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MT-CNC
Tool Data Handling

Machine User Interface Description

DOK-MT*CNC-BOF*WZH*V15-ANW1-EN-P

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Purpose of this document This manual describes MUI (Machine User Interface) menu item 6 as well as NC program specific Setup Lists.

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Contents

1 Introduction

The tool management of the MT-CNC provides powerful functions to configure and operate different types of tool magazines and tool turrets as well as the MUI's tool data handling.

Automatic tool check

Prior to machining, a comparison between the NC-program related tool reference data (Setup List) and the actual tool data stored in the MT-CNC takes place. This process is called 'automatic tool check'.

The actual tool data of individual tools is compared with the setup data in the tool Setup List, using the common tool names as a reference. The Tool Name (ID) may consist of any 28 case sensitive letters or numerals. This method allows for an 'automatic tool check' and nearly excludes any tool collisions while preventing damage to man, machine and material, reducing cycle downtime based on incorrect tool setup.

The tool management of the MT-CNC handles numerical (servo) as well as programmable controller (PLC) controlled magazines and turrets.

Each process (0..6) is capable of controlling one magazine or turret and can also be operated via MUI Tool Data Handling. System and process parameter setup defines these capabilities. Tool storage movements are performed asynchronous to the axis movements of a process.

Configurable data sets allow optimum adaptation to the technology used (Drilling, Milling, Turning, Grinding, etc.), machine specifics and processing. The MUI also adapts automatically to the Tool Data Handling configuration defined by the machine parameter.

The simultaneous application of different manufacturing technologies, e.g., milling and turning, allow complete precision machining on one machine without re-chucking whereby a uniform and technology overlapping MUI tool data handling is used.

2 Basic Principle

2.1 General Basics

The following summary outlines the basic context between NC-program and Tool Data Organization.

- The MT-CNC contains 7 independent processes (0..6)
- Each process can execute NC-programs, independent of other processes
- The MT-CNC provides two NC-memories (A and B) as well as one tool data memory for each process (active tool list).
- Into each memory a NC-program package can be downloaded via MUI.
- Each NC-program package can contain up to 99 NC-programs per process.
- Tool Setup Lists can be station (process) or NC-program specific. All NC-programs of a process share the same Setup List if station specific is defined in the Process Parameters.
- The Tool Setup list contains the tool requirements of all tools that are used in the NC-programs.
- Each tool storage contains the latest actual tool data (active tool list) of the related process.
- Actual tool data can be entered directly via MUI (online data). Tool Lists can be generated and prepared via MUI (Machine User Interface) during machining and then downloaded to and uploaded from MT-CNC (off-line data).

Tool reference data (Setup Lists) determined during NC programming, are automatically downloaded together with NC program package download to the control.

Active Tool Lists in the MT-CNC can be entered or modified via the SOT (Station Operator Terminal) or the control PC's MUI.

With the help of tool lists, magazine or turret equipment can be created at the machine or externally (tool list preparation, off-line data) In order to prepare the next job, predefined tool lists can be downloaded into the control via MUI.

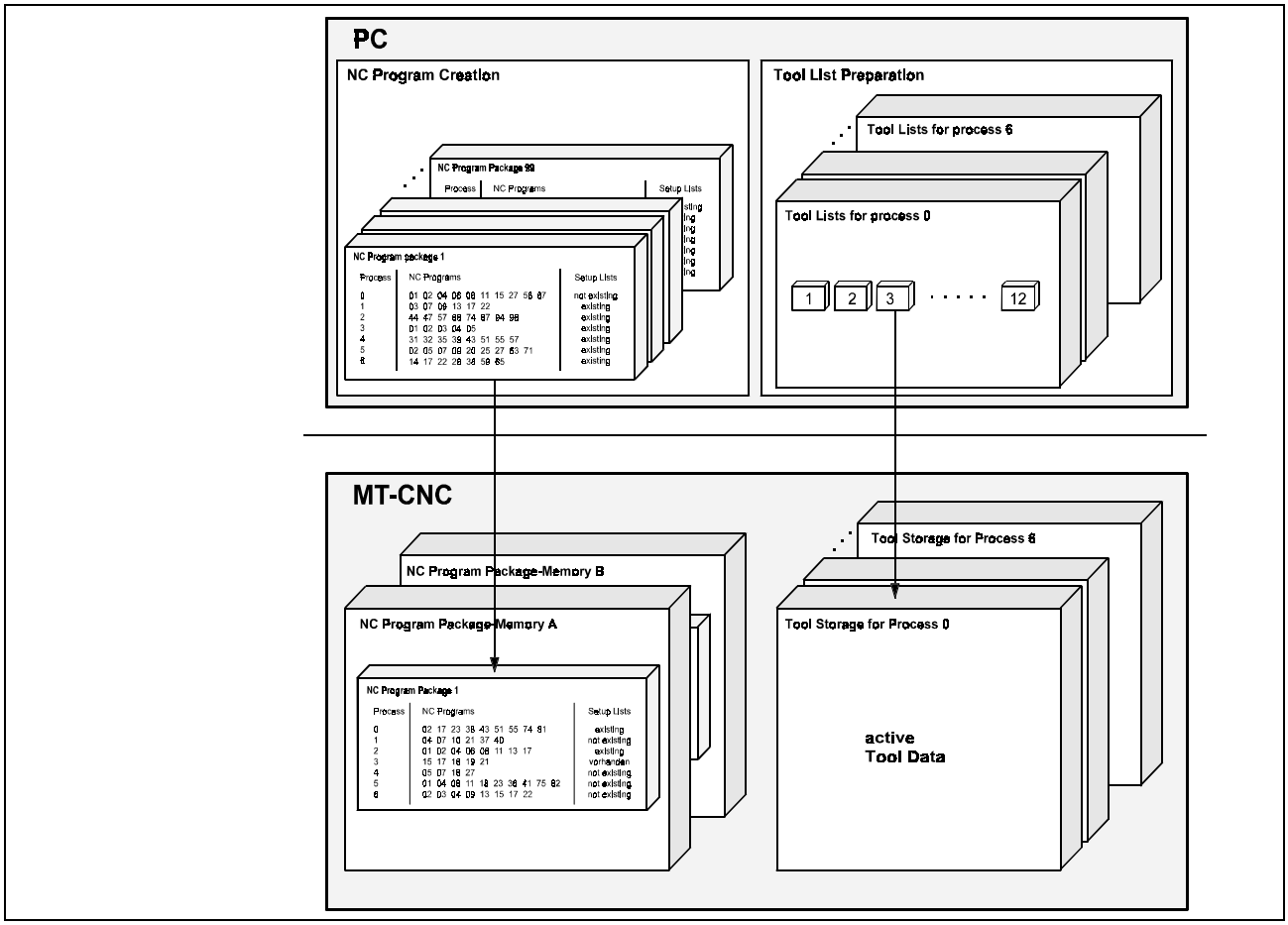


Fig. 2-1: MT-CNC Program and Tool Data Management (station/process specific Setup List)

2.2 Setup Lists and Tool Lists

Overview - Use of Setup List and Tool

In order to perform the automatic tool check, the tool management requires *Setup List specific tool reference data* and. *Tool List specific actual tool data* . A successful comparison between tool reference data of the Setup List and the active data of a magazine or turret equipment, represented by a processes active tool list, is a necessary requirement for starting an NC program.

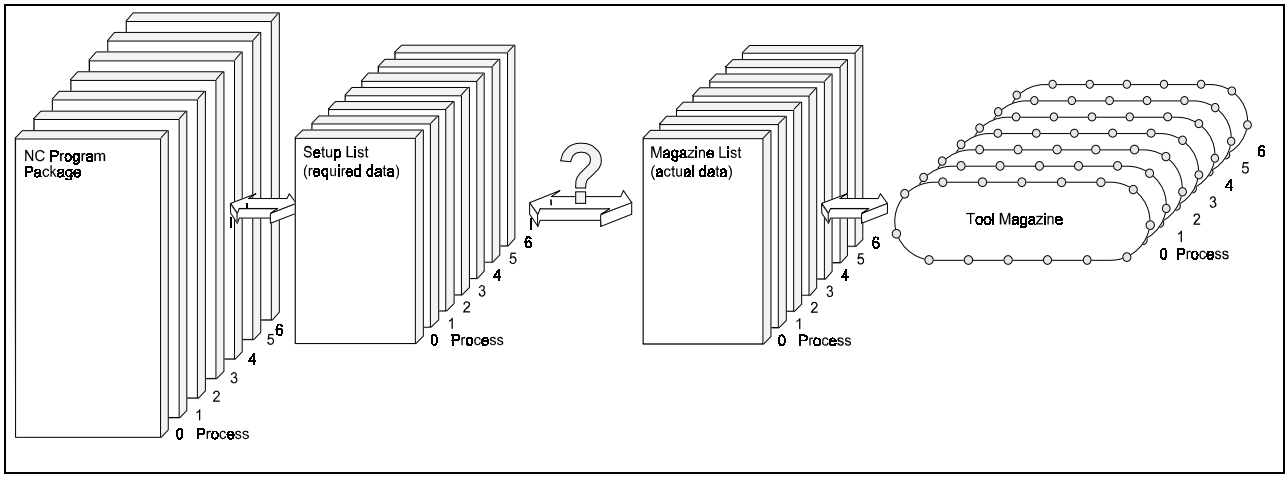


Fig. 2-2: Automatic tool check - basic method of working (station specific Setup List)

	Tool Setup List	Tool List
Task	Tool requirements for all needed tools.	Actual tool data of all tools that are contained in the tool storage. Can be prepared and archived.
Contents	**Basic Tool data:** * Tool Name * Units * User Data (option) **Tool Edge data:** * Tool Edge ID * Tool life data (option) * Geometric data (option) * Wear factors (option)	**Basic Tool Data:** * Tool Name * Location data * Units * User data (option) **Tool Edge data:** * Tool edge ID * Tool life data (option) * Geometric data (option) * User data (option)
Identification	Tools are identified via T-number and Tool name (ID).	Tools are identified via location (pocket) number and tool name (ID).
Ext. Modification (PC, SOT, PLC, or NC Program)	Setup Lists in the MT-CNC cannot be modified.	Active tool lists (Tool Lists in MT-CNC) can be modified during NC program execution.
Int. Modification (MT-CNC)	No modification by MT-CNC.	MT-CNC updates the tool life and tool wear when necessary.
General Organization	Setup Lists are part of a NC program package.	Tool Lists are independent of other Tool Lists and data.

	Tool Setup List	Active Tool List
MUI Organization	**Station specific Setup Lists:** **One Tool Setup List can exist per process.** **Program specific Setup List:** **One Tool Setup List can exist for each NC program within a NC program package.**	One Active Tool List is allowed per process. In the MUI, up to 99 Tool Lists can be available per process.
Loading MT-CNC	Available Tool Setup Lists are loaded together with the NC program package.	Tool Lists are loaded independent of other Tool Lists or data.
Activation	Tool Setup Lists are loaded into NC memory A or B and selected accordingly.	One Tool List must be loaded for each process.
List Storage	Tool Setup Lists are saved together with the NC program package.	Tool Lists are saved individually.

Fig. 2-3: Use of Setup List and Tool List

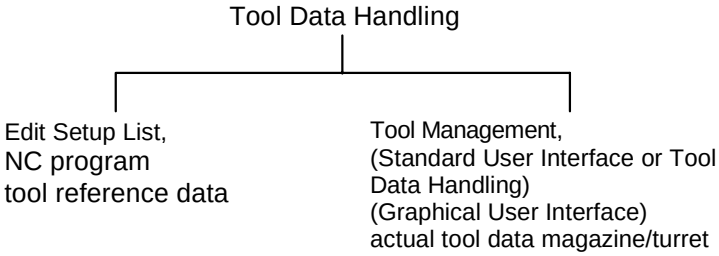
2.3 User Interface

The MT-CNC Machine User Interface's Tool Data Handling provides all functions required to create, modify and save MT-CNC tool data.

Because MT-CNC tool data sets are defined by parameter, the MUI reacts according to the tool parameter setting. Whenever dependency on machine parameters is referred to in the following description, see section 'Tool Management Parameters' of Tool Management Manual'.

Structure of Tool Data Handling

The entire Tool Data Handling of the user interface is structured as follows:



Call up Tool Management - MT-CNC User Interface

In the case of MT-CNC standard user interface (MUI), Tool Data Handling is called up via main menu item

<F6> Tool Management.

Call up Tool Data Handling - Graphical User Interface

In the case of Graphical User Interface (GUI), The Tool Data Handling function key is user defined and can be located anywhere within the GUI function key settings.

Example: <F6> 'Tool Data Handling'

An error message is displayed if the concerning process does not have a Tool Management.

Main Areas of Tool Data Handling

The Tool Data Handling of the user interface, MUI or GUI, is split into two main areas:

I. Tool List Preparation	II. Edit Online Data
The Tool List Preparation provides functions to create and save tool data with the help of the user interface (PC) regardless of control operation: – Create and save tool lists (0...99) for each process. Store on PC (off-line and online operation), – Download tool list (one per process) from user interface (PC) into MT-CNC, – Upload tool list (one per process) from MT-CNC into user interface (save actual tool data to PC).	Using Edit Online Data, the active tool list (one per process) stored in MT-CNC can be displayed and edited. – Display and edit active tool list stored in MT-CNC. – Display and edit tool data stored in MT-CNC.

Fig. 2-4: Main Areas of Tool Data Handling

WARNING

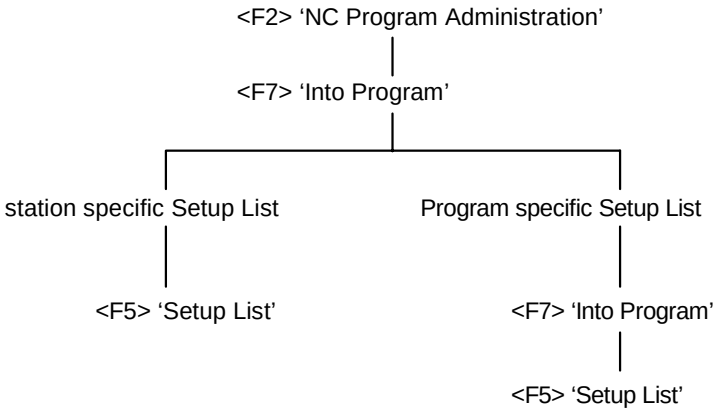
⇒ If the PC is not connected to the control (off-line operation), it is directly switched to Tool List Preparation (off-line data on PC) after calling up the Tool Data Handling. Online data cannot be called up or edited.

⇒ If the PC is connected to the control (online operation), online data (active tool list) are displayed first after calling up Tool Data Handling. Calling up Tool List Preparation is performed by pressing key combination <Ctrl>+<F8> 'Tool List Preparation'

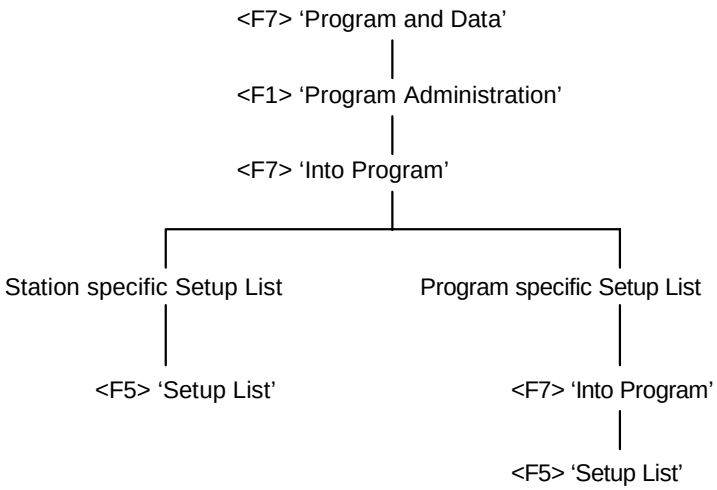
Standard User Interface (MUI) NC Program Administration

Setup Lists are handled in NC Program Administration.

- From main menu:



- From Graphical User Interface main menu item 'Production Administration': The following is only an example. The "Program Administration key is user defined in the GUI and can be located anywhere within the GUI function key settings.



3 Tool List Preparation

Tool List Preparation is used to prepare and store tool data. All Tool List Preparation data that can be displayed and edited is located on the PC's harddrive. They do not represent MT-CNC online data. When downloading, the Tool List in the MT-CNC becomes the Active Tool List (see section 3.1, page 3-7and section 3.2, page 3-9).

Online Operation

During online operation (PC is connected to the MT-CNC), Tool List Preparation is called up from the Active Tool List by pressing the key combination:

<Ctrl>+<F8> 'Tool List Preparation'.

Tool storage configurations for consecutive machining can be prepared up front without machining downtime.

Off-line Operation

During off-line operation (PC is not connected to the MT-CNC), press key combinations:

<F6> 'Tool Data Management'
(via MUI main menu)

or the user defined function key; i.e.,

<F6> 'Tool Data Handling'
(via **G**raphical **U**ser **I**nterface)

will lead directly to the Tool List Preparation of the active process.

After calling up Tool List Preparation, an index of tool lists momentarily stored on the PC for the relevant process is displayed.

3.1 Tool List Index

The Tool List Index contains all physical actual tool data of a certain tool storage device within a relevant process. As tool lists are created and edited inside the Tool List Preparation, the data is not current control data but stored on the PC.

Up to a maximum of 99 tool lists per process with Tool Management can be entered into the index; i.e., stored on a PC. Every single entry corresponds to a tool storage device.

Tool Lists are exclusively for archiving and preparation purposes.

When downloading the tool storage contents, represented by the tool list containing the related tool data, the tool list becomes active in the MT-CNC. Fig. 3-1 shows an example. (see Functions in Tool List Index).

WARNING

⇒ Changes such as inserting, deleting or moving tools, in the Active Tool List must reflect the actual conditions of the tool storage (magazine/turret) and vise versa to prevent damage to man or machine.

Once machining is in process, the Tool List stored on the PC does not match the Tool List transferred into the MT-CNC any more, because the MT-CNC regularly updates the tool data during program execution. (see section 4). Tool Lists in Tool List Preparation are **not** updated during program execution.

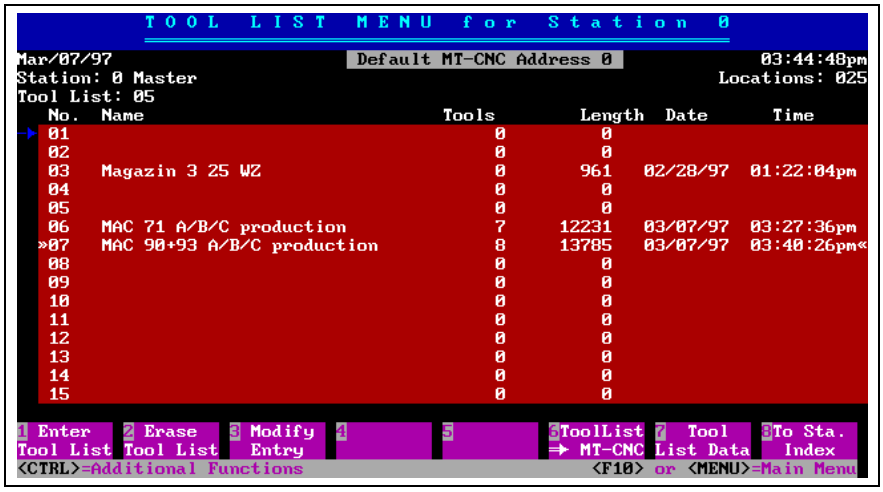


Fig. 3-1: Tool List Index

Functions available in Tool List Index

<F1>	Enter Tool List	Insert new Tool List to vacant index no.
<F2>	Erase Tool List	Erase entire Tool List from index location
<F3>	Modify Entry	Modify existing Tool List designation
<F6>	Tool List ⇒ MT-CNC	Download Tool List into MT-CNC. The Tool List is selected via cursor and downloaded into MT-CNC by pressing <F6>
<F7>	Tool List Data	Displays Tool storage contents of the relevant Tool List
<Ctrl>+<F1>	Copy Tool List	Copy Tool List within the process and among processes
<Ctrl>+ <F6>	MT-CNC ⇒ Tool List	Save current Tool List from MT-CNC to Tool List Index location (see section 4). Data is stored to PC's harddisk.
<Ctrl>+<F2>	Import Data	Imports Tool List from external source (i.e. network drive, serial port)
<Ctrl>+<F3>	Export Data	Exports Tool List to external source (i.e. network drive, serial port)
<Ctrl>+<F8>	Active Tool List	Return to Active Tool List

The most recent entry that was downloaded into the MT-CNC by pressing <F6> ('Tool List ⇒ MT-CNC') or uploaded from the MT-CNC pressing <Ctrl> <F6> ('MT-CNC ⇒ Tool List') is marked as **'» «'** .

