

**EAT•N**

**Vickers**

## Target-Pro 2 Analyzer and Sampler

Operation Manual



**VICKERS**<sup>®</sup>

# Target-Pro 2

Laser Particle Analyzer

User Guide:

September 2004

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## Operating Precautions

### Battery

- The Target-Pro 2 uses a nickel-cadmium (NiCd) battery. Charge it for at least 24 hours before first use.
- For optimum performance, fully discharge and recharge the battery once a month: Leave the Target-Pro 2 switched on until the LCD screen goes blank, then switch off the Target-Pro 2, connect the charging adapter, and allow it to charge the battery for 24 hours.
- To prolong battery life, switch off the analyzer when it is not in use.

### Internal Cleaning

**Do not** clean the Target-Pro 2 or Bottle Sampler with acetone or other solvents that are not compatible with nitrile seals. The recommended cleaning fluid for internal flushing is mineral spirits.

# Introduction

## Target-Pro 2 Analyzer

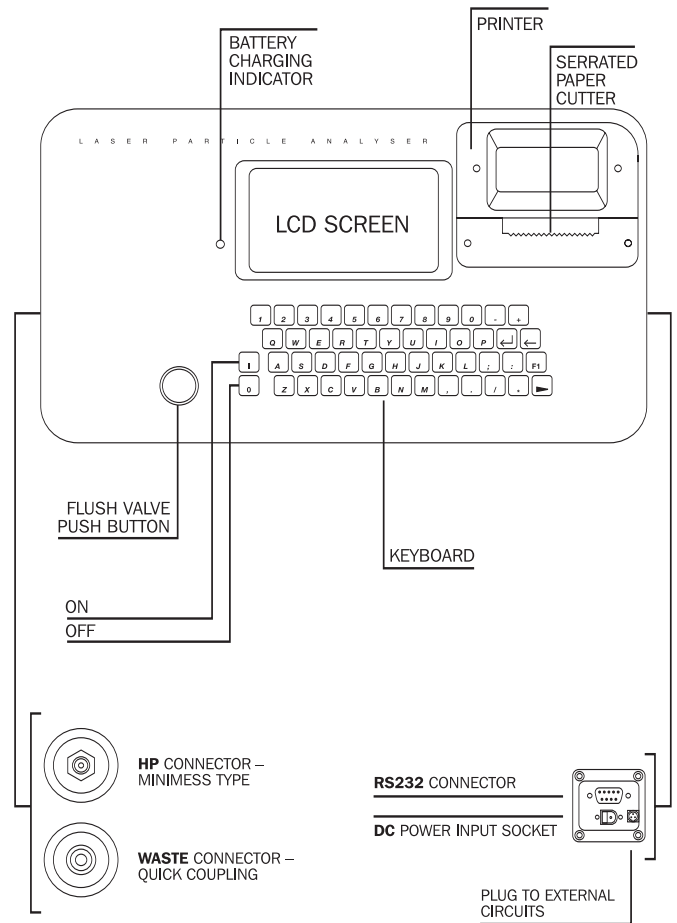
The Target-Pro 2 measures and quantifies solid contaminants in hydraulic, lubrication and transmission applications. It is designed to provide laboratory accuracy in the field, using mineral oil as the operating fluid.

The analyzer uses the light extinction principle, in which two lasers are projected through the fluid and toward photo diodes. Particles that interrupt the beams reduce the light received by the diode; their sizes are measured by changes in condition.

**Hydraulic and lubricating systems** contain metal parts that move continuously, with hydraulic fluid as the power medium. The fluid also creates a lubrication film to keep precision parts separated, and serves as a cooling medium.

By their nature, hydraulic systems produce solid particulate contaminants. When contamination exceeds set levels, hydraulic systems can fail. A revised standard cleanliness code, ISO 4406, classifies the numbers of particles that can be tolerated; the Target-Pro 2 measures the levels of these contaminants.

The international standard for reporting solid contaminants is ISO 4406. This standard has been revised to incorporate the change to ISO Medium Test Dust as the calibration standard.



## Operation—Online

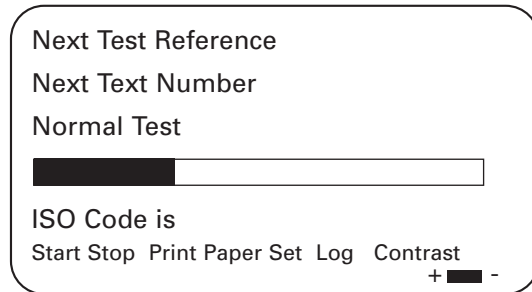
1. Insert the **waste fluid hose** in the **waste disposal bottle** provided.

**Important:** Do not connect the waste fluid hose to a pressurized system; this will cause the analyzer to malfunction and could cause internal leakage. Discharge the waste fluid hose into the bottle provided, or into a tank or vessel vented to the atmosphere.

2. Connect the **waste fluid hose** to the waste connector port on the analyzer. Push back the quick-coupling outer ring before connecting or disconnecting the hose end.
3. Connect the **fluid sampling hose** to the **HP connector** on the analyzer.
4. Connect the **fluid sampling hose** to the system using a minimess connector; the system to be monitored must be more than 2 bar and less than 400 bar.
5. Press the **green button** to switch on the analyzer; the 'Main/Test' progress screen will be displayed.

**Note:** To improve LCD screen visibility, unlatch the two extension feet on the case bottom and tilt the case. If LCD screen remains blank, refer to battery charging instructions.

## Main/Test Progress Screen



### Button

1. **Start**—Starts sampling and emptying cycles
2. **Stop**—Stops test at any point (next test will start with emptying cycle before new sampling cycle begins)
3. **Print**—Prints a copy of test results
4. **Paper**—Advances printer paper by three lines
5. **Set**—Selects Operations Screen
6. **Log**—Selects software options
  - Transfer Log Downloads memory to software package
  - Clear Log Clears memory
  - Clear Last Clears last result
  - Recall #0 Recalls results from memory
  - Print Prints recalled results
7. **+ Contrast**—Increases backlight intensity
8. **- Contrast**—Reduces backlight intensity

### Low Battery Indicator

# Analyzer Set-up

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Press the Set button [5] to program the analyzer. The display will show the Operations Screen.

