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PDP-11 SPECTROMETER CONTROL SYSTEMUSERS GUIDE

by

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OPENING REMARKS

Two versions of the spectrometer control system are currently available. In the most flexible system all programs are called as overlays from the central disk and the user should, in general, not find it necessary to meddle with any controls other than those on the teletype. The back-up system involves the use of program overlays read in from paper tape and should be used only in emergencies. Note that an emergency includes the situation in which the user is unable to start the disk system by following the procedure detailed in this guide. Personal initiative, while often commendable, is strongly discouraged in this case since improper use of the PDP-11 toggle switches can easily result in a system crash which affects all individual stations.

MONITORS

Two monitors are currently in use: they are labeled

- i) PDNOPS
- ii) PDNOPS - paper tape version

Evidently monitor (i) is for the disk-overlay system while #(ii) is for the emergency, tape-overlay, backup system. Use of the wrong monitor may cause chaos.

STARTING THE DISK-OVERLAY SYSTEM

- 1) Machine in HALT
- 2) Set 137500 in switch register
- 3) LOAD ADDRESS
- 4) Put appropriate monitor in paper tape reader
- 5) ENABLE
- 6) START

When tape has been read

- 7) HALT
- 8) Set 000560 in switch register
- 9) LOAD ADDRESS
- 10) Put switches #15, #14 up
- 11) ENABLE
- 12) START

Teletype message WHICH PROGRAM? appears

- 13) type SUPDK** (carriage return)
- 14) type 151 (carriage return)
- 15) put switch #9 up

** See memo attached to individual PDP-11 for name of current version.

HALTING AND RESTARTING DISK-OVERLAY SYSTEM

When a new user takes over a spectrometer he may wish to restart all programs and to delete all previously defined variables, scan lists, etc. To halt the disk-overlay system either use the AB command or type CTRL-A followed by CTRL-C; the system will enquire "WHICH PROGRAM?" The user should proceed from instruction 13) above

SIGNIFICANCE OF TOGGLE SWITCHES

In the foregoing instructions certain of the PDP-11 toggle switches were required to be in the up(set) position. These switches have the following significance:-

Switch #15: Reentrant mode switch. When set this switch causes a resident overlay to be recalled (either from disk or paper tape) rather than reentered.

Switch #14: If switch #14 is set overlays will be called from disk. Conversely, if the switch is unset the system will require overlays from paper tape.

Switch #9: When set this switch reduces built-in line feed delays to an almost tolerable level.

Under no circumstances should switches, other than those listed above, be used. Attempts to do so may result in failure of both the central machine and individual stations.

USE OF BACK-UP SYSTEM

If the disk-overlay system cannot be restarted after a system failure the paper-tape overlay system must be used. However, the latter system requires a different monitor the loading of which will cause all spectrometer angles and stored variables to be lost. Before loading the paper-tape overlay monitor the user should therefore:

- 1) put switches #14, 15 down
- 2) HALT machine
- 3) Set 000570 in switch register and LOAD ADDRESS
- 4) ENABLE/START
- 5) Load paper tape overlay #20 in tape reader
- 6) Depress carriage return on teletype (tape will then be read)
- 7) Define all motor numbers (page 9)
- 8) Use QU and LI commands
- 9) Start paper-tape overlay system (see below)

STARTING THE PAPER-TAPE OVERLAY SYSTEM (read "Use of back-up system" above)

The first seven instructions for loading the disk-overlay system (page 3) should be followed with the CORRECT MONITOR. Then:-

- 8) Set 00574 in switch register
- 9) Load supervisor tape (labeled "SUPOV-overlay supervisor")
- 10) ENABLE
- 11) START
- 12) Depress any teletype key.

The tape reader will now start. When about half the tape has been read, HALT machine and carefully remove the tape which has been read. ENABLE the machine and press CONTINUE. This procedure is necessary because the paper tape reader will not read the entire SUPOV tape without tearing it or folding it incorrectly. If you destroy or mutilate a tape you are responsible for its replacement.

LOADING PAPER-TAPE OVERLAYS

In the paper-tape overlay system the commands

SC, TH, RS_n

require an appropriate overlay tape to be loaded in the tape reader.

The procedure is:-

- 1) Check that switches #15 and #14 are in the down(unset) positions (see page 4)
- 2) Type the desired command, followed by a carriage return.

