

MANUAL

HUMAN FACTORS ENGINEERING - ATTENTION HIERARCHY CODING FOR GRAPHICAL DISPLAYS

DEP 30.00.60.16-Gen.

April 2006

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the methods by which a project management team can create consistent layouts and coding of information of pictorials, and limits the opportunities for design teams to deviate from this path of best practice. This DEP is intended to provide guidance for the formulation of a static and dynamic process data coding system for the designing of pictorials according to the required attention values.

Consistency in the coding of information throughout a facility or plant is of paramount importance. Not only does this help new trainees who are learning the system but it also helps existing employees perform their task at a high level of proficiency.

A full description of the methodology is provided in detail and is supported by worked examples in the Appendices.

The early consideration of human factors engineering in design projects will help to reduce errors during operation and improve the efficiency of human-technical interactions. Overall, operating costs and life-cycle costs will thereby be reduced.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This DEP is intended for use in oil refineries, chemical plants, gas plants, oil and gas production facilities, and in supply/marketing installations.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this document which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this document as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions and abbreviations

The terms employed in this document are defined as follows:

Coding	The way in which static or dynamic process data is presented in a pictorial.
Hierarchy	Structuring of data in ascending order of required attention value.
Attention value	The degree to which the presentation of static or dynamic process data attracts the required attention of the operator (by means of contrast and/or dominance) as compared with the presentation of other process data.
Contrast	Relative reflection factor of an object or text in relation to the immediate surroundings.
Dominance	Predomination (in terms of attention value) of an object or text in relation to some other object or text.
Static data	Process data whose coding is independent of process conditions.
Dynamic data	Process data whose coding is dependent on process conditions.
Test pictorial	A pictorial with a layout and information density approaching real-life conditions.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets.

1.5 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the DEP Administrator at standards@shell.com. Shell staff may also post comments on this DEP on the Surface Global Network (SGN) under the Standards folder. The DEP Administrator and DEP Author monitor these folders on a regular basis.

2. BACKGROUND

Experience has shown that pictorial designers proceed from differing assumptions when hierarchically coding data. It is known that the use of a wide range of symbols, colours and acoustic/visual signals has a negative impact on the attracting of attention.

Consequently, the layouts and coding of pictorials are often inconsistent and insufficiently intelligible, which can give rise to misinterpretation. This has a negative impact on efficient process control and entails unnecessarily high mental effort for operators.

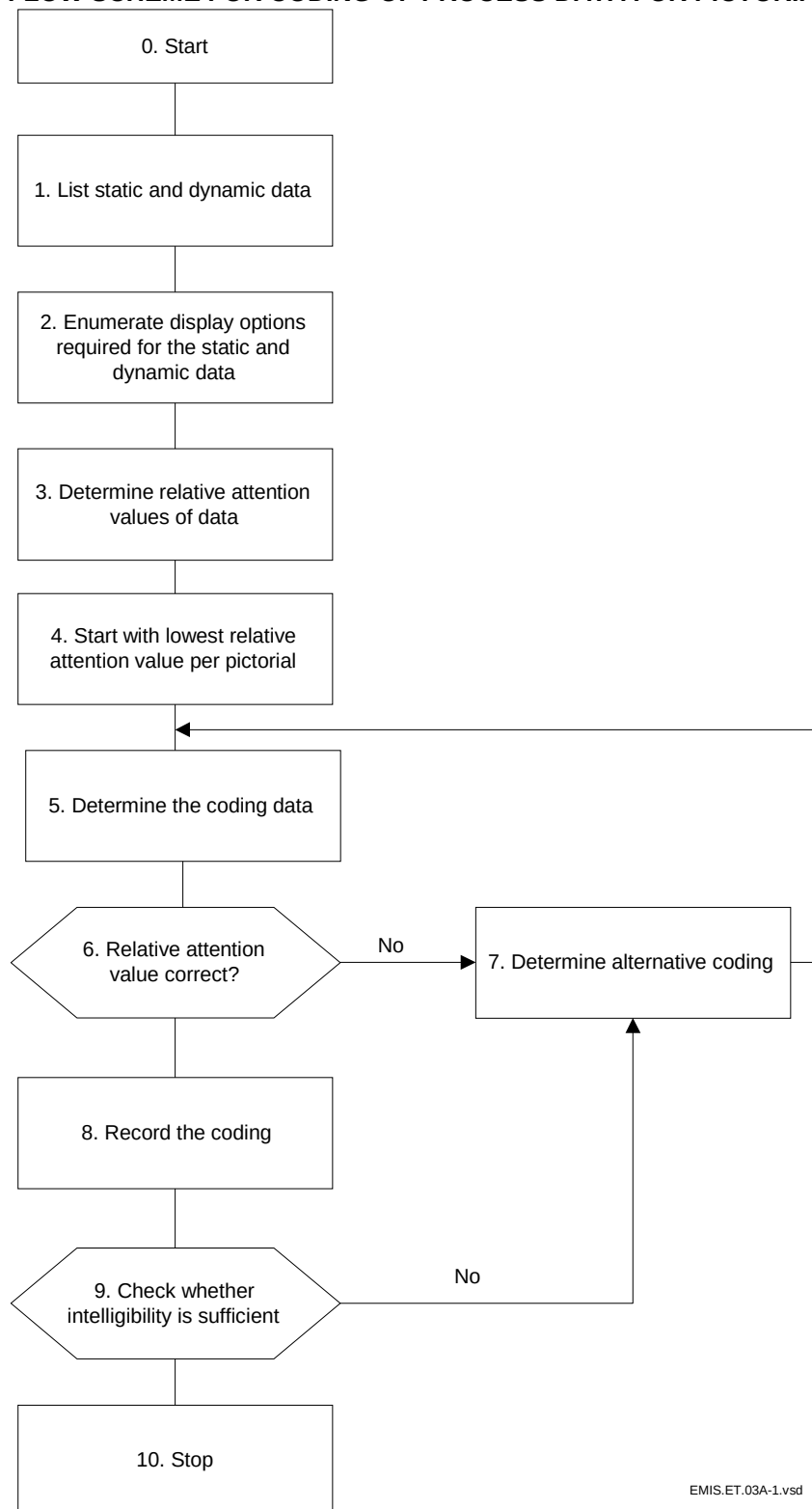
Use of this DEP will promote the consistent layout and coding of pictorials and the effective use of the various alternatives for coding modern operator control systems and other systems with fewer selective options.

Benefits

The use of a coding hierarchy based on the required attention values of process data leads to:

- Reduction/elimination of pictorial design reworking.
- Reduction of interpretation (and other) errors in operator control.
- Improved intelligibility of information and reduction of search times.
- Promotion of consistent reproduction of information.
- Standardization of pictorial layout.
- Reduction of mental effort and improved quality of work (well-being).
- Promotion of intuitive and reliable operator control.

3. **FLOW SCHEME FOR CODING OF PROCESS DATA FOR PICTORIALS**



4. EXPLANATORY NOTES FOR FLOW SCHEME

The coding of process data for pictorial designs may be required for either of the following purposes:

- Design of a new pictorial;
- Update of an existing pictorial.