## Operations Screen

- 1) Test Ref:
  - 2) Test Number:
  - 3) Time and Date:
  - 4) Result Presentation Options:
  - 5) Type Test:
  - 6) Test Options:
- Press a Key to Choose or 0 to Exit

To change analyzer settings, follow this sequence:

1. **Test Reference**—Press [1], enter your reference details (up to 16 characters), and press [Return]
2. **Test Number**—Press [2], enter a number, and press [Return] (test numbers increase automatically)
3. **Time and Date**—Press [3], set time and date using keypad, and press [Return]  
A cumulative cycle count is displayed on the Time and Date screen; this value increases automatically by 1 each time a test is taken, and cannot be adjusted or reset.

1

**4. Result Presentation Option**—Press [4], then press keys to select options: Press the relevant key to switch between option selections:

- 1) ISO format, Repeat 1) NAS format
- 2) Print detailed counts, Repeat 2) Do not print detailed counts
- 3) Print test reference, Repeat 3) Do not print test reference
- 4) Automatically print results, Repeat 4) Do not automatically print results
- 5) Print space for notes, Repeat 5) Do not print spaces for notes
- 6. Language number (four options):  
Language 0 (default) . . . . .English  
Language 1 . . . . .Italian  
Language 2 . . . . .French  
Language 3 . . . . .German

To select language, press 6, enter chosen value (such as 1 for Italian), and press Return; to use a newly selected language, you must switch the analyzer off and on again.

4

# Test Set-up

**5. Test Type**—Press [5] one or more times to select test type.

## Test Types

**Normal:** Single test with 15ml sample volume.

**Dynamic:** Comprehensive triple test with results average; 30ml sample volume comprising three 10ml sampling and emptying cycles. Results are displayed on completion of three tests, including emptying cycles.

**Triple/Bottle Sampling:** Triple test with results average; faster than Dynamic test; 24ml sample volume comprising three individual 8ml samples tested consecutively. For bottle sampling instructions, see pages 12–13.

**Continuous Sampling:** For instructions, see pages 6–7.

**Short-Single Test:** 8ml sample volume; faster than Normal test; not recommended for oil samples cleaner than ISO 17/15/12 (NAS6).

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**6. Test Options**—Press 6 to display Test Operations screen.

## Test Operations Screen (continuous test only)

### Test Operations Screen

- 1) Minutes Between Tests:
  - 2) ISO Target Level:
  - 3) NAS Target Class:
  - 4) Do Not Log Every Test:
  - 5) Confirm Cleanliness Level
- Press a Key to Choose or 0 to Exit

These options only apply to the Continuous Test; ignore if other test types are selected. For detailed continuous sampling instructions, see pages 6–7.

6

# Running a Test

## Taking a Sample—Normal, Dynamic, Triple/Bottle, Short

- Press the flush valve push-button to open the flush valve; pushbutton lights up to indicate valve is open.
- Leave valve open for at least one minute or 200ml of fluid; this removes trapped air and fluid from the previous test and eliminates cross-contamination between samples.

- Press the flush valve push-button to close the flush valve; pushbutton light goes off.
  - Alternate method: Proceed to step 9—pressing the start button automatically closes the flush valve before sampling begins.
- Press the start button [1]. The analyzer will begin the sampling cycle.



- Results will be automatically displayed on the screen and, if Auto Print mode is on, will be automatically printed at the end of the sampling cycle. (If Auto Print is off, press the Print key for a copy of the printed results.)
- After displaying the results, the analyzer automatically discharges the sample fluid to waste. Test status is shown as Emptying.

- When the Sampling and Emptying cycles are completed, the test status is shown as Idle. Results are automatically stored to memory. To download, follow the instructions on page 9.

## Interpreting Results

See page 11 for hydraulic component manufacturers' recommendations on standard cleanliness requirements for various applications.

ISO 4406 and NAS 1638 are not directly comparative. Please refer to page 11.

**Online—Normal**  
Particle count and ISO Code to 4406 standard (NAS Code 1638 displayed)

```

TP2 M40001
TEST NUMBER      39 17/3/2000 11:53
TEST REF         CALIBRATION
TEST TYPE:       Normal
ISO CODE:-
                19/18/13

NAS CODE 10  SAMPLE VOLUME 15mL

µm(c) /100ml
4      451977
6      186068
14     5784
21     2064
25     1344
38     240
50     24
68     0
    
```

**Online—Dynamic**  
ISO and NAS codes, complete with average analysis

```

TP2 M40001
TEST NUMBER      39 17/3/2000 11:53
TEST REF         CALIBRATION
TEST TYPE:       Dynamic
ISO CODE:-
                19/18/13

NAS CODE 10  SAMPLE VOLUME 30mL

µm(c) /100ml  /100ml  /100ml  AVERAGE
4      432085  435913  440220  436073
6      180873  192357  185658  186296
14     4080   4632   5040   4584
21     1392   1512   1464   1456
25     816   960    888    888
38     120   144    288    184
50     48   48     48     48
68     0    0     0     0
    
```

**Online—Normal**  
Particle counts displayed; NAS Code 1638 standard (ISO Code 4406 displayed)

```

TP2 M40001
TEST NUMBER      39 17/3/2000 11:53
TEST REF         CALIBRATION
TEST TYPE:       Normal
ISO CODE:-
                10

µm  5-15  15-25  25-50  50-100  100+
NAS  10    6    7    7    0

ISO CODE 19/18/13 SAMPLE VOLUME 15mL

µm  /100ml
5-15  160593
15-25  2568
25-50  888
50-100  144
100+    0
    
```

## Analyzer Upper Contamination Limit

The analyzer upper operating limit is set at 24/22/20.