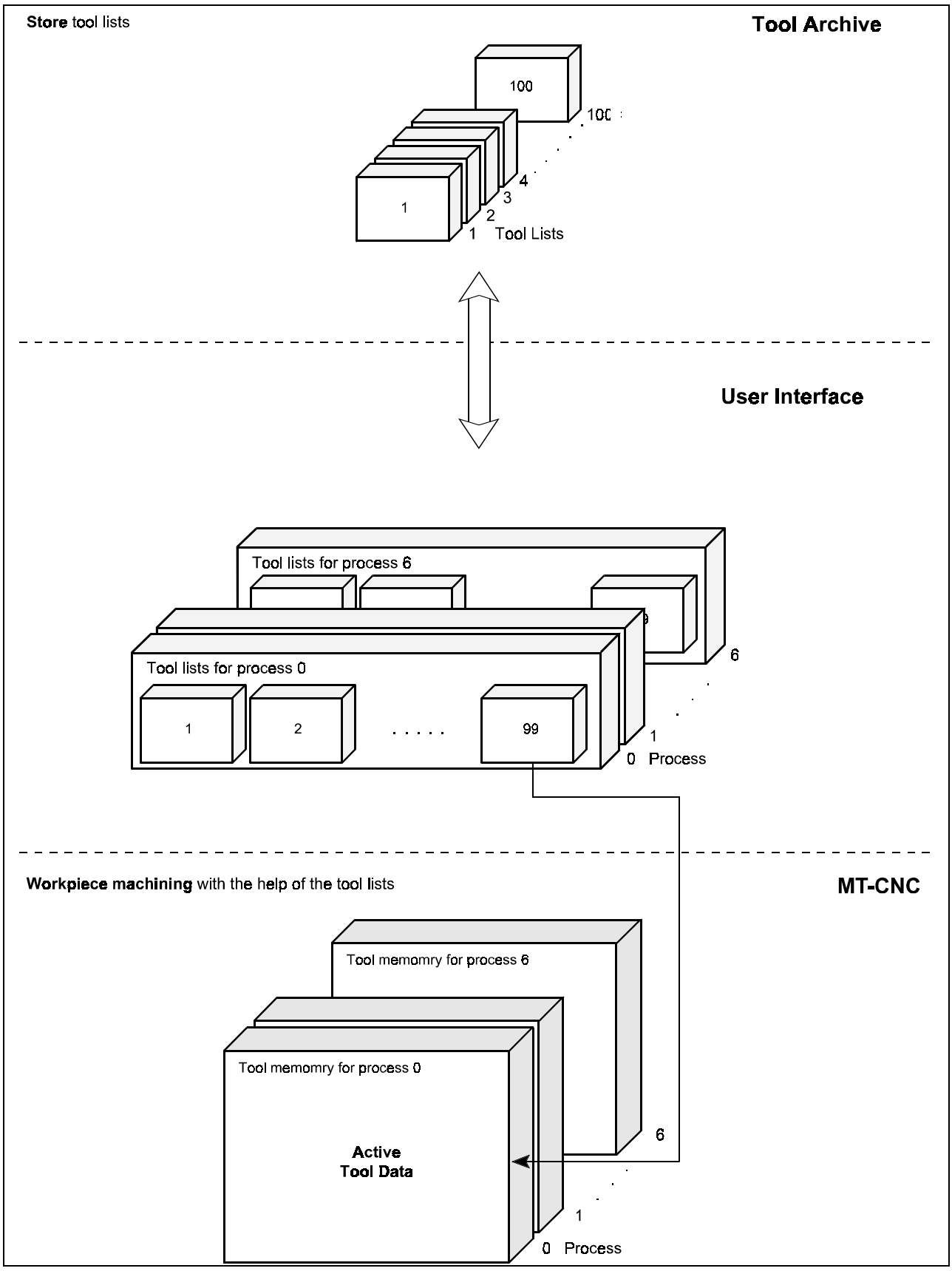


Fig. 3-2: Tool Lists within the Control System

3.2 Edit Tool List

The individual tools of a Tool List can be listed by selecting the Tool List from the Tool List Index via cursor and pressing

<F7> ‘Tool List Data’.

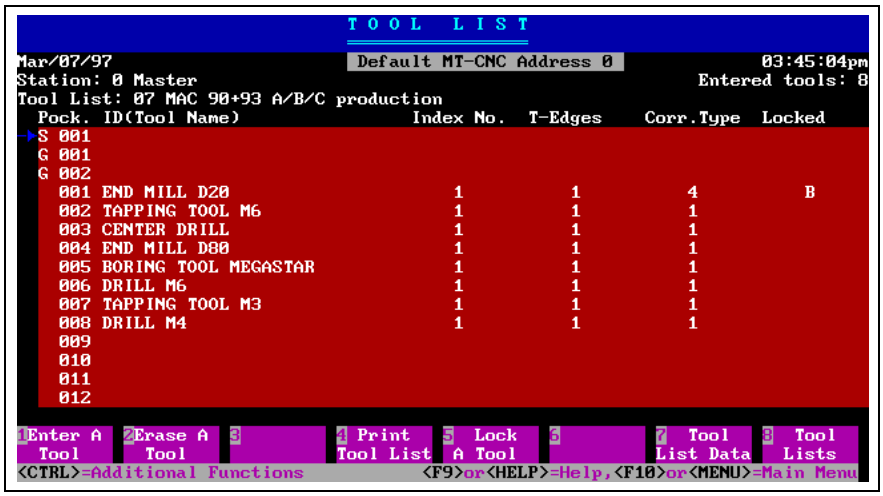
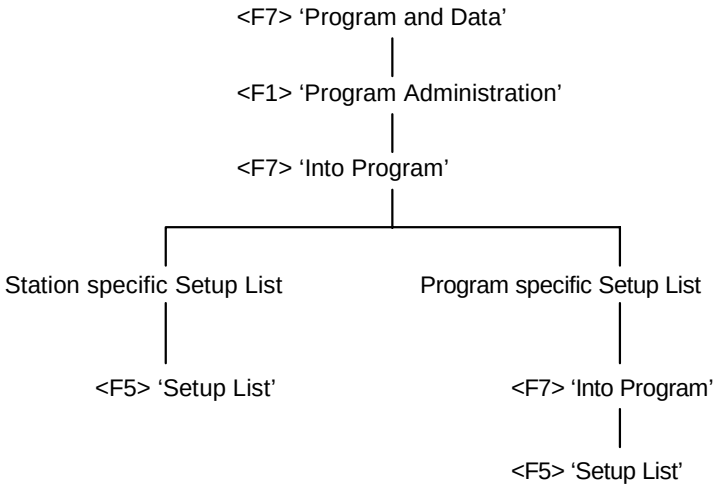


Fig. 3-3: Tool List

Menu ‘Tool List’ (Fig. 3-3) displays an index sorted by location, where each entry corresponds to a tool located in the tool storage. The maximum number of locations corresponds to the number of tool locations of the relevant process. This number is determined by process parameter ‘BXX.017’ ‘Number of Tool Storage Locations’.

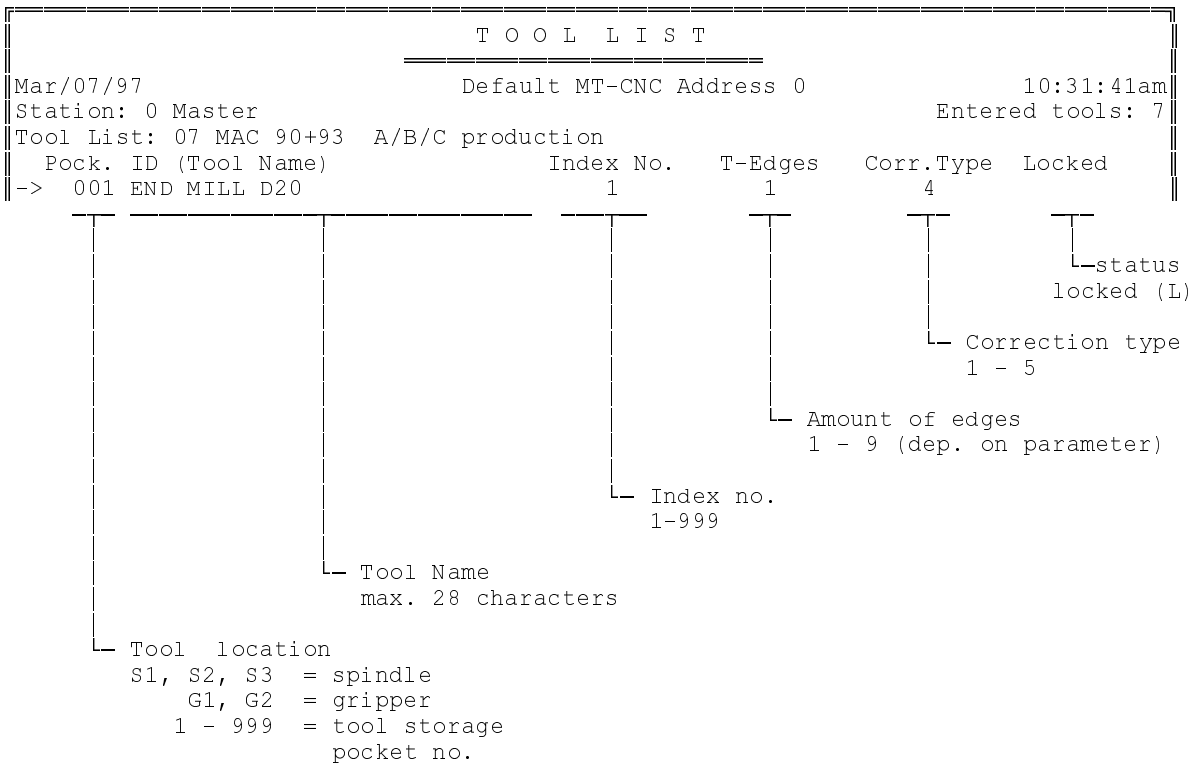
How to activated a Tool List via Tool List Preparation see also section 0 ’From Graphical User Interface main menu item 'Production Administration': The following is only an example. The "Program Administration key is user defined in the GUI and can be located anywhere within the GUI function key settings.



Tool List Preparation’ on page 2-6.

Tool List data displayed for each entry

The following data is displayed for each Tool List entry:



Tool List Edit Functions	**<F1>**	Enter a Tool	Inserts a tool to a vacant index no. of the Tool List.
	<F2>	Erase a Tool	Erases a tool from the Tool List.
	<F4>	Print Tool List	Prints the selected Tool List.
	<F5>	Lock A Tool	The tool is locked and cannot be selected during machining.
	<F7>	Tool List data	Display detailed data of the tool selected.
	<F8>	Tool Lists	Return to Tool List Index
	<Ctrl>+<F1>	Copy Tool	Copies a tool in to the tool List.

Enter a Tool

Via menu ‘Tool List’, a new tool can be entered to a vacant location of the Tool List by pressing function key

<F1> 'Enter a Tool'

Error message

`'tool already entered'`

will be generated if the location is not vacant.

A screen displaying basic tool data is called up by pressing function key <F1> (see Fig. 3-4). After entering the entire basic tool data, tool edge data MUI screens are displayed sequentially by pressing <PageDown> key (see Fig. 3-5).

All tool data is requested automatically and sequentially . Entry is performed directly to the data input screen. All data is predifined with default values, except tool name and user definable status bits.

The <Enter> key terminates every single data input and positions the cursor to the next data input field automatically. The <Tab> key moves the cursor to the next data input field while <Shift>+<Tab> moves the cursor backwards.

The complete tool data set's dimensions (basic tool data and tool edge data) depends on machine parameter setting. Tool edge data to be input depend on basic tool data 'Amount of edges' and 'Correction type'. All data input screens for basic tool data and tool edge data is automatically configured and displayed according to the above mentioned data.

See appendix 6.1 (page 6-1) for further details on the interrelation between a tool data set and machine parameter as well as geometry data and correction type.

Enter a Tool into the Tool List

1) Move the cursor to a vacant pocket of the selected tool storage (menu Tool List, see Fig. 3-3)
2) Press function key <F1> 'Enter a Tool'. A data input screen containing the basic tool data is displayed. The data 'current pocket' (P:XX) displayed at the top right of the boundary line, is determined by the location selected and cannot be altered.

   A brief description of the data to be input is given at the bottom line.

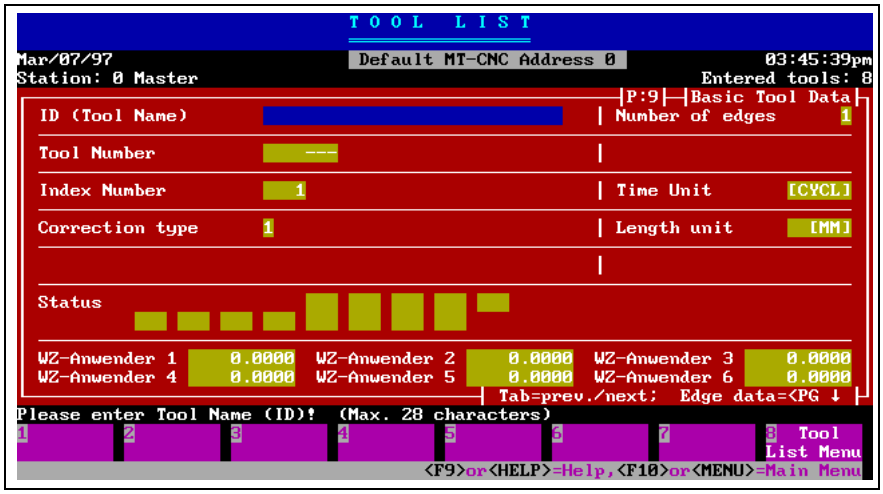


Fig. 3-4: Predifined Basic Tool Data (Correction type 1)

3) Once basic tool data is entered, pressing <PageDown> key proceeds to tool edge data of tool edge '1'.

   The following basic tool data is also displayed in every tool edge data input screen:

- 'ID' (Tool Name),
- current pocket 'P'.

  The tool edge number is displayed at the top right of the boundary line.

  A valid entry must be entered for Tool Name (ID). An attempt to continue or terminate data input without valid Tool Name will generate error message

  `'Input data incorrect (Tool Name)!'`

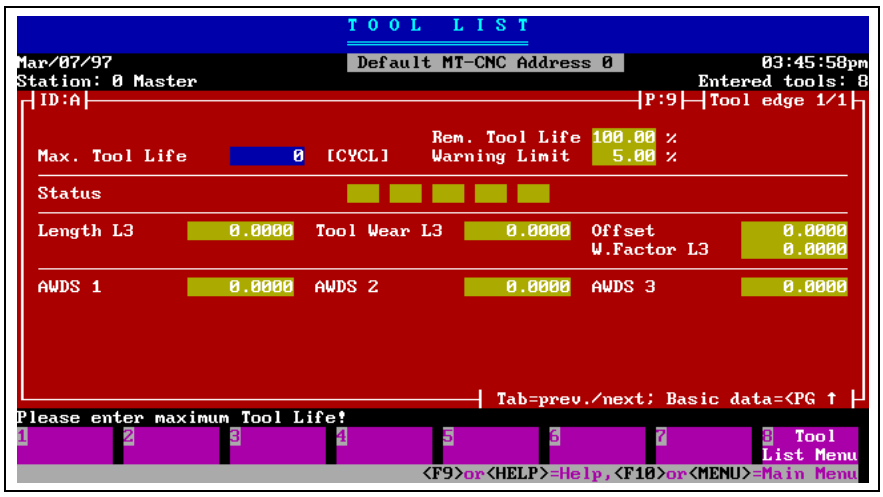


Fig. 3-5: Predefined Tool Edge Data (Correction type 1)

Required tool edge data is requested subsequently. According to the basic tool data, where correction type ‘1’ has been defined, geometry data for only one length need to be input (in this case 'L3', Index '3' not displayed, compare appendix 6.1, page 6-1).

Pressing <PageDown> key proceeds to further tool edge data screens if defined in basic tool data.

4) Pressing softkey <F8> ‘Tool List’ in either Basic Tool Data MUI screen or one of Tool Edge Data MUI screens terminates data entry and accepts the tool into the tool list. The entire data set is accepted automatically into the tool list. In addition, the tool entered is displayed in menu Tool List (see Fig. 3-3) at the location selected beforehand.

   Function <F1> 'Enter a Tool' can be exited at any time by pressing the <Esc> key. The selected pocket remains vacant. All data input for the relevant tool so far are lost.

Display and Edit Tool Data

Using function

<F7> 'Tool List Data'

in menu Tool List (see Fig. 3-3),

existing tool data of a tool already entered to the tool list can be displayed and edited.

Error message

`'No tool entered'`

will be generated, if the selected location is vacant.

Tool Data Set

A tool data set of a tool list is organized as follows:

- Basic tool data
- Tool edge data 1 ... 9

Data areas

Concerning it’s dimensions, a tool’s entire data set (basic tool data and tool edge data) depends on the machine parameter. Tool edge data to be input depend on basic tool data ‘Amount of edges’ and ‘Correction type’. All data input screens for basic tool data and tool edge data is automatically configured and displayed according to the above mentioned data.

See appendix 6.1 (page 6-1) for further details on the interrelationship between a tool data set and machine parameter as well as geometry data and correction type.

The tool status consists of 22 status bits subdivided into 15 groups (see appendix 6.5, page 6-11). Among 13 groups, one status bit is displayed together with the relevant symbol each time. Within a group, a display related priority layering is evaluated.

Tool Status Composition

The entire tool status in the tool list is composed as follows:

- Tool list status bits (14 status bits, 7 groups, location specific, tool specific), group location occupation and location reservation are not displayed.
- User defined status bits (8 groups, tool specific).

Display Basic Tool Data

Basic tool data is displayed by pressing function key

<F7> 'Tool List Data'

in menu Tool List.

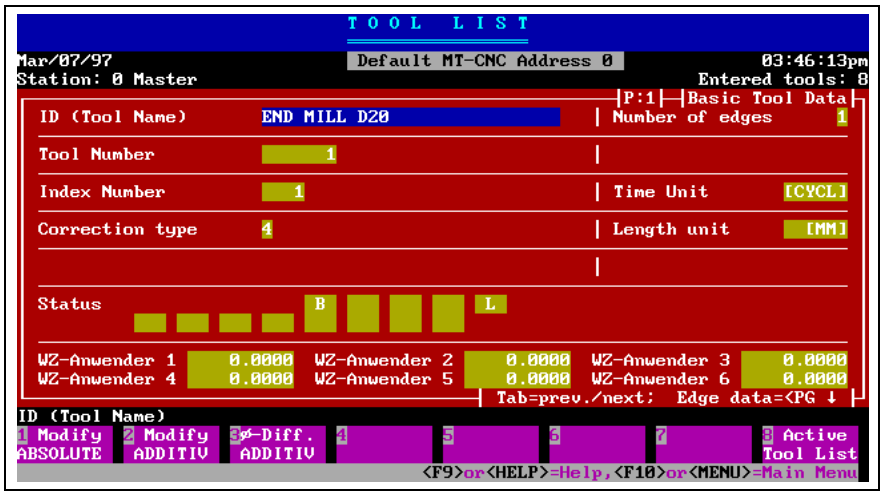


Fig. 3-6: Basic Tool Data (Correction type 4)

Select Basic Data or Edge Data and Individual Data

Using <PageUp> / <PageDown> keys, it is possible to scroll from the basic tool data screen to the tool edge data screen or from one tool edge data screen to the next. In this way, entire data areas are always displayed.

Within a data area, i.e. within the basic tool data or tool edge data, the individual field is selected using either the <Enter> key or the <Tab> key. The editing functions of the softkey line apply to the currently selected field.

Display Tool Edge Data

Pressing the <PageDown> key causes a change from basic tool data screen to the tool edge data screen.

The entire data set is displayed for each individual tool edge.

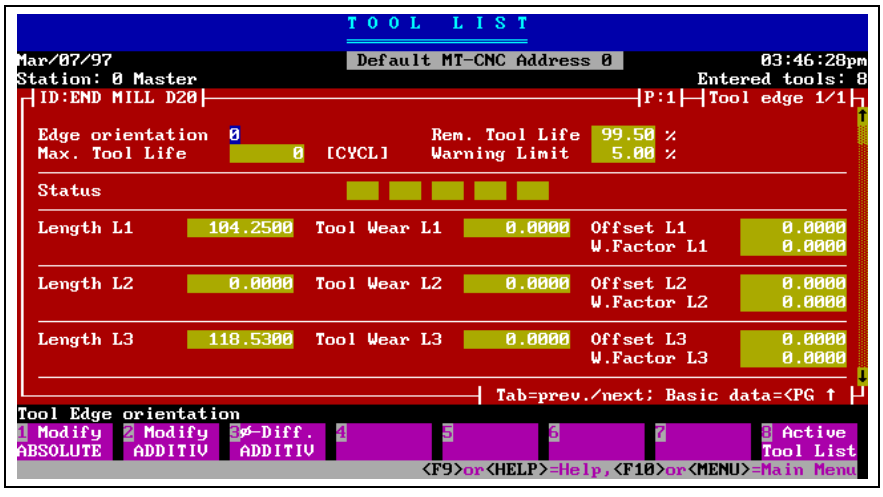


Fig. 3-7: Tool Edge Data (Correction type 4)

Important basic tool data is displayed at the upper part of the boundary line for better orientation.

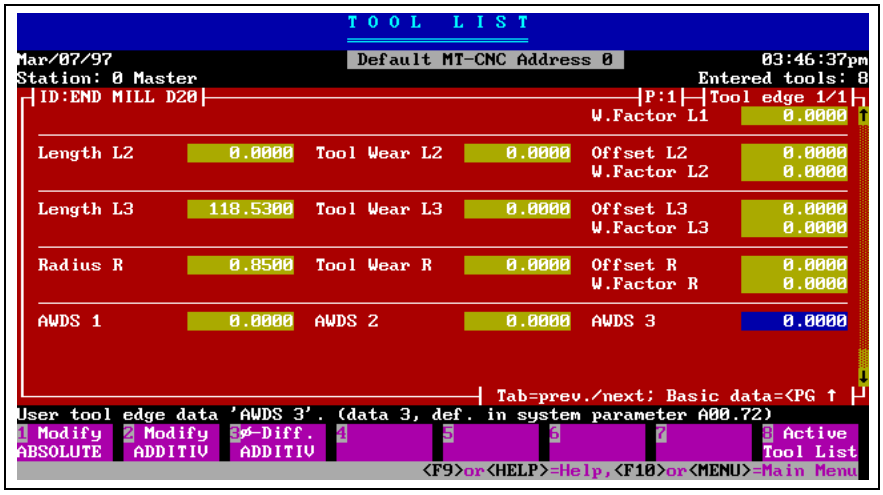


Fig. 3-8: Tool Edge Data (Correction type 2) - Screen 2

The following basic tool data is also displayed in every tool edge data input screen:

- 'ID' (Tool Name),
- current pocket 'P'.

The tool edge number is displayed at the top right of the boundary line.

The tool list's tool edge status consists of 6 status bits, subdivided into 5 groups. Out of these groups, one status bit is displayed together with the relevant symbol each time. Within the group, a display related priority layering is evaluated (see appendix 6.5, page 6-11).

Tool Status Composition

The entire tool status within a tool list is composed as follows:

- Tool list status bits (2 status bits, 1 group, tool specific),
- User defined status bits (4 groups, tool specific).

