 5, then Zone 7, making adjustments as before.

Continue until all spindles have been checked in these zones. Follow the same procedures for Zones 6 and 4 and for Zones 3 and 1 using the appropriate zone standards. For the even zones (2, 4, 6), block the spindles using the other hole in the turret. Check Zone 2, all spindles, in a similar fashion. When finished, turn off the spindles, pause for at least a minute, then reset the ECMI system using switch 1 on the 135 card. Check the probe gains for all spindles and zones against your recorded values, correcting any errors. Communication errors may occur when using the increment and decrement keys to change the probe gain. When this happens, the present probe gain value is stored under the wrong spindle and zone. It is therefore important to check all probe gains after calibration against the calibration record form. If an error is found, it should be corrected by using the clear button on the front panel (with input data enabled) and entering the correct value from the calibration record form. When finished, turn the spindles on and off to store the new probe gains in EPROM on the 133 card.

Note: A reset of the ECMI system before turning off the spindles will result in loss of any new probe gains entered while the spindles are on. New probe gain values are permanently saved only when ECMI spindles go from on to off.

If the preceding steps have been followed, the ECMI system is now calibrated.

APPENDIX E

CCMES/ECMI TESTER USE FOR CMES INSPECTION

APPENDIX E

CCMES/ECMI TESTER USE FOR CMES INSPECTION

Many variables affect the signal level given by a flawed cartridge on the ECMI bench tester. Care must be taken to control these variables when checking flawed case levels against a standard level.

The ECMI bench tester can be positioned with the cam to inspect the seven zones defined by the CCMES units. Although the cam increments are not the same for the CMES inspection zones, the tester can be used to inspect the CMES zones by adjusting the probe laterally across the case with the positioning stage to center the probe in a zone. For the tester spindle to accept a cartridge, the cartridge case spindle tips must be replaced with the cartridge spindle tips. The left tip unscrews (reverse threads) from the spindle module. The right tip is replaced by unscrewing the entire upper shaft assembly from the spindle module and replacing it with the cartridge upper shaft assembly, which includes a modified tip.

To set up the tester for cartridge inspection, change the tips as described above. Open the CMES cartridge standard box (which is to be kept by the tester) and remove the cartridge that defines the Zone 4 inspection station (labeled Z4). This cartridge has no flaw. Insert the Zone 4 cartridge into the bench tester spindle (bullet facing left). Adjust the cam and the positioning stage to center the probe between the Zone 4 marks. Rotate the cartridge so that the horizontal line on it faces and is approximately centered on the probe. Adjust the vertical positioning stage, if necessary, to center the probe on the case. Adjust the liftoff between cartridge and probe to 16 mils. Turn on the spindle drive. Null the electronics monitoring the null test signal. Set the sample position to the minimum noise level monitoring sample test. The bench tester is now set up to inspect cartridges in CMES Zone 4.

To test any CMES zone, insert the marked zone cartridge for the zone to be inspected in the test spindle and move the cam and lateral positioning stage to center the probe in the zone. The signal level of the working standard for a given zone should be checked and noted before inspecting any CMES cartridges in

that zone. This gives the reference for what is considered to be a minimum reject signal level. If the above steps have been followed and the CMES system has been calibrated and is working properly, cartridges passing through the unit as good parts should not give signal levels on the tester in any CMES zone above the level of the working standard for that zone.

APPENDIX F

ECMI STANDARDS

APPENDIX F

ECMI STANDARDS

Two sets of ECMI standard cartridges were made for the CMES/ECMI inspection station. The set located in the box mounted on the CMES unit is intended to be the working set, which is used to periodically check the calibration of the ECMI system. The second set is to be used only as standards for fabrication of new standard cartridges in the event of loss or destruction of one or more from the working set.