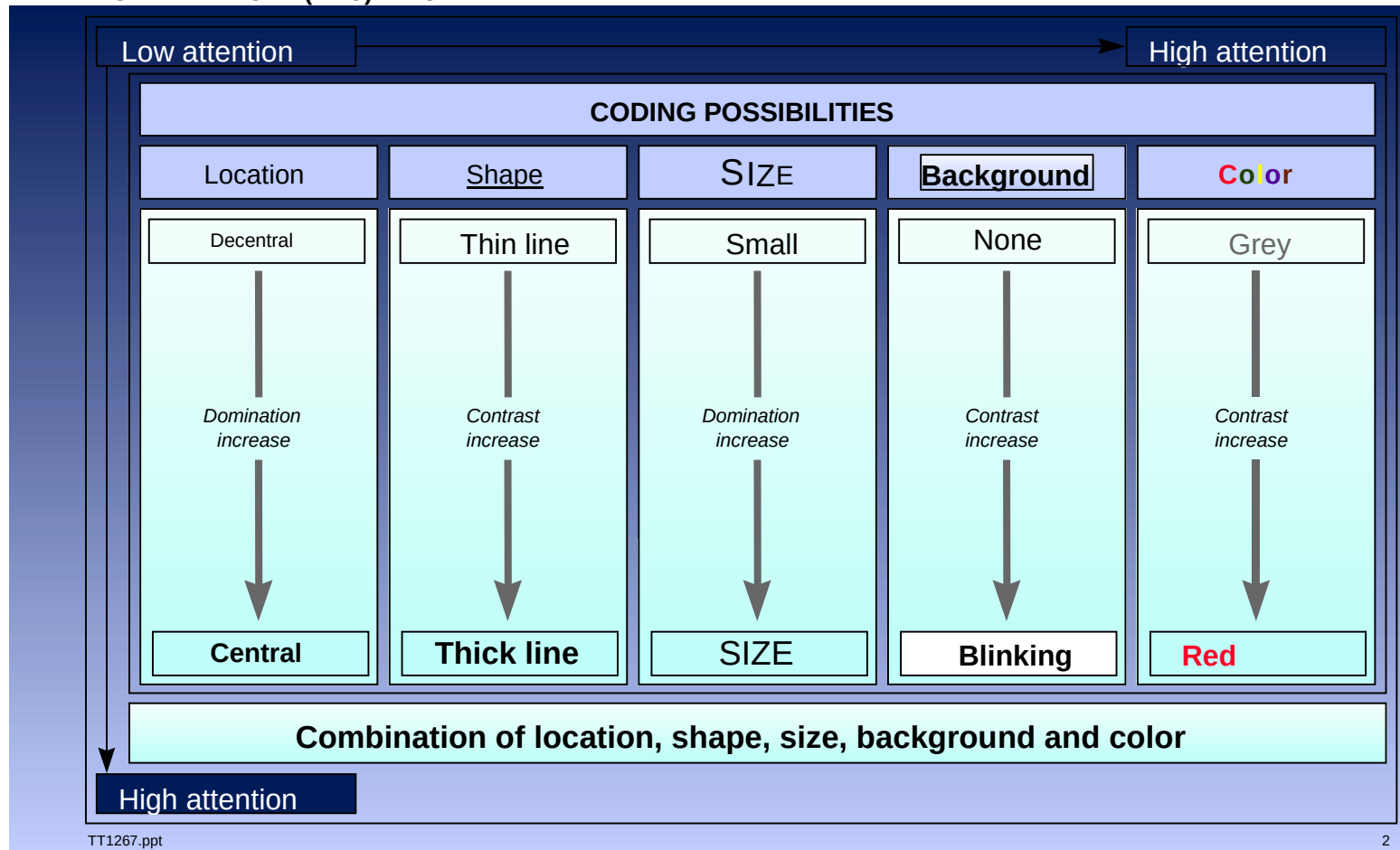
In either case, the flow scheme can be followed in order to arrive at an appropriate pictorial structure or layout. The steps in the flow scheme are further explained as follows:

1. Before starting to code the process data, the static and dynamic data to be displayed in the pictorial shall first be listed.
2. For that static and dynamic data, the number of display options required shall be enumerated. For example, if valves are to be displayed, it shall be decided whether they are to be shown open, closed or switched to manual, etc. It shall also be decided whether values are to represent various process conditions, e.g. normal value, critical value, too high value, etc.
3. The relative attention value shall be determined for each of these data items. This can be done by listing them in order of importance, according to operational urgency and the consequences if they are not displayed or the operator fails to respond. This shall be done by a multi-disciplinary team. If display objects are added later, the required attention value shall be selected according to the pre-established coding and added to the list. See Appendix 1.
To determine what attention value to give objects in a display, the purpose of the display shall first be determined. A startup graphic will have different importance than a normal operation graphic.
4. When coding process data in a pictorial, the data with the lowest attention value is entered first. In new pictorials, this will often be the background colour.
5. The coding options within the system (e.g. GUS pictorial builder) for each data item can now be determined. Coding shall be selected according to the principle that the difference in attention value between two successive data items in the attention hierarchy shall not be greater than necessary, so as not to make the pictorials over-emphatic.
Standards should also be developed for each item in Appendix 1.
6. By means of the Attention Hierarchy diagram (AH® diagram), the coding is now selected. For examples of the various coding options, see Appendices 2 to 8. The coding employed is tested for its suitability in a test pictorial (as realistic as possible) according to the following criteria:
 - a) Is the difference in attention value perceptible?
 - b) Is the difference in attention value not greater than necessary?For examples of test pictorials, see Appendices 9 and 10.
7. If the coding is not suitable, an alternative coding shall be selected from the AH® diagram.
8. If the coding is suitable, it is recorded. See the example in Appendix 11.
9. Check whether it is sufficiently intelligible when a full-size pictorial is scaled down to 25 % or placed some distance away from the reader.
If it is not sufficiently intelligible, the coding shall be adjusted.

NOTE: Poor intelligibility can also be caused by excessive information density.

If it is still not sufficiently intelligible after such adjustment, the option of reducing the number of data items per pictorial should be considered.
10. Stop.