Edit Basic Tool Data and Tool Edge Data

Modifying tool data within a tool list is performed by selecting a tool from the tool list (menu Tool List, see Fig. 3-3) and pressing function key

<F7> 'Tool List Data'.

WARNING

⇒ A field modified within the tool list, i.e. within tool list preparation, is not automatically active in the MT-CNC. Data modified in the tool list are first stored on the PC's harddisk. Modified data become active within the MT-CNC only by transferring the entire tool list containing the modified field. Tool list downloaded into MT-CNC is performed by pressing function key <F6> 'Tool List ⇒ MT-CNC' in menu 'Tool List Preparation for Station XX' (see Fig. 3-1).

After downloading a tool list, an automatic tool check is performed with the next NC program start.

Functions	**<F1>**	Modify absolute	Absolute data entry. The input value is accepted immediately.
	<F2>	Modify additive	The input value is added to the existing value.
	<F3>	∅-Diff. additive	The input value is divided in half and added to the existing value (correction type 3, turning tool, G18, for L2 (X) only)
	<F8>	Active Tool List	Return to Active Tool list

These functions can be applied to all tool list locations.

Modifying Individual Tool Data

1) Move cursor bar to the desired field within basic tool data screen or tool edge data screen using the <Enter> key or the <Tab> key. A brief description of the field at the cursor position is given in the line between the boundary bottom line and the function keys (see Fig. 3-9).
2) Press function key <F1> or <F2> or<F3>. A data input window appears, where the selected field can be modified.

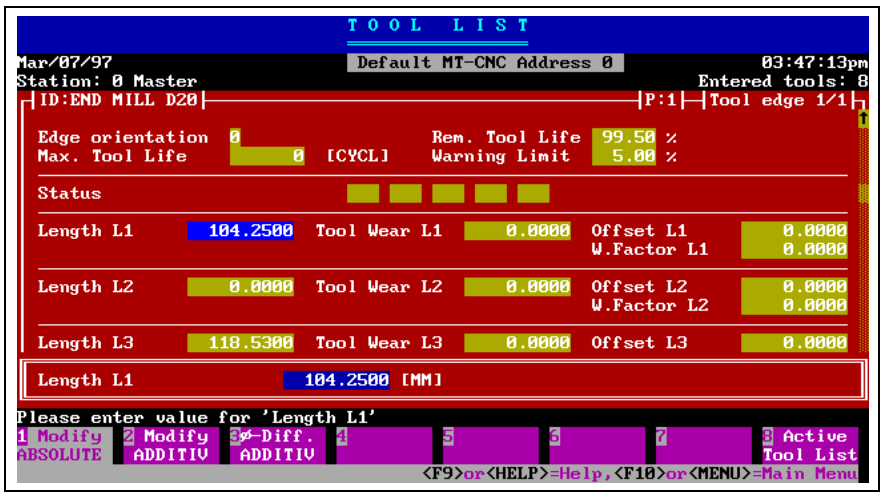


Fig. 3-9: 'Modify ABSOLUT' of a tool edge field

The cursor is blinking at the first segment of the input field. Now the data can be entered corresponding to admissible input formats (see appendix 6.3).

Data input is terminated and data input window is closed after confirming the entry by pressing the <Enter> key. The input value is accepted into the mask of values and stored on PC's harddisk.

When terminating the line editor by pressing <Esc>, the selected data remains unchanged regardless of the data input line's current contents.

At least one character or a number out of the admissible data range must be entered for 'ID' and Index number.

3) Function key <F8> 'Tool List' must be pressed upon completion of modifications. Pressing <F8> proceeds back to menu Tool List (see Fig. 3-3) .
4) From Tool List, pressing <F8> 'Tool List' proceeds back to the tool list index.
5) The tool list containing the modified data must be downloaded into the MT-CNC in order to make the changes effective.

Tool list download into MT-CNC is performed by pressing function key <F6> ‘Tool List ⇒ MT-CNC' in menu ‘Tool List Preparation for Station XX’ (see Fig. 3-1).

Step 5) must not be performed, if data is edited off-line only.

The following process parameter are effective during tool wear and offset data input:

- BXX.025 max. entry for tool length wear,
- BXX.026 max. entry for tool radius wear,
- BXX.027 max. entry for tool length offset,
- BXX.028 max. entry for tool radius offset,

The user interface automatically observes these limits and generates an error message if exceeded.

WARNING

⇒ When changing tool data, care must be taken that tool management data match the real tool data.

4 MT-CNC’s Actual Tool Data

In online operation (the PC is connected to the MT-CNC), calling up the Tool Data Handling via

<F6> 'Tool Administration'
(from MUI main menu)

or ; for example, user defined

<F6> ‘Tool Data Handling’
(**G**raphical **U**ser **I**nterface)

directly proceeds to the active tool list of the selected process.

The "Tool Administration" function key is user defined in the GUI and can be located anywhere within the Function key settings.

In online operation, the link between the PC and MT-CNC basically exists, otherwise there is a proceeding to the Tool List Preparation. All data, which can be displayed and edited in the online data handling, are located in the MT-CNC. This data is actual tool data which are updated permanently.

Modifying a tool’s data causes the data to become immediately active in the control.

Current control data is not saved to the PC’s harddisk automatically. Saving actual tool data from MT-CNC to PC takes place in Tool List Preparation (see section 3.1, page 2-6):

<Ctrl>+<F8> ‘Tool List Preparation‘
|
<Ctrl>+<F6> ‘MT-CNC ⇒ Tool List’

Data is then stored from MT-CNC to a free index location of the Tool List Preparation’s tool list index and in this way stored on the PC (Refer to Fig. 3-1).

WARNING

⇒ MT-CNC’s actual tool data can only be modified with online data handling.

The active tool list contains the entire actual data of all tool locations in the tool storage of the related process including spindles and grippers if present (see ‘Tool Management’ description, section 4). Data of the active tool list include tool list data and setup list data (see appendix 6.3).

The tool storage includes all locations of a process or station which is capable of receiving a tool. A data set contains the active tool data and, if present, setup list specific data for every tool in each tool storage location. All setup list specific data appear after automatic tool check.

With online operation, either the ‘Active Tool List (Location)’ or the ‘Active Tool List (GEO)’ is called up. The tool list displayed when exiting the tool data handling will be displayed first when calling up again.

4.1 Active Tool List (Location)

The ‘Active Tool List (Location) provides a list of the entire tool storage sorted by incrementing sequential place numbers of the entire active tool list. Location and status change can be directly observed.

Saving actual tool data from MT-CNC to PC takes place in Tool List Preparation (see section 3.1, page 2-6).

The list shown in Fig. 4-1: Active Tool List (Location)’ contains the most important data of a tool located at a certain position within the tool storage. The tool’s entire data set can be displayed pressing key combination <Ctrl>+<F7> ‘Data’ (see section ‘Display and Edit Tool Data’, page 3-13).

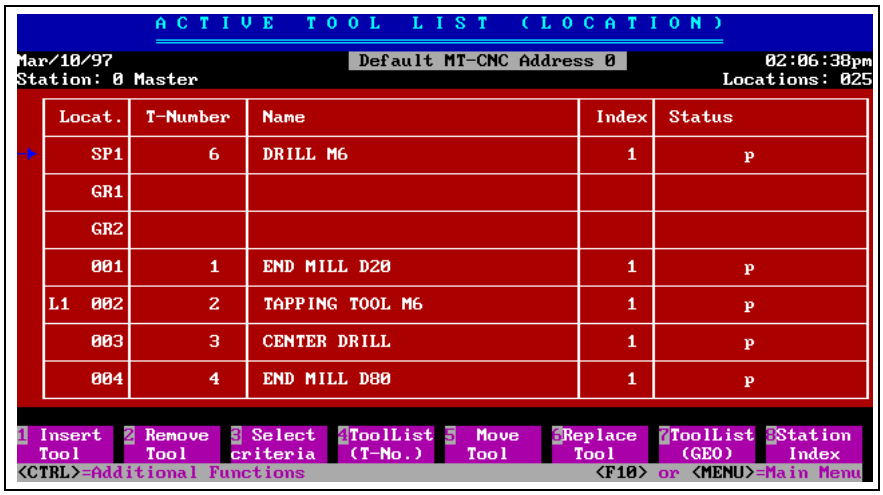


Fig. 4-1: Active Tool List (Location)

Data displayed for each Tool Storage Location

The following data is displayed for each tool storage location:

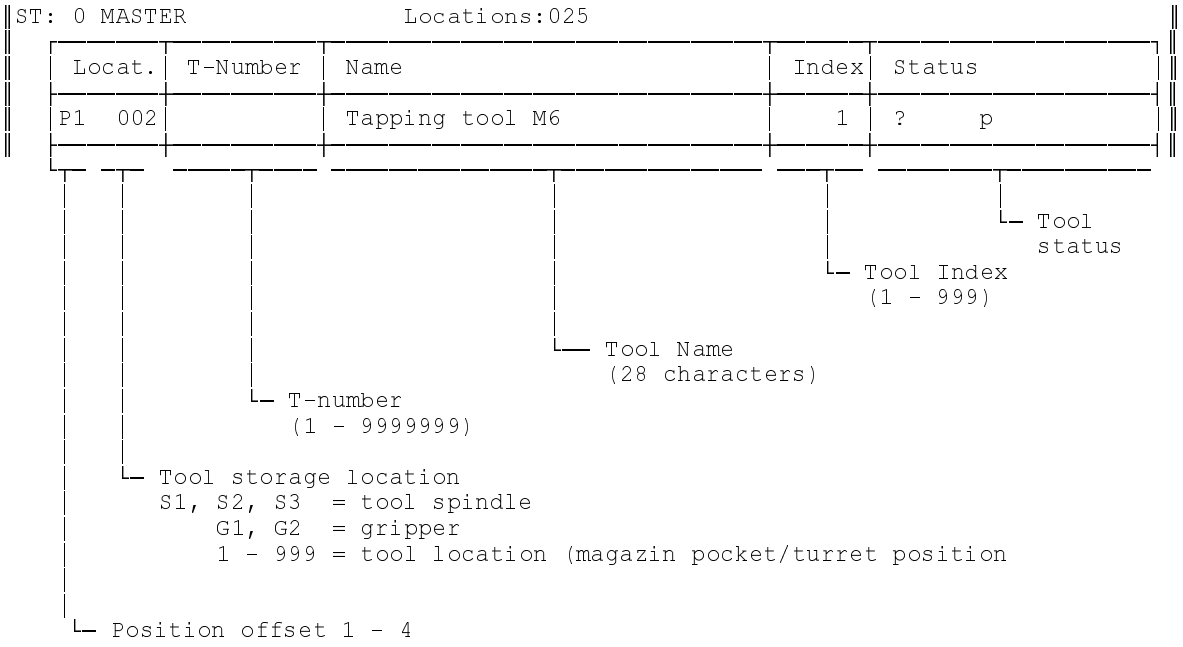


Fig. 4-2: Data - Tool Storage Location

The tool status of the active tool list consists of 32 status bits divided into 19 groups (see appendix 6.4, page 6-10). Among 17 groups, one status bit is displayed together with the relevant symbol each time. Within a group, only one status bit can be displayed due to display related priority layering.

Tool Status

The entire tool status is composed as follows:

- Setup list status bits (5 status bits, 4 groups)
- Tool list status bits (14 status bits, 7 groups, location specific, tool specific), groups 'location occupation' and 'location reservation' are not displayed
- User defined status bits (8 groups, tool specific).

See appendix 6.4 (page 6-10).

Position Offset

Data ‘P1 to P4’ can be displayed for each tool storage location (Position offset).

Process parameter 'BXX.021 ... BXX.024' determine up to 4 positions (POS 1, POS 2, POS 3, POS 4) of the tool storage, whose positions are given as a location offset relative to a reference marker (offset positions). The reference marker is the position to which the magazine is moving in the reference point return or homing procedure (MHP) as ‘Location 1’ (see description ‘Tool Management’, section ‘NC Tool Storage Move Commands and Tool change Commands’).

Similar to the reference marker, the offset positions are fixed. Their positions, relative to the reference marker, are counted in rising location numbers of the tool storage. As the tool storage moves, designations ‘P1 ... P4’ move to the tool storage locations that are at positions 1 to 4.

In the active tool list (overview), the location at position 1 to 4 is marked with the relevant position number ‘P1 ... P4’.

WARNING

⇒ The tool number is entered into column ‘T-Number’ after execution of automatic tool check.

⇒ Automatic tool check is executed among NC program start, if the setup list or the magazine list have changed.

Using the cursor keys or <PageUp>/<PageDown>, the list can be scrolled up and down. The top and bottom of the list can be displayed by pressing <Home> or <End>.

Tool Data Edit Functions

The following tool data edit functions are available in Active Tool List (Location):

<F1>	Insert	Insert a tool into active tool list.
<F2>	Remove	Remove a tool from active tool list.
<F3>	Select criteria	Select sort criteria for active tool list display.
<F4>	Tool List (T-No.)	Display active tool list sorted by T-numbers.
<F5>	Move	Move (displace) a tool from a source location to a target location within the active tool list.
<F6>	Replace	Replace a worn out tool by a new tool.
<F7>	Tool List (GEO)	Modify tool geometry data within the active tool list.
<Ctrl>+<F7>	DATA	Display and edit entire tool data of a tool selected from the active tool list.
<Ctrl>+<F8>	Tool List Preparation	Call up Tool List Preparation (see sect. 3).
<Ctrl>+<F5>	Location lock	Lock a Location from being used by Tool Management.

<Ctrl>+<F8>	Tool Look	lock a Tool from being used by Tool Management.

Display and Edit Tool Data

The entire tool data set can be accessed either from Active Tool List (Location) or Active Tool List (GEO) by pressing key combination <Ctrl>+<F7> 'DATA'.

The following message will be displayed, if no tool exists at the cursor position:

'Tool location does not contain a tool'

The active tool list's data set is structured as follows:

- basic tool data
- tool edge data 1 ... 9

data areas

Concerning its dimensions, a tool's entire data set (basic tool data and tool edge data) depends on the machine parameter. Tool edge data to be input depends on basic tool data 'Amount of edges' and 'Correction type'. All data input screens for basic tool data and tool edge data is automatically configured and displayed according to the above mentioned data.

See appendix 6.1 (page 6-1) for further details on the interrelationship between a tool data set and machine parameter as well as geometry data and correction type.

WARNING

⇒ The active tool list's data set contains setup list data (assigned to the NC program) and tool list data (tool list preparation). See also appendix 6.3.

⇒ Setup list data is displayed in the active tool list, provided that an automatic tool check took place in order to assign tool list data to a setup list. That means, that the tool number is assigned and entered into the data mask. If this is not the case, the relevant setup list data field is presented '---' (see 'Tool Management', section 5).

Display Basic Tool data

Basic tool data is displayed by pressing key combination <Ctrl>+<F7> 'Data'.

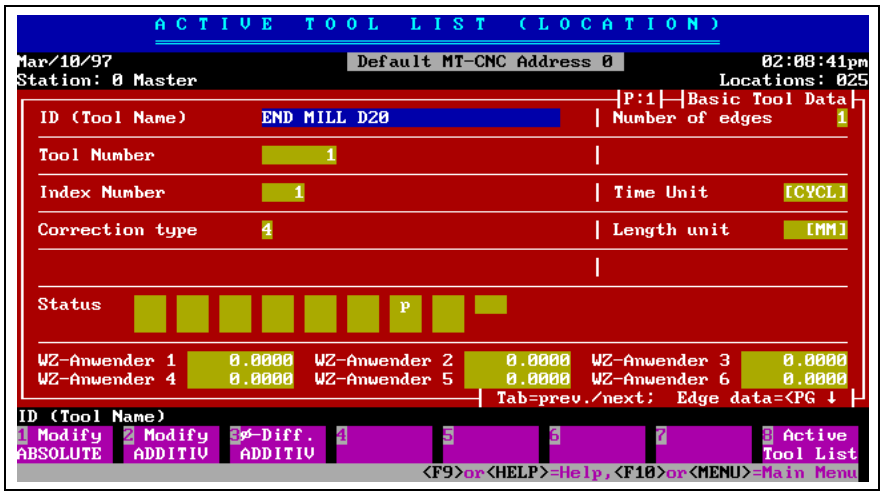


Fig. 4-3: Basic Tool Data (Correction type 4)

Select Basic Data or Edge Data and Individual Data

Using <PageUp> / <PageDown> keys, it can be scrolled from basic tool data screen to the tool edge data screen or from one tool edge data screen to the next. In this way, an entire data area is always displayed.

Within a data area, i.e., within the basic tool data or tool edge data, the individual fields are selected using either the <Enter> key or the <Tab> key. The edit functions of the softkey line apply to the currently selected field.

A scroll bar appears at the right hand side of the screen, if basic tool data and tool edge data do not fit into the screen mask. The scroll bar indicates the current cursor position with reference to the current tool edge.

Data currently not displayed is automatically scrolled into the screen when moving the cursor to the relevant item.

Concerning tool status see section 4.1 ‘Active Tool List (Location)’ (page 4-1) and appendix 6.4 (page 6-10).

Display Tool Edge Data

Pressing the <PageDown> key causes a change from basic tool data screen to the tool edge data screen.

The entire data set is displayed for each individual tool edge.

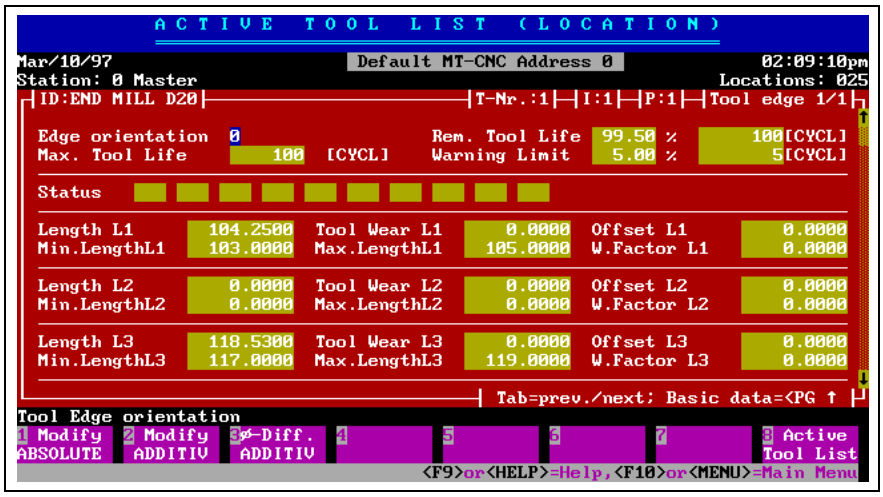


Fig. 4-4: Tool Edge Data

Important basic tool data is displayed at the upper part of the boundary line for better orientation.

The following basic tool data is also displayed in every tool edge data input screen:

- 'ID’ (Tool Name),
- tool number ‘T-No.’,
- index Number ‘D’,
- current pocket 'P'.

The tool edge number is displayed at the top right of the boundary line.

The tool list’s tool edge status consists of 16 status bits, divided into 10 groups. Out of these groups, one status bit is displayed together with the relevant symbol each time. Within the group, a display related priority layering is evaluated (see appendix 6.5, page 6-11), so that only 1 status bit per group is displayed.

Tool Status

The entire tool status within a tool list is composed as follows:

- Setup list status bits (5 status bits, 5 groups)
- Tool list status bits (2 status bits, 1 group, tool specific),
- User defined status bits (4 status bits, 4 groups, tool specific).

See appendix 6.4 (page 6-10).

Edit Basic Tool Data and Tool Edge Data

The entire active tool list data of all tools contained in the tool storage can be modified online by the operator, i.e. directly in the control.

Tool data can be modified either in the screen displayed by pressing <Ctrl>+<F7> 'Data' in 'Active Tool List (Location)' or directly in 'Active Tool List (GEO)' (<F7> 'Tool List (GEO)' only geometry data).

A modified field becomes immediately valid in the MT-CNC, but is not stored onto the PC's harddisk.

If multiple participants access a tool (NC or PLC program by TLD command), the least of all data of the relevant tool becomes valid in the control.

If communication to the MT-CNC terminates prior to termination of entry, data entered into the line editor get lost and the value stored in the control remains valid.

Functions

<F1>	Modify absolute	Absolute data entry. The input value is accepted immediately.
<F2>	Modify additive	The input value is added to the existing value.
<F3>	∅-Diff. additive	The input value is divided in half and added to the existing value (correction type 3, turning tool, G18, for L2 (X) only)

These functions can be applied to all tool list locations.

WARNING

⇒ Data directly modified in the MT-CNC (online data handling) is not saved on the PC. Saving active tool data from MT-CNC to PC can be performed via 'Tool List Preparation' (see section 3 and 3.1).

Modifying Individual Tool Data

1) Move cursor bar to the desired field within basic tool data screen or tool edge data screen using the <Enter> key or the <Tab> key. A brief description of the field at the cursor position is given in the line between the boundary bottom line and the function keys (see Fig. 3-9).
2) Press function key <F1> or <F2> or<F3>. A data input window appears, where the selected field can be modified.

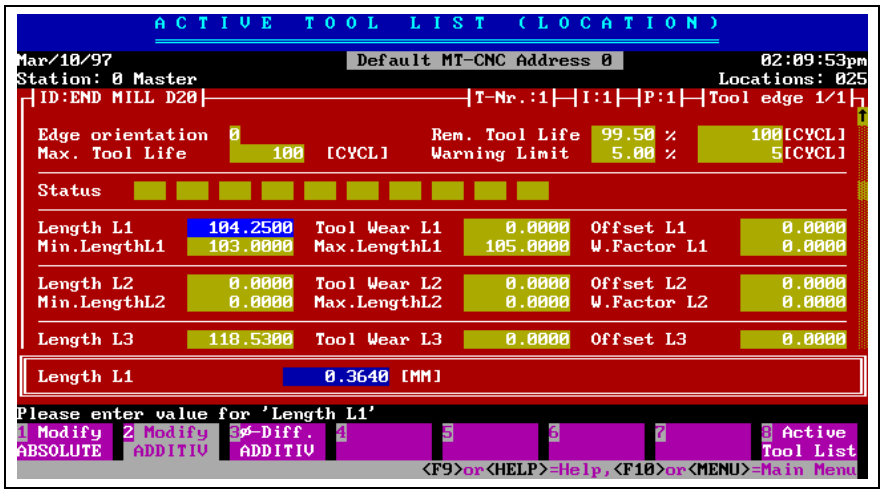


Fig. 4-5: 'Modify ADDITIV' of a tool edge data

The cursor is blinking at the first segment of the input field. Now the data can be entered corresponding to admissible input formats (see appendix 6.3).