Tests that result in particle counts exceeding any scale number in the three-part ISO upper limit has the scale number replaced by an asterisk. Associated particle counts on the printout are replaced by X's. See example.

```

TP2 M40001
TEST NUMBER      295 9/4/2002 16:02
TEST REF         RIG 1
TEST TYPE:       Triple or bottle
ISO CODE:-
                */*/20

NAS CODE **  SAMPLE VOLUME 24mL

µm(c) /100ml  /100ml  /100ml  AVERAGE
4      XXXXXXXX
6      XXXXXXXX
14     924631  952369  869153  915384
21     418251  430798  393155  414068
25     244304  256519  236974  245932
38     76254  77779  80066  78033
50     39471  41839  36313  39207
68     18142  19411  19049  18867
    
```

## Further Test—Same Sampling Point

To repeat a test on the same sample point, press the Start button [1]. The test number will increase automatically.

## Further Test—Different Sampling Point/Same System

Repeat steps 7–12 above. To change test reference/test mode data, repeat steps 1–12 on pages 4–5.

## Further Test—New System

Repeat steps 1 through 12 on pages 4–5.

## Shutting Down

- Press red button to switch off analyzer.
- Disconnect minimess connector on sampling hose to isolate fluid supply.
- Remove fluid sampling hose from analyzer.
- Remove waste fluid hose from analyzer.
- Replace end caps on sampling hose; wipe clean and store.
- Connect waste fluid hose quick-coupling end fittings together; wipe clean and store.

# Continuous Sampling

## Continuous Sampling—Set Intervals

The analyzer can run continuous tests at set time intervals.

Once continuous sampling has started, the flush valve opens and closes automatically before each test. This lets fluid reach the sensing arrangement before the 15ml sampling test begins.

The flush valve automatically opens at the end of the sampling cycle and remains open while the analyzer is emptying the sample fluid from the previous test.

Depending on the time set for minutes between tests, the flush valve operates as follows:

### Time set to 0:

At the end of the emptying cycle, the flush valve automatically closes and the next sampling test begins immediately.

### Time set between 1 and 5:

After the emptying cycle ends, the flush valve remains open for the time set, then closes automatically before the next sampling test.

### Time set between 6 and 30000:

Flush valve automatically closes after the emptying cycle ends, and remains closed until 5 minutes before the next sample test is programmed to begin.

### Notes:

When the flush valve pushbutton is lighted, the valve is open; when the pushbutton light is off, the valve is closed.

The flush valve servo motor makes a slight 'ticking' noise, whether the valve is open or closed. This is normal.

Do not connect the waste fluid hose to a pressurized system; this will cause the analyzer to malfunction and could cause internal leakage. Discharge the waste fluid hose into the bottle provided, or into a tank or vessel vented to the atmosphere.

To conserve battery life, connect the analyzer to the power adapter for continuous operation.

## Continuous Sampling—Basic Operation

- 1. Follow instructions 1–5** on page 4 to select analyzer settings. On the Operations Screen, press [5] until Continuous is selected.
- 2. Test Options**—Press [6], then press the relevant key to switch between option selections:
  - 1. Set minutes between tests:** Press [1], enter the time in minutes required between tests (value must be between 1 and 30000), and press [Return].
  - 2. Set ISO Target Level:** Press [2], enter 0 (zero), and press [Return].
  - 3. Set NAS Target Level:** Press [3], enter 0 (zero), and press [Return].
  - 4. Set logging:** Press [4] once to log every test, repeat; press [4] again to deselect logging.

*Note: If you deselect log every test, the analyzer will not store any test results in its memory.*

- 3. Press the flush valve** pushbutton to open the valve; the pushbutton will light up. Leave the valve open for at least 1 minute or 200ml of fluid—more if the HP sampling hose is longer than 1.5m.
- 4. Press the flush valve** pushbutton to close the valve; the pushbutton light will go off.

**Alternate method:** Proceed to step 5—pressing the start button [1] automatically closes the flush valve before sampling begins.

- 5. Press the start button [1].** The analyzer will begin the sampling cycle.
- 6. The completion progress bar indicates test status:**

Results will be displayed automatically on the screen; if auto print mode is on, results will be automatically printed at the end of the sampling cycle; if auto print is off, press the print key for a copy of the printed results.
- 7. Between tests,** status will show Waiting.
- 8. Press the stop button [2]** at any point in the cycle to end continuous sampling. Test status will show Idle.

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## Continuous Sampling—with Target Cleanliness Level

This mode is similar to basic operation, except that when a specified target cleanliness level is achieved, the analyzer stops testing and the test status shows Completed.

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**9. Follow instructions 1–5** on page 4 to select analyzer settings. On the Operations screen, press [5] until Continuous is selected.

**10. Test Options**—Press [6], then press the relevant key to switch between option selections:

1) Set minutes between tests: Press [1], enter the time in minutes required between tests (value must be between 1 and 30000), and press [Return].

2) Set ISO Target Level: Press [2], enter the desired Target Cleanliness Level using the format Number/Number/Number with any code combination from 5 to 24, such as 10/9/5; then press [Return].

- For continuous testing until the ISO Code is achieved, select ISO Format as described in Operating the Analyzer, step 4. Testing will continue until all three numbers in the code are reached.

3) Set NAS Target Level: Press [3], enter the desired Target Cleanliness Level as a single class number from 2 to 12, and press [Return].

For continuous testing until the NAS Class is achieved, select NAS Format as described in Operating the Analyzer, step 4.

Testing will continue until the class number is reached at each of the five micron size ranges covered by NAS 1638.

4) Set logging: Press [4] once to log every test, repeat; press [4] again to deselect logging.

**Note:** If you deselect log every test, the analyzer will only store the test results when the Target Cleanliness Level is achieved; this reduces memory storage demands.

5) Confirm cleanliness: Press [5] once to confirm cleanliness level, repeat; press [5] again to deselect confirmation.

**Note:** If you select Confirm Cleanliness Level, the analyzer will repeat the sampling cycle until the target cleanliness level is reached in two consecutive samples, and will then display Completed status. If you choose not to confirm the cleanliness level, the analyzer will stop, and the display will show Completed status, after the target cleanliness level is reached only once.