Each standard cartridge set consists of seven cartridges. one for each inspection zone. The flaws on the standard cases are made to give the minimum signal level on the ECMI bench tester which is considered rejectable for a given zone. If the minimum reject signal level for a zone is changed, a new standard should be fabricated (or found by sorting through ECMI rejects) that gives a signal at the new level. The current minimum reject signal levels, with the tester set for a 16-mil liftoff in CMES Zone 4, are as follows:

PNL Bench Tester		LCAAP Bench Tester
Zone 1	2V peak	Zone 1
Zone 2	2V peak	Zone 2
Zone 3	1.5V peak	Zone 3
Zone 4	1.1V peak	Zone 4
Zone 5	0.8V peak	Zone 5
Zone 6	1.3V peak	Zone 6
Zone 7	1.1V peak	Zone 7

APPENDIX G

DRAWING LISTS

APPENDIX G

DRAWING LISTS

The following lists indicate the drawings to be used for the ECMI/CMES. They include mechanical assemblies, ECMI and control electronic schematics, and electrical connections. Because ths system is a conglomeration of old and new designs, most of the drawings refer to CCMES (800 and 801 series) and the original CMES (600 series). The new drawings are denoted by an asterisk and are included as part of this documentation package. The other drawings should be on file as part of an existing system.

DRAWING NO.		TITLE	SIZE	REV.
FA-600-000		MASTER DRAWING LIST	A	-
~~FA-600-001~~	~~SH 1~~	~~ARRANGEMENT - PLAN~~	~~F~~	
	~~SH 2~~	~~- ELEVATIONS~~	~~F~~	
	~~SH 3~~	~~- ELEVATIONS~~	~~F~~	
	~~SH 4~~	~~- ELEVATIONS~~	~~F~~	
FA-600-002	SH 1	EXAMINATION WHEEL-ASSEMBLY, SEE 600-015	F	3
	SH 2	-DETAILS	F	3
	SH 3	-DETAILS	F	
FA-600-003	SH 1	TRANSFER WHEEL - ASSEMBLY, SEE 600-016	F	2
	SH 2	- DETAILS	F	3
	SH 3	- DETAILS	F	2
	SH 4	- DETAILS	D	0
	SH 5	- DETAILS	D	0
~~FA-600-004~~	~~SH 1~~	~~INTERFACE - ASSEMBLY~~	~~F~~	~~1~~
	~~SH 2~~	~~- ASSEMBLY~~	~~F~~	~~1~~
	~~SH 3~~	~~- ASSEMBLY~~	~~F~~	~~1~~
	~~SH 4~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 5~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 6~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 7~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 8~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 9~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 10~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 11~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 12~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 13~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 14~~	~~- DETAILS~~	~~F~~	~~2~~
	~~SH 15~~	~~- MODIFICATION~~	~~C~~	
FA-600-005	SH 1	RECIRCULATION - ASSEMBLY, SEE 600-017	F	2
	SH 2	- DETAILS	F	2
	SH 3	- DETAILS	F	2
	SH 4	- DETAILS	F	1

BULK FEED & ECMI RETROFIT

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	ORIGINAL DATE 8-21-85	US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND DOVER, NEW JERSEY 07801	
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±	DRAFT KMK / CHK		
MATERIAL	TRACER / CHK	MASTER DRAWING LIST	
TREAT	ENGR S.L.Crowell / ENGR	CMES 5Y MECHANICAL	
PROTECTIVE FINISH	SUBMITTED / APPROVED	SIZE A / CODE IDENT NO. 19200	FA-600-000
		SCALE: / UNIT WT.	SHEET 1 OF 5

SMCFR Form 1071, 7 Jun 66 (Formerly SMCFR Form C5818)