Data input is terminated and the data input window is closed after confirming the entry by pressing the <Enter> key. The input value is accepted into the mask of values and directly transmitted into the MT-CNC.

When terminating the line editor by pressing <Esc>, the selected data remains unchanged regardless of the data input line's current contents.

At least one character or a number out of the admissible data range must be entered for 'ID' and Index number.

Comparison with Setup List Data

If the tool is used within the NC program, the tool is contained in the active program's setup list and tool status bit 2=1, the MT-CNC performs a complete comparison between setup list data and active tool list data after transmitting the data of the relevant data set. Among this comparison, also basic tool data and tool edge data status bits are set or reset.

A global error message is generated by the MT-CNC after completion of data entry, if input data is incorrect (see figure below).

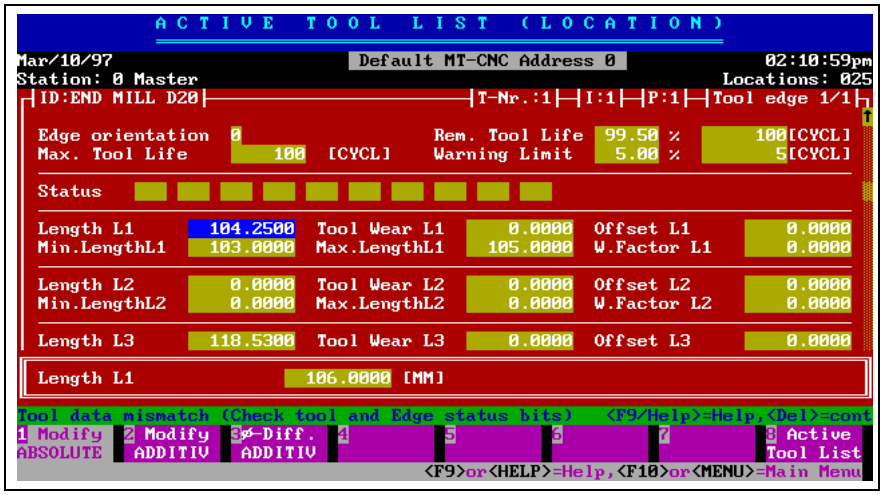


Fig. 4-6: Tool data mismatch; Length 'L1' incorrect

In the above example, the value entered for 'L1' exceeds geometry limits 'L1_min' and 'L1_max.

WARNING

⇒ Incorrect data is immediately reported by the control. The error does not affect process status 'Ready for Operation'. The error status bits are also set or reset instantly. In order to prevent incorrect data from becoming activated during operation, it must be corrected immediately.

After data modification, the MT-CNC performs an automatic tool check with next cycle start for the relevant process, if

- an error was generated prior to or after modification, or if the warning limit is reached.

Modify the Active Tool, the Tool in the Gripper or Tool Spindle

The following must be fulfilled, if the tool to be modified is located in the tool spindle or gripper, or is the active tool:

1) the process is not active,
2) STOP-signal must be applied, if process is still active (NC program in execution).

If STOP-signal is not applied in case 2, the following error message is displayed:

```
'Process still activ'
```

The modified data does not become valid in the control.

General Remarks concerning Tool Data Modification

Functions <F1> or <F2> or <F3> can only be used for tool list data. The other data of the active tool list and the setup list cannot be modified. The Editor cannot be used to access this data. The ”Active tool location “ data cannot be changed.

For modifying active tool list data in the active tool list and setup list, the following rules are valid:

1) all SL / TL data, if:
(ID, correction type, no. of edges, edge orientation)
tool status bit 2 = 1, symbol '?'
(tool is not used in the current NC program)

The following is valid for a tool used in the current NC program:

2) Correction type, if: (basic data)
correction type incorrect,
tool status bit 3 = 1, symbol 't'

3) no. of edges, if: (basic data)
no. of edges incorrect
tool status bit 4 = 1, symbol 'e'

4) edge orientation, if: (edge data)
edge orientation incorrect,
tool status bit 5 = 1, symbol 'f',
edge status bit 1 = 1, symbol 'e',

The following message occurs, if the data cannot be modified:

```
'Tool data cannot be modified'
```

The data does not become valid in the control.

5) Modifying ‘Length unit’ will **only display** all geometry data in the length unit selected.

Process parameter

- BXX.025 max. input for length wear,
- BXX.026 max. input for radius wear,
- BXX.027 max. input for length offset,
- BXX.028 max. input for radius offset.

are valid data input.

The user interface monitors these limits automatically and generates an error message if exceeded.

For a tool used in the NC program, the percentage remaining tool life and the absolute tool life ([min] or [cycl]) are derivative values. If the percentage remaining tool life is modified, the absolute remaining tool life will be adapted after closing the editing window.

The following equation is valid:

- $$\text{perc. rem. tool life}[\%] = \frac{\text{rem. tool life [min] or [cycles]}}{\text{max. tool life [min] or [cycles]}} * 100\,[\%]$$

Fig. 4-7: Percentage Remaining Tool Life

WARNING

⇒ Special care must be taken that the tool management data matches the real tool data when modifying tool data.

Enter a Tool using ‘Insert’

In menu ‘Active Tool List (Location’, a tool can be entered onto a vacant location of the active tool list by pressing

<F1> 'Insert'.

Function ‘Insert’ can be used for any tool storage location.

Error message

```
'Magazine slot number XX is already in use!'
```

will be generated, if the relevant location is not empty.

For a tool storage location, basic tool data and tool edge data is entered into the active tool list.

Function ‘Insert’- The Individual Steps

Function ‘Insert’ is subdivided into the following steps:

- Callup ‘Insert’ from menu ‘Active Tool List (Location) (the location is locked automatically),
- Enter basic tool data and tool edge data,
- Location is enabled automatically after terminating the function by pressing <F8> 'Tool List'.

By the control, tool data is assigned to a tool storage location according to pocket number.

<F1> calls up a screen containing the basic tool data. As basic tool data have been entered completely, tool edge data to be entered will be displayed after pressing <Page Down>.

All required data is automatically retrieved by the user interface. Data entry takes place directly in the screen mask containing the relevant data fields. All data is predifined with default values, except tool name and user definable status bits.

The <Enter> key terminates every single data input and positions the cursor to the next data input field automatically. The <Tab> key moves the cursor to the next data input field while <Shift>+<Tab> moves the cursor backwards.

The complete tool data set’s dimensions (basic tool data and tool edge data) depends on machine parameter setting. Tool edge data to be input depend on basic tool data ‘Amount of edges’ and ‘Correction type’. All data input screens for basic tool data and tool edge data is automatically configured and displayed according to the above mentioned data.

See appendix 6.1 (page 6-1) for further details on the relationship between a tool data set and machine parameter as well as geometry data and correction type.

The following basic tool data is displayed in any tool edge data input screen:

- 'ID' (Tool Name),
- tool number 'T-No. ',
- index number 'D',
- current pocket 'P'.

The tool edge number is displayed at the right hand side of the boundary line.

A valid entry must be input for the tool name (ID) The following error message is displayed, if an attempt is made to continue or to terminate data input without a valid tool name:

```
'Entry not possible (Tool has no tool name(ID))!'
```

Enter a Tool into the Active Magazine List

1) Move the cursor to a vacant pocket of the active tool list (menu ‘Active Tool List (Location)’, see Fig. 4-1)

2) Press function key <F1> 'Enter a Tool'. A data input screen containing the basic tool data is displayed. The 'current pocket' field (P:XX) displayed at the top right of the boundary line is determined by the selected location and cannot be altered. All other data is predifined with default values, which can now be adapted accordingly.

3)

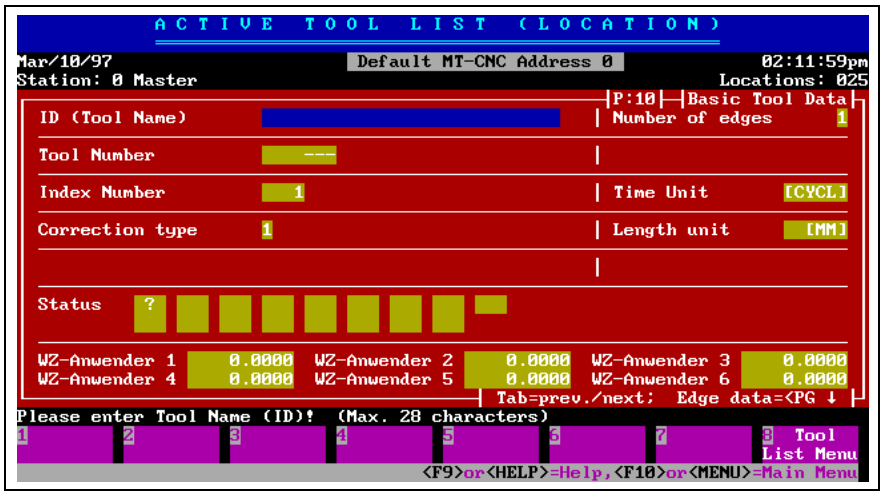


Fig. 4-8: Predifined basic tool data

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⇒ The relevant location is automatically locked when calling up function 'Insert'. Status 'Location is blocked', symbol 'B', is visible in tool status (see Fig. 4-8). Terminating the function by pressing <F8> 'Tool List' and confirming the following request by pressing <Enter> will automatically enable the tool again. In the meantime, the location is available for the user. MT-CNC does not have access.

Tool edge data can only be accessed <PageDown>, if a tool name is entered.

3) After basic tool data input, pressing <PageDown> key proceeds to tool edge 1 data.

Fig. 4-9: Predefined tool edge data (correction type 2)

Required tool edge data is requested subsequently. According to the basic tool data, where correction type 2 was defined, one length and a radius need to be entered in this example (in this case length 'L3', index '3' not displayed, see appendix 6.1). Pressing <PageDown> key proceeds to further tool edge data screens if defined in basic tool data.

4) Pressing <F8> ‘Tool List’ terminates data input for basic tool data and tool edge data of the relevant location. After pressing <F8>, the user must acknowledge the following interrogation:

   ```
   Is the tool placed into it’s location (Y/N) ?'
   ```

   After confirming, the entry is terminated and the tool location is enabled at the same time.

   <Esc> abandons the function. The selected location remains empty and is enabled.

5) The ‘Insert’ function can be abandoned at any time by pressing <Esc>. The location is enabled (location blocked is released) and regarded as empty.

General Remarks concerning ‘Insert a Tool’

Within the function <F1> ‘Insert’, only tool list data can be written. The rest of the active tool list data and setup list data cannot be entered. These fields display ‘---‘ in the relevant data field and cannot be edited. Setup list data can be displayed after entering a tool, but after the next automatic tool check earliest. Setup list data entry is performed automatically on the basis of the NC program’s setup list (see section 5). The ‘current tool location’ data cannot be modified.

If the link between PC and MT-CNC is interrupted prior to termination of ‘Insert’, the data is stored in the MT-CNC. The tool location is still blocked. This is recognizable by tool status ‘location blocked’, symbol ‘B’. The data partially entered can be removed using function <F2> ‘Remove’ (section ‘Removing a Tool using ‘Remove Tool’, page 4-12). The location is enabled again.

WARNING

⇒ After terminating of function ‘Insert’ due to interruption of communication, function ‘insert’ cannot be applied for this location again. The location must be deleted in advance using ‘Remove’

Enter a Tool into a Gripper, a Tool Spindle, a Turret

Inserting a tool into a turret, a tool spindle, or a gripper is only admissible if

1) no NC program is active for the relevant process,
2) a STOP signal is applied for the relevant process if an NC program is executed.

The following message is output if NC program is active and no STOP signal is applied:

```
'Process still activ !'
```

Location within the Tool Magazine

A tool can be entered into a tool magazine if

1) the process is not activ,
2) among an active process, the magazine has been switched into manual mode.

The following message is displayed, if this is not the case:

```
'Tool data cannot be modified !'
```

WARNING

⇒ Entering a tool into the tool list requires entering a tool into the machine’s tool storage at the same time.

⇒ Function ‘Insert’ must only be used for vacant locations.

Removing a Tool using ‘Remove Tool’

If a tool is removed from tool storage, it must also be deleted from active tool list, so that MT-CNC tool management can update tool storage’s equipment.

A tool can be removed from active tool list using function <F2> ‘Remove Tool’.

'Remove Tool' can be applied to any portion of the active tool list.

Deleting a tool from Active Tool List

1) Position the cursor to the tool location of the tool to be removed.
2) Press function key <F2> ‘Remove Tool’.

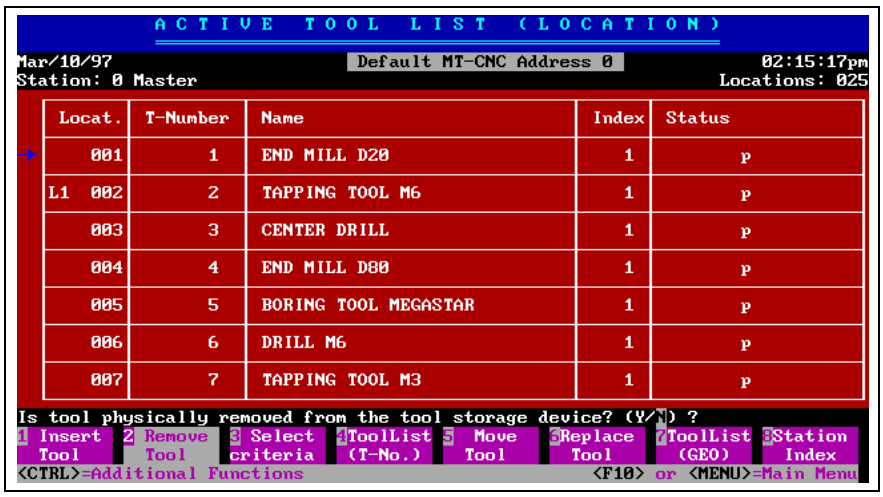


Fig. 4-10: Removing a Tool

The following question needs to be confirmed before the tool is removed actually:

```
'Is the tool removed from it’s location (Y/N) ?'
```

3) The tool is removed from the active tool list after confirming by pressing <Enter>. Tool storage equipment remains unchanged, if the function abandoned by pressing <Esc>.

Removing an Active Tool, a Tool from Gripper, from Tool Spindle or Turret

An active tool, or a tool in the spindle, or gripper can only be removed if

1) no NC program is active for the relevant process, or
2) a STOP signal is applied to the relevant process if a program is active.

The following message is output, if a program is active:

```
'Process still activ !'
```

Location within the Tool Magazine

A tool can be removed from a tool magazine, if

1) the process is not active, or
2) the magazine has been switched to manual mode among active process.

If this is not the case, the following message will be output:

```
'Tool data cannot be modified !'
```

WARNUNG

⇒ When deleting a tool, the tool must be physically removed from the relevant location at the same time.

⇒ If a tool has been deleted from the active tool list via PC operation, the operator is responsible for actually removing the tool from the tool storage. Otherwise, there is danger of collision in the machine because the MT-CNC assumes this location is free.

Arranging the Active Tool List using 'Select criteria'

Besides displaying the entire active tool list sorted by tool location or tool number, it is possible to display only tools which meet certain display criteria.

The tool status (tool status bits) is used as display criteria, from which single or multiple criteria can be selected.

Function <F3> 'Select criteria' in menu 'Active Tool List (Location)' provides the option to select certain criteria from the tool status. The selected criteria must be complied in order to display the relevant tool.

For example, the operator may select all tools which fall below the warning limit. All these tool are indicated by 'w' (tools with exceeded warning limit) in the tool status.

Selection of Display Criteria

Display Criteria		Bit no.		Symbol
not present		tool bit Nr.	1 = 1	!
not required		tool bit no.	2 = 1	?
incorrect	correction type or	tool bit no.	3 = 1 or	t
edge	no. of edges or	tool bit no.	4 = 1 or	e
data	edge	tool bit no.	5 = 1	f
worn out		tool bit no.	17 = 1	d
exceeded warning limit		tool bit no.	18 = 1	w
for machining		tool bit no.	19 = 1	p
fixed location		tool bit no.	21 = 1	c
locked tool		tool bit no.	22 = 1	L

Fig. 4-11: Selecting Display Criteria

All logical combinations out of the above list can be combined in the user interface.

Example:

To display all tools that are incorrect and whose warning limit is exceeded, the following display criteria must be selected:

- Primary tool for machining symbol 'p',
- incorrect symbol 'tef' and

Tool with exceeded warning limitsymbol 'w' .

The following combinations are not possible:

- Tools that are not present symbol '!'
  cannot be combined with any other criteria,
- the combination
  Tool with incorrect edge data symbol 'tef' and
  Tool not used symbol '?'.

Once a criteria is selected, selecting criteria which will result in invalid combinations are not possible any more.

WARNING

⇒ Criteria ‘not present (symbol '!') concerns tools that are present in the tool storage physically. If this criteria was selected, all tools detected as ‘not present’ during automatic tool check will be displayed (see section 5). These are tools that are required according to the setup list of the program to be started, but are not present in the active tool list.

In the filtered active tool list according to the selected criteria, only possible functions for that list can be called up. No additional tools can be entered using ‘Enter a Tool’ to a list of incorrect tools, because only locations containing incorrect tools are displayed.

The criteria are selected from a selection window (<F3> Select criteria). The selection window can be called up from any display variation.

Selecting Display Criteria

1) Press function key <F3> ‘Select criteria’ in ‘Active Tool List (Location) or ‘Active Tool List (Tool number). A selection window appears, where single or multiple ‘Display Criteria’ can be selected.
2) Position the cursor to the required criteria within the selection window using <CursorUp> / <CursorDown> . <Space> marks the selected criteria '√'.

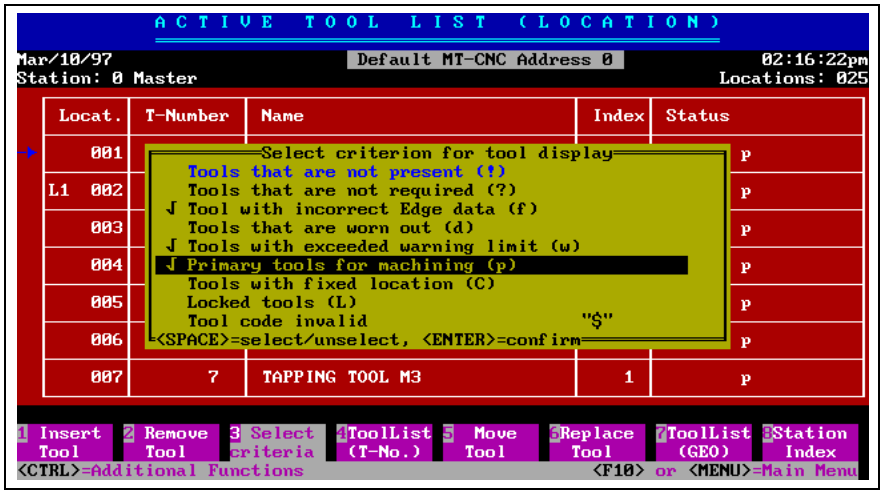


Fig. 4-12: Selecting Display Criteria

After selecting all required criteria (marked '√' in the selection window), pressing <Enter> leads to the tool list that contains only tools that meet the selected criteria.

Fig. 4-12 shows an example of tools where at least status bits ‘Tool with incorrect edge data (symbol ‘t’, or ‘e’, or ‘f’ or a combination), exceeded warning limit (symbol ‘w’) and ‘Primary tool for machining (symbol ‘p’) are set (status 1).

3) The following tools appear in the active tool list according to the criteria selected in Fig. 4-12.

Fig. 4-13: Filtered Active Tool List (Location)

Displaying sorted by Tool Numbers

Via <F4> ‘Tool List T-No.), the operator can switch from ‘Active Tool List (Location) , which is sorted by an increasing location number, to the active tool list sorted by increasing tool numbers.

Only tools which have been assigned a tool number (T-no.) are displayed here. An automatic tool check, where a tool number is assigned to the tool, must have taken in advance. (see section 5 and 'Tool Management' description, section 5).

Locations containing tools without T-number or empty locations are not displayed.

WARNING

⇒ The ‘Active Tool List (T-No.)’ only displays tools with T-numbers assigned. The entire tool storage device cannot be displayed here.

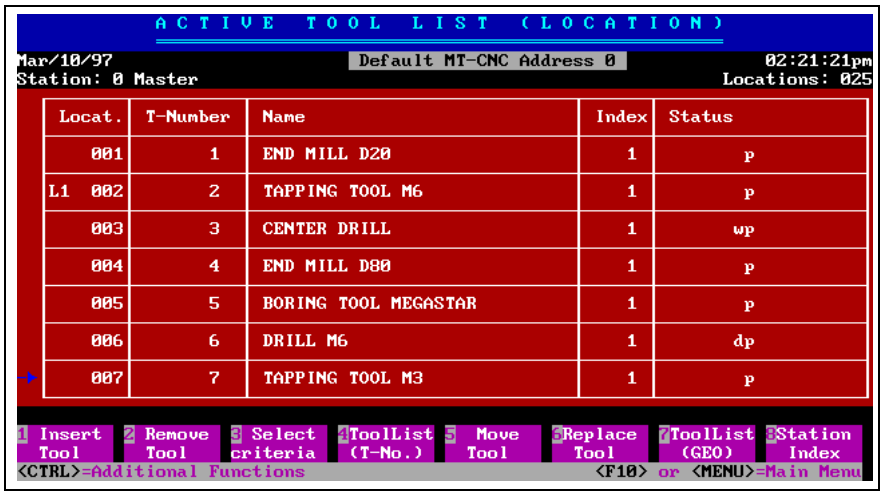


Fig. 4-14: Active Tool List sorted by Tool Numbers

Tools which do not physically exist in the tool storage may also appear in this list. These tools are required according to the setup list, but are not entered to the active tool list. These tools can be identified through the tool status bit ‘!’ ‘not present’ and no entry in column ‘Location’. Such a tool is shown in Fig. 4-14 (T-no. 4). This tool is required according to the setup list, but not present in the tool storage. For that reason it does not appear in the ‘Active Tool List (Location).