Press the flush valve pushbutton to open the valve; the pushbutton will light up. Leave valve open for at least one minute or 200ml of fluid; this removes trapped air and fluid from the previous test and eliminates cross-contamination between samples.

**11. Press the flush valve** pushbutton to close the valve; the pushbutton light will go off.

**Alternate method:** Proceed to step 12—pressing the start button [1] automatically closes the flush valve before sampling begins.

1

**12. Press the start button [1].** The analyzer will begin the sampling cycles.

**13.** The completion progress bar indicates test status.

**14. Results** will be displayed automatically on the screen; if auto print mode is on, results will be automatically printed at the end of the emptying cycle.

**15. Status** shows Waiting between tests.

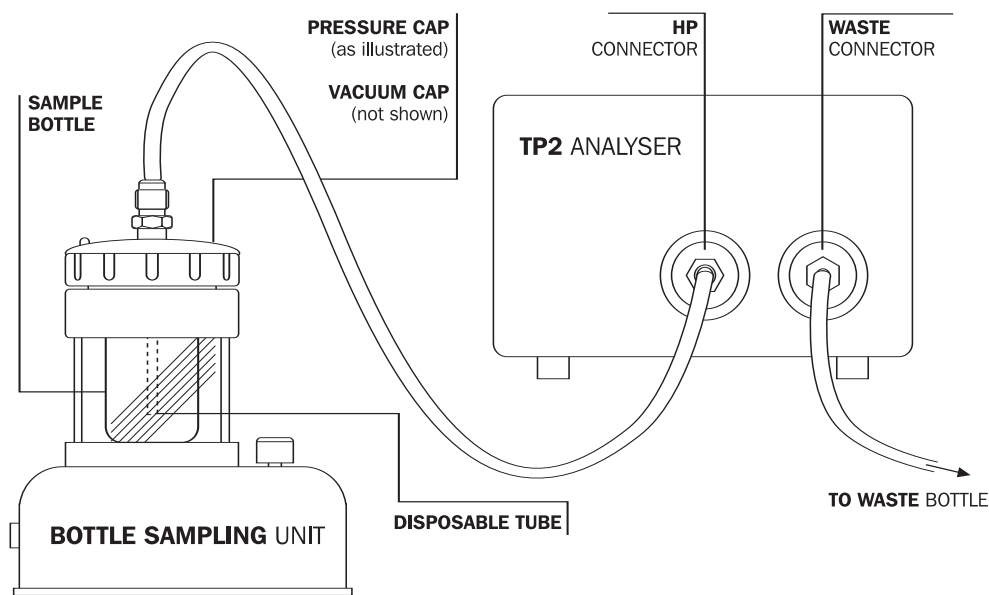
**16. Press the stop button [2]** at any point in the cycle to end continuous sampling. Test status will show Idle.

# 110ml Bottle Sampler for Target-Pro 2

110ml Bottle Sampler is designed for use with the Target-Pro 2 Analyzer. The bottle sampler allows users to test fluids in situations where the analyzer cannot be connected directly to the hydraulic circuit. This helps overcome limits of time and distance, extending testing capabilities to all equipment and locations. This unit accepts both 100ml and 110ml bottles.

The bottle sampler offers the option of de-aerating fluid samples before testing with the analyzer by applying a vacuum to the chamber holding the sample bottle. The de-aeration feature is only needed when it is suspected, or obvious, that air is present in the fluid sample.

Two cap types are supplied with the bottle sampler: a blank vacuum cap for use when de-aerating fluid, and a pressure cap with an anti-vacuum valve for use when delivering a fluid sample to the analyzer.



## Using the Bottle Sampling Unit

1. Clean the pump and hose provided with an appropriate solvent, such as mineral spirits, before taking a sample. Do not use acetone. Clean sample bottles and associated products following the instructions on page 13.
2. Draw at least **80ml of fluid** from the system into the bottle provided. If necessary, use a hand pump.
3. Insert the **waste fluid hose** in the waste disposable bottle provided.
4. Connect the waste fluid hose to the **waste connector** on the Target-Pro 2. If you are using a hand pump, discharge fluid from the hand pump into the **sample bottle**.
5. Place the sample bottle into the **bottle sampling unit**.
6. Connect the bottle sampling unit to the 12-volt DC **power supply**.

If the collected fluid contains air, follow steps 7–10 to de-aerate the sample. Otherwise, skip to step 11.

## Using the De-aeration Option

7. Fit the **vacuum cap** to the bottle sampling unit.
8. Switch off the bottle sampling unit, then turn the **selector knob** from Sample to Vacuum; the intermediate position has no function.
9. Switch on the bottle sampling unit and leave it running for several minutes, until all air bubbles have been removed from the fluid sample.
10. Switch off the bottle sampling unit; this automatically vents the chamber to the atmosphere.



## Operation with the Target-Pro 2

11. Fit a new **disposable tube** into the **pressure cap**, and fit the cap to the bottle sampling unit.
12. Connect the 0.5m **fluid sampling hose** to the bottle sampling connection.
13. Connect the fluid sampling hose to the **HP connection** on the analyzer.
14. Switch on the analyzer.
15. Press the **set button** [5] on the Main/Test Progress Screen to select the Triple or Bottle sampling option.
16. Enter **test details** as described on page 4.



17. Turn the **selector knob** to Sample.
18. Switch on the bottle sampling unit.
19. Press the **flush valve pushbutton** to open the flush valve for 10 seconds.
20. Press the **start button** [1] to begin testing.  
The bottle sampling test is a three-test analysis; see page 4 for details.
21. When the test is finished, switch off the bottle sampling unit; it will automatically vent the pressurized chamber to the atmosphere.
22. Switch off the analyzer.