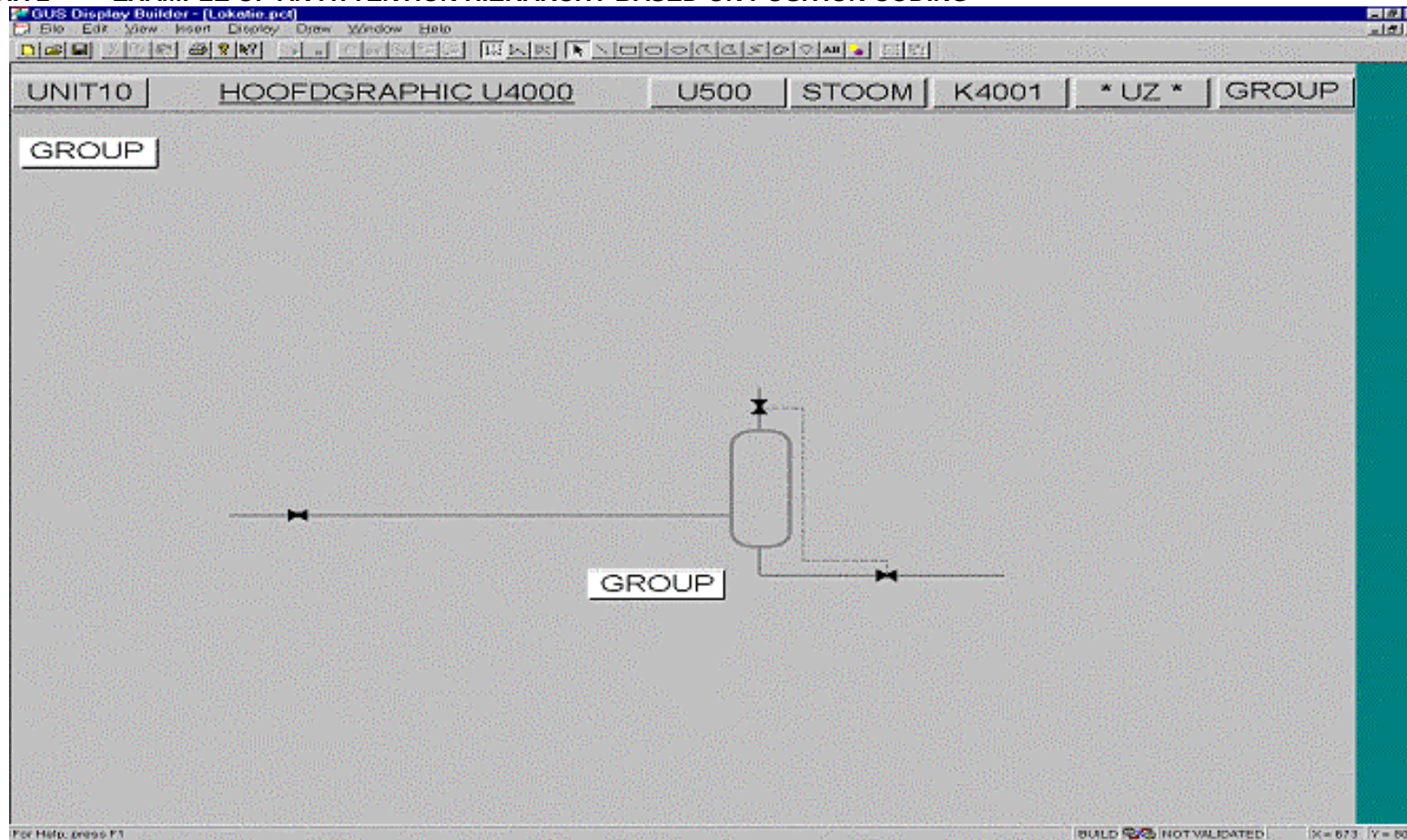
5. ATTENTION HIERARCHY (AH®) DIAGRAM



APPENDIX 1 EXAMPLE OF A TABLE WITH RELATIVE ATTENTION VALUES (LOW TO HIGH) FOR OBJECTS IN PICTORIALS

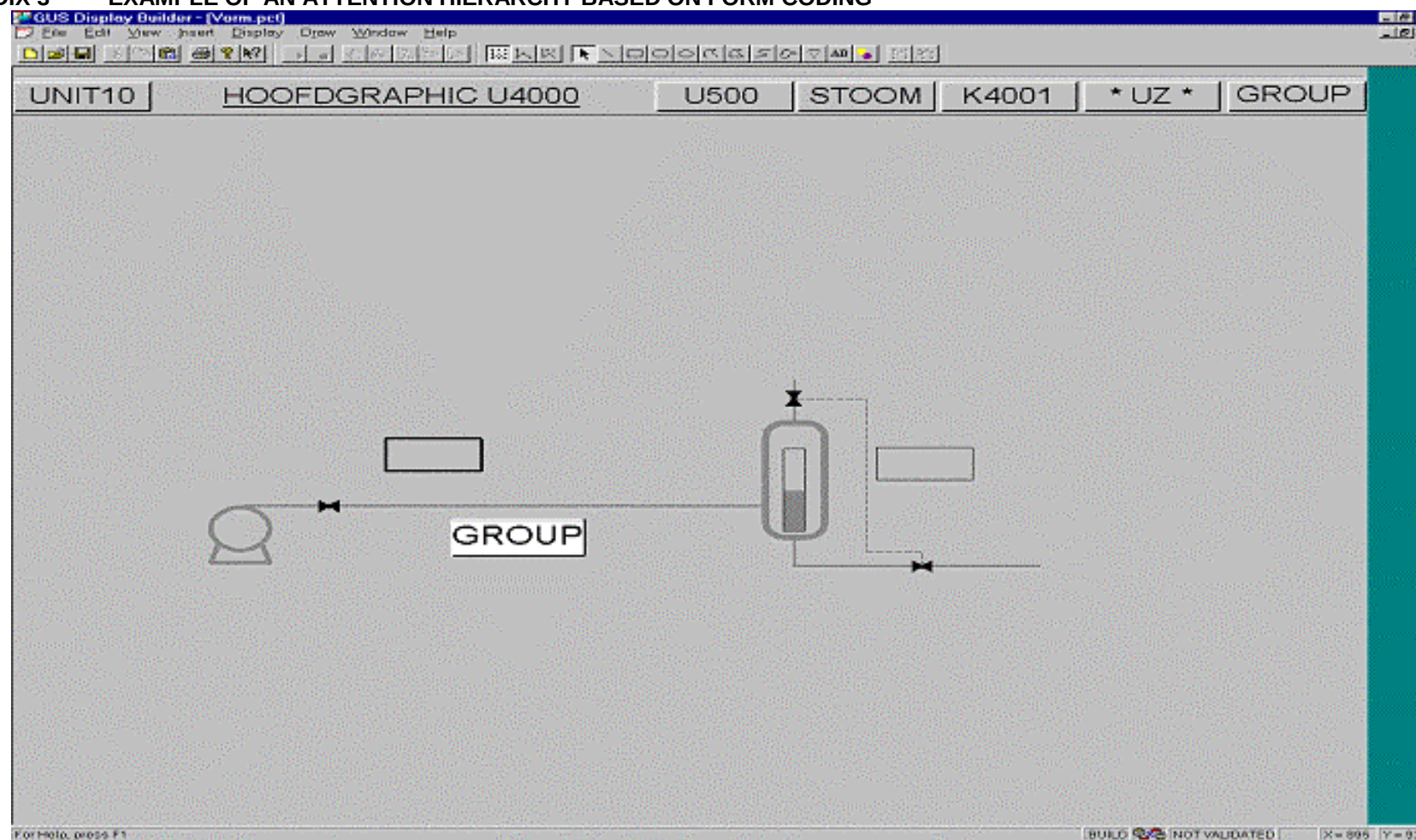
1. Display Object
2. Background.
3. Instrument lines.
4. Minor Process lines.
5. Main Process lines.
6. Process Equipment pumps, filters, exchangers.
7. Process Equipment, columns, vessels, tanks.
 - a. Non-dynamic equipment could be lower than process lines to facilitate following flow through graphic
8. Text, equipment names, tag names.
9. Buttons, navigate to other schematic.
10. Title.
11. Button in Title bar.
12. Valve, closed.
13. Valve, open.
14. Valve, travelling open → closed.
15. Valve, travelling closed → open.
16. Data point identifier (for example F, P, L, T).
17. Digital data point, status normal.
18. Numeric data point, normal.
19. Numeric data point, bad value.
20. Numeric data point, point selected.
21. Digital data point, alarm status.
22. Abnormal situation, valve position indication ignored.
23. Abnormal situation, e.g. motor not available.
24. Low alarm, acknowledged.
25. High alarm, acknowledged.
26. Emergency alarm, acknowledged.
27. Low alarm, unacknowledged.
28. High alarm, unacknowledged.
29. Emergency alarm, unacknowledged.

