Portable solutions to Condition Monitoring

MHC - *Memo* Pro

Operators Manual

portable data logger with diagnostic capture

HOLROYD
INSTRUMENTS

(for Memo Pro Firmware Version 11.X)

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SECTION I - THE MHC-MEMO PRO AND ITS USE

I - 1 SAFETY & THE ENVIRONMENT

Overriding Note : Sensors used with the MHC-Memo Pro contain strong magnets and should never be positioned in the vicinity of sensitive electrical/electronic equipment (such as pacemakers) or magnetic storage media (such as hard disk drives in PC's)

a) To avoid risk of electrical shock the MHC-Memo Pro should only be used on earthed electrical machinery.

b) Always adhere to site rules and guidelines concerning Health & Safety when using the MHC-Memo Pro.

c) Always wear safety equipment appropriate to the area where the measurement is to be made.

d) Never override safety systems in order to gain access to operating machinery and always take care to avoid physical injuries. **Do not carry out any instruction in this manual if in your application it would entail risk of physical injury to you or others.**

e) Use a viscous fluid couplant (e.g. a grease or gel) between the MHC sensor and the machine / monitoring pad which is appropriate to the environment and follow the suppliers instructions on its use particularly with regard to any irritant effects on the skin.

f) Do not use the MHC-Memo Pro in the presence of explosive gases or highly inflammable liquids. The MHC-Memo Pro is NOT certified within the meaning of ATEX, Ex , IS etc..

g) Always adhere to manufacturers instructions on the safe disposal of batteries used with the MHC-Memo Pro.

h) The MHC-Memo Pro instrument, its headphones and sensor fall within the scope of the WEEE directive and must not be disposed of in the EU except through a WEEE registered recycling scheme. This can be done by either using an approved in-house scheme (where appropriate) or by sending the instrument back to Holroyd Instruments Ltd provided it is not contaminated with toxic chemicals, biological material, bacteria or radioactive materials.

I - 2 INTENDED USE OF THE MHC-MEMO PRO

The MHC-Memo Pro is intended to be used to aid in the identification of faulty machinery (particularly motors, pumps, fans, gearboxes and shaft support bearings). The signal processing incorporated in the MHC-Memo Pro has

been very extensively evaluated and demonstrated across a wide range of industries and an outstanding ability to detect machinery distress and degradation has been established. Whilst no Condition Monitoring technique can guarantee to provide early warning of all possible fault types the applicability of the MHC-Memo Pro to a wide range of rotating machines has been successfully demonstrated. This manual provides practical advice on the use of the MHC-Memo Pro and general guidelines for interpreting its readings in accordance with the findings of this previous work. No such general guidelines, or indeed no such general purpose instrument, can be guaranteed to provide the information required in all cases. For these reasons we recommend that the MHC-Memo Pro is used to complement your existing methods and procedures for dealing with the service, maintenance and repair of machinery. The MHC-Memo Pro is intended to provide you with additional information to assist you in making your service and maintenance decisions.

NOTE : Since Holroyd Instruments Ltd has no control over the machinery to which the MHC-Memo Pro will be applied, the care taken during its use, or the appropriateness of any actions taken, Holroyd Instruments Ltd cannot accept any responsibility or liability for any consequential loss howsoever arising from the use of the MHC-Memo Pro.

I - 3   FAMILIARISATION WITH THE MHC-MEMO PRO

I - 3.1 Schematic of MHC-Memo Pro controls and connections

KEY		FUNCTION
Special Function Keys	-	Function of left and right key varies depending on lower line of alphanumeric display.
STORE	-	Temporarily captures the current readings and enters storage mode.
HOLD	-	Toggles between a frozen and an updating display.
EDIT	-	Enables return to main start-up menu.
VOLUME	-	Toggles between high and low settings of the headphones output.
B/LIGHT	-	Switches on the display backlight. Auto switches off after ~ 8 secs to conserve battery power.
ON	-	Switches on the MHC-Memo Pro.
MENU	-	Enters menu mode appropriate to when it is pressed. Options can include Auto Log, Capture Spectrum and Erase Data..
OFF	-	Switches off the MHC-Memo Pro.

I - 3.2 MHC-Memo Pro measurement options

The MHC-Memo Pro provides information related to the mechanical condition of rotating machinery. It does this by detecting high frequency stress waves (at approximately 100 kHz) associated with energy loss mechanisms such as friction and impacts that are naturally produced by machinery in poor condition. The technology it uses is known as Acoustic Emission or AE. In particular the MHC-Memo Pro is not sensitive to low frequency activity such as that associated with vibration or audible sound.

The MHC-Memo Pro can be applied to a wide variety of machine types including motors, pumps, fans gearboxes and shaft support bearings. It can be useful in the detection of bearing faults (including faults on plain, ball and roller bearings) and pitting on gear teeth provided there is a good sound path to the gearbox casing.

When using the MHC-Memo Pro to take a measurement a special AE sensor is temporarily coupled to the surface of the machine of interest. The MHC-Memo Pro has a number of modes of operation :

a) Off-route readings in Standard Mode (Distress & dB Level)

Pressing the soft key designated [no] in response to the displayed message 'Routes' enables this mode to be entered. In response to the display 'Standard Mode' select [yes] to enter the standard mode. This mode is best suited to monitoring rotating machinery rotating at speeds above 30 rpm. In this mode there is no need to make any adjustments when monitoring machinery of different types, size, design or operating speed. The MHC-Memo Pro automatically processes the signals in terms of two parameters called *Distress* and *dB Level*. To exit this mode press the 'Edit' key and respond [yes] to the display 'Return to Main'.

b) Off-route readings in Super Slo Mode (dB, Peak, Intensity & Extent)
To enter this mode press the soft key designated [no] in response to the displayed message 'Routes' and again respond [no] to the display 'Standard Mode'. The display will then change to 'Super Slo Mode' and the [yes] soft key should be pressed. This mode of operating is suitable for monitoring machine operating at rotational speeds down to ~0.25 rpm (255 seconds per revolution). In order to make a slow mode measurement it is first necessary to enter the number of seconds it takes the machine to perform one revolution using the [+] key. In this mode the MHC-Memo Pro will automatically processes the signals in terms of **dB Level (dB),** *Peak (P), Intensity (I)* and *Extent (E)* when [go] is selected. To exit this mode press the 'Edit' key and respond [yes] to the display 'Return to Main'.

c) Auto Log (time sequence of readings)
The purpose of Auto Log is to automatically store a sequence of successive readings (up to a maximum of 2338 sets). These can be either Standard Mode readings or Super Slo Mode readings (Note Auto Log mode can only be entered when taking off-route readings as described in (a) and (b) above). The MHC-Memo Pro memory space allocated for Auto Log data can be filled in one long sequence or as multiple smaller sequences. The size of each Auto Log file depends on the length of time you leave a particular Auto Log sequence running.

d) Route mode operation
Pressing the soft key designated [yes] in response to the displayed message 'Routes' enters this mode. The MHC-Memo Pro can have up to 6 routes loaded into it at any one time each of which may consist of several hundred measurement points. Routes must be created in advance on a PC using the Analysis Pro software and downloaded into the MHC-Memo Pro. Each route and its associated readings is stored in its own non-volatile memory area and follows a hierarchical format. The levels of hierarchy are as follows :

- 'Route' name (up to 16 alphanumeric characters)
- 'Site' name (up to 16 alphanumeric characters)
- 'Area' name (up to 16 alphanumeric characters)
- 'Machine' or 'Mach' name (up to 16 alphanumeric characters)
- Point name (up to 16 alphanumeric characters)

When using the MHC-Memo Pro in Route mode you can scroll through all entries at each level of hierarchy. (Note : the minimum number of key strikes

for the operator will be to take readings in sequence.) Each measurement point is pre-designated during route creation to be one of the following measurement types :

- STD : Standard mode readings (Distress and dB Level)
- SLO : Super Slo mode readings (dB Level, Peak, Intensity and Extent)
- MAN : Manually inputted values (eg an external reading of load, temperature, vibration rms etc..)

Prior to storing a new reading at any measurement point it is possible to display the previous reading taken for that point (these previous values are automatically downloaded from the PC at the same time as the route is downloaded onto the MHC-Memo Pro). When the new value is stored the previous reading for that measurement point will be lost from within the MHC-Memo Pro. All readings are date and time stamped with 1 hour resolution.

> **IMPORTANT :**
> Routes should always be re-loaded after unloading the measurement data to the PC prior to taking a further set of measurements. If this I not done the MHC-Memo Pro will assume that it is re-taking measurements on the last set of data and inconsistencies will arise when viewing Missed Points in Analysis Pro.

e) Capture Spectrum

The Capture Spectrum mode can be accessed from within the Standard mode of operation (either when live readings are being taken or from within a Route). In this mode the MHC-Memo Pro is able to store the data for up to 15 frequency spectra of the AE envelope signal. Such frequency spectra are later accessed via the Analysis Pro software and viewed in a special version of AE Lab software that is supplied with the MHC-Memo Pro. Each AE envelope spectrum covers the frequency range of 0 Hz to 1000 Hz and is representative of a 1 second period sampled at 2048 times per second.

I - 3.3 Basic operation of the MHC-Memo Pro (See sections I - 4 and I - 5 for full guide).

a) Plug the MHC sensor and the headphones into the MHC-Memo Pro unit and press the ON button. The upper line of the instruments alphanumeric display will show 'Routes'.

b) On the lower line the display reads [yes] on the left hand side and [no] on the right hand side. For this demonstration select [no] by pressing the right hand special function key (white triangle at right hand side underneath the display). The display will now change to show 'Standard Mode', Press the left hand [yes] soft key in order to display live readings of *Distress* and *dB Level*.

c) Apply a drop of a viscous fluid (such as a grease appropriate to the local environment) onto the sensor front face and couple the sensor to a steel plate.

d) Allow time for the readings to settle down.

e) To simulate machine friction rub the plate gently with a paper tissue. Observe the effects on the displayed readings of *Distress* and *dB Level* and the characteristic 'sshhh' sound in the headphones. Press the VOLUME key to toggle the volume of the headphones between high and low sensitivity.

f) Note that if *Distress* increases to 10 a single '?' appears after the reading. This changes to '??' when it reaches 15 and '???' when it reaches 20. In practice this feature draws your attention to machinery in *Distress*.

g) Observe that when the *dB Level* is less than 5 the word LOW is displayed. In practice this draws your attention to low signal levels which may result from a poor sensor coupling or even a machine that isn't running (Note that on slowly rotating machinery it can be quite normal for the *dB Level* to be less than 5 dB).

h) To simulate impacts occurring within machinery drop several grains of sugar, salt or similar particles onto the plate. Observe the effect on the displayed readings of *Distress* and *dB Level* and the characteristic multiple 'clicks' heard on the headphones.

i) Observe that although the headphones are very sensitive to rubbing and impacts on the steel plate they are not responsive to other audible noises and vibrations which may be present nearby.

j) Pressing the HOLD key freezes the display and adds the word HOLD to it. Although the display is frozen the MHC-Memo Pro continues to compute the current value of *Distress* and *dB Level*. Pressing the HOLD key a second time will release the display and it will instantly jump to the current values. This feature is useful for doing an on the spot comparison between readings at two positions on a machine or on two adjacent machines of the same type.

I - 4 GETTING STARTED

I - 4.1 Installing monitoring pads

a) General guidance

Galvanised steel sensor mounting pads are used to improve the reproducibility of measurements particularly where the surface condition of the machine is not very smooth or flat. Where possible fit a monitoring pad as close as practical to each bearing (ensuring the sensor will not foul when attached to the stud and that the stud will not interfere with future strip-down and repair operations). Bear in mind that high frequency waves are not easily transmitted across joints between different materials or through soft materials

such as rubber or plastics. If there are competing sources of activity present e.g. from an adjacent machine, high pressure jets, cavitation or process noises then position the monitoring pad as close to the bearing as possible but as distant as possible from these unwanted sources.

b)   Some common monitoring pad positions :

Shaft and roller support bearings
Position the monitoring pad anywhere on each bearing housing. If possible choose a flat (or near flat) part of the surface.

Motors
For most motors two monitoring pads are used, one for the drive end and one for the non-drive end bearings. If the non-drive end has a flimsy cover plate over the fan do not mount the pad onto this but adjacent to it (e.g. on the cooling fins where there is a break in the fin pattern). The monitoring pad can be oriented radially or axially (i.e. on the end or side of the motor) depending upon access.

In-duct fans
Mount externally, either on the ends of or immediately adjacent to the spiders supporting the internal fan. Use one pad for the front support and one for the back support (except on very small fans).

Pumps
On simple centrifugal pumps the bearings are often external and readily accessible. Mount a monitoring pad on each bearing. If possible choose a flat (or near flat) part of the surface. On multi-stage pumps access may be more difficult and it may be necessary to refer to engineering drawings to identify where the bearings are being supported. If the pump is supported on a Michelle bearing this can also be monitored with a monitoring pad bonded to the side of the bearing housing.

Axial compressors
For a two bearing design the monitoring pads should be positioned at both ends of the compressor. They can be oriented radially or axially depending upon access.

Gearboxes
On large gearboxes individual bearings associated with each shaft can often be identified. Mount one monitoring pad immediately adjacent to each bearing access plate (this allows the area of distress to be located). On smaller gearboxes use two monitoring pads one adjacent to the input shaft and one adjacent to the output shaft. On very small gearboxes use only one monitoring pad centrally located on the gearbox body.

c)   How to mount a monitoring pad
The monitoring pads are made from a galvanised steel blank and they are typically attached to the machine surface using a structural adhesive.

When you have decided where to bond the pad prepare the surface by removing dirt, grease and flaking paint and rubbing down with emery paper. If the paint is sound it is usually sufficient to roughen it to provide a good key for the adhesive.

Clean the prepared area and the back of the monitoring pad with a de-greasing agent. Use a suitable structural adhesive to bond the galvanised steel monitoring pad to the machine. Loctite* 326 with Activator N is satisfactory in many instances for gaps up to 0.5 mm.

> * For more information on Loctite products look on www.loctite.com

I - 4.2 Taking a reading
To achieve consistent readings the following procedure should be followed when using the MHC-Memo Pro :

a)   Clean the sensor front face and the face of the monitoring pad using a clean cloth.

b)   Apply a small drop of clean viscous fluid (such as a grease appropriate to the local environment) to the monitoring pad or the sensor front face.

c)   Bring the sensor towards the surface of the machine at an angle of approximately 45 degrees so that the edge of the front face touches first. Then pivot the sensor over so that contact is made across the sensor face (this method is preferred because of the very strong magnetic face).

d)   Twist the sensor slightly; it should rotate smoothly without any feel of roughness (repeat steps (a) to (c) if you can feel grit in the coupling).

e)   If the MHC-Memo Pro isn't already switched on then switch it on either for taking off route readings or on route readings (see Section I -3.2). If in 'Route' display respond appropriately to the hierarchical questions until the desired measurement position on the route is reached (as described in Section I - 5).

f)   For Standard Mode readings :
        Observe the measured values of *Distress* and *dB Level* and check that they have reached steady levels (this should take about 15 seconds). It is normal for the reading to be initially high when the sensor is placed onto the machine or the instrument is switched on.

If Distress and dB Level do not reach a steady value but continue to vary this can be the earliest indication of a machine problem arising. Use the HOLD key to freeze the display at the most representative value prior to storing it.

If appropriate use the headphones to assist in the diagnosis of any machine in Suspect (ie Distress > 10) condition.

g)   For Super Slo Mode readings :
To use super slo mode it is necessary to enter the time in seconds it takes for the item being monitored to make 1 revolution (ie the period of revolution in seconds). This does not have to be exact, always round up to the nearest full second (eg if period = 3.4 seconds select 4 seconds as the time per revolution).

On slow speed machinery it is usual for signal levels to be very low (dB levels of 0 are not uncommon at slow speeds). Because of this it is especially important that the MHC sensor, and the lead connecting it to the MHC-Memo Pro instrument is not moved since such movement may cause artificial signals to be generated from friction and triboelectric noise.

h)   When removing the sensor after taking a measurement hold the body of the sensor (not the sensor lead) and pivot it so that one side of the front face breaks away. With the sensor at an angle of approximately 45 degrees pull the sensor body away from the machine surface. Do not pull on the sensor lead when doing this.

I - 4.3 Ways of using the MHC-Memo Pro

a)   Routine Periodic Monitoring
This is the principal use for which the MHC-Memo Pro was designed and is based on the use of walk around Routes that are created in advance in the PC domain using the Analysis Pro software. A description of how routes are accessed in the MHC-Memo Pro and the information that can be stored is introduced in Section I - 3.2(d). A fuller description of this mode of use of the MHC-Memo Pro is given in Section I - 5.

b)   Ad Hoc (Off-Route) Measurements
The MHC-Memo Pro can be used to make occasional measurements in normal or slow mode without the use of the storage mode. Simply switch on the MHC-Memo Pro and follow the procedure described in Section I - 3.2(a) & (b) and respond 'no' to the Route' display. Occasions when the MHC-Memo Pro might be used in this mode are :

- For lubrication checking as part of a strategy to only grease machinery when it is needed.

- To assist in setting up a new installation to be running as smoothly as possible.
- To give immediate confirmation that a maintenance action has been successful.
- To Provide more information on a machine of concern,

c)   Troubleshooting
The simplest form of troubleshooting with the MHC-Memo Pro is to use the headphones to better understand the nature of the problem in the following ways :

    i)   Interpret the likely cause from the nature of the signal (e.g. the singular 'click of a cracked race, the periodic 'shh' of a shaft rub or the 'frying bacon' sound of generalised damage).

    ii)   Understand the operational conditions (e.g. of speed, load, tightness etc.) that aggravate the condition.

    iii)   Localise the source by moving the sensor around the component and looking for where it is loudest.

Sometimes further insight into the nature or cause of a problem can be gained from looking more closely over a longer time period at what aggravates the condition. To do this in a more systematic way than just listening on the headphones you can use the Auto Log function to record one or more sequences of successive values (see Auto Log in Section I - 3.2(c)).

With rotating machinery it is often the case that the source of detectable signal (e.g. an impact or a rub has repetition associated with it (e.g. at once per rev, ball spin or ball passing frequency etc..). For machinery rotating at speeds greater than 60 rpm the Capture Spectrum facility enables the data for such a frequency spectrum to be stored so that repetition frequencies can be viewed and analysed in the PC domain (see Capture Spectrum in Section I - 3.2(d)).