## Sample Bottle Cleaning Procedure

Use qualifying and controlling methods that conform to ISO 3372 for sampling containers. If compliant procedures are not possible, follow these guidelines at a minimum:

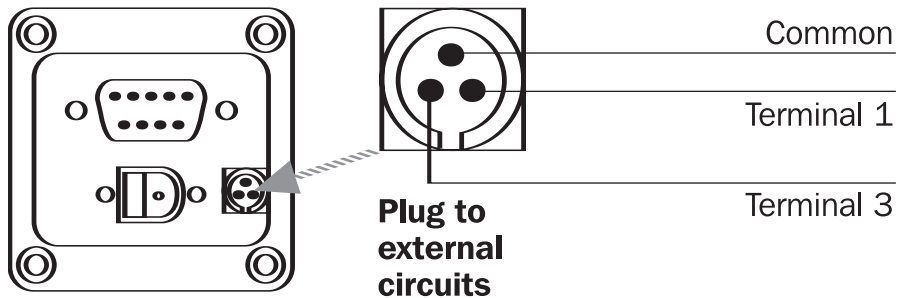
1. Half-fill the sampling bottle with the fluid to be analyzed.
2. Re-cap the bottle and shake it vigorously for 30 seconds.
3. Discard the fluid, following current COSHH legislation.
4. Repeat steps 1–3 twice, for a total of three cycles. The fourth time the bottle is filled, analyze the sample.

## External Wiring Details

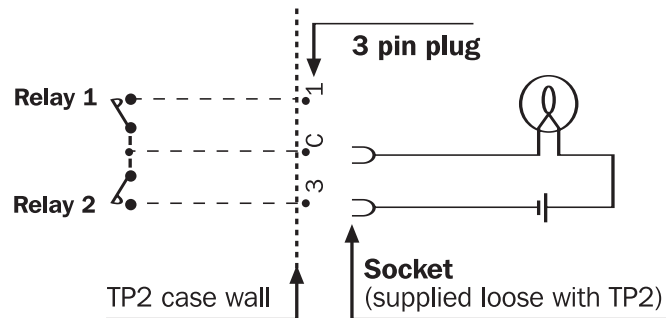
### Alarm/Indication Switching during Continuous Operation

The Target-Pro 2 can be wired to an external alarm to indicate testing status during continuous sampling. It incorporates two solid-state relays, shown in these diagrams.

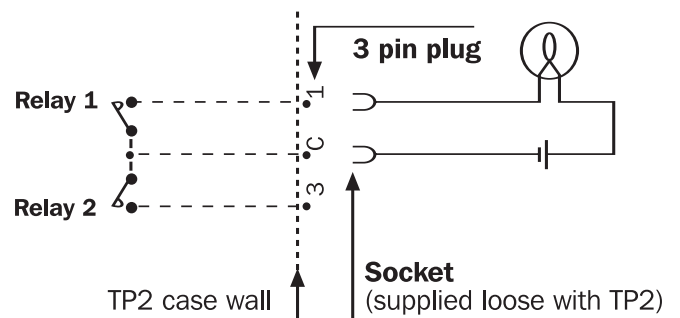
Each relay is designed for a maximum current of 1 amp at 24 volts nominal AC or DC (absolute maximum 60 volt peak). Operation above these limits will cause irreparable damage to the relays. Eaton strongly recommends using wire of at least 20 AWG, and installing a fuse between the customer circuit and the Target-Pro 2.



**Note:** An external signal, such as a monitoring light, buzzer or bell, is not necessary for continuous sampling. Use of this annunciator circuit is optional.



**Example 1:** Bulb stays off during sampling, and switches on when target cleanliness level is reached (completed status).



**Example 2:** Bulb switches on during sampling, and off when target cleanliness level is achieved (completed status). Relay 1 is also switched during Normal, Dynamic & Triple bottle test types. Relay will open at test end or when stop button is pressed.

# Memory Recall

**6** Press the log button [6] to retrieve results stored in the analyzer's memory; the Log Screen will be displayed.

## Log Screen

- 1) Transfer Log
- 2) Clear Log
- 3) Clear Last
- 4) Recall #0
- 5) Print

Press a Key to Choose or 0 to Exit

**4** To view memory contents, follow these steps:  
Select Recall #0 button [4] and enter the number of the test to be retrieved.

**+** If you do not know the test number, enter the last test number and scroll through the list using Next [+] or Previous [-] to find the test you want to review.



**0** To print the result, press the quit button [0], then press button [5]. A copy of the result will be printed.



**Note:** The result will be printed in the format last selected through the Set function.

# Software Installation

Install software Pt. No. Target-Pro 2-W-30 on a suitable PC running Windows 95®/NT 4.0 or better. Follow instructions from the Target-Pro 2-View User Manual.

## Results Download

1. Connect RS232 cable to analyzer and serial port on PC.
2. Switch the analyzer on.
3. Switch PC on.

Launch Target-Pro 2-View software.  
From the File menu, select Upload.  
Data Transfer Screen will be displayed.  
Transfer Data.

**4.** Select log function from Analyzer Main/Test Progress Screen [6].



**5.** Press Transfer Log [1].

The analyzer will download all stored results from memory to the software. After downloading, the analyzer's memory can be deleted. (select this option from the PC menu.)



**6.** When the transfer is complete, switch the analyzer off.

# Battery Charging

The internal battery can sustain 8 hours of continuous operation (approximately 100 tests) after charging for 24 hours. If the battery becomes completely discharged, charge it for at least 15 minutes before starting a test. The analyzer must remain connected to the power adapter until the battery has had time to recharge.

To recharge the battery, connect the lead from the power adapter to the DC power input socket on the analyzer. Make sure the battery charging indicator on the analyzer lights up.

## Low Battery Level Indicator



When the low battery level indicator flashes on the LCD display, recharge the battery as soon as possible.

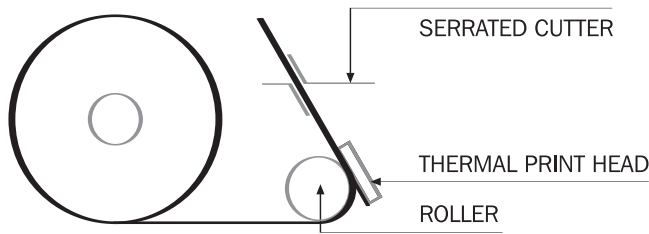
**Important:** Before recharging the battery, always press the red button to switch off the analyzer.