Moving a Tool using ‘Move Tool’

If a tool is taken out of the tool storage manually and put into a different, empty location, this modification must be carried along also in the active tool list of the MT-CNC.

This can be performed using function <F5> ‘Move Tool’ in menu ‘Active Tool list (Location).

The function ‘Move Tool’ can be applied to all locations of the active tool list including grippers and spindles.

Changing a Tool’s Location

1) Position the cursor to the tool to be removed from a location (source).
2) Confirm function key <F5> ‘Move Tool’ in menu ‘Active Tool List (Location). The source location is highlighted.

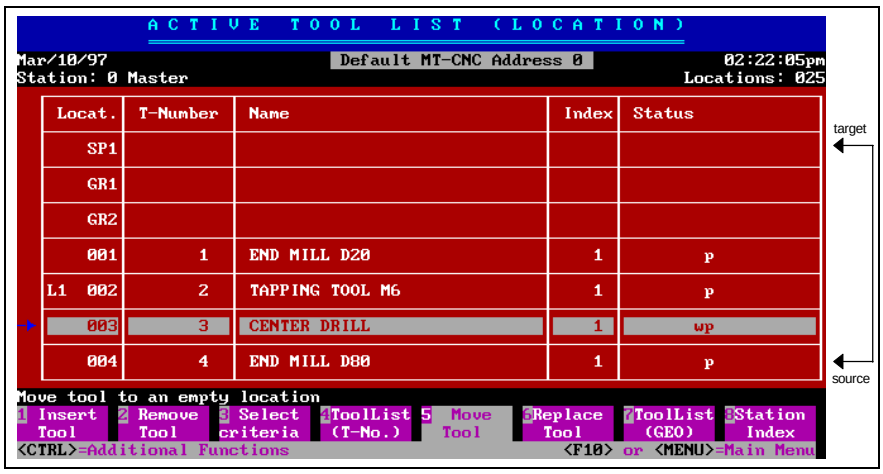


Fig. 4-15: Moving a Tool

3) Position the cursor to the desired, empty tool storage location (target).
4) Moving the tool is completed by pressing <Enter>. The tool is now moving from the source location to the marked, empty location (target).

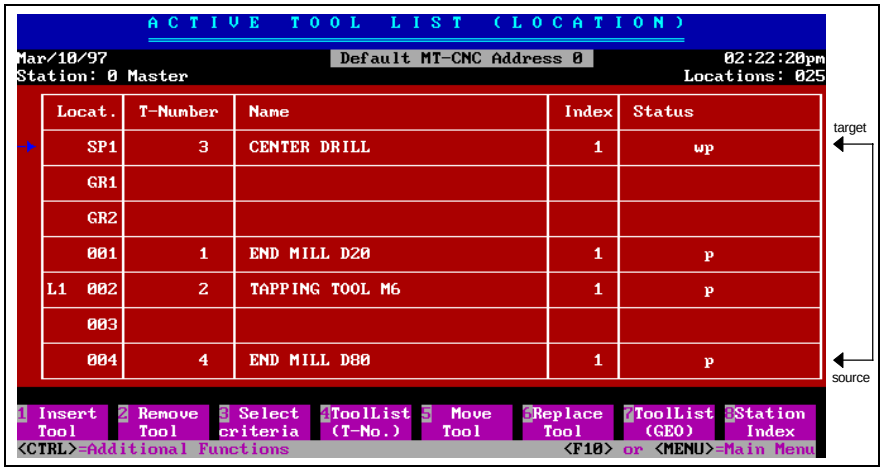


Fig. 4-16: Active Tool List after moving the tool

Steps 5 and 6 are without any meaning, if the change was performed correctly.

5) Once a moving procedure was initiated, it can be stopped by pressing <Esc>. The active tool list remains unchanged in this case.
6) Error message

   `'Tool location already contains a tool !'`

   will be generated after step 4, if the target location is not empty.

   Error message

   `'Tool location does not contain a tool !'`

will be generated if the source location is empty.

Moving an Active Tool - Gripper or Tool Spindle as Target or Source Location

Selecting an active tool, or selecting a gripper or a tool spindle as source or target location is only admissible if

1) no NC program is active for the relevant process, or
2) a STOP signal is applied to the relevant process among active NC program.

Error message

`'Process still activ !'`

will be generated, if an NC program is still active.

The message will be generated with termination of the transfer (see step 4 ‘Changing a Tool’s Location').

Source or Target Location within the Tool Magazine

A tool can be removed from a magazine or put into a magazine if

1) the process is not active, or
2) the magazine has been switched to manual mode for the active process.

If this is not the case, the following message will be output:

```
'Tool data cannot be modified !'
```

This message will be generated among termination of the (see step 4 'Changing a Tool's Location').

Replacing a Tool using 'Replace Tool'

A tool can be replaced by a new, unused tool of the same type if it is used up. The new tool's geometry and technological characteristics must be as suitable as those of the tool used up.

A new, not worn out tool has a 100% life time and wear offset value '0'.

The following data is set when using function <F6> 'Replace Tool' in menu 'Active Tool List (Location':

- Reset percentage tool life back to 100%,
- data

*wear L1
* wear L2
* wear L3
* wear R

Depending on parameter setting and correction type

are reset to '0' if existing (see appendix 6.1).

WARNING

⇒ Resetting wear data applies to all edge data of a tool!

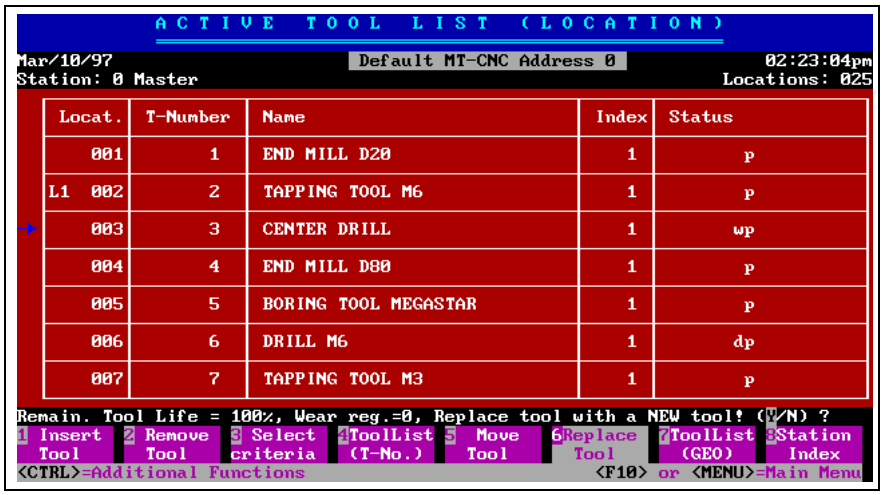


Fig. 4-17: Replacing a Worn Out Tool

Resetting the percentage tool life to 100%

1) Replace the worn-out tool with a new tool.
2) Position the cursor to the location of the tool replaced.
3) Press function key <F6> 'Replace Tool'.
4) The operator is asked if the tool was actually replaced. Pressing <Enter> confirms and completes the function. A message is displayed informing that the values for tool life and wear are set automatically by

this function. <Esc> stops the function. Tool life and wear remain unchanged.

The following status bits are automatically reset by this function:

- tool status bit 17 tool worn out symbol 'd',
- tool status bit 18 exceeded warning limit symbol 'w',
- tool edge status bit 9 edge worn out symbol 'd',
- tool edge status bit 10 exceeded warning limit symbol 'w',

WARNING

⇒ The worn out tool actually must have been replaced by a new one through the operator prior to reset the percentage tool life to 100%.

⇒ The new tool must be put into the worn out tool's location.

⇒ The technological and geometrical characteristics of the new tool must correspond to those of the worn out tool.

Setup List Data Comparison

If the tool is used in the active NC program, that means it is present in the setup list of the active NC program and tool status bit 2 = 0, MT-CNC performs a complete comparison between the setup list data and active tool list after transferring the data of the relevant tool's data set. Basic tool data and tool edge data status bits are set or reset at the same time.

A global error is reported from CNC, if resetting the wear offset results in an geometrical error.

```
'Invalid tool data'
```

WARNING

⇒ When wear offset is used, 'Replace Tool' also modifies geometry data. A geometry data error may be caused (L_min, L_max exceeded). Although incorrect data is immediately reported by the control, it instantly becomes active within the control. The error does not effect 'Ready for operation' status of the relevant process. The error status bits are also set or reset instantly. Incorrect data must be corrected immediately in order for it not to become active during operation.

Modified geometry data becomes active when the next NC block is executed, if 'Replace Tool' is applied to the active tool.

After replacing a tool, MT-CNC performs an automatic tool check at the next opportunity (next program start for the relevant process), if the following is valid:

- an error exists prior to or after 'Replace Tool'.

4.2 Active Tool List (GEO)

The 'Active Tool List (GEO) represents a display variant of the 'Active Tool List (Location) and facilitates quick and clear tool geometry data modification.

From 'Active Tool List (Location)' it is called up by pressing

<F7> 'ToolList (GEO)'

Entire geometry, wear, offset, and identification data (basic tool data) for every single tool storage location are displayed in a list at a glance.

Geometry corrections can be modified by the operator directly in the list using the function keys. The cursor can by moved only to admissible data fields of the geometry corrections using the cursor control keys. The field

of the current cursor position as well as the column's headline is highlighted. Empty locations are jumped.

When leaving the 'Tool Data Handling' from 'Active Tool List (GEO)', 'Active Tool List (GEO)' is displayed when calling up 'Tool Data Handling' again.

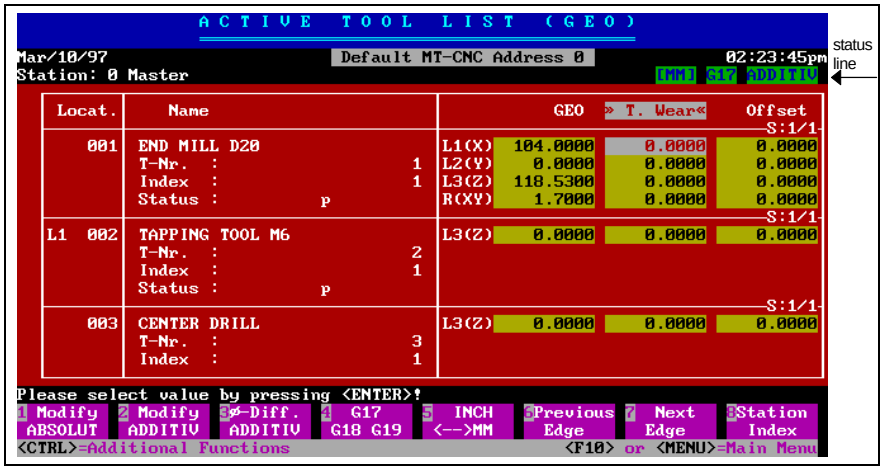


Fig. 4-18: Active Tool List (GEO)

Information - Status Line in line 3 above the list

The status line in line 3 above the list contains the following information:

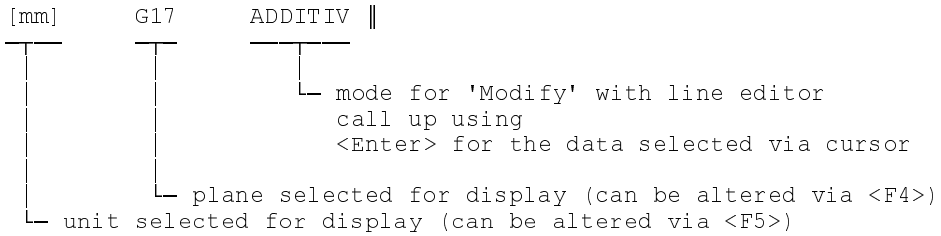


Fig. 4-19: Status Line Information

Information for each Tool Storage Location

The following information is offered for each tool storage location:

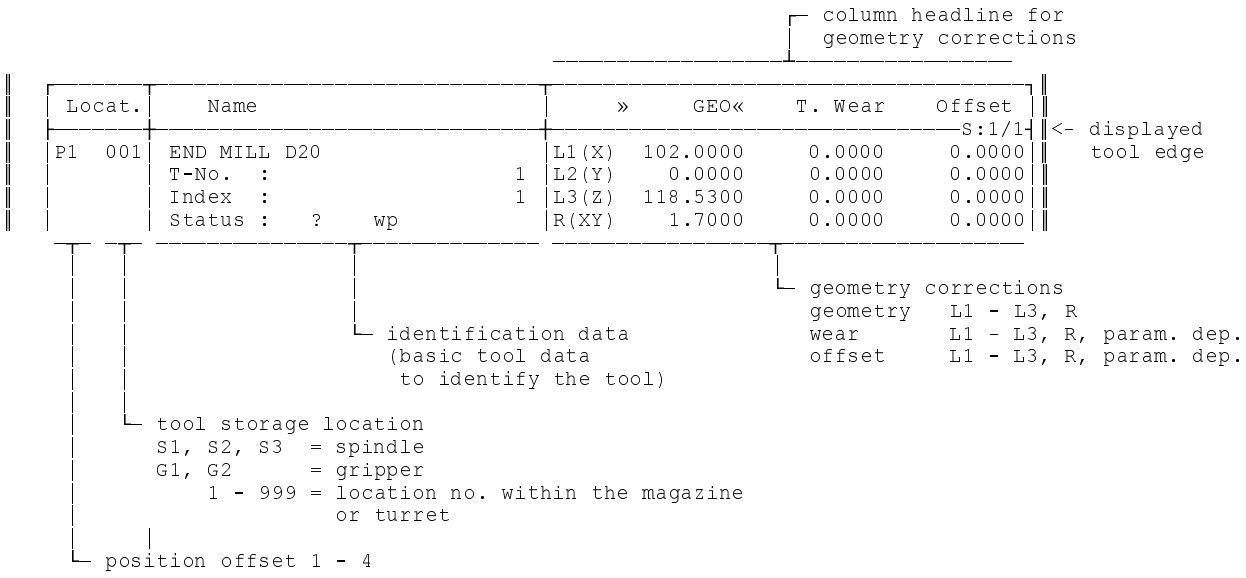


Fig. 4-20: Information for each Tool Storage Location

About position offset, identification data, and tool status see section 4.1 (page 4-1).

One line containing the relevant geometry, wear, and offset data per location is available for each coordinate setup (L1, L2, L3) and radius 'R'. The axis designation belonging to each coordinate direction is given in

round brackets. In case of the radius, the two axes representing the plane, in which the radius becomes effective, are displayed.

The interrelation between coordinate direction (L1, L2, L3) and axis meaning (X,Y,Z) depends on the plane selected and changes only with the same. For display purposes only, the plane, that defines the relationship between coordinate direction and axis meaning, can be switched off using function

<F4> 'G17, G18, G19'.

The status line shows the plane momentarily valid for display.

The relationship between coordinate direction, work plane, and axis meaning is described in section 6.2 (page 6-7).

If the plane selected for display corresponds to plane 'predifined' in machine parameters, it will be displayed as highlighted in the status line.

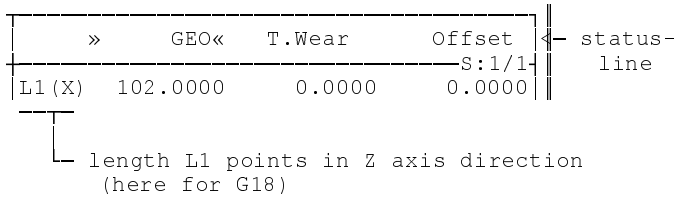


Fig. 4-21: Status Line

The entire tool data set's (basic tool data and tool edge data) depends on the machine parameter setting. Concerning number of edges and geometry corrections, tool edge data depend on the number of edges and correction type entered defined in basic tool data. All data input screens for basic tool data and tool edge data is automatically configured and displayed in accordance with these data.

The dependency of a tool data set from machine parameters and geometry data from correction type is described in section 6.1.

Functions

<F1>	Modify absolut	Geometry data absolute input. The input value becomes valid instantly.
<F2>	Modify additiv	The input value is added to the existing value.
<F3>	∅-Diff. additiv	The input value is divided by 2 and added to the existing value (correction type 3 only, turning tool, G18, L2(X)).
<F4>	G17, G18, G19	Plane switching (only valid for display).
<F5>	mm → inch	Length unit switching (only valid for display)
<F6>	previous edge	Select tool edge to be
<F7>	next edge	displayed.
<Ctrl>+<F4>	Active Tool List (Location)	Switch to Active Tool List (Location).
<Ctrl>+<F7>	DATA	Display entire tool data set
<Ctrl>+<F8>	Tool List Preparation	Select Tool List Preparation.

WARNING

⇒ Functions <F4> 'G17,G18,G19' and <F5> 'mm → inch' relate to the display of the Active Tool List (GEO) only. They do not switch neither plane selection nor the basic coordinate system!

Modify Geometry Corrections

All tool data of tools contained in the tool storage can be modified online in the active tool list, that means directly in the control. A modified data becomes instantly valid in the MT-CNC.

If multiple participants access a tool (NC or PLC program by TLD command), the least of all data of the relevant tool becomes valid in the control.

If communication to the MT-CNC terminates prior to termination of entry, data entered into the line editor get lost and the value stored in the control remains valid.

Function keys <F1> to <F3> and <Enter> are available to modify a data.

Modifying using<F1> - <F3>

<F1>	Modify absolute	Geometry data absolute input. The input value becomes valid instantly.
<F2>	Modify additive	The input value is added to the existing value.
<F3>	∅-Diff. additive	The input value is divided by 2 and added to the existing value (correction type 3 only, turning tool, G18, L2(X)).

These functions can be applied to all tool list locations.

WARNING

⇒ Data directly modified in the MT-CNC (online data handling) is not saved on PC. Saving active tool data from MT-CNC to PC can be performed via 'Tool List Preparation' (see section 3 and 3.1).

Modifying Individual Tool Data

1) Position the cursor to the desired field using either the <Tab> key or the <Enter> key.
2) Press function key <F1> or <F2> or<F3>. A data input window appears, where the selected data can be modified.

Fig. 4-22: 'Modify ADDITIV' of a Tool Edge Data

Data input is completed and the data input window is closed after confirming the entry by pressing the <Enter> key. The input value is accepted into the mask of values and directly transmitted into the MT-CNC.

When terminating the line editor by pressing <Esc>, the selected data remains unchanged regardless of the data input line's current contents.

Modifying Tool Corrections using the <Enter> key

Besides using function keys <F1> to <F3> to call up the data input window, the <Enter> key can be used to directly activate the window.

1) Position the cursor to the data to be modified.
2) Press the <Enter> key. The data input window is opened. Data input is terminated by pressing the <Enter> key again.

The following presetting is valid:

- Only functions <F2> 'Modify additiv' or <F3> '∅-Diff. additiv' are activated by the <Enter> key.
- In case of 'correction type 3' (mainly turning tools), <F3> '∅-Diff. additiv' is automatically selected for 'L2'. This is the direction in 'G18' plane.
- <F2> 'Modify additiv' is automatically selected for the other geometry data.
- The function key related to the window's modifying mode is indicated when opening the window by pressing <Enter>.

With cursor positioning, the status line indicates at it's right boundary which modifying mode will be activated for the selected field when pressing <Enter>.

Comparison with Setup List Data

If the tool is used within the NC program, then the tool is contained in the active program's setup list. Tool status bit 2=1, and the MT-CNC performs a complete comparison between setup list data and active tool list data after transmitting the data of the relevant data set. In this comparison, basic tool data and tool edge data status bits are also set or reset .

A global error message is generated by the MT-CNC after completion of geometry data entry, if input data is incorrect:

```
'Invalid tool data'
```

WARNING

⇒ Incorrect data is immediately reported by the control. The error does not effect process status 'Ready for Operation'. The error status bits are also set or reset instantly. In order to prevent incorrect data from becoming active during operation, it must be corrected immediately.

After data modification, the MT-CNC performs an automatic tool check at the next cycle start for the relevant process, if

- an error was generated prior to or after modification, or if the warning limit is reached.

Modify the Active Tool, the Tool in the Gripper or Tool Spindle

The following must be fulfilled, if the tool to be modified is located in the tool spindle or gripper, or is the active tool:

1) the process is not active,
2) STOP-signal must be applied, if process is still active (NC program in execution).

If STOP-signal is not applied in case 2, the following error message is displayed:

```
'Process still activ'
```

The following process parameters are valid for data input on wear and offset values:

- BXX.025 max. entry for length wear,
- BXX.026 max. entry for radius wear,
- BXX.027 max. entry for length offset,
- BXX.028 max. entry for radius offset.

The user interface automatically detects these limits and generates an error message if exceeded.

5 Tool Data Setup List

When creating an NC program, it is determined by programming T-numbers which tools are required for the relevant program.

The tools required for executing an NC program are entered in the setup list. The setup list represents the required tool equipment.

The setup list entry for tool name, first of all, determines when a certain tool is required to be present in the relevant tool storage of the process for program execution. Furthermore, a whole series of required data, that a tool must meet for machining, can be defined in the setup list.

The setup list is assigned to an NC program and contains all tool data required for NC program execution. On the other hand, the tool list or active tool list contains the actual data of the tools in tool storage.

For the individual setup list data see appendix 6.3 and 'Tool Management' description, section 2.

On the basis of the setup list, the presence of all tools required for machining is guaranteed within the automatic tool check. By definition of required tool data, their usability is also guaranteed (see 'Tool Management' description, section 5).

With a NC program start, the automatic tool check compares the current tool storage device (Active Tool List, see section 4) of a process with the active programs required tool data represented by the setup list.

If the tool storage device does not match the required tools of the setup list, or the detailed tool data does not satisfy the data preset by the setup list, the following message is generated after program start:

```
'Active tool list does not match the setup list'
```

The active tool list's incorrect data must now be corrected, so that all setup list requirements are fulfilled. In this way a correct NC program execution is guaranteed.