The teletype responds by typing "OVERLAY=M" where M is the number of the paper tape which the user should load.

- 3) Load paper tape in the reader.
- 4) Depress carriage return key.

The tape will now be read. If the wrong tape has been read a suitable error message will be produced. If the user finds that he has typed an incorrect command (e.g. User typed RS1 and meant RS2) he may recover from this situation by replacing instructions 3) and 4) above by

- 3) Depress carriage return key
- 4) Open and close paper tape reader.

RESTARTING PAPER-TAPE OVERLAY SYSTEM

To restart this system after, for example, the console light has lit:-

- 1) HALT machine
- 2) Set 000570 in the switch register
- 3) LOAD ADDRESS
- 4) ENABLE
- 5) START

CLAX (calibration program) from paper tape

The program CLAX is too large to be accommodated as a paper-tape overlay. Thus, should this program be required while the backup system is in operation the following instructions should be followed.

- 1) Machine in HALT
- 2) Set 000574 in switch register
- 3) LOAD ADDRESS
- 4) Load paper tape CLAX in reader
- 5) ENABLE/START
- 6) Depress any teletype key.

NOTE:-

The tape reader will now start. When about half the tape has been read HALT machine, remove tape which has been read, ENABLE and CONTINUE (see instructions on starting the paper-tape overlay system given on page 5) After the backup version of CLAX has been used the paper-tape overlay supervisor must be reloaded before other overlays can be employed.

General Information

Rub-Out Key

Each time the rub-out key is depressed a single character (starting with that most recently typed) is erased and a \ character is typed. If the rub-out key is depressed enough times a whole line can be erased. When this has occurred further use of the rub-out key has no effect either on the input buffer or on the typed output.

CTRL-C (PANIC SWITCH)

Simultaneous depression of the CTRL and C keys causes return to the supervisor program and the interruption of all motor and counter activity. If CTRL-C is used after the system has typed one or more \$ prompt characters a carriage return must be inserted after the CTRL-C in order for the latter instruction to work. If CTRL-C is used while the system is typing a message to the keyboard, the current line of output will be lost and control will return to the FORTRAN statement which follows the current write statement. In general this will cause the CTRL-C command to be executed. However, in a few cases, the output buffer may have been filled during the typing of a system message and before CTRL-C was inserted. In this case the system will type one more line of output before executing the CTRL-C command.

Line Length

No more than 80 characters (excluded rubbed-out characters) may be typed on a single line of input. Characters typed beyond this limit will be ignored with possible embarrassing consequences.

Local Mode

The use of the Local Mode switch as a means of preventing spectrometer self-destruction is not recommended except in dire circumstances. If this facility is used CTRL-C should be entered after return to computer control.

Limit Switches

In this system the manual operation of a limit switch will have no effect unless the relevant motor is in motion. Note that mechanical limit switches should be set so that they define a larger range of angles than the internal limit switches. If this requirement is ignored, it is possible for an axis to encounter a mechanical limit switch during a scan. This has the effect of aborting all spectrometer activity.

Numbering and Freezing Motors

Each of the variables C1 through A3 of Appendix B should be set to the number of the motor which drives the appropriate spectrometer axis. If an axis cannot be driven by the Computer System (e.g. the monochromator (C1) on H8) it should be assigned a motor number greater than 5; this will cause the system to ignore completely the axis in question. If a motor number of 11 or more is assigned to a particular axis the triple-axis routine will declare that axis to have been frozen and will not attempt to move it. An attempt to move an axis whose motor number has not been set to a value less than or equal to 5 will result in an error message.

Right and Left-Handed Coordinate Systems

The variable IM allows the handedness of the (H,K) coordinate system to be changed at will. The rule is:-

If IM = +1 and scattering at the monochromator is to the right or if IM = -1 and scattering at the monochromator is to the left, the (H,K) coordinate system will be left-handed (the usual BNL convention!)

Thus to continue tradition, IM = 1 on all spectrometers except H-9 on which IM = -1 should be used.

SUPERVISOR ROUTINE

When the supervisor is ready to accept a command it types \$\$ at the beginning of a new line. One of the commands listed in appendix A should be entered immediately to the right of these prompt characters and should be followed by a carriage return.

Notes on Supervisor Commands

(i) The commands:

STnxx.xx

SEnxx.xx.

No space is permitted before the motor identification number n. The target angle must be typed somewhere in a field of length 10 characters to the right of n and must include a decimal point.