I - 4.4 Some important tips

a)   Whilst the MHC sensor is of a very robust design it is a sensitive measuring device and should not be handled roughly.

b)   When the battery levels are low the display automatically changes to
                        ** LOW BATTERY**
                        please replace

and further use of the MHC-Memo Pro is not possible until the batteries have been replaced or, if appropriate, the batteries are re-charged (data has not been lost since the memory is non-volatile).

c)   If the signals being detected by the MHC-Memo Pro go out of range of the instrument the Distress reading will show two hyphens (i.e. --) rather than a numeric value. This will only occur when signal levels are

very large. *Distress* readings will resume automatically when signal levels fall.

d)   It is recommended that the MHC sensor is left permanently attached to the lead. Always ensure that the MHC sensor is attached to the sensor lead before connecting it to the MHC-Memo Pro unit. If it is necessary to disconnect the sensor from the lead make sure that the other end of the sensor cable is NOT connected to the MHC-Memo Pro unit (this is to prevent damage to the sensitive input stages of the MHC-Memo Pro instrument).

I - 5   USE OF THE MHC-MEMO PRO AS A DATA LOGGER

I - 5.1 General comments on data logging

Data logging is widely employed in Condition Monitoring particularly where many machines or measurement points need to be monitored and it would be too costly to manually handle such large amounts of data. Furthermore, where repeated measurements will be made on the same machinery over a long period of time, the analysis of data logged readings in the PC domain greatly simplifies the generation of trend plots and their analysis to reveal progressive increases.

However it does require some discipline in taking the measurements for trend analysis to be employed to best effect. When you or your colleagues are analysing trends at a later date the task will be made a lot easier if these simple points are followed :

a)   Make sure that you have got the right Route(s) loaded / re-loaded* into the MHC-Memo Pro.

b)   All readings should be taken in a consistent manner (as described in section I - 4.2)

c)   Full sets of readings should be taken on all the measurement points if at all possible (if no reading is taken you cannot infer anything about its current condition).

d)   Measurements should be taken periodically at regular intervals (e.g. every 4 weeks or whatever you choose). A calendar function built into the Analysis Pro PC software can be set to remind you when measurements are due on particular routes (see 'Advanced' drop don menu in Analysis Pro software).

e)   Care should be taken to ensure that readings are stored at their correct machine addresses (SAMP's).

        * Routes should always be re-loaded after unloading the measurement data to the PC prior to taking a further set of measurements. If this is not done the MHC-Memo Pro will assume that it is re-taking

measurements on the last set of data and inconsistencies will arise when viewing Missed Points in Analysis Pro.

I - 5.2 Hints on creating a walk around route
The MHC-Memo Pro is able to store up to 6 routes each of which may have up to 435 measurement points. Each of the Routes is defined by a hierarchical description of the measurement position. We refer to this as a SAMP (Site, Area, Machine, Point)). The complete data set consists of the following :

- the name of the *Site* at which the measurement will be made (up to 16 characters)
- the name of the *Area* within the site at which the measurement will be made up to 16 alphanumeric characters)
- the name of the *Machine* within the area at which the measurement will be made (up to 16 alphanumeric characters)
- the name of the actual *Point* on the machine at which the measurement will be made (up to 16 alphanumeric characters)
- The particular readings (dependent upon measurement type at that point)
- Date / Time Stamp (with 1 hour time resolution)

In addition the overall route can have a unique 'Route' name up to 16 alphanumeric characters.

In the as-supplied condition the different elements of the units memory are ascribed a very basic (and meaningless) set of Routes which have been entered purely for testing of the communications hardware and software during production pass-off testing. **Please ensure that you replace this test route with your own route before using the instrument.**

Checking when a Route was loaded / unloaded
With the MHC-Memo Pro instrument switched on and displaying 'Routes' together with [yes] and [no] soft keys press the [yes] soft key and advance to display the route name of the route you wish to check (together with its [yes] and [no] soft keys). Press the MENU key to display 'Loaded on' and the relevant date. If you proceed to press the [OK] soft key the display will change to show the unloaded date if applicable. Pressing the [OK] soft key again returns the display to that of the route.

I - 5.3 Navigating within a Route
Finding a particular measurement point
When using the Route mode of operation you can navigate around the various measurement points (each defined by a SAMP). Because of the hierarchical nature of the systems architecture you can quickly navigate through the 'Routes', the 'Sites' within a route, the 'Areas' within a site, the 'Machines' within an area and finally the individual points on a particular machine. The method of doing this is as follows :

On power up of the MHC-Memo Pro press the [yes] soft key in response to the initial 'Routes' display. The display will change to show the name of Route 1 and you have the soft key options of [yes] and [no]. Responding [yes] enters that particular route. Responding [no] moves the display on to show the name

of Route 2 etc.. If you respond [no] to all the 6 route options the display will change to 'Finish' with [yes] and [no] soft key options. Select [no] if you want another chance to select one of the Routes.

When you have selected a particular Route the display will change to show the name of a Site and you have the soft key options of [yes] and [no]. Responding [yes] moves down the memory hierarchy to that particular Site. Responding [no] moves the display on to show the name of the next Site etc.. If you respond [no] to all the Site options the display will change to 'Finish' with [yes] and [no] soft key options. Select [no] if you want another chance to select one of the Sites on the selected Route.

When you have selected a particular Site the display will change to show the name of an Area and you have the soft key options of [yes] and [no]. Responding [yes] moves down the memory hierarchy to that particular Area. Responding [no] moves the display on to show the name of the next Area etc.. If you respond [no] to all the Site options the display will change to 'Finish' with [yes] and [no] soft key options. Select [no] if you want another chance to select one of the Areas on the selected Site.

When you have selected a particular Area the display will change to show the name of a Machine and you have the soft key options of [yes] and [no]. Responding [yes] moves down the memory hierarchy to that particular Machine. Responding [no] moves the display on to show the name of the next Machine etc.. If you respond [no] to all the Machine options the display will change to 'Finish' with [yes] and [no] soft key options. Select [no] if you want another chance to select one of the Machines on the selected Site.

When you have selected a particular Machine the display will change to show the name of a point and you have the soft key options of [yes] and [no]. Responding [yes] moves down the memory hierarchy to that particular point. Responding [no] moves the display on to show the name of the next point in that machine etc.. If you respond [no] to all the measurement point options on a machine the display will change to 'Finish' with [yes] and [no] soft key options. Select [no] if you want another chance to select one of the points on the selected Machine.

Taking measurements around a route
Routes are created in the Analysis Pro software that is supplied with the MHC-Memo Pro instrument (see Section II). The quickest way to take and store readings is to follow the route in the sequence in which it was loaded into the MHC-Memo Pro. Note : there is provision in the Analysis Pro software to modify and re-arrange the naming and sequencing of SAMP's within a route to take into account changes in machines, measurements required and access as they occur.

When taking readings in the same sequence as they were loaded then the MHC-Memo Pro automatically walks you around the route telling you where to go next and jumping up and down the hierarchy levels as necessary. If you

get to a particular measurement point where the machine is not running then you can simply press the [skip] soft key to move on to the next SAMP.

If you have skipped taking a measurement at a particular measurement point because it was temporarily inaccessible or not running then you could consider going back to that point later in the measurement sequence. You can navigate back through the route by pressing the EDIT button on the MHC-Memo Pro whenever the instrument is displaying at the route (ROUTE), site (SITE) area (AREA) or machine (MC) level. Pressing the EDIT button again moves backwards through the SAMP listing. Pressing the [no] soft key moves forwards through the SAMP listing. Press the [yes] soft key when you wish to accept and then navigate as normal in the forwards direction. *(NOTE : this EDIT function for going backwards through the SAMP listing does not operate at the POINT level of hierarchy. If you are going backwards at the machine (MC) level you should only press the [yes] to accept at the machine __prior to__ the one you want to monitor. This is because at the machine (MC) level when going backwards POINT on that machine. Move forwards in the normal way through the POINTs on any particular machine to the next machine etc..)*

I - 5.4 Storing readings in the MHC-Memo Pro
The MHC-Memo Pro has the following 8 memory areas :

- Route 1 (a walk around route having up to 435 measurement points)
- Route 2 (a walk around route having up to 435 measurement points)
- Route 3 (a walk around route having up to 435 measurement points)
- Route 4 (a walk around route having up to 435 measurement points)
- Route 5 (a walk around route having up to 435 measurement points)
- Route 6 (a walk around route having up to 435 measurement points)
- Spectrum memory (up to 15 data sets each representative of one frequency spectrum)
- Auto Log memory (one or more automatic sequences of successive readings taken in either Standard or Super Slo mode up to a maximum of 2338 sets of readings)

NOTE : when using the MHC-Memo Pro to store readings in route mode it is most important that the route should be reloaded between one set of readings on that route and the next set. If this is not done the MHC-Memo Pro will assume that it is re-taking measurements on the last set of data and inconsistencies will arise when viewing Missed Points in Analysis Pro.

Storing data in route mode.
Routes are constructed in the Analysis Pro software and consist of the following hierarchical elements :

- Route name (up to 16 alphanumeric characters)
- Site (up to 16 alphanumeric characters)
- Area (up to 16 alphanumeric characters)
- Machine name (up to 16 alphanumeric characters)

- Point on machine (up to 16 alphanumeric characters)

Measurements are only taken at the lowest level (i.e. point on machine). The higher levels are for the purpose of grouping the measurements into different related regions by geographical and physical location.

Ideally routes should be created so that the members of each of the hierarchical levels are listed in the most logical order in which they will ordinarily be taken. Whilst it is possible to manually alter the order in which points are taken when on site, it is much simpler and involves less key strokes if the sequence in a route is followed (the sequence and composition can be changed in the PC domain using the Analysis Pro software.

All measurements within a route are stored alongside a 64 character hierarchical description and a date / time stamp and underneath a 16 character route name header. **Please note that it is most important that you store readings at the correct measurement address.**

When using the Route mode of operation the following readings can in principle be stored :

- Standard Mode   -   Distress & dB Level
- Super Slo Mode   -   dB Level, Peak, Intensity & Extent
- Manual Input   -   User defined reading of load, temperature, vibration etc..
- Capture Spectrum   -   Data to derive a repetition frequency spectrum.

In practice the choice of Standard, Super Slo or Manual Input modes is pre-selected during route creation and fixed for a particular SAMP when it is loaded in the MHC-Memo Pro unit. Furthermore Capture Spectrum is only appropriate for Standard Mode measurement points and there is a maximum limit of 15 such captures in the MHC-Memo Pro at any one time. Typically Capture Spectrum would be reserved for measurement points of special interest (eg ones with particularly high Distress readings) and where diagnostic information would be of benefit. Note that in route mode it is only possible to store data at the available SAMP's within a route.

The method of storing the various data types when in route mode is as follows :

a) Navigate to the particular point at which the measurement is to be made (i.e. to the lowest level of hierarchy at which the particular point on the particular machine of interest is displayed) as described in I - 5.3.
b) Press the [read] soft key and the display will change to show one of the following :

In Standard Mode :
Dst : XX dB Lev : XX

[Compare]

Wait for the readings to settle down (typically 15 secs after putting the sensors onto the machine). At this point you can compare the current readings with previous values displayed on the lower line by pressing and holding down the [Compare] soft key. You can also freeze the live readings display by pressing the HOLD key and they can be released to be instantly updated to the current value by again pressing the HOLD key.

When the required measurement of Distress and dB Level is being displayed press the STORE key. Confirm that you want to store the reading at the measurement point shown by pressing the [yes] soft key.

In Super Slo Mode :

    Time per rev ?
    [ok]   XXXs   [+]

Press [+] soft key if necessary to advance the time per revolution to the required number of seconds (if you wish to reduce it advance past 255s to go back to 001s). When this is done press the [ok] soft key and the display will change to :

    XXdB XXP XXI XXE
    [go]   [Compare]

At this point you can compare the current readings with previous values displayed on the lower line by pressing and holding down the [Compare] soft key.

With the sensor in position (and the sensor lead and MHC-Memo Pro both still) press the [go] soft key. The display will change to 'Acquiring' and data will be processed over 9 revolutions of the machine (ie 9 x Time per rev). At the completion of this the display will show the newly taken values of dB, P I and E. These values can be compared to the previously stored values which will be shown on the lower line of the display when the [Compare] soft key is pressed and held down.

To store the freshly taken values press the STORE key and confirm that you want to store the reading at the measurement point shown by pressing the [yes] soft key.

In Manual Input Mode :

    User Defined Label
    [read]   [skip]

Press read

User Defined Label
[→]   ??????   [+]

Use the two soft keys to toggle each digit of the value to be inputted (identified by a line under the digit). The [→] soft key moves along from one digit to the next and the [+] key increments the digital value from 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and ' –' on the leading character.

After the first number has been entered the options change to 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and '.'. After the decimal point has been set the options reduce to 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.

To store the manually inputted user defined value press the 'STORE' key and confirm that you want to store the reading at the measurement point shown by pressing the [yes] soft key.

Capture Spectrum :
When in the Route mode the Capture Spectrum function is only accessible when you have navigated (as described in I - 5.3) to a point on a machine at which a Standard Mode reading is being taken and the Display is showing :

Dst : XX dB Lev : XX
[Compare]

With the display showing as above press the 'MENU' key and the display will change to :

Capture   Spectrum
[yes]   [no]

Press the [yes] soft key to proceed and the display will change to :

2048 samples / sec
[go]   XX   [Exit]

where XX shows the number of Capture Spectrums that are free to be stored in the memory space (up to a maximum of 15 in total). Pressing the [go] soft key captures the data and reduces the XX value by 1 which confirms that the data capture has been successful. The file will be stored with a header which includes a date and time stamp as well as the full SAMP for the particular point which the MHC-Memo Pro was at when the 'MENU' key was pressed. Pressing the Exit soft key returns the MHC-Memo Pro to the Distress and dB Level display for the same SAMP point.

> Note : If you wish you can make more than one Capture Spectrum at a particular SAMP.

When not operating the MHC-Memo Pro within a route but instead using it to take off-route measurements then the following readings can in principle be stored :

- Standard Mode   -   Distress & dB Level
- Super Slo Mode   -   dB Level, Peak, Intensity & Extent
- Capture Spectrum   -   Data to derive a repetition frequency spectrum.
- Auto Log   -   Sequences of successive Standard or Slow mode readings (up to a maximum of 2338 sets of readings).

The method of taking the various measurement types is as follows :

Standard Mode :
After first switching the MHC-Memo Pro on press the soft key designated [no] in response to the displayed message 'Routes'. In response to the display 'Standard Mode' select [yes] to enter the normal mode. The display will now show live readings of Distress and dB Level. The displayed values can be frozen by pressing the HOLD key and released again to be instantly updated to the current value by pressing again pressing the HOLD key. To exit this mode press the 'Edit' key and respond [yes] to the display 'Return to Main'.

Super Slo Mode :
After first switching the MHC-Memo Pro on press the soft key designated [no] in response to the displayed message 'Routes' and again respond [no] to the display 'Standard Mode'. The display will then change to 'Super Slo Mode' and the [yes] soft key should be pressed. The display will then change to the following :

<div align="center">

Time per rev ?
[ok]   XXXs   [+]

</div>

Press [+] soft key if necessary to advance the time per revolution to the required number of seconds (if you wish to reduce it advance past 255s to go back to 001s). When this is done press the [ok] soft key and the display will change to :

<div align="center">

dB   P   I   E
[go]

</div>

With the sensor in position (and the sensor lead and MHC-Memo Pro both still) press the [go] soft key. The display will change to 'Acquiring' and data will be processed over 9 revolutions of the machine (ie 9 x Time per rev). At the completion of this the display will show the newly taken values of dB, P I and E as follows :

XXdB XXP XXl XXE
[go]
.
The measurement can be repeated at the same time per rev setting by pressing the [go] soft key. To exit this mode press the 'Edit' key and respond [yes] to the display 'Return to Main'.

Capture Spectrum :
First enter the normal mode to give live readings of Distress and dB Level as described above. Next press the MENU key and press the display will change to show Auto Log ? Press the [no] soft key in response to this and the display will change to show :

Capture   Spectrum
[yes]   [no]

Press the [yes] soft key to proceed and the display will change to ready to :

2048 samples / sec
[go]   XX   [Exit]

where XX shows the number of captured spectra that are free to be stored in the memory space (up to a maximum of 15 in total). Pressing the [go] soft key captures the data and changes the display to :

[→] Store As   [+]

Press the [+] soft key twice and the display will change to :

A
[→] Store As   [+]

Keep pressing the [+] soft key to get the desired first character of the filename you wish to give the Capture Spectrum file (the sequence is from A to Z then 0 to 9 and then back to A etc) When you have selected the correct first character press the [→] soft key to move on to the next character as shown below :
.   A_
[→] Store As   [+]

Press the [+] soft key to get the desired second characters of the filename. Carry on like this to create the required filename up to a maximum of 16 characters. Once this has been done the file is stored along with an automatically applied date and time stamp by pressing the STORE key. The display will then change to :

2048 samples / sec
[go]   XX   [Exit]

Press the [Exit] soft key to go back to live readings of Distress and dB Level or alternatively press the [go] soft key to capture another spectrum.

Auto Log :
Each Auto Log sequence is manually started and manually stopped. After which it can be stored by pressing the STORE key on the keypad. Provision is made to enter a filename as part of the header to each sequence. This header is automatically time and date stamped from the MHC-Memo Pro internal real-time clock.

First you must decide whether you wish to carry out an Auto Log of Standard Mode readings (Distress and dB Level) or alternatively of Super Slo Mode readings (dB, Peak, Intensity and Extent). The way in which Auto Log readings are taken in each mode is as follows :

Auto Log of Standard Mode
After first switching the MHC-Memo Pro on press the soft key designated [no] in response to the displayed message 'Routes'. In response to the display 'Standard Mode' select [yes] to enter the normal mode. The display will now show live readings of Distress and dB Level. Now press the 'MENU' key and the display will change to :

Auto Log ?
[yes]   [no]

Press the [yes] soft key and the display will change to :

Dst : XX dB Lev : XX
[go]   YYYY   [Exit]

The value YYYY shows the number of memory spaces left in the Auto Log memory space. Pressing the [go] soft key changes the display to :

Dst : XX dB Lev : XX
[end]   YYYY ZZZZ

The Auto Log function is now working and you can observe the YYYY value counting down as memory is used up and the ZZZZ value increasing to show the number of samples within the current file that is being built up.

Important : If you immediately switch off the MHC-Memo Pro at this point the Auto Log file will not have its complete header written to memory and may therefore be corrupted.

When you have stored a sufficiently large number of samples press the [end] soft key.

[→] Store As   [+]

Press the [+] soft key twice and the display will change to :

A
[→] Store As   [+]

Keep pressing the [+] soft key to get the desired first character of the filename you wish to give the Auto Log file (the sequence is from A to Z then 0 to 9 and then back to A etc) When you have selected the correct first character press the [→] soft key to move on to the next character as shown below :

.