5.1 Setup List Organization Forms

The setup lists are basically valid for NC programs within a NC program package. Every NC program package has it's own setup list if required. The setup list is automatically downloaded into MT-CNC when downloading a NC program package.

System parameter 'A00.053 - 'Setup List Organization Form' determines, whether a setup list must be defined for each NC program package, or the setup list is valid for all NC programs of the relevant process.

Station (Process) specific Setup List Organization Form

The station (process) specific organization form allows the placing of **one** setup list for **each** process within an NC program package. The setup list is then valid for all 99 NC programs possible for the process. This is advantageous if the tool requirements of the various programs do not vary that much and the tool storage can be equipped with all the tools required.

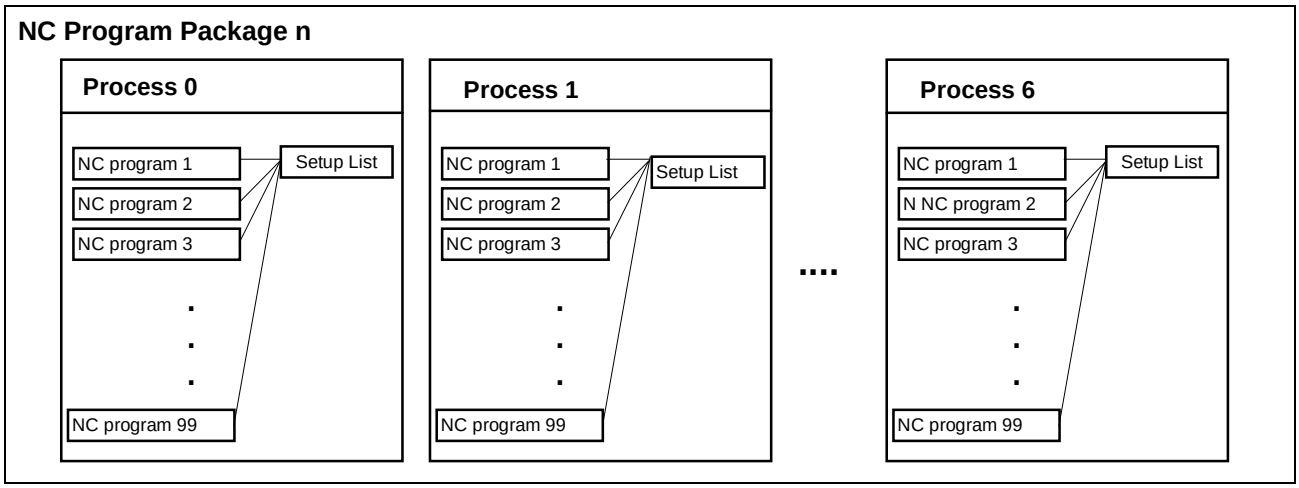


Fig. 5-1: Station (Process) specific Setup List

Program specific Setup List Organization Form

Program specific setup lists enable the user to define setup lists for each of the 99 possible NC programs of a process. The program specific setup list is recommended if NC programs vary and frequent tooling is required. In this way, it guarantees that after a program change no errors in tool equipment occur.

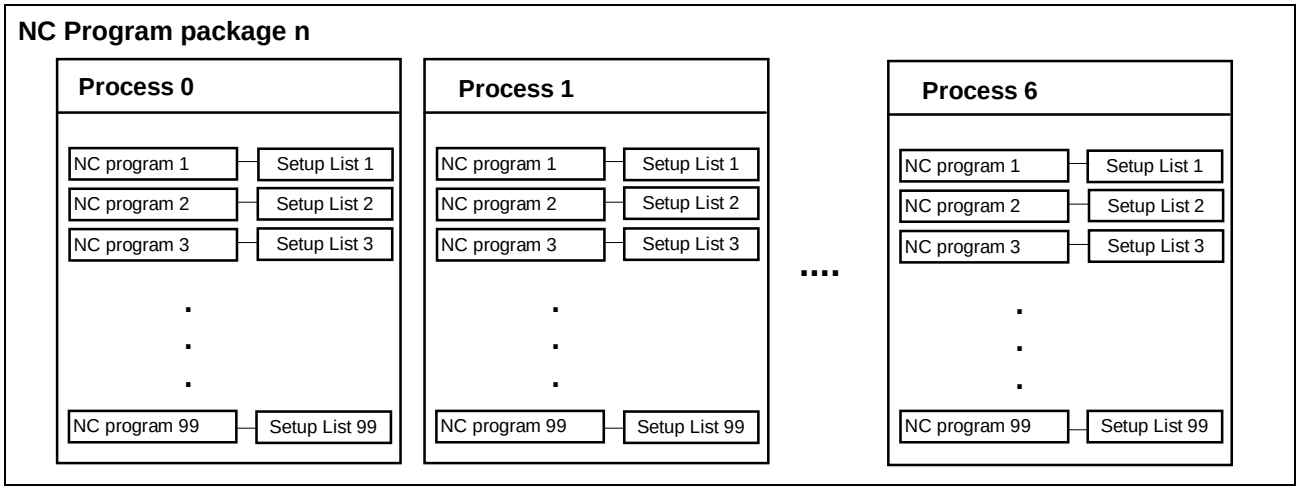


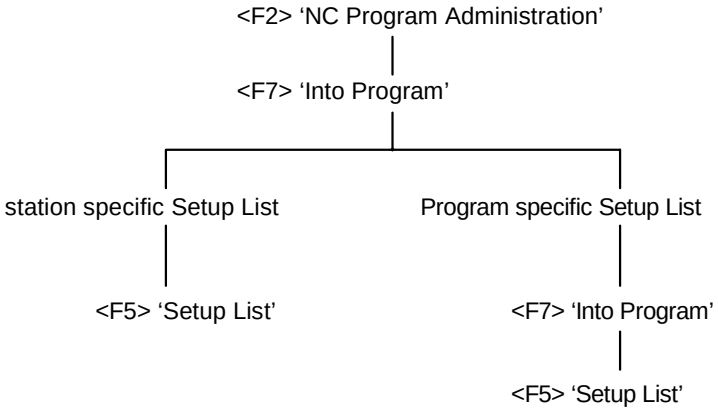
Fig. 5-2: Program specific Setup List

5.2 The Setup List within the Control System

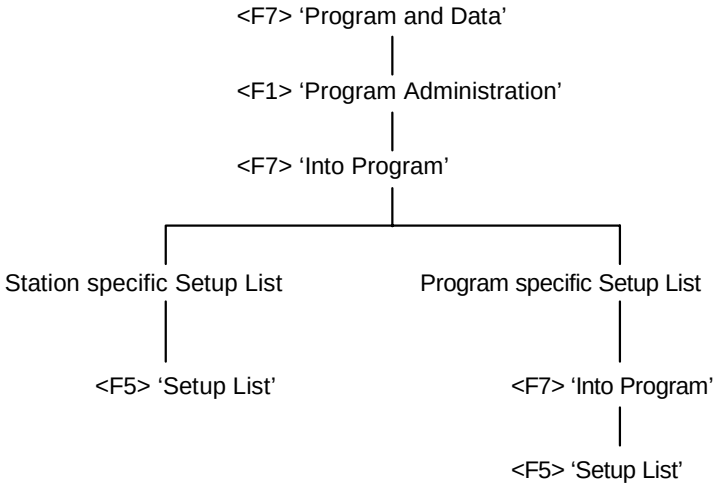
The Setup Lists containing the required tool data is assigned to a program package's NC programs (see section 5.1, page 5-1). Setup Lists are handled in NC Program Administration.

Standard User Interface (MUI) NC Program Administration

- From main menu:



- From Graphical User Interface main menu item 'Production Administration': The following is only an example. The "Program Administration key is user defined in the GUI and can be located anywhere within the GUI function key settings.



Like NC programs, setup lists can be prepared during machining or in off-line mode.

Setup list are downloaded together with the NC program packages. The setup lists downloaded in this way are then active within the control. The subsequent NC program start initiates an automatic tool check in order to compare the data with the active tool list.

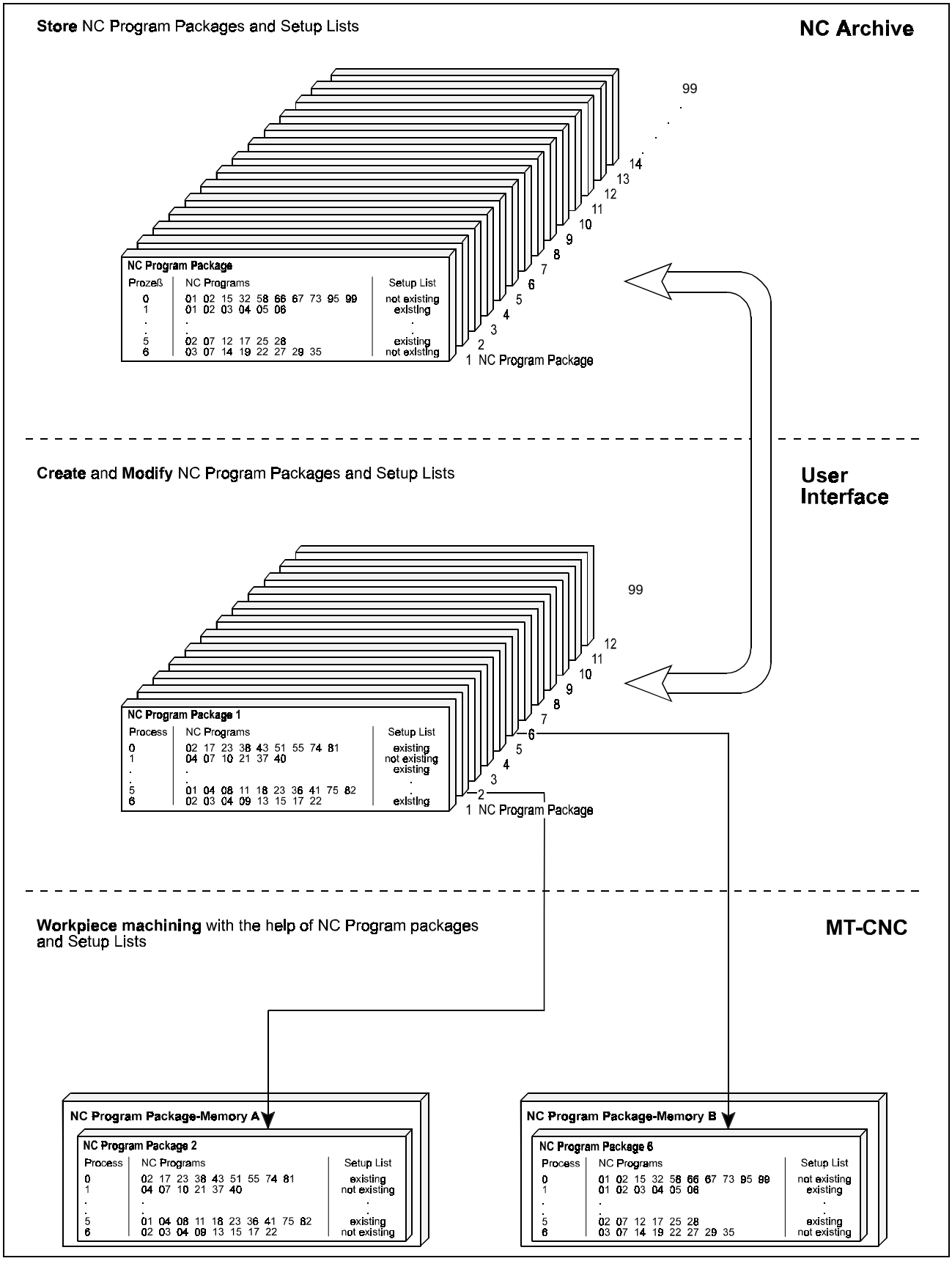


Fig. 5-3: NC Programs and Setup Lists

5.3 Editing Setup Lists

Section 5.2 (page 5-2) describes how to Access the setup lists depending on the organization form (station or program specific).

An index containing tools sorted by tool number is displayed after pressing function key <F5> 'Setup List'.

Fig. 5-4: Setup List

The tools entered to the list can be programmed

- for one program in case of program specific organization and
- for all programs of the relevant process in case of station specific organization of the setup list.

Every entry of the list corresponds to a tool required in the NC program.

WARNING

⇒ Setup list entries do not correspond to a tool physically existing at the machine. Such an entry only determines, that such a tool with the tool number entered is programmed in the relevant NC program and in this way is required for machining. The tools actually existing in the tool storage are entered to the active tool list.

Data Display for each Setup List Location

The following data is displayed for each setup list location:

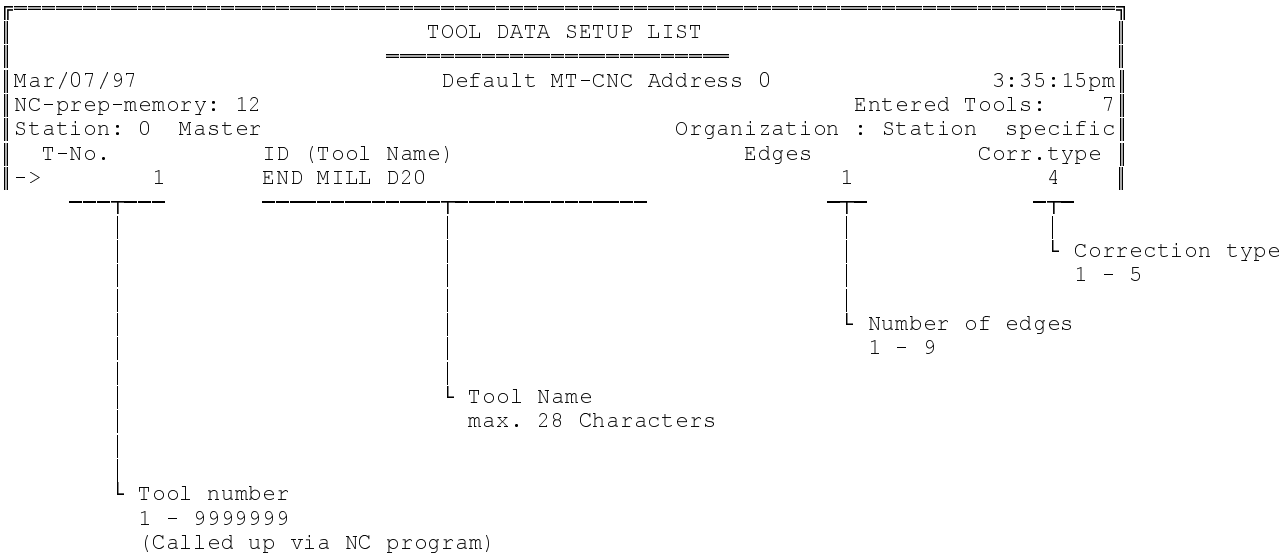


Fig. 5-5: Data Display for each Setup List Location

See appendix 6.3 for detailed data description.

Setup List Editing Functions

<F1>	Enter a Tool	Inserts a tool to a vacant index no. of the setup list.
<F2>	Erase a Tool	Erases a tool from the setup list.

<F4>	Print Setup List	Prints the selected setup list.
<F7>	Tool List Data	Display detailed data of the tool selected.
<F8>	Into Program	Back to NC program (program specific organization) or NC program index(station specific organization).
<Ctrl>+<F8>	NC Program Package Index	back to 'NC Program Package Index'.

Once a setup list is created or modified, the corresponding NC program package must be downloaded into the MT-CNC to make the setup list valid.

NC program package download takes place in 'NC Program Package Index' menu using function <F6> 'NC Package ⇒ MT-CNC'.

Enter a Tool

A new tool can be entered to the setup list using function key

<F1> Enter a Tool

in menu 'Tool Setup List'.

Function key <F1> calls up a screen containing the basic tool data. Once the basic tool data have been entered completely, pressing <PageDown>, leads to the tool edge data to be entered.

The following error message is output if an already existing tool number is entered to the basic tool data:

```
'Invalid tool number'
```

The user interface retrieves all data subsequently. Data input takes place directly at the screen mask. All data, except 'Tool Name', are predefined with default values. This data needs to be adapted to the required data of the tool to be entered.

Pressing the <Enter> key completes data input for every data field. The cursor automatically proceeds to the next data field. The <Tab> key or <Shift>+<Tab> can be used to move the cursor forwards or backwards.

The size of the entire required tool data set (basic tool data and tool edge data) depends on machine parameter setting. Relating to the number of edges and geometry data, tool edge data to be entered depend on number of edges and correction type entered to the basic tool data. All data input screens for basic tool data and tool edge data is automatically configured and displayed accordingly to view the respective data. Redundant data is not displayed.

See appendix 6.1 for dependency between a tool data set and machine parameter as well as geometry data and correction type.

The following basic tool data is displayed in every tool edge data screen:

- 'ID' (Tool Name),
- Tool Number.

The tool edge number displayed is shown at the right boundary.

A valid entry must be given for 'Tool Name' (ID). The following error message is output, if an attempt is made to continue or to complete data entry without a valid tool name:

```
'Invalid tool name!'
```

Enter a Tool to the Setup List

1) Press <F1> key 'Enter a Tool' in menu 'Tool Data Setup List' (see Fig. 5-4). A data input screen containing the basic tool data to be input is displayed.

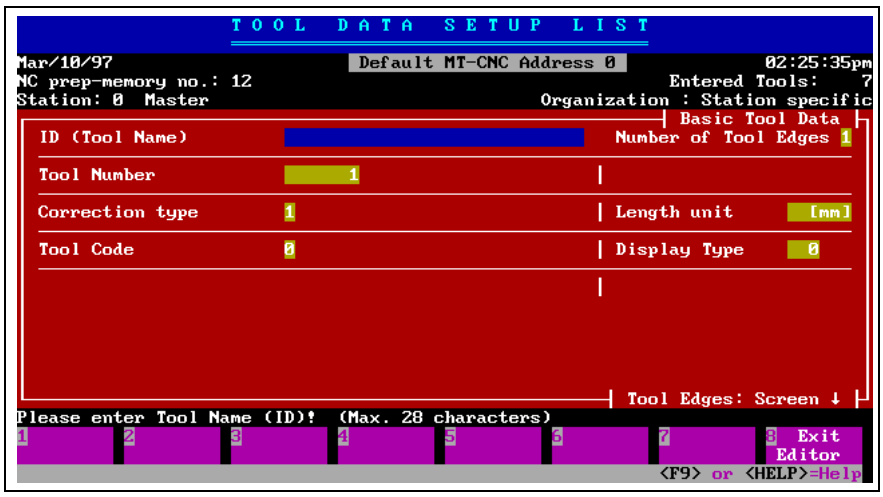


Fig. 5-6: Predifined Basic Tool Data

2) After data entry for the basic tool data is completed, pressing <PageDown> key proceeds to the tool edge data of tool edge no. 1.

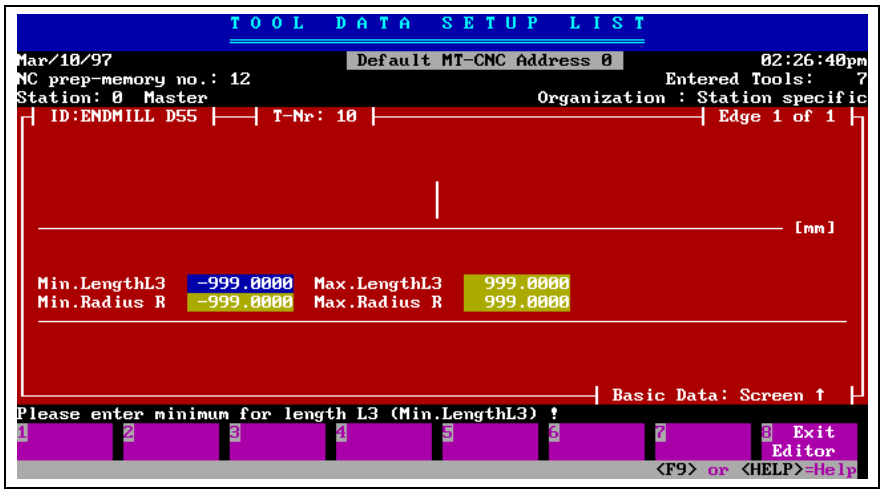


Fig. 5-7: Predifined Tool Edge Data (Correction Type 2)

The screen shown in Fig. 5-7 is displayed provided that ‘Correction Type 2’ was entered in basic tool data. Also, in this case, the required tool edge data is retrieved subsequently. The geometry data limits as well as the wear factors for length ‘L3’ and ‘R’ are entered depending on the parameter setting (see appendix 6.1). Tool edge data input screens can be called up as many as defined in basic tool data by pressing <PageDown>.

3) Pressing function key <F8> in either a tool edge data or the basic tool data input screen terminates data input and accepts the entire data set to the setup list. Besides this, the tool appears in the menu ‘Tool Data Setup List’ at the tool number specified (see Fig. 5-4).

Function <F1> ‘Enter a Tool’ can be stopped at any time by pressing <Esc>. The data entered as well as the tool number specified are then discarded.

Display and Edit Setup List Data

Function key

<F7> ‘Tool List Data’

in menu ‘Tool Data Setup List’ is used to display and edit tool data of a tool already entered to the setup list(see Fig. 5-4).

A setup list tool data set is structured as follows:

- basic tool data
- tool edge data 1 ... 9

data area

The size of the entire tool data set (basic tool data and tool edge data) depends on machine parameter setting. Relating to the number of edges and geometry data, the tool edge data to be entered is dependent on the number of edges and correction type entered to the basic tool data. All data input screens for basic tool data and tool edge data is automatically configured and displayed according to this data.

See appendix 6.1 for dependency between a tool data set and machine parameter setting as well as geometry data and correction type.

Tool and tool edge status bits are only displayed in the active tool list during machining (see section 3). See also appendix 5.4 Tool Management’ description, section 4.