Note: A comma inadvertently typed during the ST or SE commands has the effect of redefining the field length for the target angle. Thus,

ST120,

gives the target for motor 1 as 0.20. In general

STnxxxxx.xx

will cause the characters after the comma to be ignored and a decimal point to be inserted before the last two characters retained. This sort of "finger-trouble" at the keyboard is therefore to be deplored.

(ii)

Any number of motors may be zeroed at the same time, i.e. commands ZRn may be issued consecutively with different values of n. However, if any motor has been given the ZR command no motor may be sent to a target. This restriction is necessary because the ZPn command sets a flag which will cause any moving motor to stop at its mechanical zero if it passes the latter point on the way to a target. The ZRn command usually causes motor n to move towards zero encoder reading and to stop at its mechanical zero if it passes the latter point while in motion. If the motor starts moving in the wrong direction it will continue to move until a limit switch is hit. The motor will then reverse and move to its mechanical zero providing the latter is between the two limit switch settings for the motor in question. When ZRn is entered the system only knows that motor n is in motion and does not (by a quirk of the SDS system) know that the mechanical zero has been achieved until all motors are stationary. When all motors have stopped the system sets a 'LIMIT SWITCH HIT' flag for any motor which hits such a switch. The message(s) 'MOTOR n HIT LIMIT SWITCH' will not be typed until the user tries to execute a new supervisor command. When this message is typed no further instruction may be executed before a CTRL-C command has been given.

(iii) The command:

C0

initiates a count which proceeds until MCx1000 (see READ package) monitor counts have been accumulated. During a count the commands LI,QU,RD,ST,SE,ZR given in Appendix A are available. When the count has finished the result will be typed only after a new command is given. The dummy command carriage-return is provided for this purpose. If a typed record of the count is not required type CTRL-C after the count has finished before proceeding with further commands.

(iv)

To repeat a count several times at a given spectrometer configuration use the Scan Designated Axis routine (page 26) with SA equal to the desired angle of motor AX and DA = 0.

(v)

The commands RD,QU and LI are the only ones which may be used before motor numbers have been set. If the command RSn (see (vi) below) is issued before motor numbers have been set an error message will be typed, the overlay will not be called and the value given for n will be ignored. Note that successful completion of an RSn command is required before an LG command can be obeyed.

(vi) The command

RSn

where n is a single digit number, causes overlay number n to be loaded either from paper tape or from disk depending on the system in use (see page 4). Note that no space is allowed before the overlay number. A list of overlay numbers currently in use is given in Appendix C.

Error Messages From Supervisor

(i) INVALID INSTRUCTION - Operator typed a command not understood by the system or a command which could not be executed because the spectrometer was not in idle status. In the latter situation type CTRL-C and try again.

(ii) MOTOR OR COUNTER ROUTINE FAILED. TRY AGAIN--

- a) Check that spectrometer is under computer control. If it is, type CTRL-C and try again.
- b) This message will result if an ST or an SE command follows a ZR command.

(iii) HARDWARE PROBLEM. STOP MOTORS IN LOCAL--

Do as instructed, return to computer control, type
CTRL-C and try again.

(iv) MOTOR MOVING. ENTER LOCAL MODE--

A motor is moving when the system expects it
to be idle. Enter local mode, return to com-
puter control, type CTRL-C and proceed.

(v) MOTOR n HIT LIMIT SWITCH

Type CTRL-C and proceed.

(vi) SET MOTOR NUMBERS

Set variables C1 through A3 of Appendix B.

READ PACKAGE

This package, which allows external variables to be set and interrogated, may be called from the supervisor by typing the command RD. The read package responds by typing READ and a \$ prompt character at the beginning of a new line. External variable identifiers are given in Appendix B.

General Variables

The variables IM through A3 in the list given in Appendix B may be set according to one of the following examples.

(i) \$ IM = 1, IK = -1, AS = 0.75

(where in this and all following examples the \$ sign is provided by the system) causes IM to be set to 1, IK to be set to -1 and AS to be set to 0.75. Note that extra spaces are ignored and that a decimal point is inserted after the last numeric character of an entry if the point has been omitted by the user. These remarks imply that

\$ AS = 0. 75

causes a* to be set to 0.75 and that

\$ AS = 075

causes a* to be set to 75.0

(ii) Variables may be set in the order listed in Appendix B. Thus

\$ AS = 0.75, 0.75, 0.0

causes the assignments a* = 0.75, b* = 0.75, cos(γ^*) = 0.0.