A_
[→] Store As   [+]

Press the [+] soft key to get the desired second characters of the filename. Carry on like this to create the required filename up to a maximum of 12 characters. Once this has been done the file is stored along with an automatically applied date and time stamp by pressing the STORE key. The display will then change to :

Dst : XX dB Lev : XX
[go] YYYY   [Exit]

Press the [Exit] soft key to exit Auto Log mode and go back to live off-route Standard Mode readings. Alternatively press the [go] soft key to start another Auto Log sequence. To exit this mode press the 'Edit' key and respond [yes] to the display 'Return to Main'.

Auto Log of Super Slo Mode
After first switching the MHC-Memo Pro on press the soft key designated [no] in response to the displayed message 'Routes'. In response to the display 'Standard Mode' select [no] and the display will change to show :

Super Slo Mode
[yes]   [no]

Press the [yes] soft key and the display will change to :

Time per rev ?
[ok]   XXXs   [+]

Press [+] soft key if necessary to advance the time per revolution to the required number of seconds (if you wish to reduce it advance past 255s to go back to 001s). When this is done press the [ok] soft key and the display will change to :

dB   P   I   E

[go]

With the sensor in position (and the sensor lead and MHC-Memo Pro both held still) press the [go] soft key. The display will change to 'Acquiring' and data will be processed over 9 revolutions of the machine (ie 9 x Time per rev). At the completion of this the display will show the newly taken values of dB, P I and E as follows :

XXdB XXP XXI XXE
[go]

.

Now press the 'MENU' key and the display will change to :

Auto Log ?
[yes]   [no]

Press the [yes] soft key and the display will change to :

dB   P   I   E
[go]   XXXX   [Exit]

The value XXXX shows the number of memory spaces left in the Auto Log memory space. Pressing the [go] soft key will change the display to :

dB   P   I   E
[end]   YYYY AV: ZZ

The Auto Log function is now working and you can observe the YYYY value increasing to show the number of samples within the current file that is being built up as well as the values of dB, P I and E as they are taken. The value of ZZ shows where the Super Slo Mode measurement is within each measurement cycle (it counts between 1 and 9).

Important : If you immediately switch off the MHC-Memo Pro at this point the Auto Log file will not have its complete header written to memory and may therefore be corrupted.

When you have stored a sufficiently large number of samples press the [end] soft key and the display will change to :

[→] Store As   [+]

Press the [+] soft key twice and the display will change to :

A
[→] Store As   [+]

Keep pressing the [+] soft key to get the desired first character of the filename you wish to give the Capture Spectrum file (the sequence is from A to Z then 0 to 9 and then back to A etc) When you have selected the correct first character press the [→] soft key to move on to the next character as shown below :

.
A_
[→] Store As   [+]

Press the [+] soft key to get the desired second characters of the filename. Carry on like this to create the required filename up to a maximum of 16 characters. Once this has been done the file is stored along with an automatically applied date and time stamp by pressing the STORE key. The display will then change to :

XXdB XXP XXI XXE
[go] YYYY   [Exit]

Press the [Exit] soft key to go back to exit Auto Log mode and go back to single off-route Super Slo mode readings. Alternatively press the [go] soft key to start another Auto Log sequence with the same time per revolution.

To exit this mode press the 'Edit' key and respond [yes] to the display 'Return to Main'.

I - 5.5 Reviewing and Retaking freshly stored values

If you navigate (as described in Section I - 5.3 to a point at which a reading has already been stored (e.g. a SAMP named 'Drive End' at the lowest level of hierarchy) then the display will show :

Drive End
[Retake]   [skip]

To either Review the stored value or retake it press the [Retake] soft key and the display will change to show one of the following if the measurement type for that point is of the Standard or Super Slo modes :

Dst : XX dB Lev : XX   Time per rev?
      [Compare]   [ok]   XXXs   [+]
                                                 ↓
                                         XXdB XXP XXI XXE
                                         [go]   [Compare]

Press and hold the [Compare] soft key to review the previously stored value. Pressing the STORE key changes the display to :

Drive End
[yes] ReStore   [no]

If you wish to overwrite the previously stored value with the new one then press the [ReStore] soft key otherwise press the [no] soft key.

If on the other hand the measurement is of the manually inputted type (user defined as 'Temperature', say) then the display will look as follows :

<div align="center">

Temperature
[Retake]   [skip]

</div>

Pressing the [Retake] soft key changes the display to show the previously taken value (10.123 say) as together with the appropriate soft keys to amend the previously stored value as shown below :

<div align="center">

Temperature
[→]   10.123   [+]

</div>

Use the two soft keys to toggle each digit of the value to be inputted. The [→] soft key moves along from one digit to the next and the [+] key increments the digital value.

I - 5.6 Erasing previously stored measurements

Route Mode data

Measurements are stored in non-volatile memory in the MHC-Memo Pro within a Route alongside the SAMP (Site Area Machine Point descriptions) and time the reading was taken. When this stored data is transferred to the PC using the Analysis Pro software the software will automatically change these last stored measurement values to become the previous values to be displayed prior to taking the next measurement once the route has been reloaded.

Manual Erasing of Stored Values

Provision is made for manually erasing the various memory areas within the MHC-Memo Pro. This is done by use of the Menu key on the MHC-Memo Pro when either within a route or off route. It is first necessary to navigate to a point where the display is showing one of the following as described in Section I - 5.3 :

Dst : XX dB Lev : XX   Dst : XX dB Lev : XX
                                          [Compare]

 dB   P   I   E   XXdB XXP XXI XXE
[go]   [go]   [Compare]

To get to the ERASE options from any of these displays press the following key sequences :

1. Press 'Menu' button (when unit is ready for either live or route mode readings).
2. Auto Log ?   Select [no] on soft keys.
3. Capture Spectrum   Select [no] on soft keys.
4. ERASE Data ?   Select [yes] on soft keys.
5. 'Name of Route 1   Select [yes] or [no] on soft keys to erase each Route in turn.
6. ERASE Spectrum   Select [yes] or [no] on soft keys to erase all stored Spectra data.
7. ERASE Auto Log   Select [yes] or [no] on soft keys to erase all Auto Log sequences.

When one of the ERASE options is chosen the display will show [yesx4] and this will count down as the [yes] soft key is repeatedly pressed. After pressing the last the ERASING routine will commence for the particular memory area selected **WARNING : It is not possible to reinstate readings on the MHC-Memo Pro after they have been erased**.

I - 5.7 Communications with a PC
In order for a communications link to be effected between the MHC-Memo Pro and a PC via the USB interface it is essential for the MHC-Memo Pro to be switched on and the USB communication cable to be connected between the two devices.

In addition the Analysis Pro software must be loaded and opened on the PC and its 'Settings' set to the COM port to which the Memo Pro is connected.

When wishing to communicate between the MHC-memo Pro and the PC recommend that the MHC-Memo Pro instrument should be in the Main menu displaying :

                    Routes
         [yes]   [no]

(i.e. the condition after switching on the MHC-Memo Pro once the time and date display has changed

I - 6   INTERPRETING STANDARD MODE READINGS (Distress & dB Level)

When used in standard mode the MHC-Memo Pro characterises the AE signal in terms of the two parameters *Distress* and *dB Level*.

Distress
This measurement parameter gives early warning that an item is in distress. The way in which it is derived is a commercial secret but in broad terms it is a summation of the clicks, crunches, whistles and groans which are generated by defective rotating machinery. It is very sensitive and can detect inadequate

lubrication at an early stage allowing remedial action before significant permanent damage has been done. Because it is so sensitive it is important not to over react and strip down a machine on the basis of a single high *Distress* reading.

One major advantage of the *Distress* parameter is that for the vast majority of rotating machinery a *Distress* reading of 5 or less equates to very good condition and a *Distress* reading of 10 or less is satisfactory condition. This makes it easy to identify rotating machinery in distress even if no previous measurements have been made. In general we refer to machinery running with a Distress greater than 10 as having a 'Suspect' condition.

dB Level
This is a measure of the mean level of the high frequency signal and does depend on machine type, size and speed etc.. It must therefore be used comparatively. That is the *dB Level* reading should be compared with that on other identical machines or with previous readings taken on the same machine (at the same speed). In general the trend of *dB Level* with time is a particularly useful indicator of the rate of deterioration of machinery which is in a 'Suspect' condition.

An idealised plot of how *Distress* and *dB Level* vary throughout the life of a typical machine throughout the operational life of a component is shown below :
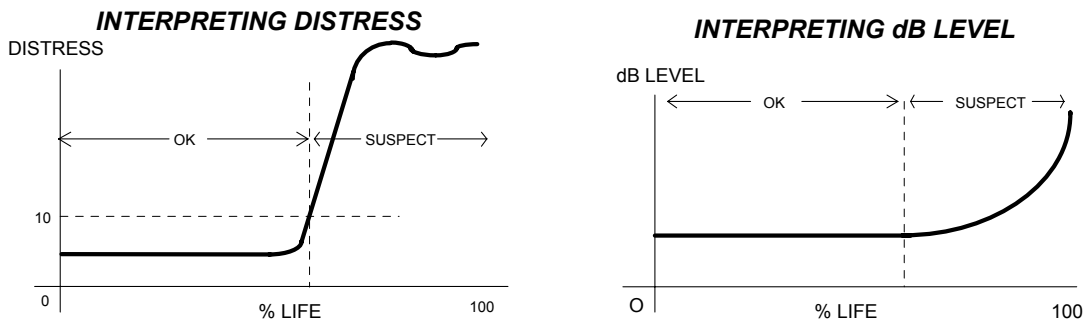
In brief the general interpretation of the *Distress* and *dB Level* readings from the MHC-Memo Pro are as follows :

a)   Observe the *Distress* reading :   less than 5 is very good condition, between 5 and 10 is satisfactory condition, greater than 10 is suspect condition.
b)   On suspect machines check for adequate lubrication and improve if appropriate.
c)   Re-check *Distress* reading after improving lubrication, if its below 10 its no longer in the suspect category but satisfactory.
d)   On suspect machines observe the trend of both *Distress* and *dB Level* over time in order to help identify their rate of deterioration.
e)   Typically on normal speed machinery the *dB Level* increases at an accelerating rate as final failure approaches. In such cases extend by

eye the curve of *dB Level* vs time and estimate when it would reach a point say 30 dB higher than when it was running in the OK condition. This can provide a rough guide to the remaining life of the machine. Modify this guideline in the light of experiences on your particular machines.

However there are exceptions :

a)   Particularly on slowly rotating machinery Distress may increase but dB Level may only increase much later in the life of the component. Hence for slowly rotating machinery it would be wrong to automatically assume that if the dB Level has not increased then the damage is not too significant. If in doubt refer to past experiences.

b)   When a pure rubbing problem exists it is possible that the Distress Level may remain low but the dB Level increases.

c)   We have also observed a bearing fault in which the Distress level increased dramatically and the dB Level reduced. This was caused by the outer race of the bearing slipping within the bearing housing (the lower dB Level resulting from the lower effective rpm of the bearing).

d)   Sometimes during the very early stages when Distress is starting to increase it has been observed that one reading is higher than normal and then the next it is back to normal. In such cases this is often a precursor to the Distress reading remaining high from one reading to the next.

e)   During the terminal stages of failure of a machine running at normal speeds (when dB Level is increasing) it is possible for the Distress reading to reduce to low values. Take care not to misinterpret this as an improvement in machine condition. Under such circumstances the increase in dB Level is the indicator that all is not well. In fact you could interpret an increase in dB level accompanied by a reduction in Distress as an indicator that the terminal stage of operation is being reached.

And there are some machines on which interpretation may be more difficult or impossible :

a)   *Split bearings* – these naturally produce an impact as the rolling element passes over the split and so give rise to a higher than normal Distress reading. The severity of these repetitive impacts and hence the Distress reading depends on the size of the gap as well as the contact force of the rolling element on the bearing race. Because of this we recommend that you determine the appropriate datum of normal Distress for each installation and look for increase from this to alert to the evolution of damage.

b)   *Reciprocating machinery* – the load reversals, valve actions and pressure fluctuations which take place during the operation of reciprocating machinery usually result in a much increased Distress reading. Under such circumstances the Distress parameter will be

rendered ineffective and cannot be used as a sensitive indicator of damage evolution.

c)   *Inverter driven, synchronous and DC braked motors* – We get mixed feedback from our customers when monitoring motors of these types. We suspect that for each type there are two categories; the first category is one where the MHC-Memo Pro will work satisfactorily and the second category is where there is significant noise which will mask the activity due to bearing degradation. We would therefore be wary of such motors which exhibit an uncharacteristically high dB Level for their operating speed usually accompanied by a low Distress readings).

d)   *Hydraulic power packs* – High pressure hydraulic power packs typically give rise to rapidly repeating pressure pulses each of which is accompanied by a burst of turbulence or local cavitation. Such activity will mask the degradation of the bearings, particularly at the early stages of failure.

General Discussion

When applying the MHC instrument to rotating machinery operating in standard mode a common finding across many industries is beginning to emerge for progressive bearing deterioration due to spalling of race or rolling element surfaces as follows :

Stage 1 - Good condition
dB Level readings at their lowest level for this machine & speed.
Distress reading is less than 10 (typically less than 5 if very good).

Stage 2 (Not always observed) - First signs of a possible problem.
Sporadic impacts form asperities
dB Level readings at their lowest level for this machine & speed.
Distress readings show increased values above 10 on some occasions but are less than 10 on others.

Stage 3 - The problem becomes established. Copious impacts from asperities
dB Level readings at their lowest level or may slightly increase.
Distress readings are consistently above 10.

Stage 4 - Continuing degradation. Increasing frictional activity
dB Level readings increase.
Distress readings may fluctuate (even dropping below 10).

Stage 5 - The approach to final failure. Severe fictional activity
dB Level readings increase at an accelerating rate.
Distress readings are most likely to be low.

However, it must also be borne in mind that not all failures follow this path. For example, it is quite normal for bearings to be re-greased (or have other changes to their lubrication regime) and this will affect the detected AE signals. Another example would be when a machine is only used intermittently and some readings are taken when the machine has been running for a long time, whereas others are taken immediately after start-up (when lubrication effectiveness and dimensional tolerances may be different). Of course another failure mode altogether may be the cause, such as high friction from the outset.

NOTE : These guidelines are provided in good faith from the feedback to date and may evolve as more experience emerges. Your experiences will be helpful in this process whether they confirm the above guidelines or are at variance to them - please let us know.

I - 7   INTERPRETING SUPER SLO MODE READINGS (dB, Peak, Intensity and Extent)

I - 7.1 General Interpretation

When used in Super Slo mode the MHC-Memo Pro characterises the AE signal in terms of four parameters *dB Level (dB) Peak (P), Intensity (I) and Extent (E)I*.

dB = dB Level (the average overall signal level)
P = Peak (the average of the absolute peak signal level measured during each of the 8 rotational   cycles)
I = Intensity (an average magnitude for all the detected activity)
E = Extent (the percentage of the rotational cycle in which activity is detected)

Feedback from industrial application of Super Slo mode suggests the following approach to be the most widely applicable :

a)   Observe the 'E' value. Machinery in good condition often has a value of 0 or only 1 or 2. The presence of a high 'E' value is usually an indicator of the presence of damage. In most circumstances the 'E' value alone gives you the information you need to identify the presence of a fault and rank it (a higher 'E' value being worse than a lower one). A high E value tells you that there is damage throughout the rotational cycle.

b)   For those measurements that have a significant 'E' value it may sometimes be useful to observe the 'I' value since this shows if the magnitude of the activity is getting worse (a higher 'I' value being worse than a lower one).

c)   Under most circumstance the 'P' value is not of prime interest. It tends to be the most variable of the three readings. However it comes into its own when a large singular defect occurs (for example a cracked race) at which time P would markedly increase even though E may remain 0

or very low. We therefore strongly recommend that P is monitored and significant increases taken seriously (suggest you listen on the headphones throughout a revolution or two).

I - 7.2 Top Tips When Interpreting Super Slo Mode Readings

- If we were taking Super Slo mode measurements on a number of similar machines we would compare 'P', 'I' and 'E' values across them and look for significant differences to highlight rogue machines.

- We are aware that 'I', and 'E' values tend to be fairly steady from measurement to measurement whilst 'P' values have more scatter on successive readings. We would therefore always look for a bigger difference in 'P' than either I and E to regard it as significant.

- If we saw an increase in 'E' from a very low value we would regard this as an indication of progressive deterioration spreading within the relevant part of the machine being monitored.

- We would use the headphones to listen to the detected activity throughout the rotational cycle to get a better understanding of the nature of the fault (e.g. a large singular fault, generalised damage, a cyclic rub).

NOTE : These guidelines are provided in good faith from the feedback to date and may evolve as more experience emerges. Your experiences will be helpful in this process whether they confirm the above guidelines or are at variance to them - please let us know.

I - 8   USING THE HEADPHONES

The headphones output is a de-modulated version of the high frequency AE signal. Although the AE signal is purely at high frequency the modulations in its amplitude are at audio frequencies and can therefore be heard through headphones. For low level signals the Headphones output can be increased by pressing the VOLUME key. This key toggles between high and low settings. The default setting when the MHC-Memo Pro is switched on is at the low level.

Listening on the headphones, whilst subjective, is often useful to :

- Provide a secondary means of confirming that a Problem exists.
- Help in the identification of the fault type.
- Further localise the fault position whilst moving the sensor to different points on the machine.
- Listen to very slowly rotating or slowly reciprocating machinery.

Note : Since the audio circuitry is automatically switched on when the headphones are connected the use of the headphones increases the current being drawn from the batteries.

I - 9   CHANGING BATTERIES

When the battery levels are low the display changes to :

** LOW BATTERY**
please replace

and further use of the MHC-Memo Pro is not possible until the batteries have been replaced or, if appropriate, the batteries are re-charged.

The MHC-Memo Pro requires two nominally 9 volt batteries and the following points should be noted when installing or changing them :

- Use only 6R61 (or equivalent) batteries in the PP3 can style.
- Always use two batteries of the same battery technology (e.g. 2 dry cell batteries, or 2 NiCd batteries)
- Avoid shorting battery terminals and ensure they are fitted the right way round (ie polarity correct).
- Always dispose of batteries according to the battery manufacturers instructions.

The MHC-Memo Pro has an additional internal battery (3 volt Coin Cell - Varta CR 1616 or equivalent) that provides back-up power for the internal real time clock. When this battery is no longer able to power the real time clock the MHC-Memo Pro display changes to :

Please Replace
Clock Battery

The required course of action is to replace the internal clock battery and re-set the time and date with it connected to the Analysis Pro software. This is automatically done by re-loading any route (If the time and date are not re-set in this way after changing the batteries then various features of the MHC-Memo Pro will not work).