Display Basic Tool Data

Pressing

<F7> 'Tool List Data’

in menu ‘Tool List’ leads to the basic tool data of a tool already entered

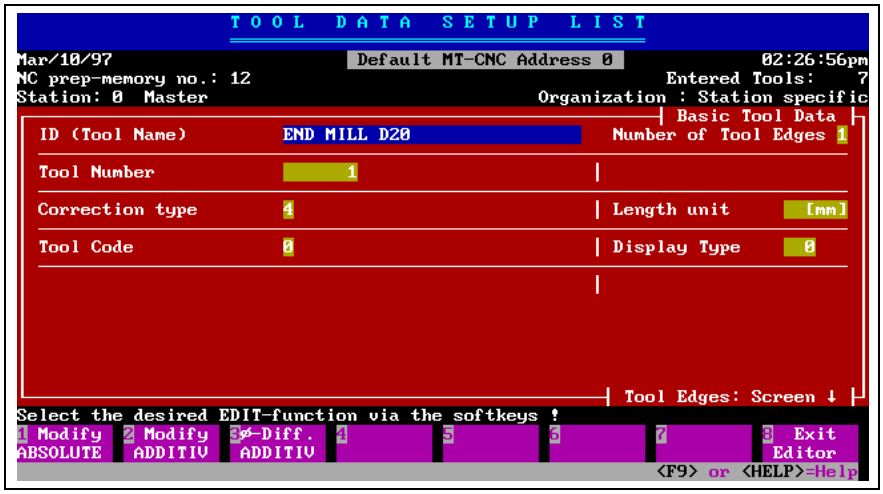


Fig. 5-8: Basic Tool Data (Correction Type 4)

Select Basic Tool Data or Tool Edge Data and Individual Data

Pressing <PageUp> / >PageDown> keys proceeds from basic tool data to the tool edge data and one tool edge data to the next. A complete data area is always selected in this way.

Within a data area (basic tool data or tool edge data), the operator selects an individual basic tool data or tool edge data by positioning the cursor using the <Enter> or <Tab> key. The data editing functions available in the function key line can be used to modify the data.

A scroll bar appears at the boundary line if data cannot be displayed on a single screen. The scroll bar indicates the cursor position regarding the tool edge selected. Data momentarily not shown will be displayed automatically when moving the cursor.

Display Tool Edge Data

The entire tool edge data set is displayed for each tool edge.

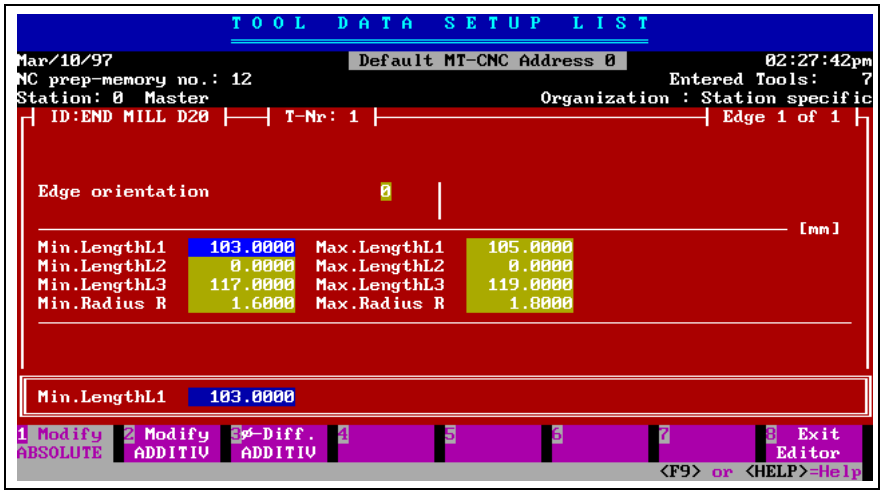


Fig. 5-9: Tool Edge Data (Correction Type 4)

For best orientation, some basic tool data is inserted for each tool edge in the upper boundary line.

Every tool edge data screen contains the following basic tool data:

- 'ID' (Tool Name),
- Tool number.

The tool edge number displayed is shown at the right boundary.

Modify Basic Tool Data and Tool Edge Data

Modifying tool data within the setup list is performed by selecting a tool from the setup list (menu Tool Data Setup List, see Fig. 5-4) and pressing function key

<F7> 'Tool List Data'.

WARNING

⇒ Data modified within the setup list does not become active in the MT-CNC. Modified data becomes active within the MT-CNC only when downloading the relevant NC program package containing the setup list to the MT-CNC.

Data modified in the setup list are first stored on the PC's harddisk.

NC program package download into MT-CNC is performed by pressing function key <F6> 'NC Program Package ⇒ MT-CNC' in menu 'NC Preparation Memory.

After the setup list data of a NC program package in either memory 'A' or 'B' has been modified, the highlighted representation of the relevant NC program package is removed.

Functions	**<F1>**	Modify absolute	Absolute data entry. The input value is accepted immediately.
	<F2>	Modify additive	The input value is added to the existing value.
	<F3>	∅-Diff. additive	The input value is divided in half and added to the existing value (correction type 3, turning tool, G18, for L2 (X) only)

Modifying Individual Tool Data

1) Move cursor bar to the desired field within basic tool data screen or tool edge data screen using the <Enter> key or the <Tab> key.

2) Press function key <F1> or <F2> or<F3>. A data input window appears where the selected data can be modified.

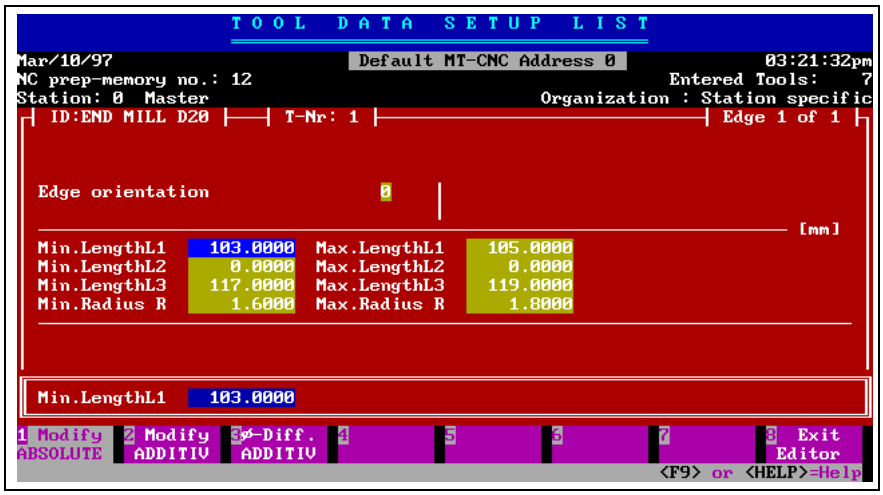


Fig. 5-10: 'Modify ABSOLUT' of Tool Edge Field ‘L1_min’

The cursor flashes at the first segment position of the value field. The data can now be entered as per the input format (see appendix 6.3).

Data input is completed and data input window is closed after confirming the entry by pressing the <Enter> key. The input value is accepted into the mask of values and stored on PC’s harddisk.

When exiting the line editor, by pressing <Esc>, the selected data remains unchanged regardless of the data input line’s current contents.

At least one character or a number out of the admissible data range must be entered for ‘ID’ and Index number.

The following message appears if an attempt is made to continue or to end data entry without a valid tool name:

```
'Invalid tool name!'
```

3) After all modifications are completed, all data is accepted in the setup list by pressing function key <F8>. An abandonment using <Esc> discards all modifications and leaves the tool’s data unchanged.

4) Pressing key combination <Ctrl>+<F8> ‘Into Program’ exits the setup list and reverts back to NC preparation memory.

5) The entire NC program package containing the setup list with the modified tool must be downloaded into the MT-CNC in order to make the modified data valid.

   NC program package download takes place in menu ‘NC Preparation Memory’ using function <F6> ‘NC Program package ⇒ MT-CNC'. Do not execute step 5) in case of off-line modification of setup list tool data (for example during preparation).

After the NC program package downloads, an automatic tool check is performed together with the subsequent program start of the relevant process.

6 Appendix

6.1 Consideration of Machine Parameter and Correction Type when displaying Tool Data

A number of setup and tool list data or active tool list data is available. The system and process parameter determine whether the relevant are used in the existing tool management (see appendix 'tool specific parameter' of 'Tool Management' description'). If such data is not supposed to be used, according to machine parameter setting, it does not appear in the screen masks containing the detailed tool data.

Besides the machine parameter, also the correction type entered to the basic tool data leads to an automatic adaptation of the screens containing tool data. The correction type determines the coordinate direction, in which the geometry corrections become valid. Only geometry corrections affiliated to a correction type are accessible and considered in tool edge data display.

An automatic adaptation of the MUI's tool data handling to the machine parameter and the tool types used takes place in any area, where tool data can be displayed and/or modified.

The use of the tool corrections in accordance with the regulations requires a Cartesian coordinate system. At least one of the three main axes must be physically present.

Among machining, the following planes can be selected independent of the existing number of axes:

- XY (G17)
- ZX (G18)
- YZ (G19)

Tool length correction 'L3' is always effective perpendicular to the active plane. Length corrections 'L1' und 'L2' as well as the tool nose radius or cutter radius are always effective in the active plane.

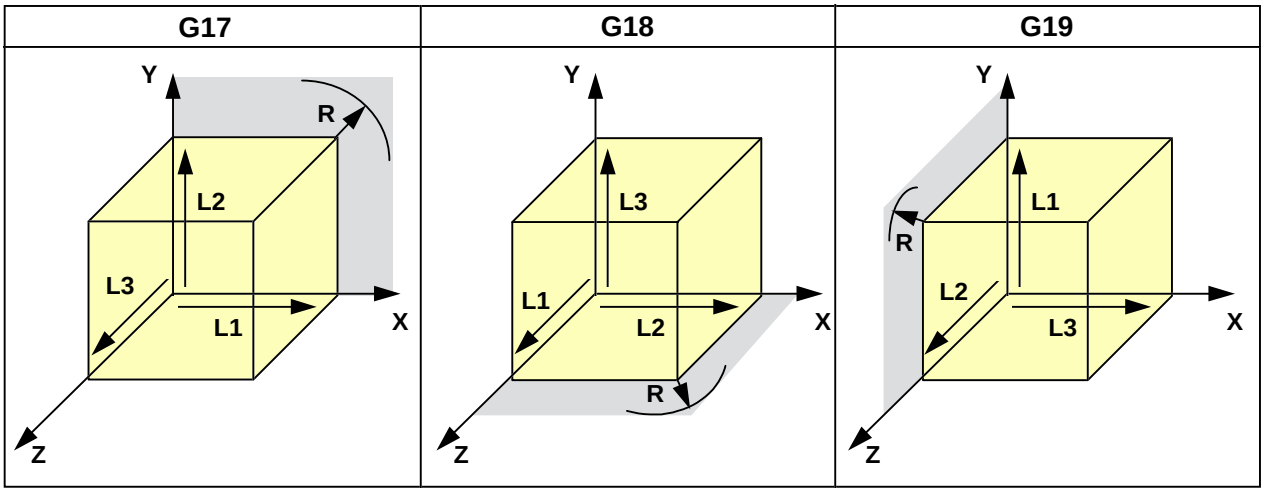


Fig. 6-1: Mode of Action L1, L2, L3, R depending on the plane selected

Tool List - Active Tool List

The following describes the difference between tool list and active tool list:

Tool List The tool list belongs to 'Tool List Preparation' and contains data which are stored only on the PC.

Active Tool List The active tool list on the other hand contains actual MT-CNC data.

I. Tool List Preparation	II Online Data Handling
Tool List Preparation serves the tool data preparation and storing with the help of the MUI (PC) independent of control operation: – Create and store tool lists (0...99) for each process and store on PC (off-line and online operation), – Download of tool lists from MUI (PC) into MT-CNC (one per process), – Tool list upload (one per process) from MT-CNC to MUI (Store actual tool data on PC).	Online Data Handling allows to display and modify the active tool list of every process with tool management: – Display and modify MT-CNC's active tool list, – Display and modify individual tool data directly in the MT-CNC.

WARNING

⇒ If the PC is not connected to the control (off-line operation), calling up the tool data handling directly branches to the Tool List Preparation (off-line data on PC). Online data cannot be called up or modified.

⇒ If the PC is connected to the MT-CNC (online operation), online data (active tool list) is displayed first after calling up tool data handling. Key combination <CTRL>+<F8> calls up 'Tool List Preparation'.

Consideration of Machine Parameter when displaying Basic Tool Data

System parameters

- + AXX.061...AXX.069, Description of user tool data XX,
  + AXX.075...AXX.082, Symbol for user tool status bits XX,

are evaluated for basic tool data display.

These are the user definable user data designations and user status bit symbols. The settings apply to all tools of the system (process 0 ... 6), because these parameters are system parameters.

No data is displayed if no designations or symbols are given to these parameters.

The field 'old location', is only displayed, if

- *process parameter*
  + BXX.015 Type of Tool Storage

is set to 'Magazine'.

Consideration of Machine Parameter when displaying Tool Edge Data

The following system parameters are considered for tool edge data display:

- *System parameter*
  + AXX.055 Wear factor register,
  + AXX.056 Offset register,
  + AXX.058 Wear factors,

+ AXX.059	Tool life data
+ AXX.060	Tool geometry limits,
+ AXX.070...BXX.074	Description of user tool edge data XX,
+ AXX.083...BXX.086	Symbol for user tool edge status bit

These settings apply to all tools of the system (process 0 ... 6), because these parameters are system parameters.

If parameter no. 55, 56, 58, 59 or 60 are set to 'no', the relevant data is not displayed. No data is displayed if no designations or symbols are given to parameter no. 70 ... 74 or no. 83 ... 86 .

Consideration of the Correction Type when displaying Tool Edge Data

The following representation considers the relationship between coordinate direction (axis designation) and geometry data index in dependency of the correction type (see 'Tool Management' description and appendix 6.2, page 6-7).

The data named in the tables are automatically considered in the screen mask according to the correction type entered to the basic tool data. In addition, machine parameters are considered. All data marked 'p' are parameter depending.

Correction Type 1: Tools of this correction type have only one length correction that is always perpendicular to the active plane. Only data indexed '3' is displayed. The index '3' itself is not displayed.

Example:

Drilling Tool, length L3; wear L3; offset L3

Geometry data	Geometry limits	Wear values
geometry wear (p) offset (p)	length min., length max.	wear factor (p)

Correction Type 2: Tools of this correction type have only one length correction 'L3', that is always perpendicular to the active plane. A radius correction (R) in the active plane is also performed.

Only data indexed '3' as well as the radius are displayed.

The index '3' itself is not displayed.

The field 'Tool edge orientation ' is not displayed.

Example:

Milling tool, length L3; wear L3; offset L3; radius R

Geometry data	Geometry limits	Wear values
geometry wear (p) offset (p)	length min., length max.	wear factor (p)
geometry R wear (p) offset (p)	R_min, R_max (p)	wear factor R (p)

Correction Type 3: Tools of this correction type can have two length corrections (L1, L2) and a radius correction within the active plane.

Only data indexed '1' and '2' as well as the radius are displayed.

Example:

Turning tool; length 1,2; wear 1,2; offset 1,2; radius R

Geometry data	Geometry limits	Wear values
geometry L1,2 wear L1,2 (p) offset L1,2 (p)	L1_min, L1_max (p) L2_min, L2_max (p)	wear factor L1 (p) wear factor L2 (p)
geometry R wear R (p) offset R (p)	R_min, R_max (p)	wear factor R (p)

Correction Type 4: Tools of this correction type have length correction (L1, L2, L3) for all three main axis (x,y,z) and a radius correction (R) in the active plane. The length L3 is always perpendicular to the active plane, while L1 and L2 reside in the active plane. All data is displayed with the relevant index.

Example:

Right angle milling tool; length 1,2,3; wear 1,2,3; offset 1,2,3;
radius R; wear R ; offset R

Geometry data	Geometry limits	Wear values
geometry L1,2,3 wear L1,2,3 (p) offset L1,2,3 (p)	L1_min, L1_max (p) L2_min, L2_max (p)	wear factor L1 (p) wear factor L2 (p) wear factor L3 (p)
geometry R wear R (p) offset R (p)	R_min, R_max (p)	wear factor R (p)

Correction Type 5: A tool with correction type 5 (tool gripper) can perform length corrections in all directions of the main axes (X, Y, Z) via the length correction (L1, L2, L3). Length L3 works always perpendicular to the active plane, while length L1 and L2 always work in the active plane. The correction type 5 corresponds to correction type 4 with the difference that it has no radius R correction.

WARNING

⇒ If the individual tool data is accessed via ‘Active Tool List (Location)’ or ‘Active Tool List (GEO)’ during online operation using <Ctrl>+<F7> ‘Tool List Data’ the geometry values, geometry limits as well as tool wear values are displayed in tool edge data depending on parameter settings. If defined in machine parameter, wear factor and geometry limits are setup list data. They can only be modified in the setup list and are only displayed in the active tool list (online data). They are not displayed in the tool list (Tool List Preparation).

The ‘Active Tool List (GEO) only displays geometry data depending on parameter setting.

When calling up individual tool data from Tool List Preparation via
<Ctrl>+<F7> 'Magazine Lists' (online operation only)
<F7> 'To Tool List'
<F7> ‘Tool List Data’,

geometry limit wear values do not appear in the tool edge data display, because this is a setup list data as mentioned above.

Tool list data and active tool list data (setup list data and tool list data) are described in detail in 'Tool Management' description, section 3 and section 4 and in appendix 6.3.

Setup List

Consideration of Machine Parameter when displaying Basic Tool Data

- *System parameter*
  + A00.057 Comment (assembly regulation)

is considered for setup list basic tool data display.

A comment of max. 5 x 76 characters can be entered to the basic tool data, if this parameter is set to 'yes'. For example, this comment may contain a regulation for the machine operator.

Consideration of Machine Parameter when displaying Tool Edge Data

The following system parameters are considered for tool edge data display:

- *System parameters*
  + A00.058 Wear factors,
  + A00.059 Tool life time,
  + A00.060 Geometry limits

These settings apply to all tools of the system (process 0 ... 6) because these parameter are system parameters.

If parameters no. 58, 59 or 60 are set to 'no', the relevant data is not displayed.

Consideration of the Correction Type when displaying Tool Edge Data

The following representation considers the relationship between coordinate direction (axis designation) and geometry limit index or wear factors in dependency of the correction type (see ‘Tool Management’ description).

The data named in the tables are automatically considered in the screen mask according to the correction type entered to the basic tool data. In addition, machine parameters are considered. All data marked 'p' are parameter depending.

Correction Type 1: Tools of this correction type have only one length correction that is always perpendicular to the active plane. Only data indexed ‘3’ is displayed. The index ‘3’ itself is not displayed.

Example:

Drilling Tool, length L3

Geometry limits	Wear values
length min., length max.	wear factor L

Correction Type 2: Tools of this correction type have only one length correction ‘L3’, that is always perpendicular to the active plane. A radius correction (R) in the active plane is also performed.

Only data indexed ‘3’ as well as the radius are displayed.

The index ‘3’ itself is not displayed.

The field 'Tool edge orientation' is not displayed.

Example:

Milling tool, length L3;radius R

Geometry limits	Wear values
length min., length max.	wear factor L (p)
R_min, R_max (p)	wear factor R (p)

Correction Type 3: Tools of this correction type can have two length corrections (L1, L2) and a radius correction within the active plane.

Only data indexed ‘1’ and ‘2’ as well as the radius are displayed.

Example:

Turning tool; length 1,2; radius R

Geometry limits	Wear values
L1_min, L1_max (p) L2_min, L2_max (p)	wear factor L1 (p) wear factor L2 (p)
R_min, R_max (p)	wear factor R (p)

Correction Type 4: Tools of this correction type have length correction (L1, L2, L3) for all three main axis (x,y,z) and a radius correction (R) in the active plane. The length L3 is always perpendicular to the active plane, while L1 and L2 reside in the active plane. All data is displayed with the relevant index.

Example:

Right angle milling tool; length 1,2,3; radius R

Geometry limits	Wear values
L1_min, L1_max (p) L2_min, L2_max (p) L3_min, L3_max (p)	wear factor L1 (p) wear factor L2 (p) wear factor L3 (p)
R_min, R_max (p)	wear factor R (p)

Correction Type 5: A tool with correction type 5 (tool gripper) can perform length corrections in all directions of the main axes (X, Y, Z) via the length correction (L1, L2, L3). Length L3 works always perpendicular to the active plane, while length L1 and L2 always work in the active plane. The correction type 5 corresponds to correction type 4 with the difference that it has no radius R correction.

WARNING

⇒ The setup lists are accessed via NC program preparation(see section 5).

⇒ A detailed list of setup list data is described in ‘Tool Management’ description, section 2.