DRAWING NO.		TITLE	SIZE	REV.
FA-600-006	SH 1	TRANSFER GUIDES - ASSEMBLY, SEE 600-018	F	1
	SH 2	- DETAILS	F	2
	SH 3	- DETAILS	F	1
	SH 4	- DETAILS	F	1
	SH 5	- DETAILS	F	1
	SH 6	- DETAILS	F	0
	~~SH 7~~	~~- MODIFICATION~~	~~F~~	~~0~~
	~~SH 8~~	~~- MODIFICATION~~	~~F~~	~~0~~
	~~SH 9~~	~~- MODIFICATION~~	~~F~~	~~0~~
	~~SH 10~~	~~- MODIFICATION~~	~~F~~	~~0~~
FA-600-007	SH 1	BASE - ASSEMBLY	F	2
	SH 2	- DETAILS	F	3
	SH 3	- DETAILS	F	3
FA-600-008	SH 1	ENCLOSURE FRAME - ASSEMBLY	F	0
	SH 2	- DETAILS	F	1
FA-600-009	SH 1	PANEL ENCLOSURE - ASSEMBLY	F	0
	SH 2	- ASSEMBLY	F	0
	SH 3	- ASSEMBLY	F	0
	SH 4	- ASSEMBLY	F	0
	SH 5	- DETAILS	F	0
	SH 6	- DETAILS	F	0
	SH 7	- DETAILS	F	1
	SH 8	- DETAILS	F	0
	SH 9	- DETAILS	F	0
	SH 10	- DETAILS	F	0
	SH 11	- DETAILS	F	0
	~~SH 12~~	~~- MODIFICATION~~	~~F~~	~~0~~
~~FA-600-010~~	~~SH 1~~	~~SPINDLE DRIVE - ASSEMBLY, SEE 600-019~~	~~F~~	~~2~~
	~~SH 2~~	~~- DETAILS~~	~~F~~	~~3~~
	~~SH 3~~	~~- DETAILS~~	~~F~~	~~1~~
	~~SH 4~~	~~- DETAILS~~	~~F~~	~~0~~
	~~SH 5~~	~~- MODIFICATIONS~~	~~0~~	~~0~~
~~FA-600-011~~		~~CLUTCH MOUNTING - ASSEMBLY~~	~~F~~	~~0~~

SIZE	CODE IDENT NO.	FA-600-000
A	19200	
SCALE:	UNIT WT.	SHEET 2 OF 5

DRAWING NO.		TITLE	SIZE	REV.
~~FA-600-012~~	~~SH 1~~	~~REJECT CHUTES - ASSEMBLY~~	~~F~~	~~1~~
	~~SH 2~~	~~- DETAILS~~	~~F~~	~~1~~
	~~SH 3~~	~~- DETAILS~~	~~F~~	~~1~~
	~~SH 4~~	~~- DETAILS~~	~~F~~	~~0~~
FA-600-013				
FA-600-014				
		- ECMI RETROFIT-		
★ FA-600-015	SH 1	EXAMINATION WHEEL - ASSEMBLY, SEE 600-002	F	2
	SH 2	- DETAILS	F	2
	SH 3	- DETAILS	F	2
★ FA-600-016	SH 1	TRANSFER WHEEL - ASSEMBLY, SEE 600-003	F	0
	SH 2	- DETAILS	F	0
★ FA-600-017	SH 1	RECIRCULATION WHEEL - ASSEMBLY, SEE 600-005	F	0
	SH 2	- DETAILS	F	0
	SH 3	- DETAILS	F	0
★ FA-600-018	SH 1	TRANSFER GUIDES - ASSEMBLY, SEE 600-006	F	0
	SH 2	- DETAILS	F	0
★ FA-600-019	SH 1	SPINDLE DRIVE - ASSEMBLY, ~~SEE 600-018~~	F	0
	SH 2	- DETAILS	F	0
	SH 3	- DETAILS	F	0
	SH 4	- DETAILS	F	0
	SH 5	- DETAILS	F	0
★ FA-600-020		FACILITY & SERVICES - ARRANGEMENT	F	
~~FA-600-021~~	~~SH 1~~	~~ELECTRICAL ENCLOSURE MOUNTING - ASSEMBLY~~	~~F~~	~~1~~
	~~SH 2~~	~~- DETAILS~~	~~F~~	~~1~~
	~~SH 3~~	~~- DETAILS~~	~~F~~	
~~FA-600-022~~	~~SH 1~~	~~PIPING RUNS ARRANGEMENT - PLAN~~	~~F~~	
	~~SH 2~~	~~- ELEVATION~~	~~F~~	