NOTE : To avoid the likelihood of this problem arising we strongly recommend that the coin cell battery is replaced every 5 years after purchase at the time of its annual recalibration.

IMPORTANT : We strongly advise you not to continue to take readings without replacing the internal coin battery and re-setting the time and date. This is because in the absence of a correctly operating real time clock any newly stored data will not be time and date stamped and Auto Log will not function. Furthermore you will be unable to correctly add data from the route files to the trend plots in the Analysis Pro software.

I - 10 CALIBRATION

The MHC-Memo Pro and its associated MHC sensor incorporate special design features to stabilise their response and can be expected to give accurate measurements over a long period of time. Nevertheless it is wise to periodically check their calibration. Holroyd Instruments Ltd offer a re-calibration service and recommend that both that MHC-Memo Pro instruments and the MHC sensor are re-calibrated every 12 months.

In addition the calibration should be checked under the following circumstances :

- The sensor or instrument has been dropped or otherwise damaged.
- The sensor or instrument has been exposed to extreme temperatures.
- All measured values have unexpectedly reduced *.

Note : All MHC sensors are calibrated to a standard factory sensitivity. Hence in the event of damage or loss of a sensor it can be changed for a replacement sensor without the need to send the instrument away for re-calibration. To minimise disruption in this event you may therefore choose to stock/carry a spare MHC sensor.

* IMPORTANT : If measured readings are different or if readings of Distress and dB Level do not reduce to 1 or 0 when the sensor is stationary hanging in free space then it may be that the sensor lead is damaged. To check for this temporarily replace the sensor lead with the spare sensor lead supplied with the MHC-Memo Pro unit. If this cures the problem then discard the damaged lead and order a replacement form Holroyd Instruments Ltd.

I - 11 ELECTROMAGNETIC COMPATIBILITY

The MHC-Memo Pro conforms to the EC Directive on Electromagnetic Compatibility (EMC) 89/336/EEC as amended by 92/31/EEC. Hence for normal use on the industrial shop-floor it will not interfere with adjacent electrical equipment and its own readings are unaffected by interference from the machinery it is intended to monitor.

However the variety of electromagnetic environments encountered within industry is such that it is possible that on rare occasions operating machinery may temporarily interfere with the readings on the MHC-Memo Pro (e.g. welding equipment, automotive ignition systems etc..). To check whether or not this is the case, simply switch on the MHC-Memo Pro with the sensor dangling in air nearby the intended measurement point. Off route readings of both *Distress* and *dB Level* should fall to near zero. If either of these readings does not fall below 1 then we recommend caution in the interpretation of readings for that particular machine.

I - 12 WARRANTY

The warranty (for the period specified at the time of purchase) is inclusive of all parts and labour costs subject to the exclusions listed. The decision to repair or replace defective product will be at the discretion of Holroyd Instruments Ltd. The warranty shall not apply to defects or damage resulting from :

- Unauthorised modification or misuse
- Operation outside the environmental specification
- Fair wear and tear
- Accidental damage
- Cost of shipping back to base

In no event will Holroyd Instruments Ltd or its suppliers be liable to you for any consequential or incidental damages including any lost profits or lost savings or for any claim by any party.

I - 13 OTHER RELATED PRODUCTS

The following products are available to extend the benefits you gain from your MHC-Memo Pro :

- Monitoring Pads - for improved measurement consistency.
- Extension probes - when access is limited.
- Air/40 Ultrasonic airborne sensor for detecting air and vacuum leaks.
- Permanently installed sensors - for areas where access whilst running is not possible.
- On-line monitoring modules with built in alarms and data logging - MHC SetPoint™ & MHC SloPoint™.
- MHC-DS1 and MHC-SM1 smart sensors with built-in dual alarm and dual analogue outputs.

SECTION II - MHC-ANALYSIS PRO™ SOFTWARE GUIDE

SECTION II - MHC-ANALYSIS PRO™ SOFTWARE GUIDE
(Applicable to Analysis Pro version 1.72)

The MHC-Memo is supplied complete with Analysis Pro software, which provides many features that have been introduced as a result of customer feedback in using the MHC-Memo Analysis software. Every effort has been made to make this software straightforward and logical to use yet provide a comprehensive analysis capability for the successful use of the MHC-Memo Pro to assist in improving the efficiency of your maintenance function.

NOTE : The Analysis Pro software is covered by a licence agreement as detailed in Appendix III.

IMPORTANT TIPS :
We strongly recommend that when creating or modifying large files you regularly save them to disk. In addition don't forget to regularly back-up files onto another storage media so that you won't lose everything if you have a fatal disk crash.

II - 1   INTRODUCTION TO THE ANALYSIS PRO SOFTWARE

The CD-ROM supplied with the MHC-Memo Pro contains the Analysis Pro software, which is an integrated analysis and data transfer program. This PC based software enables the user to :

   a) create routes
   b) load routes into the MHC-Memo Pro
   c) retrieve stored readings from the MHC-Memo Pro
   d) trend (i.e. plot versus time) the historic values of measurements for a particular measurement point.
   e) apply alarm levels to each measured parameter for each measurement point.
   f) produce an exception report of those measurement points which are in exceedance of their alarm limit
   g) export data to other programs
   h) Import Auto Log files from the MHC-Memo Pro and export them to third party software (e.g. spreadsheet programs)
   i) Import Capture Spectrum files from the MHC-Memo Pro and export them to AE Lab analysis software (which is also supplied on the CD-ROM with the Analysis Pro software).

Central to the operation of the Analysis Pro software are the concepts of :
   a) Machine Databases,
   b) Action Lists
   c) Routes

Machine Databases
A machine database is a database file that contains the hierarchical Site, Area, Machine and Point (SAMP) information that defines measurement

positions together with any measurements that have been taken and transferred from the MHC-Memo Pro in the past.

To be strictly accurate the *machine database* only keeps the data from the most recent 52 downloads. Previous data is automatically archived. You can create as many *machine database* files as you wish but there is an advantage to only having one *machine database* within one organisation.

Each *machine database* file forms the source file from which *Action Lists* and *Routes* are created.

NOTE : It is not possible to merge different *machine databases* or simultaneously analyse measurements stored on different *machine databases*. From the outset you should build up a single machine database for all measurements of common interest – in most companies thios meand you will only have 1 machine database. However CM conusltants will probably choose to have a separate machine database for each of their client organsisations.

Action Lists
An *Action List* is a selection of measurement points taken from a particular *machine database*. A list forms the basis for analysis within the Analysis Pro software and for the creation of a measurement route that can be loaded into the MHC-Memo Pro.

A special form of *Action List* is a *Route* (see below). The reason for having both lists and routes is that an *Action List* can be formed which consists of selected measurement points from a number of *Routes*. For example you may wish to create an *Action List* from a machine databases that consists of all (say) screw compressors from a number of different *Routes*. Because you can create and save any number of *Action Lists* you can create separate ones for each machine type if you wish (eg screw compressors, stirrers, extract fans or whatever other type of machinery). Hence the concept of *Action Lists* allows you to analyse readings by machine type rather than by *Routes*.

Routes
A *Route* is an *Action List* that has been especially saved as a *Route* and is the only type of file that can be loaded into the MHC-Memo Pro in order to allow measurements to be stored.

II - 2   SOFTWARE INSTALLATION AND SETUP

II- 2.1 Analysis Pro Installation
The installation of MHC-Analysis Pro is automatic – simply follow the instructions on the screen. If manual installation is required then the SETUP.EXE program can be run from the disc separately.

Automatic installation screen shots :

Start screen
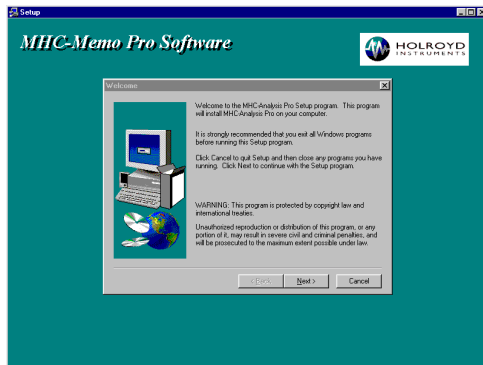
Specify location on hard disc
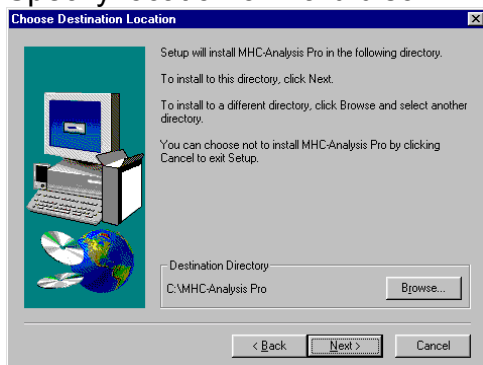
Specify name of group (used in windows start menu)
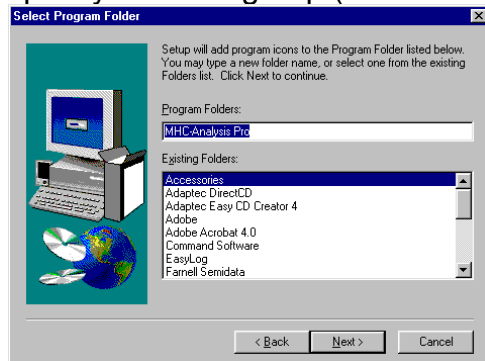
Check before installing
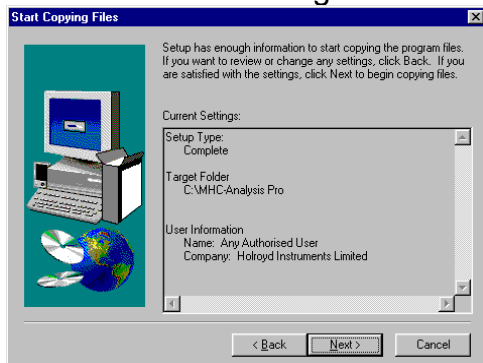
Program installs

View the readme file (to tell you how to install AELAB software). This can also be read directly from a file called AELABText.txt file on the discs
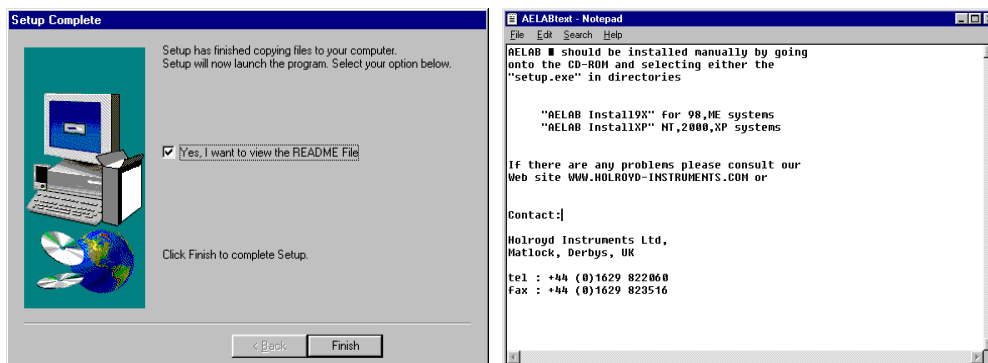
II - 2.2 Installing the USB driver

The first time you insert the USB lead from the MHC-Memo Pro into the PC the found new hardware wizard will appear (if not go to the PC Control Panel and click on Add Hardware).

a) From the options click on *Install from a list or specific location* as shown in the screenshot sequence below.
b) After clicking on Next (with the MHC Analysis Pro Installation CD still inserted).
c) Select *Include this location in search* and Browse to find the appropriate USB driver for the PC operating system as shown in the screenshot sequence below.
d) Click on Next and after installation click on Finish.

Surprisingly it its necessary to repeat steps (a), (b), (c) and (d) for the installation to be completed !
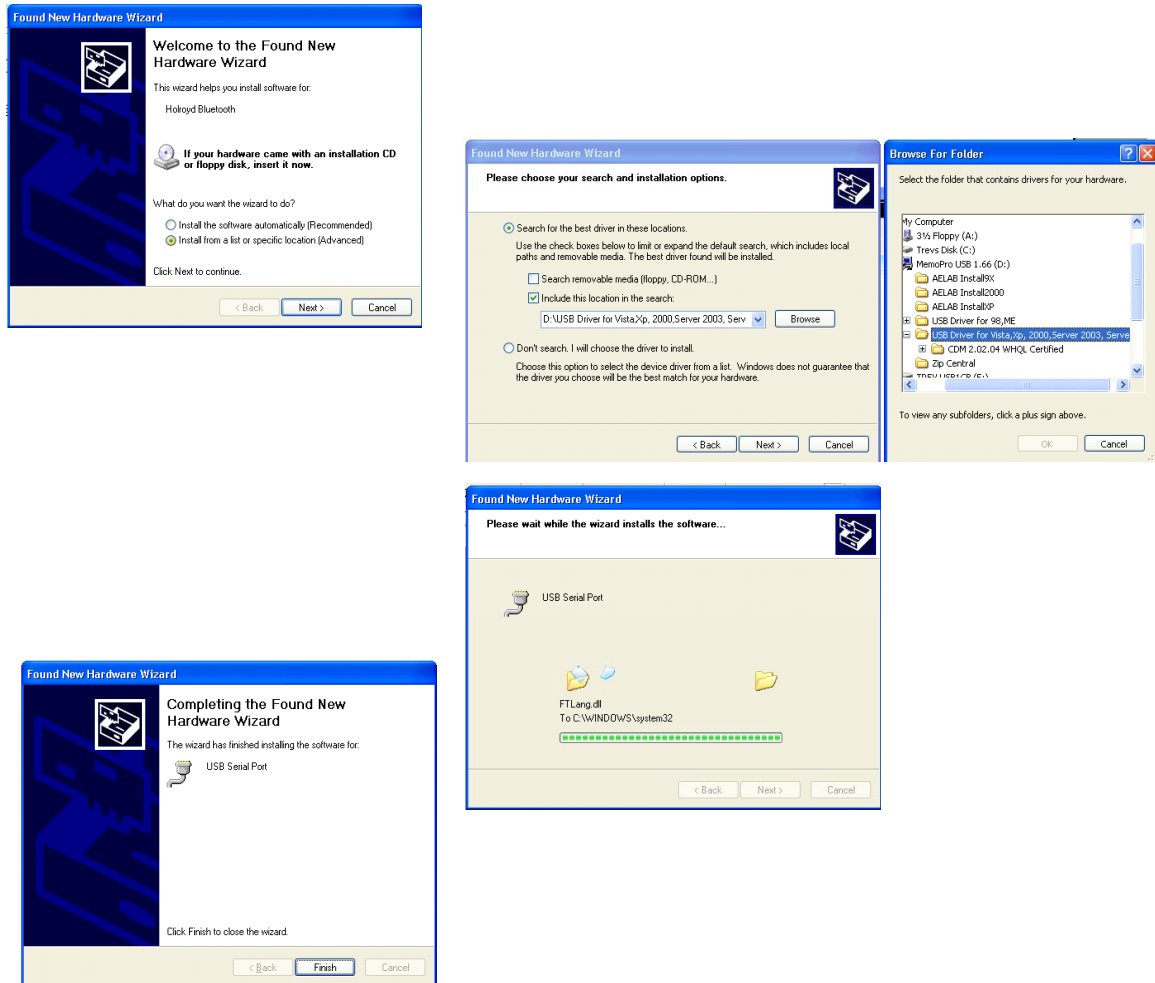
II - 2.3 COM ports setup

Before the MHC Analysis Pro software can communicate with the MHC-Memo Pro instrument it is essential that the COM port is set in the software to the appropriate port that will be used. The first step in doing this is to connect the PC to the MHC-Memo Pro instrument as described in Section II - 3

Next start the MHC Analysis Pro software and click on the Select COM-PORT button at the bottom of the list on the left hand side of the screen. This opens the ComPort dialogue box in which there are two main areas of possible interaction .

    a) The Search for button at its top left hand side lets you :
            - Search for Com port
            - Search for MHC-Memo Pro on selected Com Port
            - Search for MHC-Memo Pro
            - Add Com 1-50

    b) The drop down dialogue box to select a particular COM port

Use these functions to find a spare COM port or find the COM port that the MHC-Memo Pro is on.

II - 2.4 Default Alarm Level setup

The Analysis Pro software has default alarm level values for each of the measurement parameters. These alarm levels can be changed individually for each measurement point at the time it is created or edited at any later time when using in Analysis Pro. However it may be that you wish to change these default values. To do this start the Analysis Pro software and click on the 'Settings' option on the upper toolbar. Click on the 'Set Alarm defaults' option and choose your required default values for the various measurement types in the dialogue box that appears.

II - 3 MACHINE DATABASES

The Analysis Pro software is formed around a database concept. Measurement points (or SAMP's) can only exist within a named machine database. In the Analysis Pro software these details are found within the tab page entitled *Machine Database*

II - 3.1 Creating a New Machine Database

A *Machine Database* is described in general terms in Section II – 1 above and forms a reference source of SAMP's (and their associated stored readings) from which an *Action List* (or *Route*) is created. SAMP stands for S̲ite, A̲rea, M̲achine and P̲oint. Every measurement point at which data is to be stored in the MHC-Memo Pro has a hierarchical description consisting of Site, Area, Machine and Point descriptions (up to 16 alphanumeric characters for each level of description).

To create a new machine database click on 'File' (top left hand corner) and then 'New Database' within its drop down menu. Name the file and assign the Directory where it will reside (to change the Directory from that displayed click on the 'Change' button).

Individual SAMP information is entered as described in II – 3.2 below. To extend individual SAMP's to a full machine database you should take advantage of the following features :

a) Within a database you can create multiple Sites, within each Site you can create multiple Areas, within each Area you can create multiple Machines and within each Machine you can create multiple Points.

b) Whenever you create a new Site you should proceed to add an Area then Machines and Points so as to complete the hierarchical string. (Do not create multiple Sites, then Areas then Machines then Points since it is not until Points are finally added that they can be saved in a machine database and so you are in danger of losing a lot of typing if you hit Save).

c) You can duplicate a field at any level of hierarchy (i.e. Site, Area, Machine or Point) by clicking on the appropriate Duplicate button (i.e. , , ,) This will open a dialog box in which you can rename the duplicate copy (take care to ensure that all fields are either correct or modified as required). Notice that duplication at one level of hierarchy

replicates all lower levels of hierarchy also. Hence if you have a number of identical machines you can enter the various measurement points for only the first machine and then continue to duplicate this machine using the ᴹᴹ button (and rename it) for the other identical machines. Alternatively at higher levels of hierarchy you can duplicate at the Area level using the ᴬᴀ button (eg production Line 1, Line 2. Line 3 etc.) or at the Site level ˢₛ where an entire Site is replicated.)

d) Even when an exact duplicate is not required use of the appropriate duplicate button may be the quickest way of creating additional SAMP's. In this case carry out the appropriate duplication and then highlight one at a time those fields that are not required and click on the ➖ button for that field to initiate its deletion.

e) Similarly highlight any fields where you wish to change the name and use the appropriate ✎ button to edit the name.

f) Next add any additional fields at any level of hierarchy that may be required by clicking on the ➕ button.

g) Finally, if necessary, re-arrange the points list for each machine (eg if you want the route to walk you down the length of one machine and then back up the one adjacent to it you will need to reverse the order of alternate machines). To do this select the particular machine of interest and click on the ☰ Re order button. Using the ➕ button to select in the required sequence items from the *Source* list and place them in the *Selected* list. Notice that you can use the ➖ button to return items from the *Selected* list to the *Source* list.