Adjacent commas (separated by any number of blank characters) cause the appropriate variable to be unaltered. Thus, if having entered

\$ AS = 0.75, 0.75, 0.0, 1.87

the user typed

\$ AS = 0.5, , , 1.87345

the following assignments would have been made: a* = 0.5, b* = 0.75, cos (γ^*) = 0.0, τ_m = 1.87345.

General variables may be interrogated by typing for example, \$ IM:8 a command which causes the identifiers and values of IM through TA (8 variables in all) to be typed out. Note that a maximum of 9 variables may be simultaneously interrogated. Extra blanks are ignored in the interrogation command.

Scan Variables

Variables for triple axis scans (NS through DK) in Appendix B are treated slightly differently from general variables. Each assignment or interrogation of a scan variable must begin with a definition of NS. To set parameters for scan 3, for example, type

\$ NS = 3, HS = 0.5, KS = 0.5, etc.

or \$ NS = 3, 0.5, 0.5 etc.

Apart from the need to specify NS, the assignment of scan variables follows the same rules as those given above for general variables.

Interrogation of scan variables proceeds via a command of the form

\$ NS : n

which causes the identifiers and values of the parameters for scan n to be typed.

General Notes on READ PACKAGE

(i) Return to the supervisor occurs if either CTRL-C or a blank line (carriage return only) is entered. The supervisor announces its presence by typing a \$\$ prompt string as opposed to the single \$ issued by the read package.

(ii) Variables not set by the user have either the default values (see Appendix B) or, if the system has been previously used, the values assigned by the previous user. To check values of all variables use the LI command available in the supervisor.

(iii) For IK = 1 (-1) one must specify TA and KI (TM and KF).

Error Messages from READ Package

(i) ILLEGAL CHARACTER IN NUMERIC FIELD	}	self explanatory
(ii) IDENTIFIER UNKNOWN		
(iii) IDENTIFIER ABSENT		
(iv) CONJUNCTION MUST BE = OR:		
(v) ILLEGAL SCAN LIST - reference to a scan variable did not begin with specification of NS.		

(vi) ATTEMPT TO REFERENCE OUTSIDE STORAGE -

- a value of NS outside the allowed
range was used. ($1 \leq NS \leq 31$ for triple-
axis program)

(vii) ***** MOTOR NUMBERS RESET - This is a warning message which
is provided to prevent the user from
accidentally resetting motor numbers and
may be ignored if these numbers have been
deliberately tampered with.

TRIPLE AXIS CONTROL PROGRAM

This program may be entered from the supervisor by typing the command LG immediately after the \$\$ prompt string. The program responds by typing a heading and the enquiry

SCAN ORDER?

\$

The scan order may be entered to the right of the \$ character in several ways.

- (i) n1, n2, n3, etc. - Scan numbers (i.e. values of NS) of scans to be performed in the order required. Note that scans may be repeated.
- (ii) n1:n2, n3:n4, etc. - Scans n1 through n2 will be followed by scans n3 through n4.
- (iii) - Lists of the forms given by (i) and (ii) may be combined.

- (iv) carriage return - Scans will be performed in an order which depends on the condition of previous exit from the triple-axis program. If previous exit occurred after completion of a set of specified scans, carriage return will cause scans 1 through 31 to be performed in sequential order. If previous exit was caused by a CTRL-C character being entered scans will continue from the interrupt point and will include any new scans with sequence number (value of NS) greater than that of the interrupted scan but less than the previously defined maximum sequence number.

A maximum of 31 scans may be performed.

When the scan order has been specified correctly the system types the enquiry

MOTORS TO BE TYPED?

\$

The numbers of the motors whose angles are to be typed should be entered in the same format as has been specified above for the scan numbers. No more than four and no less than one motor angle may be typed. If carriage return is typed at

this point and previous exit from the triple-axis program occurred after completion of a set of scans the angles of the two motors nearest the reactor will be typed. If previous exit was caused by insertion of CTRL-C, carriage return will cause the angles of previously entered motors to be typed.

The final enquiry issued by the triple-axis program is

HEADING?

§

At this point the user may enter any title of 80 characters or less which he would like to have typed at the head of each scan. Carriage return entered at this point causes the previously entered heading to be used. If no heading has been entered since the program was first loaded, the heading will probably consist of some interesting characters created by the imagination of the keyboard.