SIZE	CODE IDENT NO.	FA-600-000
A	19200	
SCALE:	UNIT WT.	SHEET 3 OF 5

DRAWING NO.		TITLE	SIZE	REV.
~~FA-600-023~~	~~SH 1~~ ~~SH 2~~	~~INSTRUMENT LOCATION ARR. - PLAN~~ ~~- ELEVATION~~	~~F~~ ~~F~~	
~~FA-600-024~~		~~MACHINE LAYOUT & CARTRIDGE FLOW DIAGRAM~~	~~F~~	~~1~~
~~FA-600-025~~		~~CMES FACILITY & SERVICES ARRANGEMENT~~	~~F~~	~~2~~
~~FA-600-026~~	~~SH 1~~ ~~SH 2~~	~~SENSOR MOUNT & LOCATION - ASSEMBLY~~ ~~- DETAILS~~	~~F~~ ~~F~~	~~0~~ ~~0~~
~~FA-600-027~~		~~5Y FIBER OPTIC BUNDLE~~	- VOID -	
~~FA-600-028~~		~~PHOTOMULTIPLIER TUBE MOUNTING~~, SEE 500-036	- VOID -	
~~FA-600-029~~	~~SH 1~~ ~~SH 2~~	~~LASER & COLLIMATOR MOUNT - ASSEMBLY~~ ~~- DETAILS~~	~~F~~ ~~F~~	~~1~~ ~~1~~
~~FA-600-030~~		~~LASER HOUSING, EXPLOSION - PROOF~~	~~F~~	
~~FA-600-031~~		~~PHOTOMULTIPLIER HOUSING, EXPLOSION - PROOF~~	- VOID -	
FA-600-032	SH 1 SH 2	ENCODER MOUNTING - ASSEMBLY - DETAILS	F F	
~~FA-600-033~~	~~SH 1~~ ~~SH 2~~	~~CASE PRESENT ENCLOSURE - ASSEMBLY~~ ~~- DETAILS~~	~~F~~ ~~F~~	
~~FA-600-034~~	~~SH 1~~ ~~SH 2~~	~~CONDUIT RUNS ARRANGEMENT - PLAN~~ ~~- ELEVATION~~	~~F~~ ~~F~~	
~~FA-600-035~~		~~FLAW DETECTOR - MULTIPLEX BOX - ASSY & DET.~~	~~F~~	
* FA-600-036		CASE PRESENT - ASSEMBLY	F	
* FA-600-037	SH 1 SH 2	BEVEL WHEEL - ASSEMBLY - DETAILS	F F	
* FA-600-038		REJECT - ASSEMBLY	F	

SIZE	CODE IDENT NO.	FA-600-000
A	19200	
SCALE:	UNIT WT.	SHEET 4 OF 5

DRAWING NO.		TITLE	SIZE	REV.
~~FA-600-039~~		~~LIGHT SHIELD - ASSY & DET~~	~~D~~	
FA-600-040				
FA-600-041				
FA-600-042				
FA-600-043				
FA-600-044				
FA-600-045				
* FA-800-011	SH 1	ROTARY SPINDLE - ASSEMBLY	F	6
	SH 2	- DETAILS	F	4
	SH 3	- DETAILS	F	6
	SH 4	- DETAILS	F	6
	SH 5	- DETAILS	F	6
	SH 6	- ALTERNATE ASSY	F	2
	SH 7	- ALTERNATE ASSY	F	1
* FA-850-069		EDDY CURRENT DETECTOR MOUNTING - ASSY	F	0
FA-801-070	SH 1	EDDY CURRENT METAL INTEGRITY DETECTOR - ASSY	F	2
	SH 2	- DET	F	2
FA-801-072	SH 1	ECMI INSPECTION WHEEL ELECTRONICS BOX - ASSY	F	1
	SH 2	- DET	F	1
	SH 3	- DET	F	1
FA-801-073	SH 1	ECMI INSPECTION WHEEL INTERFACE - ASSY	F	0
	SH 2	- DET	F	0
	SH 3	- DET	F	1