II - 3.2 Entering a SAMP (measurement point)

Every measurement point (or SAMP) at which data is to be stored in the MHC-Memo Pro has a hierarchical description consisting of Site, Area, Machine and Point descriptions (up to 16 alphanumeric characters for each level of description).

a) Either create a new machine database (as described in II - 3.1 above) or open an existing database (as described in II - 3.4 below) in which you wish to enter the new SAMP.

b) Next you must define a *Site* name. To do this click on the ➕ button sign at the right hand side of the *Site* name box. Enter a site name in the dialog box that appears.

c) Next define an *Area* name. To do this click on the ➕ button at the right hand side of the Area name box. Enter an *Area* name in the dialog box that appears.

d) First create a *Machine* name by clicking on the ➕ button at the bottom of the Machine list box. Enter a machine name in the dialog box that appears.

e) Next create a *Point* name associated with that particular machine by clicking on the ➕ button at the bottom of the Points list box.

f) Select the measurement type that is to be made at this point; STD (standard mode), SLO (Super Slo mode) or MAN (manually inputted value).

g) The dialog box will change to allow a *Point* name to be added together with a comment that may be used to provide a fuller description of the measurement point (eg its plant code.

h) Note the *CLASS* dialog area where the option exists to assign this measurement point to a particular category (numbered 1 to 9). This *CLASS* tag can prove useful in creating special lists of SAMP's during subsequent route creation and data analysis using the *FIND* function. A possible use of the *CLASS* tag is to assign SAMP's with similar criticality to your operations to the same *CLASS* number. Alternatively the *CLASS* tag can be used to identify the frequency with which measurement should be taken at this point (e.g. 1 = every week, 2 = every 2 weeks etc..)

i) Note the ALARM dialog area where the opportunity exists to set the Alarm threshold for each of the measured values relevant to the measurement type being defined for the point being created. The Alarm condition corresponds to a value equal to or greater than the Alarm value that you enter. In the case of a Manual Input measurement point the option exists to 'un-tick' the 'Alarm >=' condition in which case the manual input parameter will cause an Alarm when the value is equal to or less than the Alarm value.

j) Note also the PICTURE dialog area where the option exists to import a variety of picture file types from an external file. See Section II - 3.3 for more information on this facility.

k) Finally, if creating a measurement point for the 'SLO' measurement type then it is essential to enter the time per revolution in seconds for the item being monitored. This does not have to be exact, always round up to the nearest full second (e.g. if period = 3.4 seconds select 4 seconds as the time per revolution).

II - 3.3 Adding and Marking Pictures

The SAMP information on a machine database can be dramatically augmented by importing a digital image (or drawing) of the appropriate part of the machine where a measurement point is situated. Each machine database has its own PICTURES Directory. When you create a new machine database you will need to import a new picture file. Typically pictures will be chosen to show the region of the machine where the measurement point is located.

To add and mark pictures first click on the 🔲 'Edit' button in the Points section for the SAMP of interest and observe the PICTURE section on the right hand side of the dialogue box. To add a picture link click on the 📂 'Open picture link' Icon and select the picture from your files that you wish to open (variety of picture formats is supported including .jpg). Existing picture links can be cleared using the ❌ 'Clear picture link' button. Note : The maximum picture file size is 480 by 640. Also be aware that the bigger the picture file the longer it will take for the picture to load

The facility exists to mark the actual location of the measurement point (i.e. where the AE sensor is positioned to take the measurement) on a picture using the 🔲 'Edit marker position' button within the PICTURE dialog area.

Click on and drag the marker dot to the correct position for this SAMP. (Note you have the freedom to re-define the colours of the dot and its perimeter).

II - 3.4 Opening an Existing Database
To open an existing database, either when first starting the Analysis Pro software or at any time later, click on 'File' (top left hand corner) and then 'Open Database' within its drop down menu. Next select the file that you wish to open in the usual way.

II - 3.5 Modifying an Existing Database
Open an existing database as described in II - 3.4 and use the ➕, ➖, 🔲 and 🔲, 🔲, 🔲, 🔲 duplicate buttons in the Site, Area, Machine and Point fields to effect the required modifications.

II – 3.6 Importing SAMP's for a machine database
If you already have a list of SAMP point names that are in a spreadsheet format (e.g. MS Excel) it is possible to automatically create the SAMPs by importing the data as a CSV file using the "Create points from CSV file" function. The format of the file is defined below and must be adhered to

For standard mode points :

Column	Defined as	Range	e.g.
A	Site	16 chars	Wembley
B	Area	16 chars	Process area 1
C	Machine	16 chars	Water Pump 1
D	Point	16 chars	NDE
E	Comment	50 chars	Cleaning water pump
F	Type	STD	STD
G	Class	0-9 (0=none)	0
H	Picture filename	32 chars	Pump 1.jpg
I	Distress alarm	0-99	10
J	dB alarm	0-99	80

For "slo" mode points :

Column	Defined as	Range	e.g.
A	Site	16 chars	Wembley
B	Area	16 chars	Process area 1
C	Machine	16 chars	Dryer 1
D	Point	16 chars	NDE
E	Comment	50 chars	Material dryer
F	Type	SLO	SLO
G	Class	0-9 (0=none)	0
H	Picture filename	32 chars	Dryer 1.jpg
I	Peak alarm	0-99	80
J	Intensity alarm	0-99	70
K	Extent alarm	0-99	85
L	dB alarm	0-99	65
M	time per rev	1-255	10

For Manual Entry mode points :

Column	Defined as	Range	e.g.
A	Site	16 chars	Wembley
B	Area	16 chars	Process area 1
C	Machine	16 chars	Dryer 1
D	Point	16 chars	Motor Current
E	Comment	50 chars	Motor current (Amps) for Material dryer
F	Type	MAN	MAN
G	Class	0-9 (0=none)	0
H	Picture filename	32 chars	Ammeter 1.jpg
I	Alarm	-99999 to 999999	35.7
J	Alarm Above	>= or <=	>=

So in a spreadsheet like MS Excel you would create the following :

You then save it as a CSV (comma delimited) file
e.g. this example you would generate the following file called
"ExampleCSVFile.CSV" containing the following

Wembley,Process area,Water pump1,NDE,Cleaning water pump,STD,0,Pump 1.jpg,10,80,,,
Wembley,Process area,Dryer 1,NDE,Material dryer,SLO,0,Dryer 1.jpg,80,80,70,85,65
Wembley,Process area,Dryer 1,Motor Current,Motor Current (Amps) for material dryer,MAN,0,Ammeter 1.jpg,35.7,>=,,,

This can then be imported into the database by using
FILE>IMPORT>CREATE POINTS FROM CSV FILE
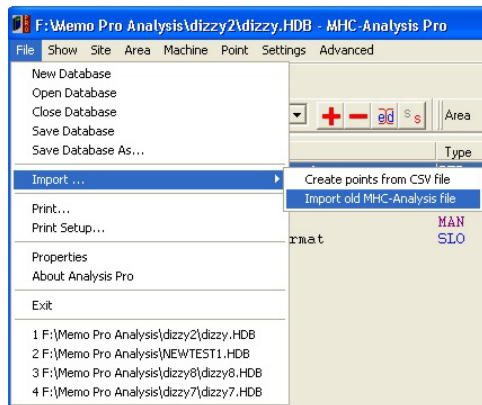
IMPORTANT :
Modifications to a machine database do not update any previously created Action lists. It is therefore important to ensure that Action lists / Routes are updated accordingly whenever a machine database is edited.

II - 4 ACTION LISTS

II - 4.1 Creating a New Action List

An *Action List* is a sub-set formed from a machine database and is described in general terms above. *Action Lists* are the basis from which trends are viewed, alarm levels modified and exception reports created. In addition an *Action List* can be saved in the form of a *Route*. A new *Action List* is created as follows :

a) To create a list open a source machine database that contains the SAMP's you are currently interested in (click on 'File' then 'Open Database' in its drop down menu and choose the database of interest).

b) Click on the 'Action List' tab page (second form the left) on the lower edge of the screen.

c) Highlight one or more Machine names from the left hand column and add to the right hand list by clicking the ➕ button that is situated between these two regions. Notice that when a machine is transferred to the Action List it carries with it all the measurement points and stored data associated with that particular machine. Multiple adjacent Machines can be highlighted by clicking the mouse button to highlight one line, holding the button down and moving the mouse up or down so as to highlight several lines and then releasing the button and then acted upon by clicking on the ➕ button.

d) You can keep adding to the list using the ➕ button that is situated between these two regions.

e) You can select from any of the SITE options in the names available in the top left SITE field and also from any of the AREA options in the top right AREA field available for each site.

f) If you wish to remove a SAMP from the Action List you are creating then click on the appropriate line of the list so that it is highlighted. Observe that the ➕ button has changed into a ➖ button Click on the ➖ button and the highlighted SAMP line will be removed from the list. Note that multiple adjacent SAMP's can be highlighted by clicking the mouse button to highlight one line, holding the button down and moving the mouse up or down so as to highlight several lines and then releasing the button.

g) The order of the SAMP's in the Action List can be re-ordered by clicking on the ▦ 'Re order list' button. Note that a ⧉ 'Sort source list' button is provided if it is required to initially re-order the source list in alphabetical order. Use the ➕ button to build up a list in the 'Selected list' lower field in the order you require. Alternatively click on the ⧉ to transfer the entire 'Source List' to the 'Selected List'. Note that you can remove SAMP's from the 'Selected list' by highlighting them and clicking on the ➖ button.

h) Using the ▤ 'Re order list' button it is possible to import a pre-existing Action List and add it to the current Action List. This is done by clicking on the ▤ 'Load selected list' button at the lower right hand side of the screen and opening previously stored lists which will be added to the *Selected list* field.

i) Alternatively you can click on the ▤ 'Load source list' button at the mid right hand side of the screen to open a previously stored list which will be added to the *Source list* field.

j) Click on the ▤ 'Save list file' button at the lower right hand side of the screen to name and save the list that has been created.

k) Action Lists created in this way are used to form the source data for viewing Trends, generating Exception reports and creating Routes.

II - 4.2 Using Find to create an Action List ▤

By clicking on the ▤ Find button you can enter into the 'Search Database' facility in which you can pull out of a machine database all the measurement points which satisfy the user defined search criteria in one of a number of fields (Site, Area, Machine Point, Comment, Measurement type and Class). Use just one or a combination of these search fields to produce a List. At its simplest you could use this function to pull out all machines of a certain type (eg all motors) or all machines on certain sites, or all machines having a certain *CLASS* number.

II - 4.3 Opening an existing Action List ▤

Previously saved Action Lists can be opened from within the 'Action List' tab page by clicking on the ▤ 'Open list file' button and selecting the appropriate 'Action List' filename.

II - 4.4 Editing an Action List

A previously created Action List can be edited at any time using the same editing functions that are used to create a new Action List (See section II - 4.1).

II - 4.5 Saving an Action List ▤ ▤

Click on the ▤ 'Save list file' button to save the current Action List for future use as an Action List. Alternatively you can click on the ▤ 'Save as Route file' button if you wish to save the current Action List as a Route (note that in this case the maximum number of alphanumeric characters in the title is 16 and the number of points making up the list should not exceed 435.

II - 4.6 Routes and Action Lists

A *Route* is a special type of Action List that is created in Analysis Pro and loaded into the MHC-Memo Pro for the purpose of guiding the user around a number of machines and storing measured values at each identified point. *Routes* are identified with a user defined alphanumeric name of up to 16 alphanumeric characters (maximum) and the number of points making up the list should not exceed 435. To create a Route simply create (or open a pre-existing) Action List and click on the ▤ 'Save as Route file' button to save this Action List as a Route.

II - 5   TRANSFERS

The tab page 'Transfers' can be seen at the bottom of the screen whenever you are not working on a machine database.

The 'Transfers' tab page enables *Routes* to be loaded into the MHC-Memo Pro and stored data (i.e. route based readings, Auto Log files and Capture Spectrum files) to be unloaded from it. This transfer is done via the USB bi-directional communications port on the MHC-Memo Pro.

II – 5-I Connecting the PC to the MHC-Memo Pro
It is necessary to connect the PC to the MHC-Memo Pro instrument in order for communications to be established so that various features of the MHC Analysis Pro software can be used. To do this :

1. Connect the USB communication cable between the PC and the MHC-Memo Pro.

2. Switch on the MHC-Memo Pro instrument. We recommend that the MHC-Memo Pro instrument should be in the Main menu, displaying :

<div align="center">

Routes

[yes]   [no]

</div>

(i.e. the condition after switching on the MHC-Memo Pro once the time and date display has changed).

3. The Analysis Pro 'Settings' must be set so that the USB comms port selected matches that being physically used (see Sections II – 2.2 and II 2.3).

4. To avoid program conflicts we recommend that you only have the Analysis Pro program running on your PC when performing transfers.

For brevity we will refer to the two transfer functions as Route Loading and Data Unloading.

II - 5.2 Route Management

Only Route files with the .rut suffix can be loaded into the MHC-Memo Pro (See section II - 4.6). Note that although you can create as many *Routes* as you like and store them on your computer disk drives, you can only load a maximum of 6 routes into the MHC-Memo Pro at any one time.

> **IMPORTANT :**
> **Routes should always be re-loaded after unloading the measurement data to the PC prior to taking a further set of measurements. If this is not done the MHC-Memo Pro will assume that it is re-taking measurements on the last set of data and inconsistencies will arise when viewing Missed Points in Analysis Pro. To ease this task a Re-load button is provided which quickly loads the Routes used last time back onto the MHC-Memo (see below)**

If you use more than 6 *Routes* then you will need to ensure the appropriate one(s) are loaded into the MHC-Memo Pro each time before you go out take measurements.

It is most important that the route that is loaded or re-loaded into the MHC-Memo Pro is the latest or current version of the route before measurements are taken. Be aware of this whenever you make modifications to a route (e.g. adding or removing measurement points and re-ordering them).

The various functions in the Transfers page relevant to Route Management are explained below :
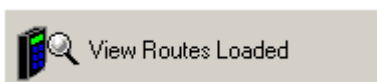
This button lets you see at a glance the route names currently loaded into the MHC-Memo Pro. Note that the asterisk (star symbol) denotes those routes with new data (i.e. data yet to be uploaded to Analysis Pro).

This button lets you remove an unwanted route from the MHC-Memo Pro. Simply click on the white circle at the left hand side of the appropriate route so that a black dot appears in it. Next click on the 'Remove Route' button. Follow further dialogue boxes to complete the action.
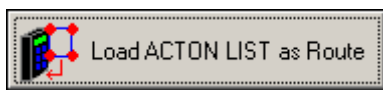
This button lets you load the current Action List as a Route provided the current Action list has already been saved as a Route (i.e. with a .rut extension). If this has not already been done return to the Action List tab page and follow the instructions in Section II - 4.5. Follow further dialogue boxes to complete the action.

This button lets you re-load the same routes that were loaded last time. <u>Be aware that you should ensure that measurement data has been unloaded into Analysis Pro before a route is overwritten with a freshly loaded route otherwise the measurement data will be lost</u>. Follow further dialogue boxes to complete the action.

II - 5.3 Measurement Data Unloading.

Measurement data stored within the MHC-Memo Pro can only be analysed once they have been transferred back to the PC.

IMPORTANT :
Routes should always be re-loaded after unloading the measurement data to the PC prior to taking a further set of measurements. If this I not done the MHC-Memo Pro will assume that it is re-taking measurements on the last set of data and inconsistencies will arise when viewing Missed Points in Analysis Pro. To ease this task a Re-load button is provided which quickly loads the Routes used last time back onto the MHC-Memo (see below)

This button lets you unload all files that have new data (routes, Auto Log or Capture Spectrum files). Files that do not have new data will not be unloaded to the PC. Follow further dialogue boxes to complete the action.

If you click on the Advanced box above the 'Quick Unload button five new options appear.
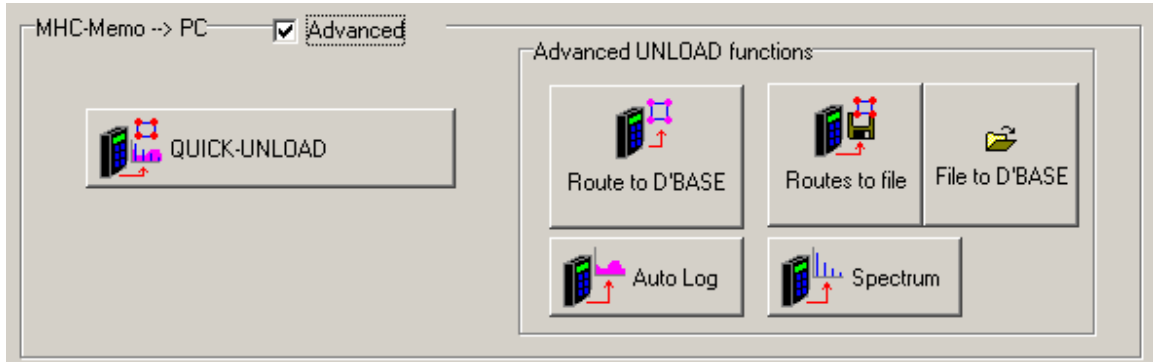
Routes to D'Base
This button allows measurement data from routes to be unloaded and inputted to the database (i.e. it is similar to Quick Unload except it does not unload the Auto Log or Capture Spectra files).

Routes to File
This button allows measurement data from routes with new data to be sent directly to a user named file rather than being immediately inputted into the machine database. The purpose of this function is to allow measurement data being taken remotely from the analysis PC to be temporarily stored in a file so that it can be sent (e.g. by e-mail) to a different PC where the analysis will be carried out.

Add to database
This button allows external files (created using the Routes to file button above) to be added to a machine database. The purpose of this function is to allow measurement data that has been taken remotely from the analysis PC to be imported into Analysis Pro.

Auto Log
This button allows measurement data from the Auto Log memory to be unloaded to the PC.