APPENDIX 2 EXAMPLE OF AN ATTENTION HIERARCHY BASED ON POSITION CODING

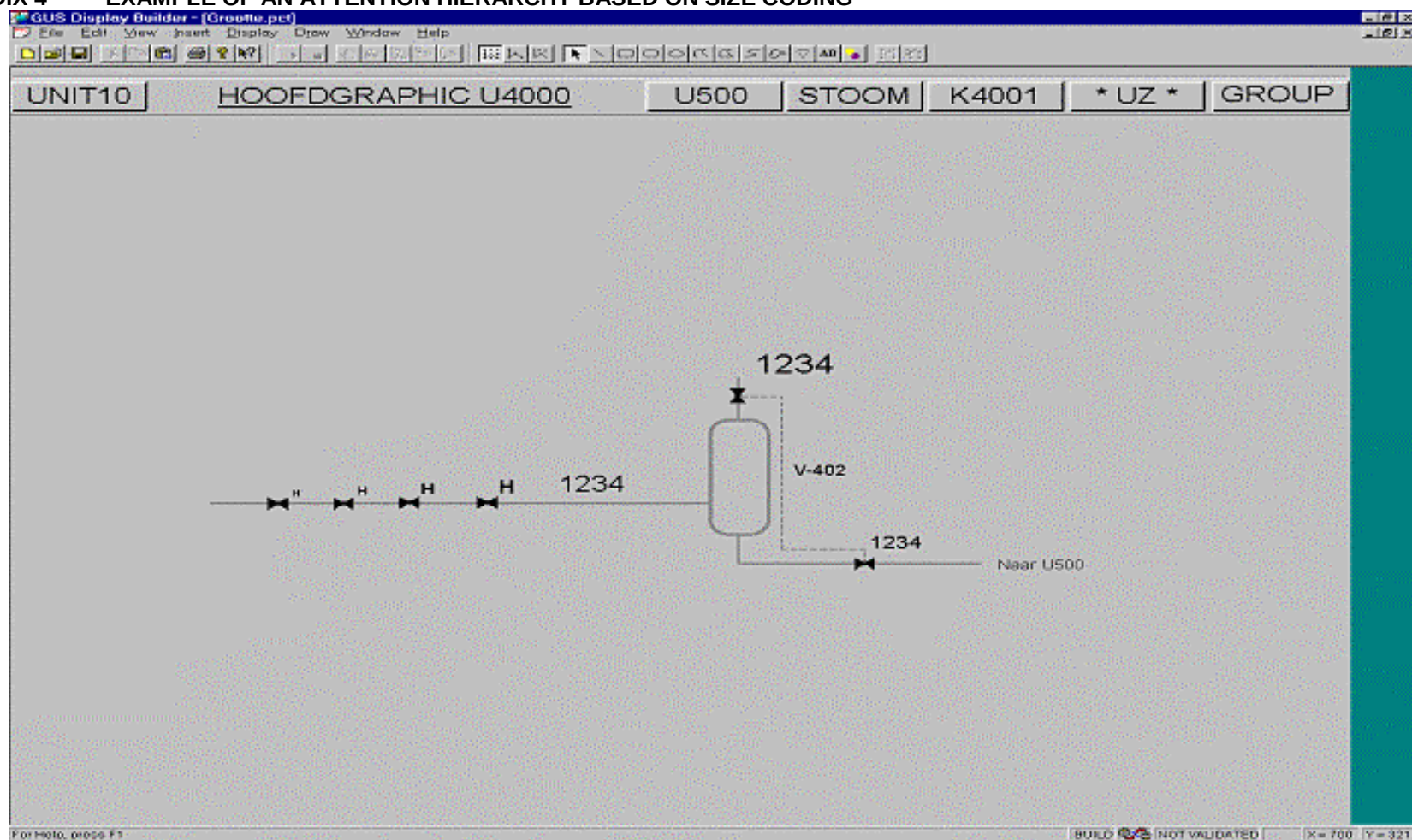


Legend for Graphics in Appendices 2 through 10: Hoofd graphic = Main graphic; Stoom = Steam; UZ = Safeguarding display