Once the heading has been specified the system types

DRY RUN STARTED.

During the dry run the following checks are performed for all scan points.

- (i) Scattering triangle will close.
- (ii) Required energies can be obtained from monochromator and analyser.
- (iii) No internal limit switches are encountered for any motor.
- (iv) Monitor is not zero for any scan specified.

If any of these conditions is not fulfilled a suitable message is typed. Errors detected during a dry run may be corrected by typing CTRL-C and returning to the supervisor. If the errors are not corrected execution proceeds but scan points for which errors occurred are omitted.

During the dry run the system may type

MONITOR NOT SET FOR N SCANS.

This message implies that N of the scans requested by the user have zero

monitor settings. At execution time these scans will be ignored by the system.

Available Facilities

- 1) Scenario: - User has performed triple-axis scans during the night and, in the morning, wishes to check a Bragg point.

Action: - Interrupt scans by entering CTRL-C command, execute Bragg point, return to triple-axis program by typing LG and answer "carriage return" to all questions asked by the latter program. Execution continues from the interrupt point.

- 2) Scenario: - User has asked for scans 1 through 25 to be performed but has only loaded variables for scans 1 through 10. User realizes that the 10 scans specified commit him to an early awakening on Saturday morning.

Action: - Interrupt current scans via CTRL-C command. Call Read package and define scans 11 through 25. Return to supervisor and thence to triple-axis program by typing LG command. Answer "carriage return" to all questions asked by triple-axis program and execution will continue from interrupt point. Note that if the user had only asked originally for 10 scans (instead of 25) to be performed, only 10 will be executed!

- 3) Scenario: - User has asked for scans 1 through 10 and midway through Scan 4 decides that scans 5 and 6 are not interesting.

Action: - Interrupt current scans by CTRL-C command. Enter Read package and set monitor for scans 5 and 6 to zero. Return to triple-axis program and answer "carriage return" as for

cases (1) and (2) above.

Note that exit from the triple-axis program via the CTRL-C command causes the integrated intensity (SUM) of the current scan to be reset to zero.

BRAGG ROUTINE

This routine which counts for MB monitor points at the Bragg point (HB,KB) (see Appendix B) may be entered from the supervisor by typing the command BR followed by a carriage return. Before moving the spectrometer the routine checks

- 1) that all necessary variables (a^* , b^* , r_M , etc.) have been set.
- 2) that the scattering triangle will close.
- 3) that the required energy can be obtained from monochromator and analyzer.
- 4) that no internal limit switches are violated.

If any of the above errors occurs a suitable message is typed and control returns to the supervisor. If no error has occurred, values of HB, KB, MB and calculated motor angles are typed out, the spectrometer is moved to the correct position and the count is initiated. No further keyboard messages are typed until the count has been completed. At this stage the value of the count is printed out. In addition, if calculated and set motor angles differ by more than 0.02° for one or more motors the differences between set and calculated angles are printed.

Note that if a particular motor angle does not appear on the keyboard output it has been ignored by the system and may inadvertently have been frozen (see page 9). The appearance of the message

-25-

MOTOR OR COUNTER ROUTINE FAILED

usually indicates that the user has failed to place the spectrometer in computer control.

CTRL-C is available as an escape command in this routine.

SCAN-DESIGNATED AXIS ROUTINE

This routine, which performed the scan defined by parameters AX through MS of Appendix B, may be called from the supervisor by typing the command SC followed by a carriage return.

Note: -

- 1) An attempt to scan a frozen or undefined motor will result in an error message and return to the supervisor.
- 2) If the angular step (DA of Appendix B) is zero the spectrometer will count repeatedly at its initial position.
- 3) If the modulus of DA is less than $.02^\circ$ the spectrometer will not move until sufficient steps have been accumulated to make the target angle differ from the current angle by more than 0.02° . Thus if $DA = 0.01^\circ$ and $SA = 10.0^\circ$ for $AX = 3$ the spectrometer will count twice at motor-3 angles of 10.0° , 10.02° , 10.04° , etc.
- 4) The message

MOTOR OR COUNTER ROUTINE FAILED

generally indicates that the spectrometer is not under computer control. To recover from this situation type CTRL-C, enter computer control and repeat the command SC.