Spectrum
This button allows measurement data from the Capture Spectrum memory to be unloaded to the PC.

NOTE :
Don't forget to regularly back-up files onto another storage medium so that you won't lose everything if you have a fatal disk crash.

II - 6   TRENDS

The tab page 'Trends' can be seen at the bottom of the screen whenever you are not working on a machine database.

| Standard Mode	Super Slo Mode	Manual Input
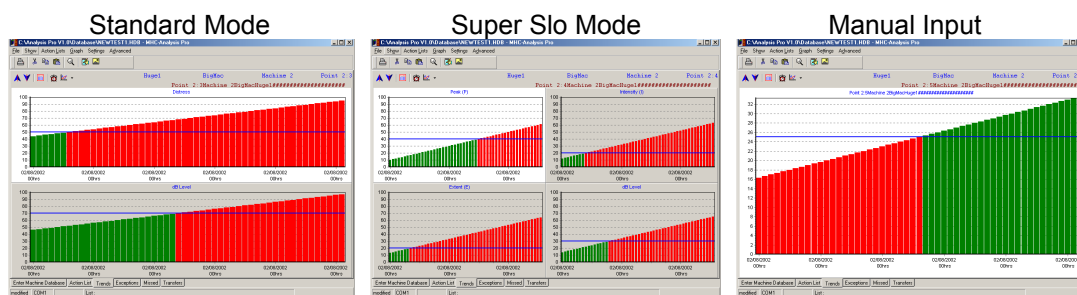
In the *Trends* tab page the trend plots for a particular measurement point on the chosen Action List or Route are shown.

a)   First open an *Action List* or *Route* or by creating a new list (as described in II – 4.1) or alternatively by opening an existing list (as described in II - 4.3).

b)   Click on the *Trends* tab at the lower edge of the screen and the relevant plots will now be generated on the screen for the point highlighted in the Action List (Distress and dB Level for Standard Mode, dB, P, I and E for Super Slo Mode and the parametric value for Manual Input mode).

c)   The number of points displayed in each graph is equal to the number of measurements that have been made at that point and transferred to the Analysis Pro software until this exceeds 52 sets of readings. After this only the most recent 52 sets of readings will be displayed in the plots in the *Trends* tab page.

d)   Although time is printed on the horizontal axis be aware that the plot is of equally spaced measurements irrespective of the time between measurements. Hence interpretation of rate of increase of trends will be simplified if measurements are made at roughly equal intervals (e.g. once every 4 weeks) which is good practice in any case when doing periodic Condition Monitoring.

e)   Use the ▲▼ 'Previous' / 'Next' buttons to scroll through the trend plots for previous and next SAMP's on the Action List.

f)   Where multiple graphs are present on the screen you can enlarge one particular graph to full screen by double clicking on it.

g)   The relevant Alarm levels to the trend plots shown can be adjusted by clicking on the 🕭 'Show alarm panel' button. Overwrite any of the

displayed Alarm levels as required and click on the 'Update' button. Observe that the alarm value displayed as a horizontal line on the appropriate graph has changed to the new alarm value.

In addition there are a number of advanced features when viewing Action List Trends. First of all be aware that where multiple graphs are displayed (ie for STD and SLO measurement types) you can choose to view only one of the graphs by double clicking on the graph of interest to produce a Graph Enlargement to full screen

A number of other features are accessed by either clicking on the right hand mouse button or on the ![icon] 'Graph options' button as follows :

<u>Copy Graph</u>	the displayed graphs for the particular measurement point are copied to the clip board for pasting into external documents (eg reports).
<u>Copy as Reference</u>	the displayed graphs for the particular measurement point are retained and displayed as a reference to be compared with graphs for other measurement points.
<u>Change Y scale</u>	change the max and min values on the graph (leave category blank for it to be auto scaled)
<u>View as</u>	View graphs as line or bar type plot.
<u>Toggle Grid</u>	Allows X and Y grids to be displayed or hidden.
<u>Set Colour</u>	Customise the colour of the *Alarm level* line, the plot *Above alarm* and the plot *Below alarm.*
<u>File Graph Settings</u>	Save your graph setting as a file so that they can be recalled later on.

The ![icon] 'View Data as a Table' button allows both entering of new data values and editing of existing data. Note that both the data values and the time and date can be modified within this function. Possible uses include :

- entering readings taken with a non data collecting instrument s (e.g. the MHC-Classic)
- correcting measurements which are known to be erroneous
- correcting dates which are known to be erroneous (eg PC had wrong time / date settings)

II - 7   EXCEPTIONS

'Exceptions' are those SAMP's in an Action List for which the latest unloaded readings put them into an alarm status. An alarm status arises if one or more of the values associated with that point is equal to or greater than the alarm setting for that particular measurement at that particular measurement point. Note : for the special case of 'Manual Input' points it is possible to have an alarm if the value is <u>less than</u> or equal to the alarm level by deleting the tick denoting 'Above alarm' in the alarms dialogue box.

Each line of the Exceptions Report shows the SAMP and the amount by which the different readings had exceeded the respective alarm levels for that SAMP (i.e. the exceedance of Distress and dB Level for Standard mode, P, I, E and dB for Super Slo mode and Parameter value for Manual input mode).

The *Exceptions* SAMP's can be automatically sorted from High to Lo by clicking on the 'Sort by exceedance severity' button so that those most in alarm can be clearly seen.

You can save the Exception Report as a new 'Action List' by clicking on the 'Save SAMP's only as a list' button. By opening this new Action List you can easily review the trend plots (and if required amend the alarm levels) of each of the SAMP's that is in alarm. You may wish to save this Action List as a Route and conduct more frequent monitoring on these points in Alarm. In doing this you may wish to alter the Class of each point so that its criticality can be recognised in later searches of the entire machine database.

Note also the 'Show All' tick box which provides the option to list all items in the Action List with those in Alarm being coloured yellow on a red background (e.g. 19), missed points in white on a purple background (e.g. 19).

Finally you can force a rebuild of the exception list by clicking on the 'Build exception & missed points report' button.

II - 8   MISSED POINTS

'Missed points' are those measurement points for which there are no freshly stored readings in the last set of readings unloaded from the MHC-Memo Pro (e.g. those points you pressed 'skip' rather than 'read' at when taking the measurements). The importance of missed points is that their current condition is not known since a measurement was not taken and stored during the latest.

You may wish to go around the route and fill in the missed points in which case there are two options. Firstly you can literally take the MHC-Memo Pro out and navigate through the route to identify the missed points and re-take the readings (this is not ideal if most points have not been missed). Secondly you can save the missed points as a list (click on the 'Save SAMP's as a list' button), open this list as an Action List, convert it into a Route and load it

into the MHC-Memo Pro. In this way the MHC-Memo Pro will guide you around a shortened route consisting of only the missed points.

Finally you can force a rebuild of the missed points list by clicking on the 🌐 'Build exception & missed points report' button.

II - 9   MODIFYING INDIVIDUAL ALARM VALUES AND CLASS NUMBERS

The *Alarm* levels and Class number associated with each measurement type at each SAMP can be individually adjusted within the Analysis Pro software.

Activation of an alarm for a particular measurement point by the most recent route data unload to the PC adds that measurement point to the Exception Report (see Section II - 7 & II - 11.2). Alarm levels for an individual SAMP can be easily adjusted from within the *Trends* tab page as follows :

- With the appropriate Action List opened click on the Trends tab page.
- Click on the 🕘 'Show alarm panel' button and the 'Alarms' dialogue box will open.
- Adjust the alarm(s) as necessary and click on the 'Update' button to effect the change.
- Observe the horizontal alarm bar move accordingly on each affected plot for that SAMP.
- If required adjust the 'Class' number within the same Alarms dialogue' box.

Alternatively the Alarm levels and Class number for an individual SAMP can be adjusted from within the Machine Database tab page using the EDIT function in the Points section.

Top tips when setting alarm levels
As a first starting point for rotating machinery we would recommend a Distress alarm of 10 and an Extent (E) alarm of 5. On precision machinery (e.g. machine tool spindle bearings) you may wish to select a lower alarm value so that faults are alerted at an earlier stage. On machinery that normally runs with a higher value (e.g. split bearings under load) you may wish to select a higher alarm value for Distress and Extent. Do bear in mind that when you start taking measurements on a large number of machines some of them are likely to be in a fault condition so it is unwise to automatically consider the first measurement as being a datum for good condition.

We recommend that the initial alarm values for dB Level, Intensity and Peak should be set at 99dB (which is beyond the 92 dB range of range of the MHC-Memo Pro instrument. Since 99 dB is outside the operating range these parameters will never cause an Alarm condition (i.e. trigger its inclusion in the Exception Report). Once you have taken some measurements adjust the dB Level, Intensity and Peak alarm values downwards from 99 to (typically) about 10 dB above the normally observed values. This is best done graphically from

within the *Trends* tab page for each measurement point. We suggest you start at the first measurement point in a Route or Action List adjust the Alarm levels and click on the ▲▼ 'Previous' or 'Next' button to systematically adjust the Alarm levels of all measurement types for each of the measurement points in turn.

Notice that when trend plots are viewed as either a bar or a line plot then the colour changes for those values that equal or exceed the appropriate Alarm Level.

II - 10 GLOBAL ADJUSTMENTS TO A GROUP OF SAMP's

On some occasions you may wish to carry out a global adjustment of parameters (eg Alarm Levels) that affect a group of SAMP's. To do this you must first create the group of SAMP's by loading one or more Action Lists containing the required SAMP's of interest for global adjustment. Do this as follows :

> From within the 'Machine Database' tab page move the cursor to 'Point' in the top line of menus and click on 'Adjust Point Parameters' in its drop down options. Now click on 'Load Source list' button (middle RHS of screen) and select the Action List(s) which includes the SAMP's of interest. Build up the selected list in the lower half of the screen to include only those SAMP's you wish to join the group for global adjustment. (Note if you do not require to pick selectively from an Action List then simply load the entire Action List directly into the selected list by clicking on the 'Load Selected list' (bottom RHS of screen).

Once you have built up your Selected List (and considered saving this list using the 'Save Selected list' button) click on the 'OK' button. This opens the 'Adjust parameters' dialogue box. Notice that you have the option of globally adjusting the various parameters in one of two ways :

> either by incrementing / decrementing (adding to / subtracting from) the current value of the chosen 'parameter' for each SAMP by your chosen 'value' (e.g. add 3 to the current Distress alarm level of all SAMP's).

> or alternatively by replacing all the values of the chosen 'parameter' for each SAMP with your chosen 'value' (e.g. change Distress alarm level of all SAMP's to 12).

To select the parameter to adjust click on the arrowhead at the RHS of the 'Parameter' options line and the following options for adjustment are available in the drop down list :

Class Value <ANY>
       Alarm Distress <STD ONLY>
       Alarm dB Level <STD ONLY>
       Alarm Peak <SLO ONLY>
       Alarm Intensity <SLO ONLY>
       Alarm Extent <SLO ONLY>
       Alarm dB Level <SLO ONLY>
       Secs per Rev <SLO ONLY>
       Alarm parametric <MAN ONLY>
       Comment Text <ANY>   *Applies the same comment to each SAMP*
       Picture Filename <ANY>   *Links all SAMP's to the same picture*
       Delete UserNotes <ANY>   *Deletes all user notes*

II – 11 REVIEWING AND REPORTING ON MACHINE STATUS

II - 11.1 Reviewing the data after the first set of readings

From the very first set of measurements you can start to benefit from the MHC-Memo Pro by looking for exceptional items as follows :

- For STD measurement points observe if Distress levels are high (e.g. greater than 10)
- For SLO measurement points observe if Extent (E) values are greater than 5.
- For MAN measurement points observe if values are outside expectations (e.g. a high bearing temperature etc..)
- Compare values across the same measurement positions on equivalent machines of the same type.

II - 11.2 Reviewing the data once you have enough points to make a useful trend

Once you have taken a few sets of readings it is important to check that the alarm settings are at a sensible value for each measurement point. To do this follow the procedure outlined in II - 9. ***Note : Failure to set realistic alarm levels for all measurement types will seriously diminish the effectiveness of the Analysis Pro software and the MHC-Memo Pro.***

Once the alarm levels have been set for each measurement type at each measurement point those which are currently in alarm can be viewed as an Exceptions Report (accessed by selecting the '*Exceptions*' Tab Page). Typically '*Exceptions*' would be the first page to select after loading a fresh set of measurements. The list of exceptions is drawn from measurements made during the most recent upload and consists of those measurement points for which at least one of the measurement types is equal to or exceeds the appropriate alarm level. The exceedance values for each of the SAMP's that is in alarm show by how much each of the relevant parameters (i.e. Distress or dB Level in Standard mode etc.) is above the appropriate alarm

level (Note that for the case of Manual Input points it is possible for the alarm to have been set for a lower than condition).

Note that in the Exceptions listing you have the option to either show only those items in Alarm in the Action List or alternatively by clicking on the 'Show All' tick box show all items in the Action List with those readings in Alarm being coloured yellow on a red background (e.g. `19`, missed points in white on a purple background (e.g. `19`).

To view the trend plots specifically for all those SAMP's forming the Exception Report save it as an Action List as described in II - 7. Then with this as the Action List open the 'Trends' tab page and use the ▲▼ 'Previous' or 'Next' button to observe any trend in the previous readings for each SAMP. If appropriate you can take this opportunity to ensure that Alarm levels are correctly set and/or adjust them to new levels as described in II - 9.

If alternatively you wish to view the trend plot for a particular SAMP that does not form part of the Exceptions Report (e.g. one that has been recently serviced or repaired) then it is a simple matter to open the 'Action List' tab page (for the entire Route), click the mouse button once on the appropriate measurement point to highlight it and then open the 'Trends' tab page.

Do not forget that measurements made on equivalent measurement points from different machines, areas, sites, and routes can be very easily compared by building a new Action list as described in II - 4.1 and 4.2.

II - 11.3   Reporting the data

A number of different printouts are available from the Analysis Pro software. These can be accessed either by clicking on the 🖨 'Print' button in any of the tab pages or alternatively by clicking on 'File' then 'Print...' to reveal the drop down menu as follows :
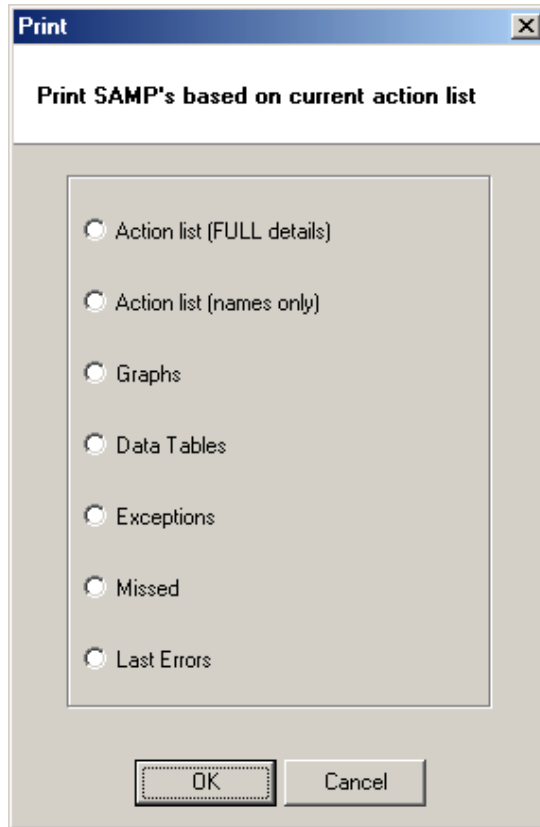
When you click on any of these options you will be presented with a Source List in the upper screen (consisting of the entire Action List) and the Selected List in the lower screen. Click on the ✚ button to transfer selected SAMP's from the Source list into the Selected list. Repeat this process to build up a number of selections. Alternatively click on the ✢ to transfer the entire 'Action List' to the 'Selected List'.

II - 11.4 User Notes 📝
User notes form a useful means of keeping track of changes that affect the machine and its condition. User notes are specific to individual measurement points (SAMP's) and can be entered whilst in any of the tab pages of the Analysis Pro software. To do this simply click on the 📝 User Notes button and type the required entry (e.g. an observation that it was hot, idling, leaking oil etc.) or to keep a record of a maintenance action that has been made which is relevant to the measurements at that point (e.g. re-greased, bearing replaced, aligned, tightened etc..).

Provision is made for entering the time and date at which the notes are being made. We suggest that you precede each User Notes entry with a time & date stamp. To do this click on the 🕐 'Insert current date/time' button.

When you have finished entering User Notes click on the ✔ 'Accept changes' button.

If you wish to add the same or very similar user notes to a number of measurement points (e.g. to all measurement points on a machine) then it is a simple matter to enter the notes at one measurement point and use the 📋📋 ('Copy' and 'Paste') to duplicate them elsewhere.

The 🔍 'Find' button can be used to search for specific words, phrases or dates, where extensive User Notes are kept.

Those SAMP's for which User Notes have been saved can be readily identified from within the Machine Database tab page by observing the 'Order' number. If the number is followed by a '+ N' then that particular SAMP has USER notes attached. An example is shown below where user Notes are present on The 'Motor DE' of 'Compressor #1'.

Machine	Order	Point	Type	Comment Text
Compressor #1	1+N	Motor DE	STD	
Heater #1	2	Motor NDE	STD	
	3	Pump DE	STD	
	4	Pump FE	STD	
	5	Pressure	MAN	

II – 12 EXPORTING INFORMATION FROM THE ANALYSIS PRO SOFTWARE

The Analysis Pro software includes the provision to easily export information to other software packages by copying it to the clipboard :

II - 12.1 Copy Graph 📋
The 'Copy Graph' function can be found in the 📈 ▾ 'Graph 0ptions' drop down menu when in the Trends tab page. Where multiple graphs are displayed the selected graph (on a white background) is transferred to clipboard and can be pasted into external software packages (e.g. written reports).

II - 12.2 Exceptions Report
The Exception Report can also be saved to clipboard using the 📋 'Copy' button in the 'Exceptions' tab page. This enables the Exception Report to be pasted into other documents.

II - 12.3 Missed Points Report
The Missed Points Report can also be saved to clipboard using the 📋 'Copy' button in the 'Missed Points' tab page. This enables the Missed Points Report to be pasted into other documents.

II - 12.4 Action List

The Action List can also be saved to clipboard using the 📋 'Copy' button in the 'Action List' tab page. This enables the Action List to be pasted into other documents.

II - 13 AUTO LOG

Auto Log Files contain sequences of measurements (in either Standard or Super Slo mode). The Auto Log memory space in the MHC-Memo Pro can save up to a maximum of 2338 sets of readings. This memory space can be filled in one long sequence or as multiple smaller sequences. The size of each Auto Log file depends on the length of time each Auto Log sequence was left running.