6.2 Correction Type and Tool Edge Orientation

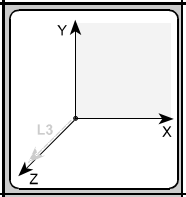
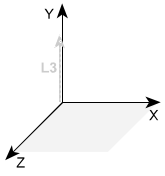
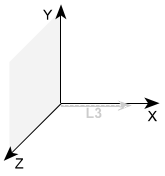
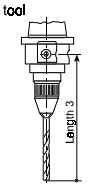
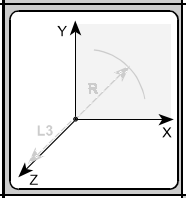
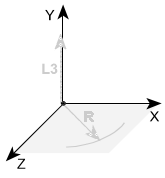
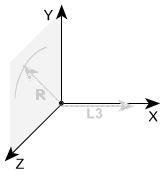
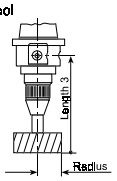
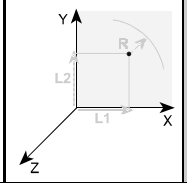
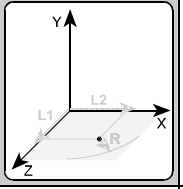
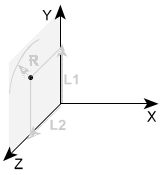
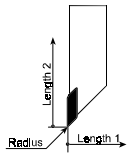
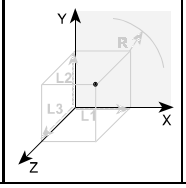
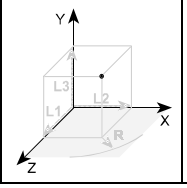
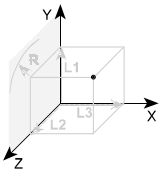
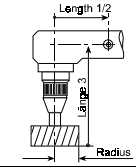
Type	Active Corrections	Function of Correction			Example	Edge Orientation
		G 17	G 18	G 19		
1	1 Correction: 1 length correction perpendicular to the active plane				Drilling tool 	0
2	2 Corrections: 1 length correction perpendicular to the active plane Radius correction in the active plane				Milling tool 	0
3	3 Corrections: 2 length corrections in the active plane Radius correction in the active plane				Turning tool 	0 - 8
4	4 Corrections: 1 length correction perpendicular to the active plane 2 length corrections in the active plane Radius correction in the active plane				Right angle mill 	0 - 8

Fig. 6-2: Possible Correction Types

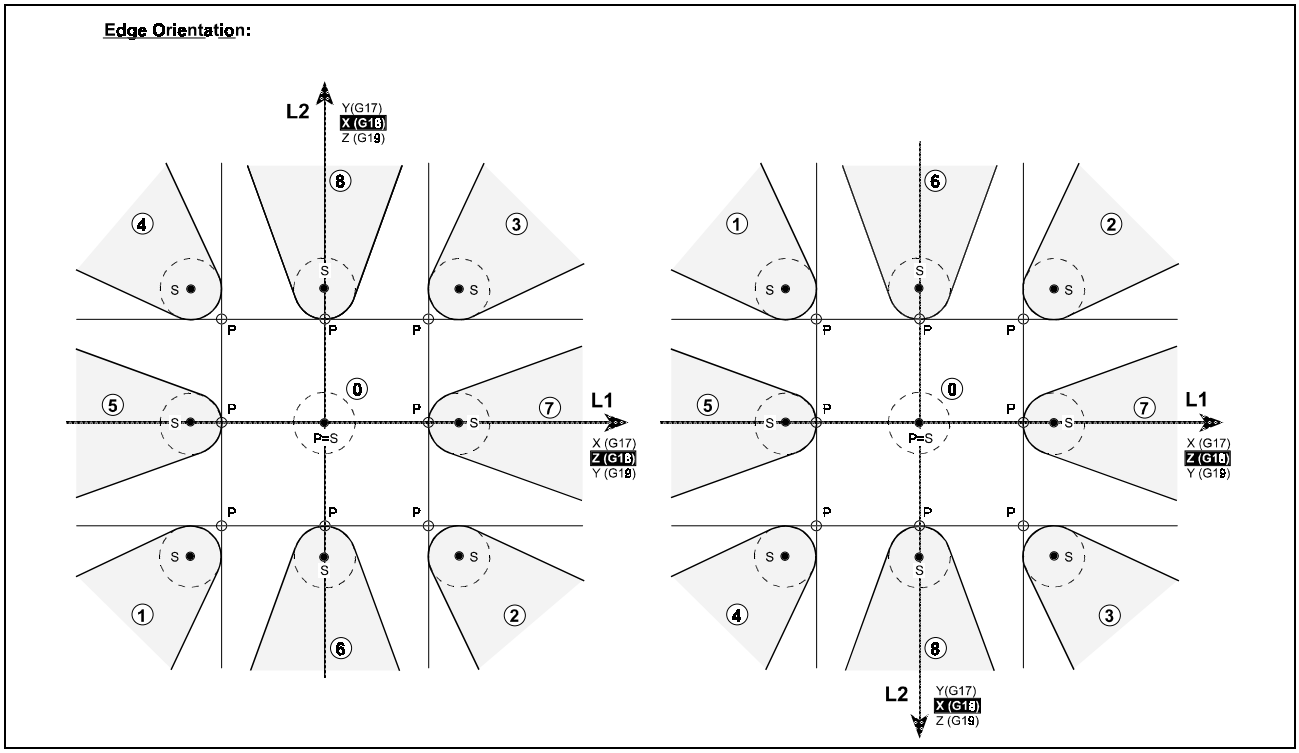


Fig. 6-3: Possible Tool Edge Orientations

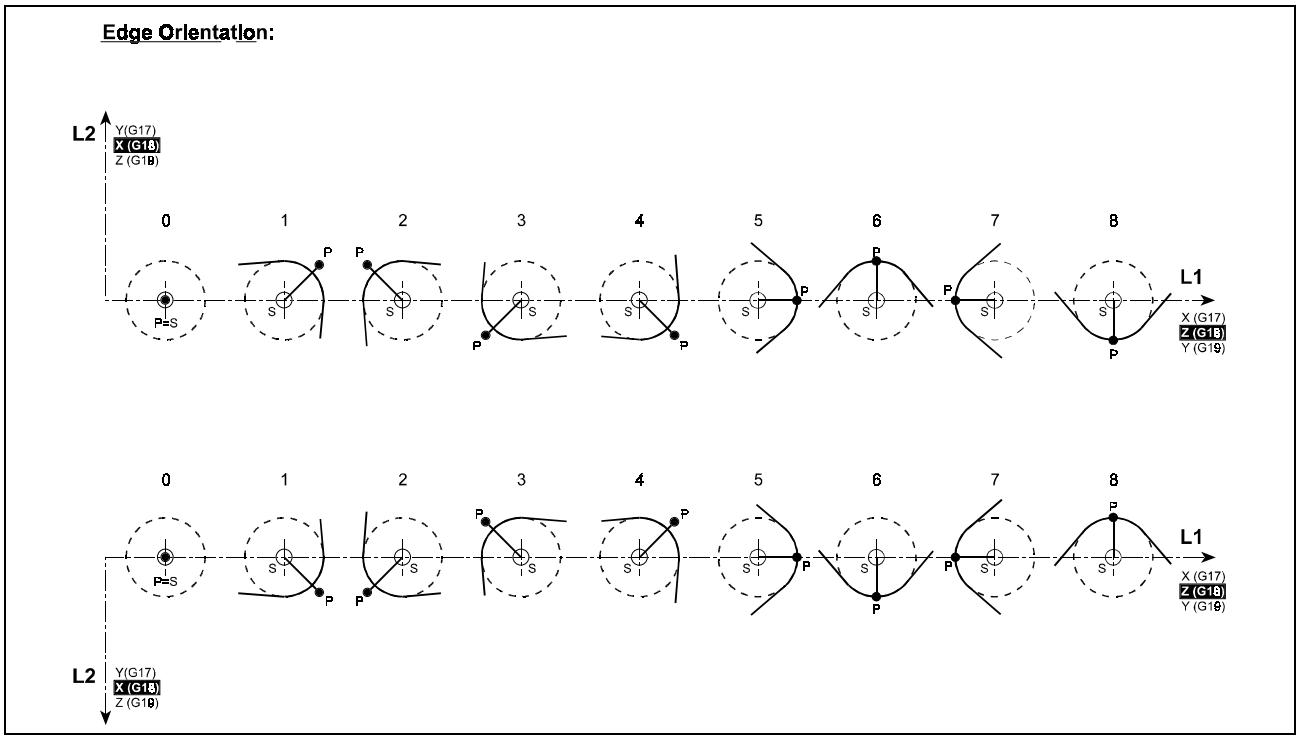


Fig. 6-4: Possible Tool Edge Orientations

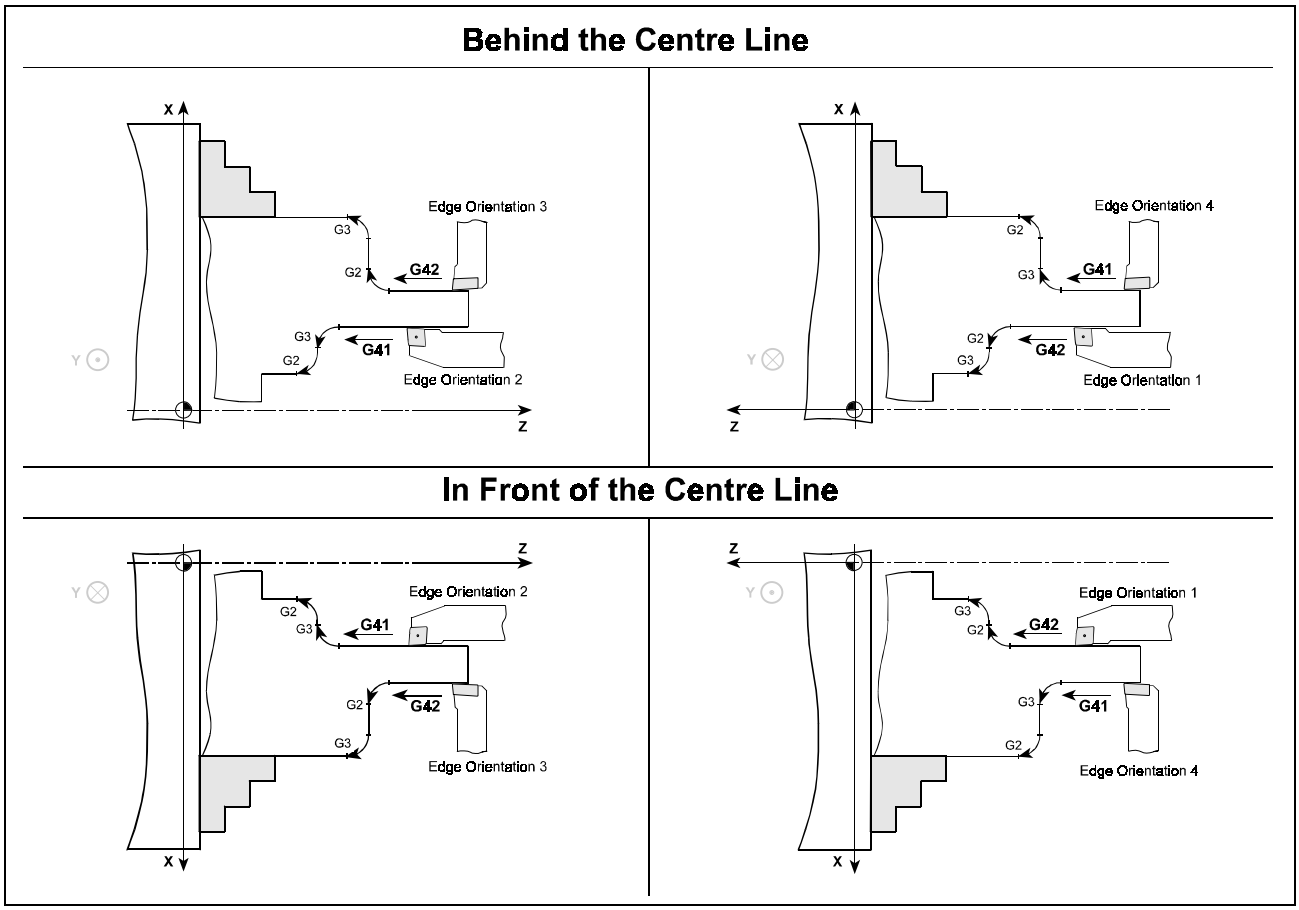


Fig. 6-5: Tool Nose Radius/Cutter Radius Compensation in G18 Plane

6.3 Active Tool List Data

The data below are online data from MT-CNC.

Description	Value Range	Unit	DE	OP	SL	TL
Basic Tool Data						
Tool Identification						
Index address	hexadecimal long word with 32 bit (read only)	-	01			X
ID (Tool Name)	up to 28 case sensitive characters	-	02		X	X
Storage	0 - 2 (0: magazine/turret, 1: spindle, 2: gripper)	-	03			
Location	1 - 99		04			
T-number	1 -9999999	-	05		X	
Index no.	1 - 999		06			X
Correction type	1 - 5	-	07		X	X
No. of edges	1 -9	-	08		X	X
Tool status	0/1	-	09			X
Location data						
Free half location	0 - 4	-	10			X
Old location	1 - 999	-	11			X
next E/T memory	0 - 2 (0: magazine/turret, 1: spindle, 2: gripper)	-	12			
next E/T location	1 - 999	-	13			
prev. E/T memory	0 - 2 (0: magazine/turret, 1: spindle, 2: gripper)	-	14			
prev. E/T location	1 - 999	-	15			
Units						
Time unit	0/1 (0: [min], 1: [cycl])	-	16		X	
Length unit	0/1 (0: [mm], 1: [inch])	-	17		X	X
Technology data						
Tool code	1-99		18		X	X
Type of representation	0-999		19		X	X
User data						
User tool data 1	$+/- 1.2 * 10^{-38}$ - $+/- 3.4 * 10^{+38}$ und 0 (mom. entry via MUI as with geometry data)	any	20	X		X
:				X		X
User tool data 9	$+/- 1.2 * 10^{-38}$ - $+/- 3.4 * 10^{+38}$ und 0 (mom. entry via MUI as with geometry data)	any	28	X		
Comment	up to 5 x 76 characters each	-			X	
Tool Edge Data						
Edge ID						
Edge Orientation	0 - 8	-	01		X	X
Edge Status	0/1 (16 status bits)	-	02			X
Tool Life Data						
Remaining Tool Life	0.00 - 100	%	03	X		X
Warning Limit	0.00 - 100	%	04	X		X
Max. Tool Life	0 - 9999999 (0: no tool life monitoring)	min or cycl.	05	X	X	
Tool Life	0 - 9999.999	min or cycl.	06			
Geometric Data						
Length L1	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	07			X
Length L2	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	08			X
Length L3	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	09			X
Radius R	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	10			X
Wear L1	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	11	X		X
Wear L2	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	12	X		X
Wear L3	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	13	X		X
Wear R	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	14	X		X
Offset L1	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	15	X		X
Offset L2	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	16	X		X
Offset L3	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	17	X		X
Offset R	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	18	X		X
Geometry Limits						
L1_min	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	19	X	X	
L1_max	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	20	X	X	
L2_min	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	21	X	X	
L2_max	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	22	X	X	
L3_min	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	23	X	X	
L3_max	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	24	X	X	
R_min	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	25	X	X	
R_max	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch	26	X	X	
Tool Wear Factors						
Wear Factor L1	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch/min or cycl	27	X	X	
Wear Factor L2	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch/min or cycl	28	X	X	
Wear Factor L3	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch/min or cycl	29	X	X	
Wear Factor R	-9999.9999 - +9999.9999 or -999.99999 - +999.99999	mm or inch/min or cycl	30	x	x	
Anwenderdaten						
User Edge Data 1	$+/- 1.2 * 10^{-38}$ - $+/- 3.4 * 10^{+38}$ and 0(nom. Entry via MUI: as with geometric data)	any	31	X		X
:		:		:		:
User Edge Data 5	$+/- 1.2 * 10^{-38}$ - $+/- 3.4 * 10^{+38}$ and 0 (nom. Entry via MUI: as with geometric data)	any	35	X	X	X
User Edge Data 6	-9999.9999- +9999.9999 or -999.99999- +999.99999	any	36	X		X
:	:	:	:	:		:
User Edge Data 10	-9999.9999- +9999.9999 or -999.99999- +999.99999	any	40	X		X

Fig. 6-6: Active Tool List Data

Explanations: SL: = setup list specific status bit
TL: = tool list specific data

6.4 Active Tool List's Tool and Tool Edge Status

Active tool list data is online via the MT-CNC.

Group	Definition	Sym	Write by	Type	Bit	Value	Remark
Presence	Tool not present/ Tool present	!	Tool Mgmt.	Setup List	1	1 0	Tool missing
	Tool not required/ Tool required	?	Tool Mgmt.	Setup List	2	1 0	Tool not required for machining
Correction Type Incorrect	Incorrect correction type/ Correction type O.K.	t	Tool Mgmt.	Setup List	3	1 0	Correction type does not meet requirements
Incorrect Edge Amount	Edge amount incorrect/ Edge amount correct	e	Tool Mgmt.	Setup List	4	1 0	Tool edge amount does not meet requirements
Incorrect Edge Data	Edge data incorrect/ Edge data correct	f	Tool Mgmt.	Setup List	5	1 0	Tool edge data does not meet requirements
Spare ! (Bit 6 - 8)							
Block Location	Location blocked/ Location not blocked	B	User Prgs / OP	Locat. Stat.	9	1 0	e.g., location block since damaged
	Upper half location blocked / Upper half location not blocked		Tool Mgmt.	Locat. Stat.	10	1 0	blocked for fixed location tool in gripper or spindle
	Lower half location blocked / Lower half location not blocked		Tool Mgmt.	Locat. Stat.	11	1 0	blocked for fixed location tool in gripper or spindle
Location Reservation	Upper half location reserved / Upper half location not reserved		User Prgs	Locat. Stat.	12	1 0	e.g., to channel a tool in
	Lower half location reserved / Lower half location not reserved		User Prgs	Locat. Stat.	13	1 0	e.g., to channel a tool in
Location Occupancy	Upper half location occupied / Upper half location not occupied		Tool Mgmt.	Locat. Stat.	14	1 0	A tool occupies the upper half location
	Lower half location occupied / Lower half location not occupied		Tool Mgmt.	Locat. Stat.	15	1 0	A tool occupies the lower half location
	Location occupied / Location not occupied		Tool Mgmt.	Locat. Stat.	16	1 0	The location is occupied by a tool
Tool Wear Status	Tool worn out / Tool not worn out	d	Tool Mgmt.	Tool Stat.	17	1 0	Tool worn out (exchange)
	Tool warning limit exceeded / Tool warning limit not exceeded	w	Tool Mgmt.	Tool Stat.	18	1 0	Warning limit of tool life is exceeded
Spare Tools (tool family)	Primary tool / Not a primary tool	p	Tool Mgmt.	Tool Stat.	19	1 0	Primary tool of tool family will be used
	Spare tool / Not a spare tool	s	Tool Mgmt.	Tool Stat.	20	1 0	Spare tools replace worn primary tools
Fixed Location	Tool has fixed location / Tool has no fixed location	C	User Prgs / OP	Tool Stat.	21	1 0	Tool location in Tool magazine is fixed
Tool Locking	Tool is locked / Tool is not locked	L	User Prgs / OP	Tool Stat.	22	1 0	Tools can be locked, e.g., edge is broken
Spare ! (Bit 23 - 24)							
User Tool Status 1	User tool status bit 1 set / User tool status bit 1 reset	any	User Prgs / OP	Tool Stat.	25	1 0	any
: :							
User Tool Status 8	User tool status bit 8 set / User tool status bit 8 reset	any	User Prgs / OP	Tool Stat.	32	1 0	any

Explanations:

Tool Mgmt.: = Tool Management
User Prgs.: = User programs of PLC and NC
OP: = Operator
SL: = Setup list specific status bit
Locat. Stat.: = Location specific status bit
Tool Stat.: = Tool specific status bit

Fig. 6-7: Active Tool List's Tool Status Bits

Group	Definition	Sym.	Write by	Type	Bit	Value
Invalid Edge Orientation	Edge orientation invalid/ Edge orientation valid	o	Tool Mgmt.	SL	1	1 0
Invalid Tool Length L1	Tool length L1 invalid/ Tool length L1 valid	1	Tool Mgmt.	SL	2	1 0
Invalid Tool Length L2	Tool length L2 invalid/ Tool length L2 valid	2	Tool Mgmt.	SL	3	1 0
Invalid Tool Length L3	Tool length L3 invalid/ Tool length L3 valid	3	Tool Mgmt.	SL	4	1 0
Invalid Tool radius R	Tool radius R invalid Tool radius R valid	r	Tool Mgmt.	SL	5	1 0
Spare ! (bit 6 - 8)						
Edge Wear Status	Edge worn out / Edge not worn out	d	Tool Mgmt.	Tool Stat.	9	1 0
	Edge warning limit exceeded / Edge warning limit not exceeded	w	Tool Mgmt.	Tool Stat.	10	1 0
Spare ! (Bit 11 - 12)						
User Edge Status 1	User edge status bit 1 set User edge status bit 1 reset	any	User Prgs./OP	Tool Stat.	13	1 0
: :						
User Edge Status 4	User edge status bit 4 set User edge status bit 4 reset	any	User Prgs./OP	Tool Stat.	16	1 0

Explanations:
Tool Mgmt.: = Tool Management
User Prgs.: = User programs of PLC and NC
OP: = Operator
SL: = Setup list specific status bit
Tool Stat.: = Tool specific status bit

Fig. 6-8: Active Tool List's Tool Edge Status Bits

6.5 Tool List's Tool and Tool Edge Status

Tool list data is 'Tool List Preparation' data stored on PC. They are not actual data from MT-CNC.

Group	Status Bits	Symbol	Remark
Block Location	Location blocked	L	in preparation
	Upper half location blocked		in preparation
	Lower half location blocked		in preparation
Location Reservation	Upper half location reserved		in preparation
	Lower half location reserved		in preparation
Location Occupancy	Upper half location occupied		in preparation
	Lower half location occupied		in preparation
	Location occupied		updated automatically
Tool Wear Status	Tool worn out	d	cannot be modified
	Tool warning limit exceeded	w	cannot be modified
Spare Tool	Primary tool	p	cannot be modified
Identification	Spare tool	s	cannot be modified
Fixed Location	Tool has fixed location	C	in preparation
Tool Locking	Tool is locked	L	can be modified
User Tool Status 1	User tool status bit 1	any	can be modified
User Tool Status 2	User tool status bit 2	any	can be modified
User Tool Status 3	User tool status bit 3	any	can be modified
User Tool Status 4	User tool status bit 4	any	can be modified
User Tool Status 5	User tool status bit 5	any	can be modified
User Tool Status 6	User tool status bit 6	any	can be modified
User Tool Status 7	User tool status bit 7	any	can be modified
User Tool Status 8	User tool status bit 8	any	can be modified

Fig. 6-9: Tool List's Tool Status Bits

Group	Status Bits	Symbol	Remark
Tool Wear Status	Edge worn out	d	cannot be modified
	Edge warning limit exceeded	w	cannot be modified
User Edge Status 1	User edge status bit 1	any	can be modified
User Edge Status 2	User edge status bit 2	any	can be modified
User Edge Status 3	User edge status bit 3	any	can be modified
User Edge Status 4	User edge status bit 4	any	can be modified

Fig. 6-10: Tool List's Tool Edge Status Bits

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