## Conserving Battery Power

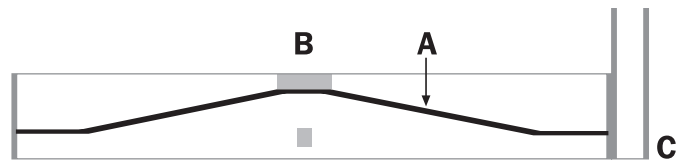
To help extend battery run time, use the power adapter whenever possible. You can also save battery power by switching the analyzer off between samples, and by turning off the Auto Print mode. The LCD screen backlight dims automatically when the external power supply is not connected.

# Printer Paper

To change thermal printer paper, remove the four thumb-screws securing the cover and serrated paper cutter. Thermal printer paper is sensitized on one side only, and must be fed into the printer mechanism as shown below.



Using a finger, press down on the print head spring at point A; tilt the print head to the open position by pulling it back at point B.



Feed the paper under the roller and pull the paper end out of the mechanism. Return the print head back to its normal position by pressing on the green lever at point C. Make sure the print head spring returns to the position shown above.

**Important:** Do not operate the printer without paper; doing so will damage the printer. Replace the roll when the "end of roll" indication appears on the paper.

## Warranty and Recalibration

The Target-Pro 2 is guaranteed for one year after delivery. Eaton recommends you return the analyzer once each year for recalibration.

## Specifications

<b>Technology</b>	Automatic Optical Particle Analyzer
<b>Laser Package</b>	Twin Laser and Twin Optical Diode Detectors
<b>LCD display</b>	(backlit)
<b>Sensitivity</b>	>4, 6, 14, 21, 25, 38, 50, 68 $\mu\text{m(c)}$ , Micron range to revised ISO 4406 Standard
<b>Accuracy/Repeatability</b>	Better than 3% typical
<b>Calibration</b>	Each unit is individually calibrated with ISO Medium Test Dust (MTD) based on ISO 11171:1999 on equipment certified by I.F.T.S.
<b>Analysis Range</b>	ISO 8 to ISO 24 to ISO 4406 (NAS 1638-2 to 12)
<b>Report/Print Format</b>	ISO and NAS codes, with individual particle counts as a built-in option Printer Fixed head thermal printer (384 dots per line)
<b>Target-Pro 2 Sample Volume</b>	15 ml. (normal), 30 ml. (dynamic) 24 ml. (bottle sampler) 15 ml. (continuous), 8ml. (short)
<b>Operation</b>	Max. system working pressure, 400 bar; Min. working pressure, 2 bar
<b>Viscosity Range</b>	to 400 centistokes
<b>Operating Temperature</b>	+5 to +80°C
<b>Fluid Compatibility</b>	Mineral oil and petroleum based fluids (consult Eaton for other fluids)
<b>Typical Test Time</b>	Result in <2.5 mins. (normal test)
<b>Power</b>	Internal rechargeable battery (AC charger) or external 12/24 volt DC power supply
<b>Data Storage</b>	600 tests
<b>Computer Interface</b>	RS 232 (serial) communication port
<b>Hose Connections</b>	minimess fittings microbore hose, 1.5 m waste fluid hose
<b>Dimensions</b>	Height 210mm; Depth 260mm; Width 430mm; Weight 7.6 kg

Eaton reserves the right to alter these specifications without notice.

## Troubleshooting

### Problem Check

- LCD screen remains blank after switching on
  - Make sure analyzer battery is charged, or has been charging for at least 15 minutes
  - See if LED illuminates when power adapter is connected to DC power input socket on analyzer
- Unexpected results obtained from sample
  - Check the fluid sampling hose connections at both the system and analyzer ends
  - Confirm that there is a free flow of fluid to the analyzer: press the flush valve and see if fluid passes into the waste disposal bottle Body text:

**Note:** If you suspect high water/aeration levels, contact Eaton for advice.

**Warning:** If excessive system contamination is suspected, flush the analyzer using the bottle sampling unit in conjunction with a suitable solvent, such as mineral spirits.

**Do not use acetone.**

# ISO 4406 Cleanliness Code System

**ISO standard 4406** is the preferred method of counting solid contaminant particles in a sample. The code is constructed from the combination of three scale numbers selected from the following table.

**The first scale number** represents how many particles in a milliliter sample of the fluid are larger than 4  $\mu\text{m(c)}$ .

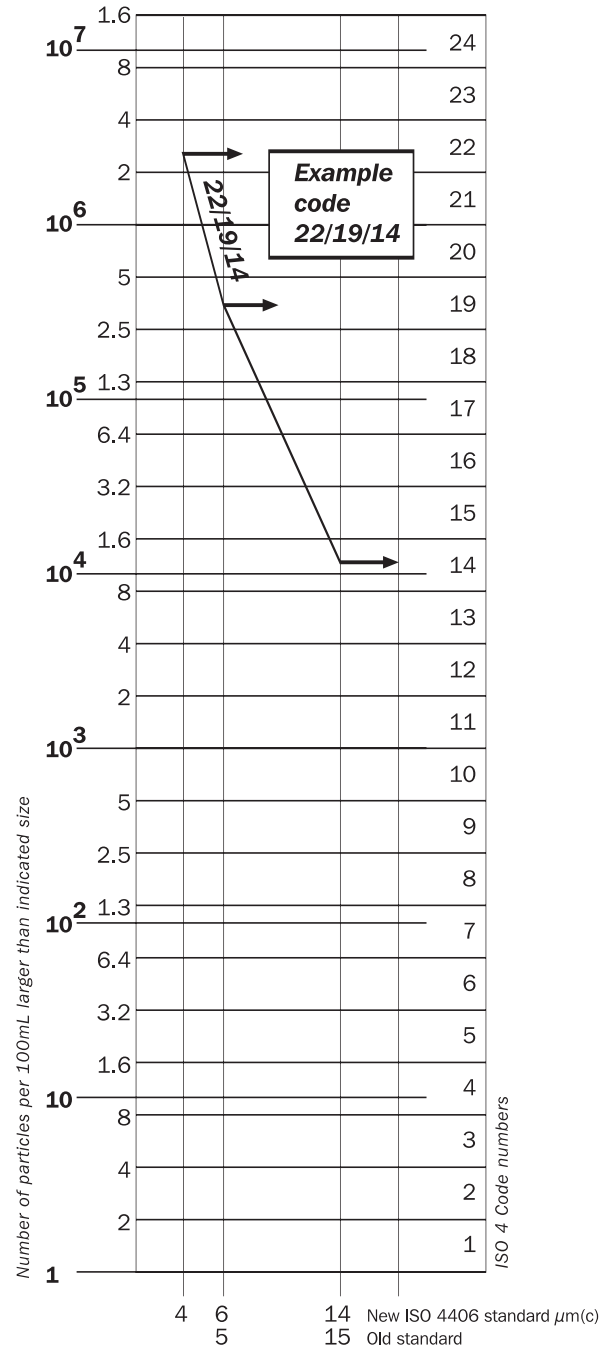
**The second number** represents how many particles are larger than 6  $\mu\text{m(c)}$ .