Auto Log files are unloaded along with all other stored information when 'Quick-Unload' is used within the 'Transfers' tab page. Alternatively Auto Log files can be exclusively unloaded using the Advanced Transfers facility as described in section II – 5.2.

Each Auto Log sequence has a filename which consists of a 'field defined' filename (up to 12 alphanumeric characters). Auto Log files are text files (.txt) and can be readily opened in spreadsheets where they will appear under the column headings of :

> Point
> Date
> Time
> Distress
> dB Level
> Peak
> Intensity
> Extent
> Time per rev

II - 14 CAPTURE SPECTRUM

Up to a maximum of 15 Capture Spectrum files can be stored in the Capture Spectrum memory space of the MHC-Memo Pro. Each file contains the necessary information to view an AE envelope frequency spectrum via the AE Lab frequency analysis software that is supplied with the MHC-Memo Pro. Capture Spectrum files are not suitable for use with any other software. Each AE envelope spectrum covers the frequency range of 0 Hz to 1000 Hz and is representative of the repetition frequency content of a single 1 second period of waveform.

Typically Capture Spectrum would be reserved for measurement points of special interest (e.g. ones with particularly high Distress readings) and where diagnostic information would be of benefit.

Capture Spectrum files are unloaded along with all other stored information when 'Quick-Unload' is used within the 'Transfers' tab page. Alternatively Capture Spectrum files can be exclusively unloaded using the Advanced Transfers facility as described in section II – 5.2.

Although the spectra have to be initially viewed in AE Lab software there is provision within AE Lab to export the spectrum as a file to other software packages (such as a Spreadsheet),

II - 15 ROUTE REMINDER CALENDAR

Analysis Pro has a route reminding calendar function built–in. The purpose of this is to allow the user to be reminded when it is time to take the next set of measurements on each of perhaps many routes. In this way it gives visibility of upcoming measurements that will need to be taken and helps you plan your future measurement workload. A pre-requisite for using this function is that you have created and stored one or more Routes.

To access this Calendar function from within the Analysis Pro software simply click on 'File' and 'Show Route Calendar'. From within the 'Calendar for selected routes' dialogue box click on the ✚ button and make your choice from pre-existing routes that you have created from this machine database. You can enter / change the number of days between readings (Interval Days) by clicking on the 🗓 button which opens up the 'Set route interval' dialogue box where you can enter the number of days (e.g. to 28 for a 4 week period). Any number of routes can be added to this list by repeating the process. You can also use the ➖ button to remove routes form this list. When complete click on the ✔ button.
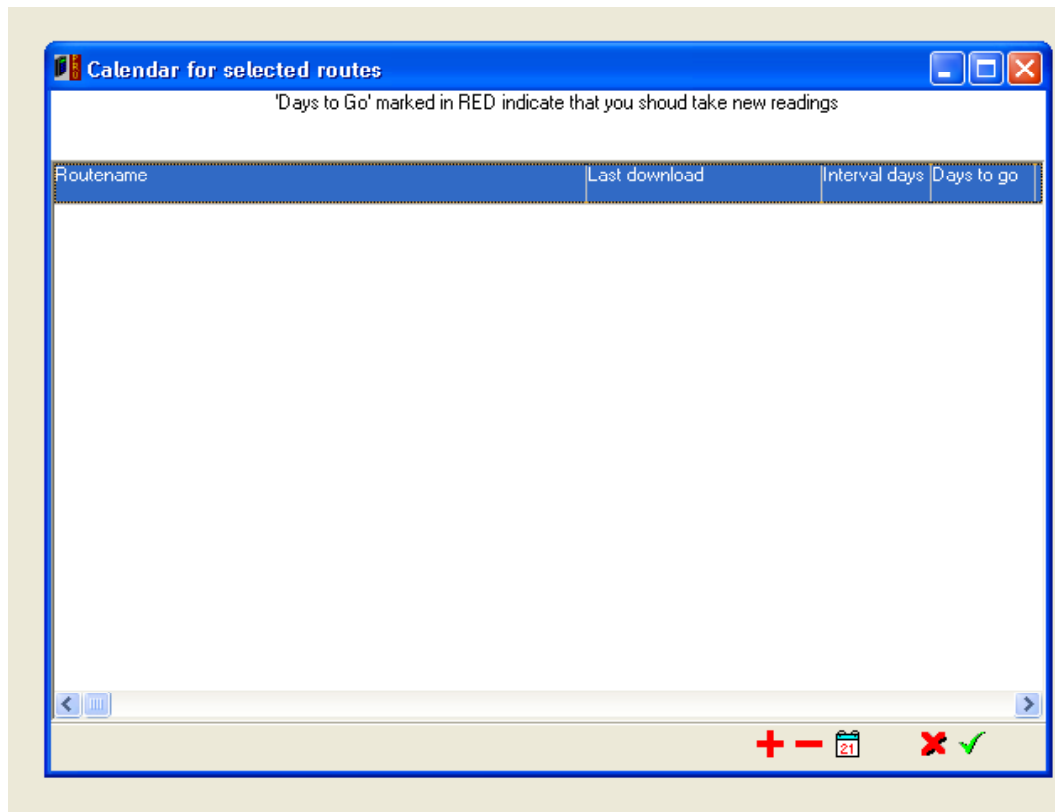
Once a download of the measurements from a Calendar listed route has been made the number of days to the next measurement for that Route will be calculated and can be displayed by clicking on File and Show Route Calendar. More conveniently this can be done by activating the 'Always show calendar' option in 'Advanced' drop down menu at the top of the screen. Once this is activated the calendar will be displayed when the machine database is opened.

II - 16 ARCHIVING, BACKUPS & RECOVERY FILES

II - 16.1 Archiving

- Machine databases including all the measurement data are automatically archived after every 52 data transfers.
- Archiving is not the same as back-up since the archive files are stored on the same recording media as the working file they would all be lost if that disk had a fatal crash. To minimise the chances of losing data we recommend that you backup files after each data transfer.
- The option exists to manually force an Archive to occur. To do this simply click on the 'Advanced' button in the upper toolbar and then click on Force archive in is drop down menu.

II - 16.2 Back-ups
We recommend that you make a back-up copy of the Analysis Pro software provided with the MHC-Memo Pro (e.g. on a separate hard disk, CD or DVD as appropriate).

We strongly recommend that you regularly back-up machine database files and associated archive files of your measurements onto another media (e.g. hard disk, CD or DVD etc.) to prevent accidental loss of data should the computer's hard disk that you are using crash.

II - 16.3 Recovery Files

When you Save a modified file in Analysis Pro the program automatically creates a Recovery File which preserves in the background the unmodified version of the file.

The file pertaining to each route can have up to 10 recovery files on a first in first out basis (i.e. you can resurrect the file for each route to what it was like up to 10 Saves ago !). This feature lets you get back to where you were before a file was accidentally corrupted or if you accidentally saved unwanted changes. These field are stored as per the original filename with the file extension ".r0" to ".r9". To restore a Recovery file click on 'File' in the top left hand corner and click on 'Open'. Click on the downwards arrow at the side of 'List of File Types' and select 'Recovery Files'. Select the appropriate file and open it.

II – 17 COPYING / MOVING FILES TO OTHER DISCS / DIRECTORIES

The actual data for each database in the MHC-Analysis Pro software is actually split into a number of separate files each of which is important for the correct operation of the software. Therefore if you need to copy a Memo Pro database to another PC it is important to copy the entire Directory containing the MHC database (usually called MHC Analysis Pro and in the C: directory). Be sure to do this copying from the desktop and not from within the Analysis Pro software.

II – 17.1 Directory Structure

[ANALYSIS PRO DIRECTORY]
            graph settings files (*.gra)
            Alarm default files (*.alm)

                    [DATABASE NAME DIRECTORY]
                        Database files (*.hdb, *.dbf, *.not)
                        Action List files (*.lst)
                        Error files (*.err)
                        Route files (*.rut)
                        Unload files (*.unl)
                        Xfer transfer files (*.xfr)

                    [AUTOLOG DIRECTORY]
                        <NAME> <DATE COLLECTED> <TIME COLLECTED> AutoLog.TXT

                    [SPECTRUM DIRECTORY]
                        <NAME> <DATE COLLECTED> <TIME COLLECTED> Spectrum.SPE

                    [PICTURES DIRECTORY]
                        <PICTURE FILENAME> (in *.jpg, *.jpeg, *.bmp, *.ico, *.emf, *.wmf)
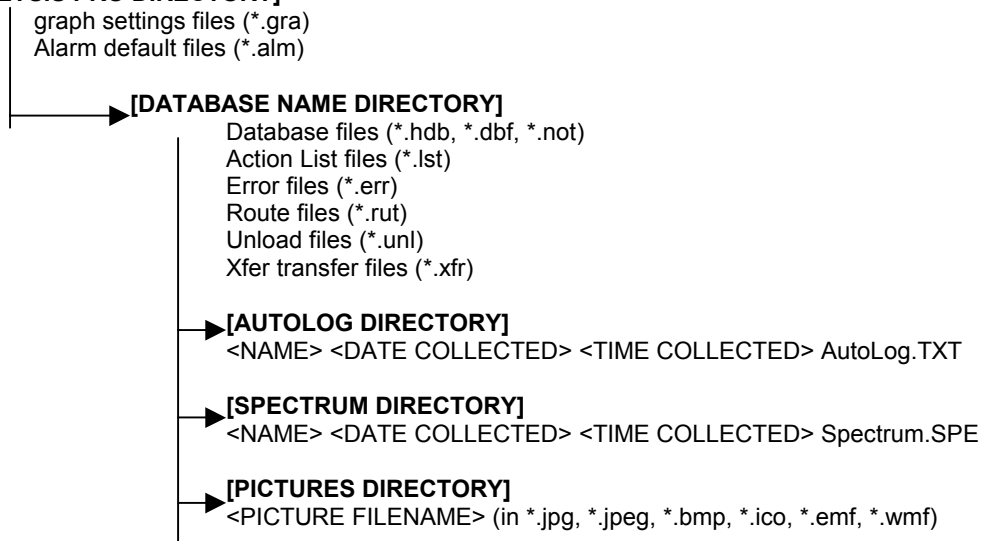
So for example of the database called DEMO (installed during setup) then the following files would exist

[MHC-ANALYSIS PRO DIRECTORY]
            any existing graph settings files (*.gra)
            any existing alarm default files (*.alm)

                    [DEMO DIRECTORY]
                        DEMO.HDB
                        DEMO_MASTER.DBF
                        DEMO_RAWDATA.DBF
                        DEMO_USERNOTES.NOT
                        Any existing action list files (*.lst)
                        Any existing error files (*.err)
                        Any existing route files (*.rut)
                        Any existing unload files (*.unl)
                        Any existing xfer transfer files (*.xfr)

> These four files **must** exist for the database to open

                    [AUTOLOG DIRECTORY]
                        Any existing autolog files

                    [SPECTRUM DIRECTORY]
                        Any existing spectrum files

                    [PICTURES DIRECTORY]
                        Any existing picture files

If some of the database files are missing (e.g. during an backup or copying to another disc) the database will not be open so it is important to understand what files are necessary.

II – 17.2 Mandatory Files
Database Files (containing SAMP names, data & user notes)
(NOTE : These must be copied as a group for the database to open)

Filename	Format	Function
<DATABASE NAME>.HDB	ASCII coded (INI file)	Database settings file
<DATABASE NAME>_MASTER.DBF	DBASE format	Database containing SAMP names, alarm settings, time per rev, picture filenames, class number & other data
<DATABASE NAME>_RAWDATA.DBF	DBASE format	Database containing actual measurement data, date & time, time per rev
<DATABASE NAME>_USERNOTES.NOT	ASCII coded	User notes with imbedded SAMP markers

II – 17.3 Optional Files

File type	Format	Function
List files (*.lst)	ASCII Coded	Action list with SAMPs
Route files (*.rut)	ASCII Coded	Route list with SAMPs
Error files (*.err)	ASCII Coded	User saved "last errors"
Unload files (*.unl)	ASCII Coded	Raw output file from MEMO
XFER transfer file (*.xfr)	ASCII Coded	Transfer file containing SAMPs and last sets of data extracted from the database
Graph files (*.gra)	ASCII Coded	Graph settings
Alarm files (*.alm)	ASCII Coded	Default alarm settings files
Auto Log files	ASCII (Comma Separated Values)	Autolog files (for import into spreadsheets etc)
Spectrum files (*.spe)	ASCII Coded	Used with AE-LAB™ software
Picture files	Various	Pictures

IMPORTANT NOTE : MOVING, COPYING & BACK-UPS
We recommend that you should COPY the WHOLE of the directory (in this case everything under [DATABASE NAME DIRECTORY] to ensure that no data is missed. Purchasing a standard ZIP program would help you to compress the files further so that they could be emailed or possibly stored on a floppy disc if the database and associated data is not too large.

The files in [AUTOLOG DIRECTORY], [SPECTRUM DIRECTORY] & [PICTURES DIRECTORY] could be left out if they were not required – the database will still open but without these features. **NOTE : This method is not to be recommended for full back-ups.**

II – 18 IMPORTING OLD MHC-ANALYSIS FILES (.dat)

Within Analysis Pro it is possible to import old MHC-Analysis files taken on the standard MHC-Memo which has only a six alphanumeric Measurement

Point Description (MPD). As part of this process it is necessary to convert the MPD's into SAMP's. The entire procedure is as follows :

Open a New Database (as described in II – 3.1) and enter the Site name(s). Click on 'File' and click on' Import old MHC-Analysis file' in the 'Import ….' Options. Select the required file in the usual way.

The screen will change to show a listing of the dates and times which are ascribed to the various points on the plots within the imported files. You can click on any of the lines in the right hand column and change it by clicking on the 'Change' button. Enter the appropriate values in the 'Change Date & Time dialogue box' and click on 'OK' to update the values for this particular point.

Note : If the data you are trying to import has the same date for more than one point then it will be necessary to modify the dates so that each date only appears once in the list.

When the list is ready click on 'OK' in the 'Confirm Dates & Times' dialogue box and the screen will change to the 'Convert old database' screen. In this screen there are two tab pages; Original Refs and Assignments. Each of the points in the Original Refs list needs to be assigned together with its Site, Area and Machine names. Highlight one or more MPD lines in the table and select (using the arrow drop down list) or create (using the ➕ button) the appropriate Site, Machine And Area names. Once the correct names are being shown click on the 'Assign' button. Note that assigned MPD's are removed from the Original Refs listing and added to the Assignments listing.

Carry on like this until all MPD's have been assigned. Finally click on the 'Convert' button to effect the conversion to SAMP's and their addition to the machine database.

Any further editing of the Point (or other) names can be done in the 'Machine Database' tab page as described in II – 3.5.

Note how the Alarm Levels and User Notes have been imported alongside the measurement data.

Obviously all old MHC-Analysis files imported in this way will be of the STD measurement type since this was the only route mode measurement that the original MHC-Memo could store.

SECTION III - AE LAB^{TM} SOFTWARE GUIDE

III - 1 INTRODUCTION TO AE LAB III SOFTWARE (ver 3.1)

The purpose of these notes is to provide an introduction to the features of AE Lab III and guidance in the use of this software to analyse '.spe' files taken using the Capture Spectrum function of the MHC Memo Pro portable instrument and downloaded using its accompanying Analysis Pro software.

AE Lab III performs an FFT calculation on the downloaded .spe file to reveal the envelope spectrum of the original AE signal. In other words the displayed spectrum in AE Lab III shows modulation frequencies affecting the detected AE signal. Because of this the frequency spectrum is able to cover the frequency range 1 Hz to 1000 Hz although the detected signal was at ~ 100 kHz.

Since Capture spectrum files cover only a 1 second period of the detected signal AE Lab II should not be used to analyse data from machinery rotating at less than 120 rpm.

The principal features of AE Lab III can be summarised as :

- Generate and display the AE envelope spectrum.
- Allow cursors to be applied to the spectrum.
- Allows comparison of the main spectrum with a reference spectrum.
- Generate and display bearing defect repetition frequencies.
- Allow the spectrum to be placed on the clipboard as either an image or as XY coordinates (e.g. for opening in a spreadsheet.

Note : Where necessary some improvement in the frequency spectrum can be gained by frequency domain averaging provided several Capture Spectrum files have been recorded at the same measurement point and at the same operating condition. This requires each of the calculated spectra to be exported to a third party spreadsheet where values of each frequency bin should be averaged before plotting the averaged values.