- ** 5) This routine DOES NOT CHECK INTERNAL LIMIT SWITCHES.

THETA-TWO-THETA SCAN

This routine, which performs the θ - 2θ scan specified by variables S1 through MT of Appendix B, may be entered from the supervisor by typing the command TH followed by a carriage return.

All notes provided for the SCAN DESIGNATED AXIS Routine apply without alteration to the θ - 2θ routine. (See especially note 5 of page 26.)

APPENDIX A

SUPERVISOR COMMANDS

LI	LIst variable identifiers & values
LIx	where x is any character. LIst scans only.
QU	QUery motor & counter status
RSn	ReSet and call overlay number n
RD	Call ReaD package
STnxx.xx	STart motor n towards target xx.xx
SEnxx .xx	Set Encoder n to xx.xx
ZRn	ZeRo motor n
AB	ABort moving motors & counters and halt disk-overlay system
CO	COunt for MC monitor counters (see Appendix B for MC)
Carriage Return	Print result of a CO command when count is completed
BR	Measure BRagg point (see Appendix B for parameters)
SC	SCan designated axis (see Appendix B for parameters)
TH	THeta-two-theta scan (see Appendix B for parameters)
LG	Load & Go with overlay loaded.

PANIC SWITCH

CTRL-C	Depress CTRL & C keys simultaneously; causes return to supervisor & abortion of motor & counter activities
--------	--

APPENDIX B

READ PACKAGE - variable identifiers in storage order

IM	-	+1(-1) for positive (negative) $2\theta_M$	(default = +1)
IS	-	+1(-1) for positive (negative) $2\theta_S$	(default = +1)
IA	-	+1(-1) for positive (negative) $2\theta_A$	(default = +1)
AS	-	a^* in A^{-1}	(default = -99.999)
BS	-	b^* in A^{-1}	(default = -99.999)
CG	-	$\cos(\gamma^*)$	(default = -99.999)
TM	-	τ_M in A^{-1}	(default = -99.999)
TA	-	τ_A in A^{-1}	(default = -99.999)
KI	-	k_i in A^{-1}	(default = -99.999)
KF	-	k_f in A^{-1}	(default = -99.999)
IK	-	+1(-1) for constant $k_i(k_f)$	(default = +1)
L0,U0,L1, U1,L2,U2,L3,U3,L4,U4,L5,U5			(default all zeroes)
-		lower & upper internal limit switches for motors 0,1,2,3,4 & 5	
HB	-	h_{Bragg} (units of a^*)	(default = 2)
KB	-	k_{Bragg} (units of b^*)	(default = 2)
MB	-	Monitor for Bragg point	(default = 10)
AX	-	axis for scan designated axis command SC	(default = 3)
SA	-	start angle	(default = 0.0°)
DA	-	step angle	} for axis AX in command SC (default = 0.1°)
FA	-	final angle	
MS	-	monitor for command SC	(default = 10)
S1	-	start angle for $2\theta_S$	} in command TH (default = 0.1°)
D1	-	step angle for $2\theta_S$	
F1	-	final angle for $2\theta_S$	

S3 - start angle for sample table in command TH (default = 0.0°)

MT - monitor for TH command (default = 10)

MC - monitor for CO command (default = 10)

C1 - motor number for monochromator crystal

A1 - motor number for monochromator drum

C2 - motor number for sample table

A2 - motor number for scattering arm

C3 - motor number for analyzer crystal

A3 - motor number for detector arm

(default = 10)

READ PACKAGE - triple-axis variable identifiers

NS	-	scan number	
HS	-	h_{start} (units of a^*)	} (default = 0)
KS	-	k_{start} (units of b^*)	
ES	-	E_{start} (meV)	} (default = 0.0)
DE	-	energy step (meV)	
NP	-	number of points in a scan	
MN	-	monitor	
DH	-	Δh (units of a^*)	
DK	-	Δk (units of b^*)	

APPENDIX C

Overlay numbers

<u>Overlay #</u>	<u>Program name</u>
1	Triple Axis Program
2	Bragg Reflection Program (PAIR)
3 *	Crystal Alignment Program (CRAL)
4 *	EMSCAN
5 *	Calibration Program (CLAX)
6	} currently unused.
7	
8	
9	
10 ⁺	SCANAX & TH2TH (pages 26 & 27)

* Currently available only with disk-overlay system

+ This overlay must be called by either the SC or the TH command.