**The third number** represents how many particles are larger than 14  $\mu\text{m(c)}$ .

**Microscope counting** examines the particles differently from APCs; the code is given with two scale numbers only. These are at 5  $\mu\text{m}$  and 15  $\mu\text{m}$ , equivalent to the 6  $\mu\text{m(c)}$  and 14  $\mu\text{m(c)}$  of the APCs.

NUMBER OF PARTICLES PER ML.		SCALE NO.
More Than	Up to and Including	
2.5M	-	> 28
1.3M	2.5M	28
640k	1.3M	27
320k	640k	26
160k	320k	25
80k	160k	24
40k	80k	23
20k	40k	22
10k	20k	21
5000	10k	20
2500	5000	19
1300	2500	18
640	1300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
2.5	5.0	9
1.3	2.5	8
0.64	1.3	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1
0.0	0.01	0

Table 5: ISO 4406 Allocation of Scale Numbers



ISO 4406 Cleanliness Code Chart (with 100ml sample volume)

# NAS [National Aerospace Standard] 1638 Cleanliness Code System

The NAS system was developed in 1964 to define classes of contamination in aircraft components. This standard was extended to industrial hydraulic systems simply because nothing else existed at the time.

The coding system defines the maximum numbers permitted of 100ml volume at various size intervals (differential counts) rather than using cumulative counts as in ISO 4406.

Although the standard provides no guidance for quoting levels, most industrial users quote the highest code recorded in all sizes; this convention is used on the Target-Pro 2.

## Contamination Level Classes according to NAS 1638 (January 1964)

Each contamination class is defined by a number from 00 to 12 that indicates the maximum particles per 100 ml, counted on a differential basis, in a given size bracket.

### Maximum Contamination Limits (per 100 ml)

Size Range Classes (in microns)

	00	0	1	2	3	4	5	6	7	8	9	10	11	12
5-15	125	250	500	1000	2000	4000	8000	16000	32000	64000	128000	256000	512000	1024000
15-25	22	44	89	178	356	712	1425	2850	5700	11400	22800	45600	91200	182400
25-50	4	8	16	32	63	126	253	506	1012	2025	4050	8100	16200	32400
50-100	1	2	3	6	11	22	45	90	180	360	720	1440	2880	5760
Over 100	0	0	1	1	2	4	8	16	32	64	128	256	512	1024

Cleanliness Code Chart (with 100mL sample volume)

### Hydraulic Component Manufacturers' Recommendations

Manufacturers know the effects of contamination. They issue maximum permissible contamination levels, and remind users that cleaner fluids will improve performance and increase component life. But no one has established a single standard for the cleanliness of hydraulic fluid, in part because working conditions are different for any two applications. As a result, even trusted sources of information on cleanliness levels give varying recommendations.

The table below should help you get started. It gives a selection of maximum contamination levels that are typically issued by component manufacturers. These relate to the use of the correct viscosity mineral fluid. An even cleaner level may be needed if the operation is severe, such as high frequency fluctuations in loading, high temperature or high failure risk.

**Note:** *The recommendations in this table should be viewed as starting levels; adjust them as needed to reflect operational experiences or user requirements.*

UNIT	TYPE	ISO 4406 CODE
<b>Pump</b>	Piston (slow speed, in-line)	22/20/16
	Piston (high speed, variable)	17/15/13
	Gear	19/17/15
	Vane	18/16/14
<b>Motor</b>	Axial piston	18/16/13
	Radial piston	19/17/13
	Gear	20/18/15
	Vane	19/17/14
<b>Valve</b>	Directional (solenoid)	20/18/15
	Pressure control (modulating)	19/17/14
	Flow control	19/17/14
	Check valve	20/18/15
	Cartridge valve	20/18/15
	Proportional	18/16/13
	Servo valve	16/14/11
<b>Actuator</b>		20/18/15

Typical Manufacturer Recommendations for Component Cleanliness (ISO 4406)

### Target Cleanliness Levels

You can use cleanliness levels to establish benchmarks. If you have no component failures over a prolonged testing period, the average level measured during that time may be an acceptable goal. If you need to reduce equipment failures, want to increase component life, or expect conditions to change considerably, you can establish a higher benchmark and use testing to help reach it.

An acceptable level of cleanliness depends on three features: **1.** the contamination sensitivity of components; **2.** the operational conditions of the system; **3.** and the required reliability and life expectancy.