## III - 2 AE LAB SOFTWARE INSTALLATION

AE Lab III needs to be manually installed on your PC in addition to the Analysis Pro software. To install AE Lab III run the SETUP.EXE in the AELAB INSTALL folder of the CD rom

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III - 3 OPENING & VIEWING CAPTURE SPECTRUM FILES
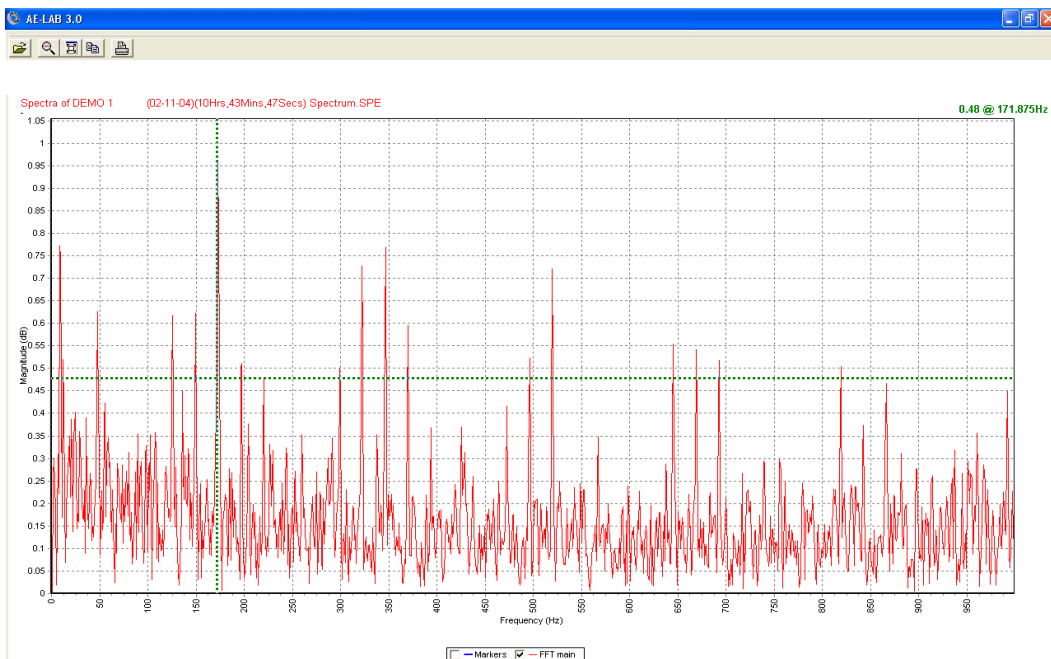
Upon opening AE Lab III the icon buttons at the top left hand side of the screen **are as follows :**
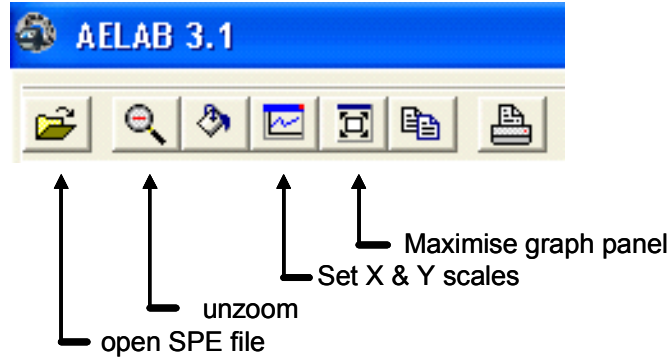
Click on the 'open SPE file' icon in the top left hand corner and navigate as usual within the 'Open' dialogue box to select the required 'Spectra **file'.**
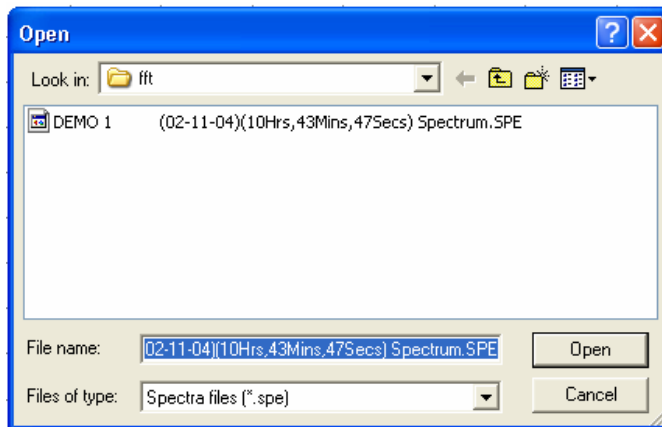
Once you click on Open in this dialogue box the FFT calculation will be immediately displayed in the plot area of the screen.

Above the displayed frequency spectrum there is a line of text (in the same colour as the displayed spectrum) which specifies the file name (or SAMP if taken on a route) and the date and time it was taken.

If you are not interested in seeing the bearing defect frequency table you can remove this and expand the spectrum image by clicking on the maximise graph icon (click on it again to reinstate the defect frequency table at any time):


You can expand a region of special interest in the displayed frequency spectrum by moving the mouse pointer to the top left hand corner of this region holding down the mouse left button and moving the mouse pointer to the bottom right hand corner (such that it is highlighted on a blue background (see figure) and releasing it. In such an expanded spectrum display you can pick up the image with the mouse right hand button and move it up/down and left/right in order to either adjust the offset of the X and Y axes or scroll along the entire spectrum at the selected scaling.
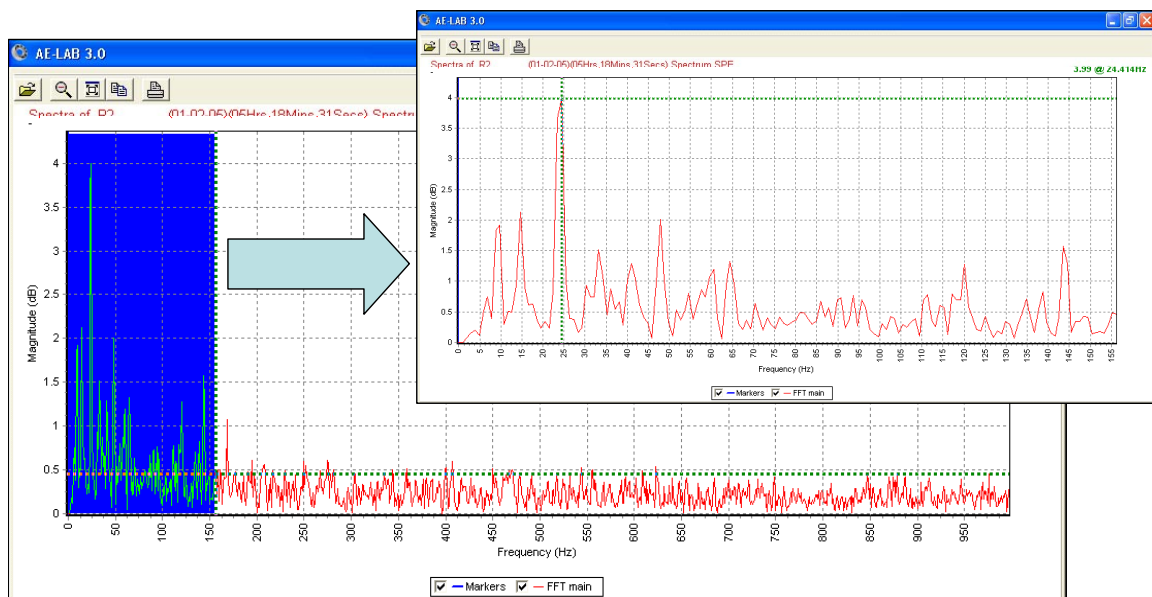
You can always return to the unmagnified image by clicking on .

III - 4 WORKING WITH CURSORS & MARKERS

The cursor operates on the frequency spectrum and is controlled by moving the mouse pointer within the plot area (see dotted green cross hairs on example plot). The corresponding Magnitude and Frequency value for the cursor position on the spectrum are displayed in green writing above the plot area at the right hand side.
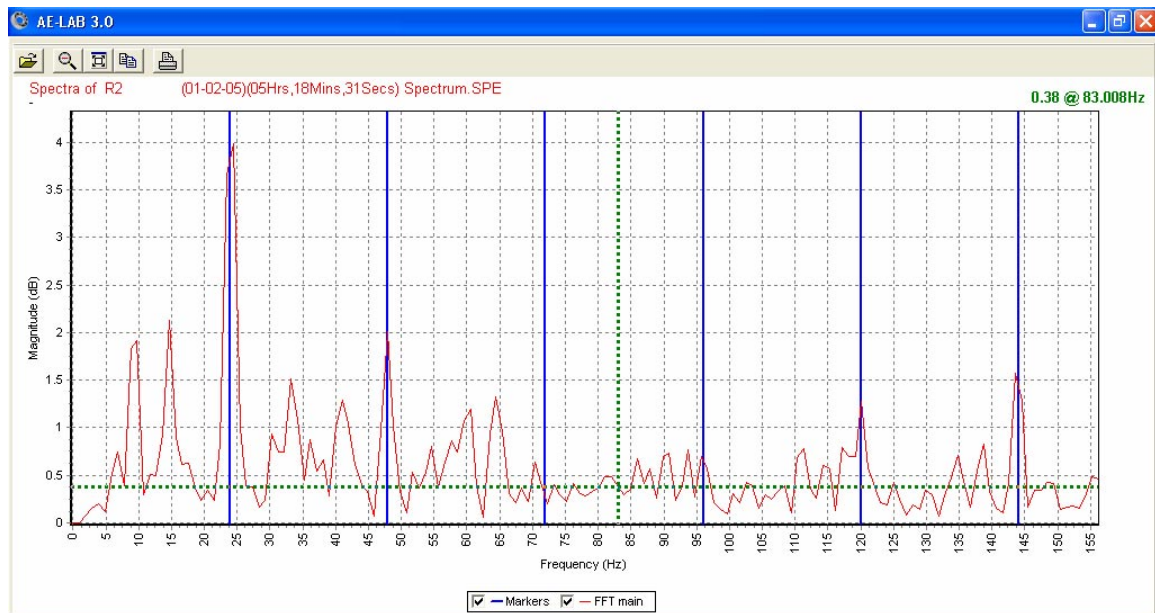
Frequency markers (vertical lines) can also be displayed as follows :

a) Ensure that the tick box adjacent to Markers (central region underneath the plot area) is ticked.

b) Enter the start frequency in the 'Start' dialogue box of the 'FFT markers (Hz)' section underneath the plot area at the right hand side of the screen. Where this corresponds to a particular peak it is usually quicker to simply click on the 'Find Peak' and 'Next Peak' buttons until the red marker passes through the peak of interest in the spectrum. Alternatively you can manually enter a numerical value.

c) Alternatively you can manually enter a numerical frequency value.

d) If you wish to display repeater markers, enter the frequency step between the first marker and subsequent markers in the 'Step' dialogue box. To remove these additional markers enter 0 in the step dialogue box.

e) If you wish the repeater markers to have spacings equal to the start frequency simply click the tick box for 'Harmonic steps'.

f) If you wish to adjust the 'Start' or 'Step' frequency click within the appropriate box and use the ↑ and ↓ keys on the PC keyboard to increment by 1 Hz. If you hold down the 'Alt' key while you do this it will increment by 0.1 Hz.

g) As an alternative to manually entering values, you can tick the 'link to worksheet' box to automatically link both the 'Start' frequency and 'Step' interval to any frequency value that you highlight in the defect frequency worksheet table. The repeat markers show harmonics of the fundamental defect repetition frequencies.
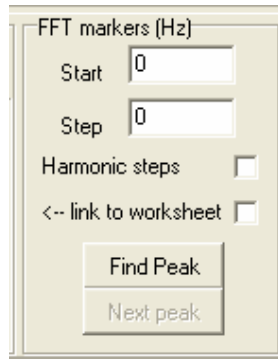
To copy the plot area including the cursor position press 'F5' or to copy the whole page (plot area with cursor and defect table) press 'Ctrl + F5' (a text reminder of this is printed at the bottom of the screen).

III - 5 BEARING DEFECT FREQUENCY CALCULATOR

The defect frequency worksheet along the bottom of the screen provides a means of calculating and saving bearing defect repletion frequencies. The icon buttons along the top left hand side of this section are as follows :
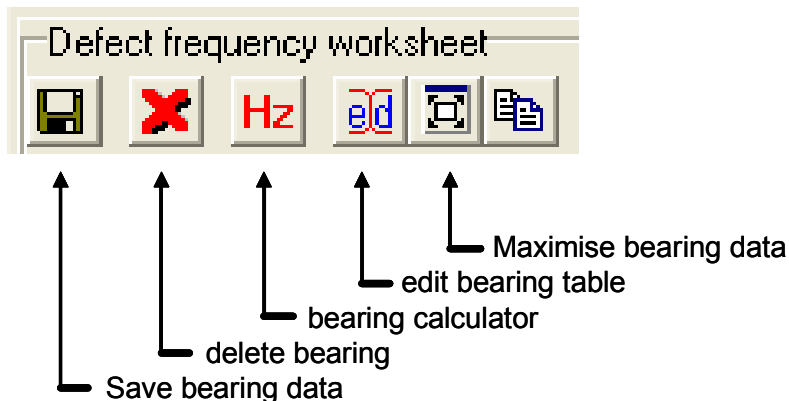
To enter a new line into the defect frequency calculator table proceed as follows :

a) Click on the 'bearing calculator' icon button to open the 'Defect Frequency Calculator' dialogue box.
b) Select either the 'Precise' or 'Approximate' tab.
c) Enter the required bearing and speed data.
d) Click on the add to defect table button.
e) Enter the appropriate description in the 'Bearing location' dialogue box that appears and click on OK.
f) Enter the appropriate description in the 'Bearing type' dialogue box that appears and click on OK.
g) The 'Defect Frequency Calculator' dialogue box remains open to allow points (b) to (g) to be repeated as many times as required. When finished close the dialogue box in the usual way.

Calculated values of defect repetition frequencies as well as the location and bearing type descriptions are all shown in the table :

The various calculated defect repetition frequencies are as follows :

1/Rev = Shaft speed (rpm) expressed in Hz
FTF = Fundamental train frequency (Cage frequency)
BSF = Ball or roller spin frequency (Note : formula used assumes impact on either inner or outer races, double the frequency if both)
O/R = Outer race frequency
I/R = Inner race frequency

There are three basic approaches to editing values in the defect frequency worksheet :

i) Correcting an error in the entered bearing data or altering the rpm :
    a) Highlight the relevant 'Location' name.
    b) Click on the 'bearing calculator' icon button to open the 'Defect Frequency Calculator' dialogue box.
    c) Make the necessary changes and click on the 'update defect table' button.
    d) When finished close the dialogue box in the usual way.

ii) Duplicating an entry with minor changes (e.g. a name or rpm change) :
    a) Highlight the relevant 'Location' name.
    b) Click on the 'bearing calculator' icon button to open the 'Defect Frequency Calculator' dialogue box.
    c) Make the necessary changes and click on the 'add to defect table' button.
    h) Enter the appropriate description in the 'Bearing location' dialogue box that appears and click on OK.
    i) Enter the appropriate description in the 'Bearing type' dialogue box that appears and click on OK.
    j) When finished close the dialogue box in the usual way.

iii) Editing names and values in a line of the 'Defect frequency worksheet' :
    a) Click on the 'edit bearing table' icon and observe that it remains depressed.
    b) Using the mouse pointer select the required table name /number that you wish to edit and double click the left hand mouse button to open

the 'Manual edit' dialogue box. Edit the entry name / number and click on OK. <u>Observe that in the 'Calc' column of the table the description will have changed from 'approx' or 'precise' to 'user' if a numeric value has been changed</u>.

Clicking on the 'Save bearing data' icon will save the bearing table such that it will be displayed next time AE Lab III is opened (there is also a reminder to save the bearing data when closing AE Lab III).

SECTION IV   -   APPENDICES

Appendix I   -   TECHNICAL SPECIFICATION

Sensor :

Sensing element	:	Resonant piezoelectric at ~ 100 kHz
Integral pre-amplifier	:	~ + 24dB gain
Power requirement	:	+10 VDC phantom power drive at < 5mA (provided by MHC-Memo)
Calibration	:	Factory set to within 1 dB of standard value

Signal Measurement :

a)   Distress Characterisation :

Description	:	Fault indicating parameter
Range	:	0 to > 40 (typical)
Resolution	:	1 unit

b)   dB Level Characterisation :

Description	:	Logarithmically scaled mean signal level
Range	:	0 to 92 dB (ie 40,000 to 1)
Resolution	:	1 dB

c)   Peak (P) Characterisation :

Description	:	Logarithmically scaled peak value (average of 8 revolutions).
Range	:	0 to 92 dB (ie 40,000 to 1)
Resolution	:	1 dB

d)   Intensity (I) Characterisation :

Description	:	Logarithmically scaled average magnitude for all detected activity.
Range	:	0 to 92 dB (ie 40,000 to 1)
Resolution	:	1 dB

e)   Extent (E) Characterisation :

Description	:	Average percentage of rotational cycle in which activity is present.
Range	:	0 to 99%
Resolution	:	1 % (rounded down to nearest digit)

f)   Capture Spectrum :

Description :   2048 samples of waveform over a 1 second period to enable a repetition frequency spectrum to be later calculated.

g)   Auto Log :

Description :   Enables a sequence of up to 2338 successive readings of either Standard mode or Super Slo mode readings to be automatically stored.

Data Collector :

Capacity   :   ROUTES

Up to 6 routes each with a user defined name up to 16 characters. Each route can have up to 435 measurement points defined by : Site name (16 characters), Area name (16 characters), Machine name (16 characters) and Point (16 characters).
Stored measurement information consists of date and time of reading to 1 hour resolution plus one of the following :
-     Standard Mode (Distress & dB Level each with 2 characters).
-     Super Slo Mode (dB, P, I and E each with 2 characters).
-     Manually inputted value up to 6 characters including decimal point.

AUTO LOG

Enables one or more sequences of up to 2338 successive readings of either Standard mode or Super Slo mode readings to be automatically stored together with a user defined filename (up to 12 characters) and a time and date stamp.

CAPTURE SPECTRUM
Storage of data for up to 15 separate repetition frequency spectra. Each is representative of a 1 second period of waveform. File includes a time and date stamp and a file header which may be either a user defined filename (up to 12 characters) or if within a route the full description of the Site, Area, Machine and Point names.

Comms.   :   Load and Unload, ASCII character format

General Characteristics :

Interface : USB
Battery Operation: 2 qty. 6R61 / PP3 (9V) batteries
       Lithium Mn : Up to 80 hours
       Alkaline : Up to 34 hours
       NiCd / NiMH : Up to 8 hours
       (Note : use of display backlight and headphones reduces these values)
Battery back-up : 3 volt Coin Cell (Varta CR 1616 or equivalent) for internal real time clock.
Display : LCD, 2 lines by 16 characters (with LED backlighting)
Hold Function : Yes
Auto Shut-Off : Yes (LED backlight after ~8 secs, main unit after ~5 mins unused)
Audio Output Socket : Yes (switched high/low volume range)
Operating Temperature : Main instrument   0 to +50 deg C.
       Standard sensor   0 to +70 deg C (other specs available).
Dimension : 101 mm x 195 mm x 44 mm / 35 mm (main unit excluding connectors & rubber housing)
Weight : ~ 500 g (main unit including batteries, excluding sensor & rubber housing)

Appendix II -   STARTER KIT CONTENTS

The following items are included as part of the starter kit.
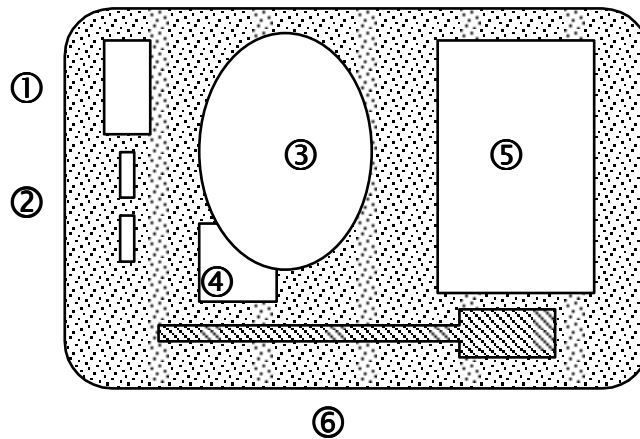
Item	Description
①	*Battery recharger*
②	*NiMH rechargeable batteries*
③	*Headphones + leads + key*
④	*Sensor (standard)*
⑤	*MHC-Memo Pro instrument*
⑥	*Extended probe (if supplied)*

Additional material:

Calibration Certificate
MHC-Analysis Pro software CD-ROM
Galvanised Pads

Appendix III - SOFTWARE LICENCE

<div style="border:1px solid black; padding:10px;">

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