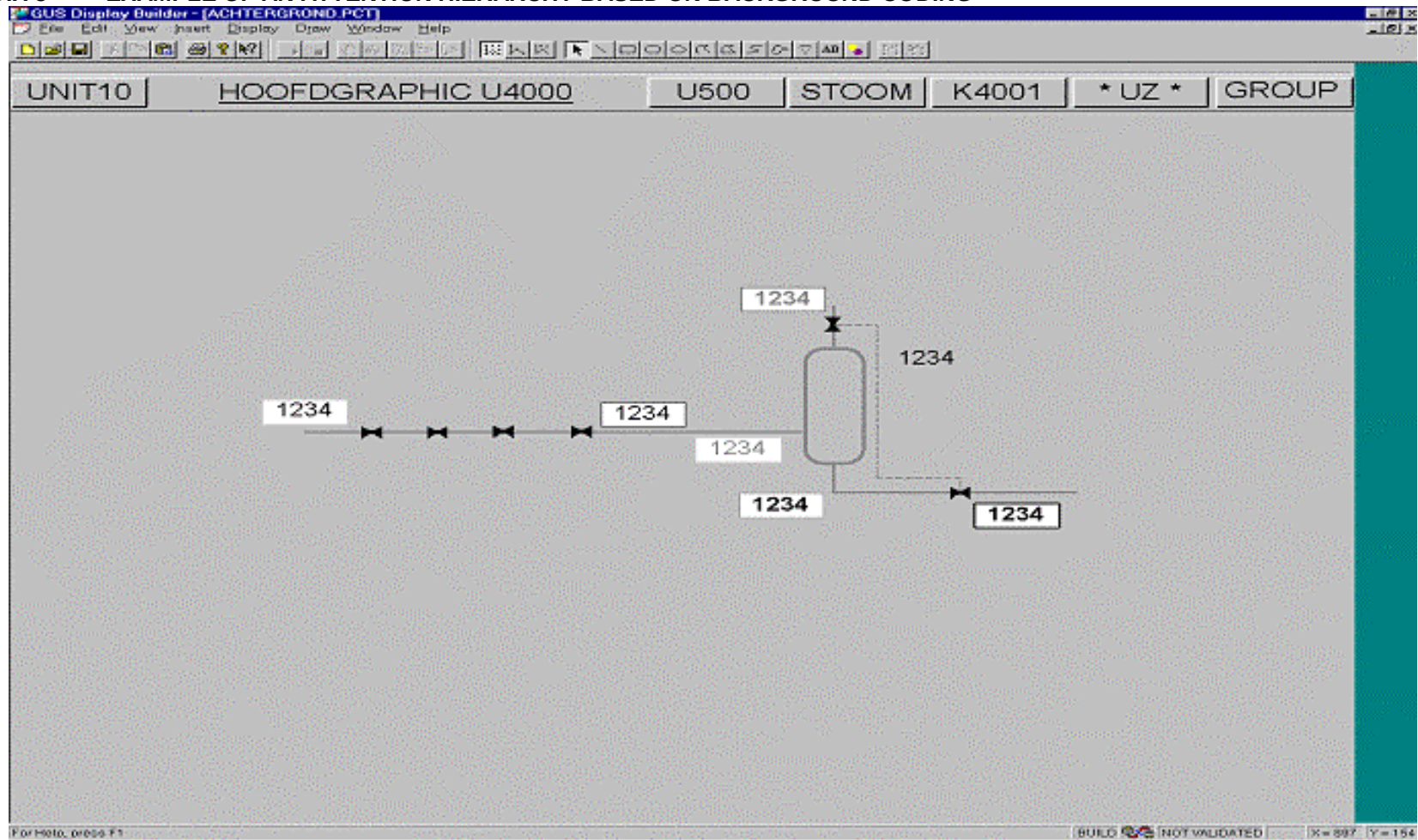
APPENDIX 3 EXAMPLE OF AN ATTENTION HIERARCHY BASED ON FORM CODING



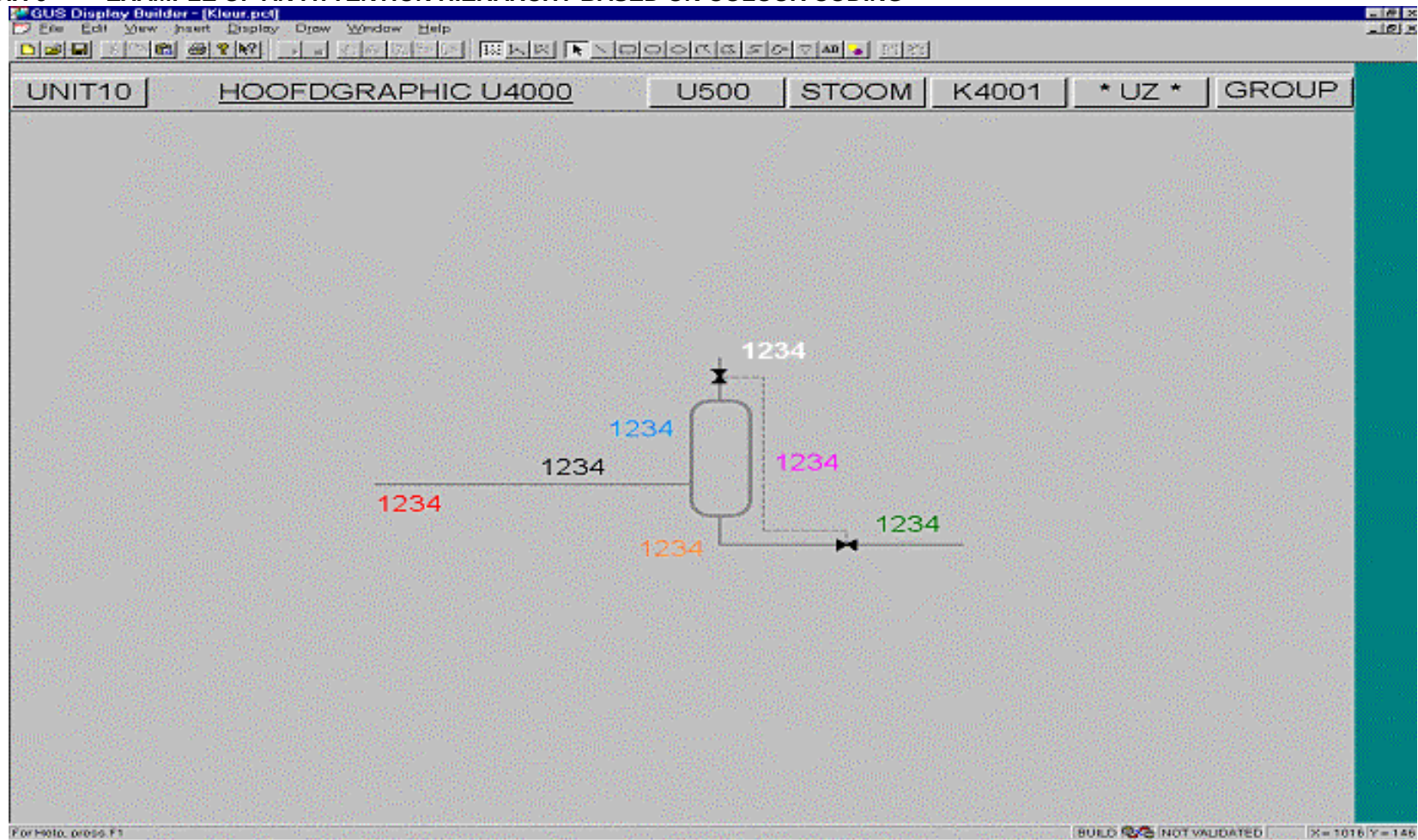
APPENDIX 4 EXAMPLE OF AN ATTENTION HIERARCHY BASED ON SIZE CODING



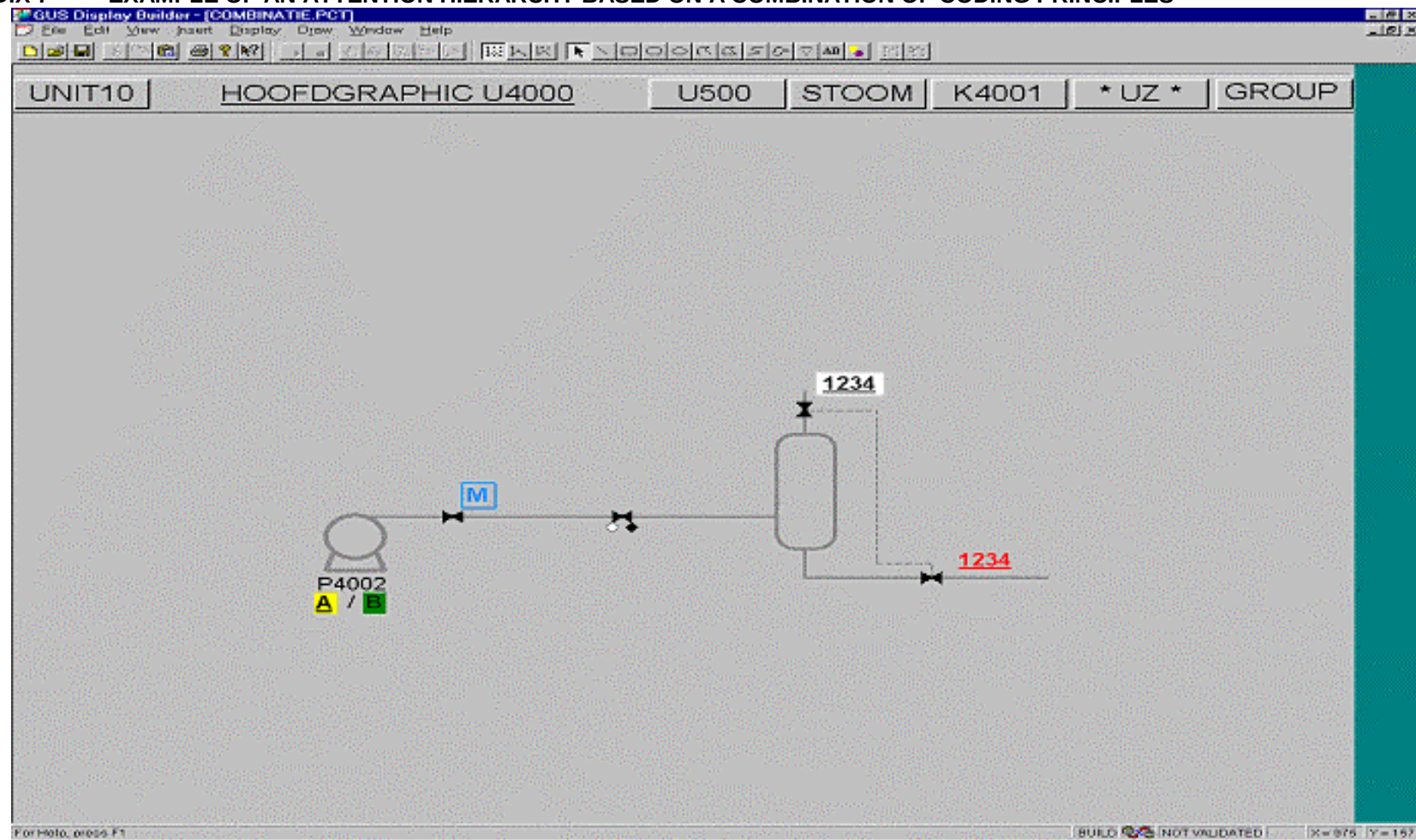
APPENDIX 5 EXAMPLE OF AN ATTENTION HIERARCHY BASED ON BACKGROUND CODING



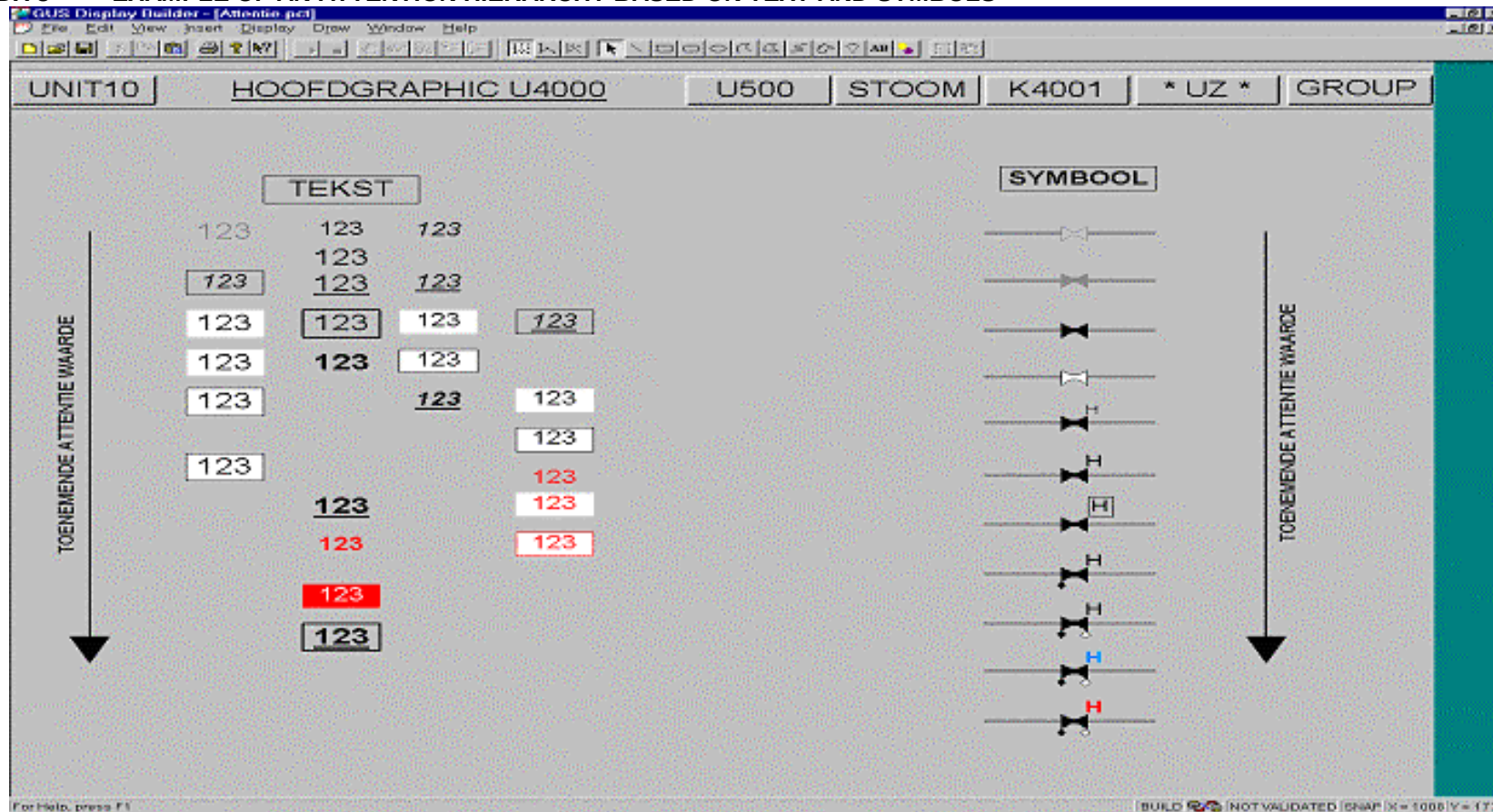
APPENDIX 6 EXAMPLE OF AN ATTENTION HIERARCHY BASED ON COLOUR CODING



APPENDIX 7 EXAMPLE OF AN ATTENTION HIERARCHY BASED ON A COMBINATION OF CODING PRINCIPLES

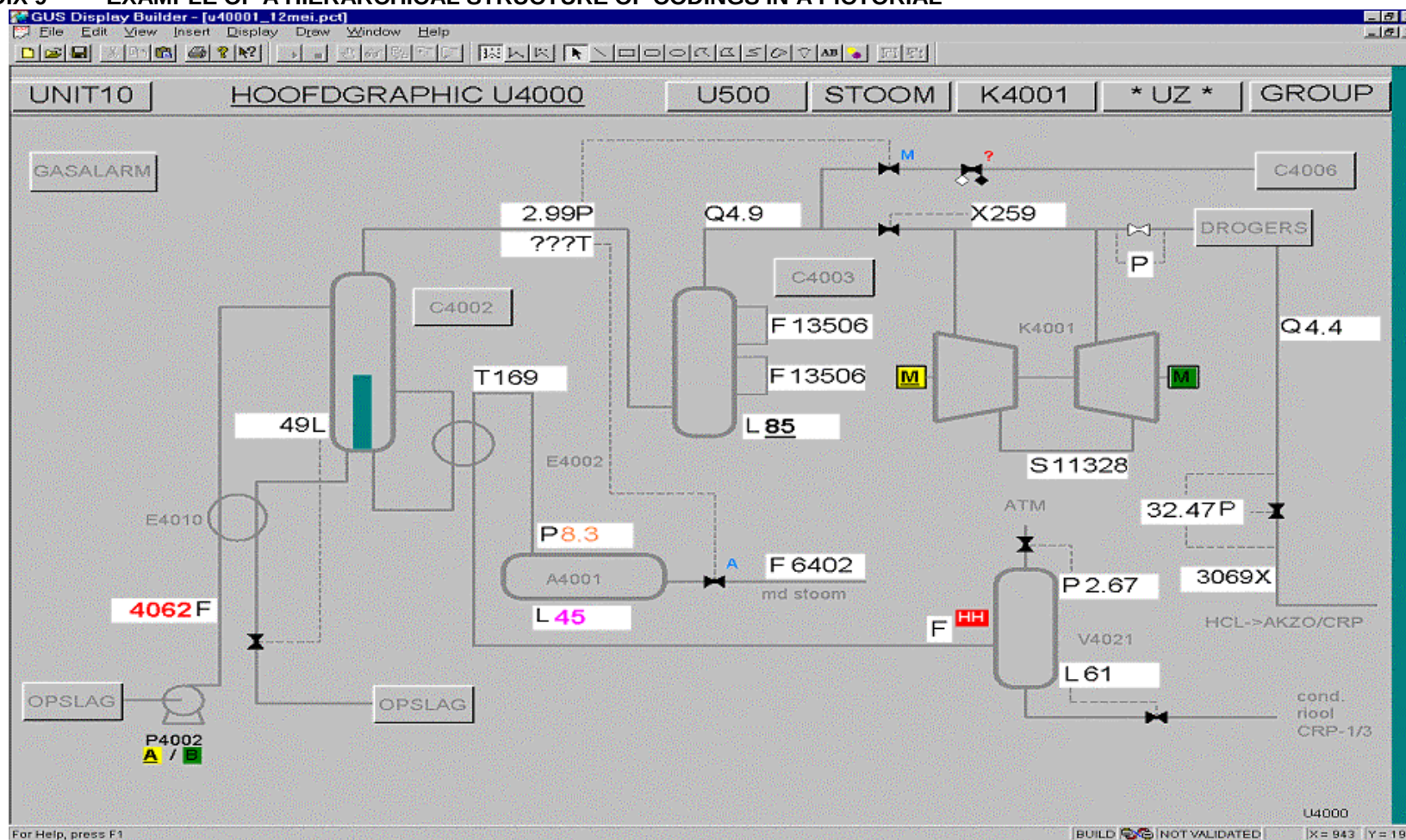


APPENDIX 8 EXAMPLE OF AN ATTENTION HIERARCHY BASED ON TEXT AND SYMBOLS



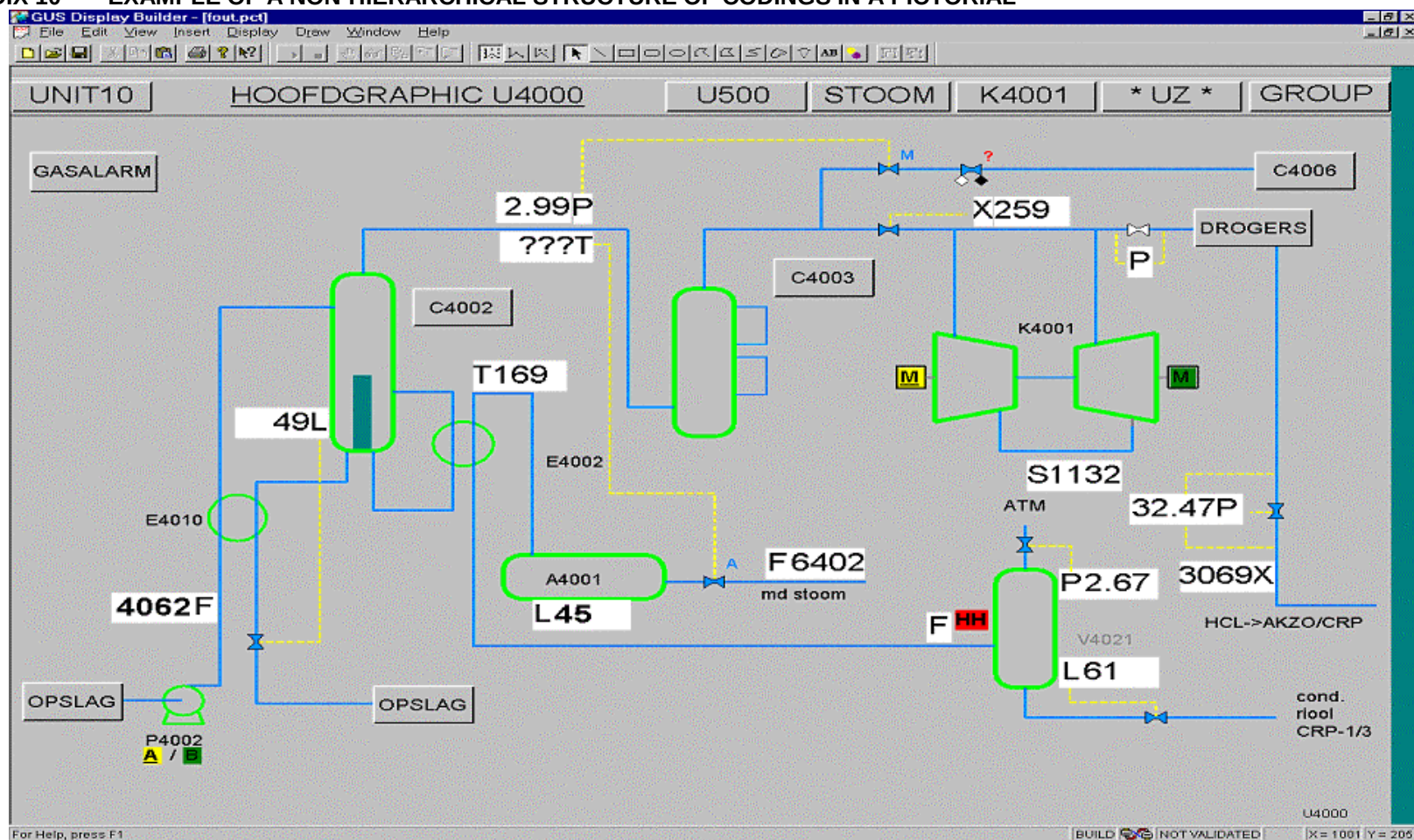