SIZE	CODE IDENT NO.	FA-600-000
A	19200	
SCALE:	UNIT WT.	SHEET 5 OF 5

CMES/ECMI DRAWING LIST - ECMI

Dwg No.	Title	Rev.	Sheets
801-126	ECMI Wheel Electronic Input Card	3	1
801-128	Six Channel Detector Driver Card	3	4
801-130	ECMI Mother Card	2	1
801-131	ECMI Detector Interface Card	2	1
8D1-132	ECMI Signal Processing Card	1.11	6
801-133	ECMI System Controller Card	0	16
801-135	ECMI System Interface	1.5	7
801-139	ECMI Cable Interconnections	0	14

The -200 series of drawings consist of layouts and I/O listings for the above -100 series (e.g., -132 is the schematic, -232 is the component layout and connector I/O pin numbers and signal names).

The -300 series of drawings consists of parts lists for the above -100 series.

Remington Reference Drawings:

B-ESK-20673	Building 1 Air Line to CMES 1
C-SK-1-1908	CMES 1 Power Distribution Bldg. 1
R-ESK-20681	Bldg. 1 CMES 1 Installation

DRAWING NO.			TITLE	SIZE
* 1 - 601-101	-	Sh 1	Electrical Wiring	B
		Sh 2	AC Interface	B
		Sh 3	Air Solenoid	B
		Sh 4	μ Switches	B
* 2 - 601-102	-	Sh 1	Rack AC/J-Box	B
* 3 - 601-103	-	Sh 1	Encoder/Eng. Display	B
* 4 - 601-104	-	Sh 1	Case Present Box	B
* 5 - 601-105	-	Sh 1	Status Panel	B
* 6 - 601-165/WW		Sh 1	Handler Status	B
7 - 801-157	-	Sh 1-Sh 2	LED Driver Card	C
* 8 - 801-162	-	Sh 1-Sh 4	System Communication - I/O	C
801-262	-	Sh 2	System Comm I/O Backplane	C
9 - 800-163	-	Sh 1-Sh 5	Case Monitor/Status Words	C
801-263	-	Sh 2	Case Monitor/Status Words Backplane	C
10 - 800-164	-	Sh 1-Sh 5	Master Encoder	C
801-264	-	Sh 2	Master Encoder Backplane	C
*11 - 801-169	-	Sh 1-Sh 2	System Communication - CPU	C
12 - 800-166	-	Sh 1- Sh 4	System Control/Gen. Status Card	C
801-266	-	Sh 2	System Control/Gen. Status Card Backplane	C
13 - 801-167	-	Sh 1-Sh 3	Motor Controller	C
801-267	-	Sh 2	Backplane	C
14 - 801-168	-	Sh 1-Sh 2	Scope Interface Card	C
801-268	-	Sh 2	Backplane	C
15 - 801-197	-	Sh 1-Sh 4	Front Panel CPU	C
16 - 801-198	-	Sh 1-Sh 3	Front Panel Interface	C

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TOLERANCES ON FRACTIONS DECIMALS ANGLES ± ± ±	DRAFT TCK	CHK	CMES/ECMI MASTER DRAWING LIST CONTROL
MATERIAL	TRACER	CHK	
HEAT TREAT	ENGR LJK	LNGR	
PROTECTIVE FINISH	SUBMITTED		SIZE A / CODE IDENT NO 19200 / 600 THRU 801
	APPROVED		SCALE: / UNIT WT. / SHEET 1 OF 1

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