Contamination Codes ISO 4406	Correspondent Codes NAS 1638	Recommended Filtration Degree	Typical Applications
4µm(c) 6µm(c) 14µm(c)		B x ≥ 200	
14 12 9	3	3	High precision and laboratory servo-systems
17 15 11	6	3-6	Robotic and servo-systems
18 16 13	7	10-12	Very sensitive-high reliability systems
20 18 14	9	12-15	Sensitive-reliable systems
21 19 16	10	15-25	General equipment of limited reliability
23 21 18	12	25-40	Low-pressure equipment not in continuous service

# Cleanliness Codes (continued)

The Target-Pro 2 is calibrated with ISO Medium Test Dust (to ISO 11171). The correlation between particle sizes and the ACFTD (old standard) to the ISOMTD (new standard) is as follows :

<b>ACFTD</b>	<1	5	15	25	30	50*	75*	100*
<b>ISOMTD</b>	4	6	14	21	25	38	50	68

\* To be confirmed by NIST.

## Correlation between Particle Sizes Obtained using ACFTD and NIST Calibration Methods

Particle Size Obtained Using ACFTD SIZE (ISO 4402:1991) $\mu\text{m}$	ISOMTD NIST (ISO 11171) size $\mu\text{m(c)}$
1	4.2
2	4.6
3	5.1
4	5.8
5	6.4
6	7.1
7	7.7
8	8.4
9	9.1
10	9.8
11	10.6
12	11.3
13	12.1
14	12.9
15	13.6
16	14.4
17	15.2
18	15.9
19	16.7
20	17.5
21	18.2
22	19.0
23	19.7
24	20.5
25	21.2
26	22.0
27	22.7
28	23.5
29	24.2
30	24.9
31	25.7
32	26.4
33	27.1
34	27.9
35	28.5
36	29.2
37	29.9
38	30.5
39	31.1
40	31.7

This table is only a guideline. The exact relationship between ACFTD sizes and the NIST sizes may vary from instrument to instrument, depending on the characteristics of the particle counter and original ACFTD calibration.

## Other Standards

Although ISO 4406 is used extensively in the hydraulics industry, other standards are occasionally required. Direct comparison is not always possible, but this table provides some estimates.

## Approximate Equivalents of Contamination Classes

ISO 4406	DEF.STD 05/42 [7]		NAS 1638[5] ISO 11218[6]	SAE 749[8]
	Table A	Table B		
13/11/08	—	—	2	—
14/12/09	—	—	3	0
15/13/10	—	—	4	1
16/14/09	—	400F	—	—
16/14/11	—	—	5	2
17/15/09	400	—	—	—
17/15/10	—	800F	—	—
17/15/12	—	—	6	3
18/16/10	800	—	—	—
18/16/11	—	1,300F	—	—
18/16/13	—	—	7	4
19/17/11	1,300	2,000F	—	—
19/17/14	—	—	8	5
20/18/12	2,000	—	—	—
20/18/13	—	4,400F	—	—
20/18/15	—	—	9	6
21/19/13	4,400	6,300F	—	—
21/19/16	—	—	10	—
22/20/13	6,300	—	—	—
22/20/17	—	—	11	—
23/12/14	15,000	—	—	—
23/21/18	—	—	12	—
24/22/15	21,000	—	—	—
25/23/17	100,000	—	—	—

## New ISO Standard Test Dust and its effect on ISO Contamination Control Standards

For more than 25 years, the measurement of solid particles in hydraulic fluids has depended on AC Fine Test Dust (ACFTD), a product manufactured by General Motors. ACFTD was used for calibrating Automatic Particle Counters (APCs), testing components such as oil filters, and testing the contaminant sensitivity of hydraulic components.

The particle size distribution of ACFTD, determined using an optical microscope, formed the basis of ISO 4402—the method for calibrating APCs. The limitations of optical microscopes meant that distribution was uncertain at particle sizes smaller than 5 microns. Consistency between batches was also a regular concern.

After General Motors decided to stop making ACFTD, the International Organization for Standardization (ISO) defined requirements for a replacement, and asked the National Institute of Standards and Technology (NIST) to produce a standard, traceable reference substance. The new dust's particle size distribution has been accurately determined with the aid of scanning electron microscopes and image analysis techniques.

### New Test Dust Benefits

The new ISO Medium Test Dust (ISOMTD) uses similar materials to ACFTD, but in a slightly coarser grade to reduce particle counting errors. ISOMTD is produced to a standard distribution and stringent quality control procedures for reliable consistency. In addition, production of ISOMTD includes a revised ISO APC calibration method.

The result is a controlled reference test dust with uniform particle size distribution. It provides the traceability required by ISO 9000, QS9000 and similar quality management systems. A procedure for determining the performance of APCs means the user can set minimum acceptable levels. Benefits include improved calibration techniques and procedures, greater particle count reproducibility with different equipment, and more accurate and consistent filter test results.

## Effect on Industry

### THE INTRODUCTION OF ISOMTD HAS REQUIRED CHANGES TO CERTAIN ISO STANDARDS. THESE INCLUDE:

<b>ISO 4402</b>	1991	Hydraulic fluid power Calibration of liquid automatic particle counters
<b>ISO 4406</b>	1987	Hydraulic fluid power Code for defining the level of contamination by solid particles
<b>ISO 4572</b>	1981	Hydraulic fluid power Filters Multi-pass method for evaluating filtration performance of filter elements

To prevent confusion over which standards to use, ISO is updating 4402 to ISO 11171, and 4572 to ISO 16889. ISO standards written for the new test dust will use a new identifier, '(c)'. Micron sizes according to ISO 11171 will be expressed as 'µm(c)' and Beta ratios according to ISO 16889 will be expressed as 'Bx(c)', e.g. 'B5(c)'.

In the new ISO 4406, new calibration sizes are used to give the same cleanliness codes as the 'old' calibration sizes of 5 and 15 microns. This will prevent the need to change system cleanliness specifications.

The proposed cleanliness codes for APCs will be formed from three particle counts at 4, 6 and 14 microns, with 6 and 14 microns corresponding closely to the previous 5 and 15 micron measurements. Users may still quote just two counts of 6 microns and 14 microns for APCs.

Counts derived by microscope counting methods are not affected, so the particle sizes used for microscopy, at 5 and 15 microns, will remain unchanged. The only real effect users will experience is improved particle count accuracy; there will be no change in filter performance or ISO cleanliness levels.

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