Legend: Toenemende attentie waarde = increase of attention value

APPENDIX 9 EXAMPLE OF A HIERARCHICAL STRUCTURE OF CODINGS IN A PICTORIAL



Legend: Opslag = Storage; MD = Middle pressure steam; Drogers = Dryers; cond. Riool = condensate top sewer

APPENDIX 10 EXAMPLE OF A NON-HIERARCHICAL STRUCTURE OF CODINGS IN A PICTORIAL



APPENDIX 11 EXAMPLE OF A CODING HIERARCHY FOR PICTORIALS

This Appendix presents an example and is not intended to be exhaustive.

1. Display colour coding table

In the description of the display attributes, the colours from the RGB (Red, Green, Blue) colour coding table (Table 1) are used. The RGB coding indicates the relative amounts, ranging from 0 (zero) to 255 (max.) inclusive, of the colours red, green and blue respectively.

There are 128 RGB combinations in the GUS display builder.

Table 1 RGB colour coding

Colour	RGB coding
Black	0,0,0
Red	255,0,0
Orange/yellow	235,135,0
Yellow	255,218,0
Green	54,191,0
Blue	0,64,255
Magenta	226,0,255
Cyan	0,191,191
Grey	115,115,115
Light grey	221,221,221
Soft white	238,238,238
White	255,255,255

2. Static attributes of the graphic display

The static attributes of the display cover those items that are not dependent on process changes.

2.1 Background colour

Colour: Light grey

2.2 Text

Font: Arial

Style: Regular

Arial is a font that can be readily scaled without distortion.

Text should preferably be aligned left and in lower case.

2.3 Process lines

Colour: Grey

Line thickness: Main process lines 3 pixels

Line thickness: Minor process lines 2 pixels

It helps to have different colours for process lines that have very different fluids (e.g. loading systems). Steam, caustic and hydrocarbon on the same page can be quickly identified if they are differentiated.

Different colours also add value where lines frequently intersect.

Allowing a line width of 2 to 5 pixels creates further hierarchical differentiation.

2.4 Instrument lines

Colour: Grey

Line type: Dashed

Line thickness: 2 pixels

2.5 Buttons

Buttons are used to navigate to other displays. A button may be activated by means of a touchscreen or by operating the left mouse/trackerball button.

Font size: 10

Text centred in button.

Text colour: Grey

3D effect shadow lines: 2 pixels

Bottom/right lines: Black

Top/left lines: White

Buttons may not always be the best tool to create a link. There is extra space on all sides of the text. It is also not easy to integrate buttons with the text describing the link or process line. An alternative is to use underlined text as a link since it is only one level higher in the described hierarchy and is commonly understood as this is the normal convention on Internet.

2.6 Equipment

Equipment can be subdivided into two groups:

- Vessels, tanks, columns, reactors

Line thickness: 4 pixels

- Pumps, filters, coolers

Line thickness: 3 pixels

If the fill colour is slightly different from the background, the thickness may be decreased to 1 or 2 pixels.

Equipment nomenclature

Font size 10

Colour of equipment and nomenclature: Grey

2.7 Title bar of GUS layout

UNIT	Title of display				GROUP	TREND
------	------------------	--	--	--	-------	-------

The Title bar is designed to give a clear display of functions such as navigating to other displays. It consists of 6 buttons and a title text. 3 buttons have a fixed function/position and 3 buttons can be freely assigned. The bar is at the top of the display.

Shadow lines of bar: line thickness 1 pixel with colours grey, white and black.

Buttons

Font size: 15
Text colour: Black
Text centred in button.
3D effect shadow lines: 2 pixels
Bottom/right lines: Black
Top/left lines: White

Title

Font size: 15
Text colour: Black
Text style: Underlined

NOTE: Some of this information can be embedded in the objects through a right-click menu. Multiple title bars do not necessarily add value if dual or quad-head displays are used. A title for the display may be integrated into the display.

3. Dynamic attributes of graphic display

Items with dynamic attributes include:

- Valves
- Motors (e.g. pumps, mixers)
- Numeric datapoints
- Digital signals (e.g. level switch for alarm activation)

An item with dynamic attributes displayable in the change zone is given a dashed black contour line when selected by the mouse/trackerball or touchscreen. This is so that it can be immediately seen from which item the datapoint originates if a datapoint is in the change zone.

3.1 Valves

For each situation, the contour line is black and 1 pixel thick.

Status of valve	Colour fill of valve	Comments
Open	Black	not applicable for a control valve
Closed	White	also for a control valve if fitted with annunciator
Moving open → closed	Black flashing	not applicable for a control valve
Moving closed → open	White flashing	not applicable for a control valve
Normal mode	Black	not applicable for an open/closed valve

If it is possible to set an open/closed signal as 'ignored', this may be displayed by placing a 'wyber' aligned left or right underneath the valve.

Ignore 'wyber' open: Fill black

Ignore 'wyber' closed: Fill white

There should be differentiation between control and block valves. Further dynamic information can be graphically indicated on a control valve such as whether it is saturated, its operating position, and its output.

3.2 Numeric datapoints (values)

A value consists of an identifier letter (F, L, P, T etc.) and a 5-character value text.

Currently, the identifier is usually the tag name located directly above the value text. An alternative is to only display the engineering units (without an identifier). Units are more specific (e.g. differential pressures can be in mm H₂O, kPa, MPa etc.), have a quick recognition time, and can give additional information (e.g. MLBH is more often used for steam).

Identifier

Font size: 13

Background colour: Soft white

Text colour: Black

Position of identifier: Left or right of value

The identifier has no dynamic attributes.

Value text

Font size: 13

Alignment of value text

Left if identifier left.

Right if identifier right.

Table 2 Colour table for numeric datapoints (values)

Situation	Background colour	Text colour/style	Comments
Normal	Soft white	Black	
Overview	Soft white	Black, style: bold underlined	PV deviating from set value
Emergency alarm unacknowledged	Soft white and red	Black and white	Flashing frequency is 1 s
Emergency alarm acknowledged	Soft white	Red, style: bold	
High alarm unacknowledged	Soft white and magenta	Black and white	Flashing frequency is 1 s
High alarm acknowledged	Soft white	Magenta, style: bold	
Low alarm unacknowledged	Soft white and yellow/ orange	Black and white	Flashing frequency is 1 s
Low alarm acknowledged	Soft white	Yellow/orange	
Bad value (value text ???)	Soft white	Black	Reading not reliable

Operating value

The following functions can be obtained by clicking the value with the touchscreen or mouse/trackerball.

The change zone can be called up by means of the left button or touchscreen. By means of the right button, a pop-up menu appears on the value with the TDC3000 functions DETAIL,

TREND and GROUP. The GROUP and TREND functions are also displayed in the title bar, so that operation via the touchscreen is also possible.

Value script

Operation and attributes of the value are programmed in a script (BASIC language).

The script consists of a number of routines that are activated after a particular event in the display. In the value script, the following actions are programmed:

- Definition of script variables.
- Event OnDisplayStartUp (once-only routine during start-up):
 - Determine the point identifier of the datapoint.
 - Place this letter to the left or right of the value.
 - Determine the numeric format of the datapoint.
 - Determine the overall percentage of the datapoint.
- Event OnDataChange (routine executed every 4 s to update the LCN data):
 - Determine the alarm status and overview of the datapoint.
- Event OnPeriodic Update (routine executed every second):
 - Set the colours of the value text and background according to the alarm status.
- Event OnRButtonClick:
 - Activate the pop-up menu.
 - Execute the selected function.
- Event OnLButton Click:
 - Activate the change zone.

3.3 Digital alarm (text)

A digital alarm point may be displayed by means of a static identifier text and dynamic alarm text.

Example: F^{HH}

Identifier

Background colour: Soft white

Text colour: Black

Alarm text

Font size: 9

Style: Bold

No alarm: Text HH is invisible

Alarm: See Table 2.

3.4 Running indication (pump, mixer)

Stop indication: Text colour black on yellow background; text style underlined.

Start indication: Text colour black on green background.

The start/stop indication can be displayed by means of the equipment name or by affixing a letter to the equipment (e.g. R for running and S for stop).

Non-conforming situations

A non-conforming situation is one that does not conform with normal process control. This is represented by placing a letter in the upper right, aligned with the equipment (e.g. valve, motor).

NOTE: If stop is to be considered as a normal mode (A run/B stop) stop should not have attention called to it by placing it on a yellow background. Having the normal mode indicated by bright colours (high attention) does not make sense if a pump's status does not change often.

Letter

Font size: 9

Text style: Bold

Text colour: Blue or alarm priority colour

Table 3 Alarm priority colours

Alarm priority	Colour
Emergency	Red
High	Magenta
Low	Yellow/orange

3.5 Bar graph

Bar graphs are mainly used in tanks or vessels, and give a rapid indication of the level in that tank.

Bar graphs are coloured cyan.

NOTE: Bar graphs can give quick indication of the levels of outputs on valves as well. Integrating a level into the stem of the valve requires very little space. Since the size of the graph is small it follows the attention hierarchy.