CS-17 Standard for the Scanning of Hardcopy Seismic Sections

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1.0 CDA SCANNING STANDARD FOR HARDCOPY SEISMIC SECTIONS

1.1 INTRODUCTION

This document describes the scanning standard to be used for offshore UKCS seismic hardcopy sections when submitted to CDA UKOilandGasData.

A hardcopy section that meets the format as described by the CDA Scanning Standard will be deemed by DECC to be a suitable substitute for the original hardcopy source.

A digital image captured from a hardcopy section that has been scanned correctly using the CDA Scanning Standard, and subject to the quality of the original image, could be used to reconstruct the post stack seismic data to a SEGY digital file.

2.0 HARDCOPY SECTIONS

2.1 SEISMIC SECTION SELECTION

The important factors that govern the scanner settings to be used in order to capture the preferred hardcopy section are based on:

(1) Display Scale; and
(2) Display Type.

These factors, along with the quality of the original hardcopy section, have an important impact upon whether the scanned image can be converted to SEGY.

2.2 DISPLAY SCALE

The most common display scale for hardcopy seismic sections is 10cm per second (vertical) and 1:25,000 (horizontal). Most seismic hardcopy is displayed with a vertical record length of between 2000ms and 6000ms. Once the shot-point,

elevation and velocity boxes etc. are displayed above the seismic, the overall image is not normally wider than 100cm. This vertical scale has the advantage of being small enough to fit into normal tube storage and standard scanning machines, while at the same time being large enough to produce a good quality reproduction of the seismic.

Seismic sections displayed at scales smaller than 10cm/sec and 1:25,000 pose two problems:

i) The original plots will probably have less detail than larger scale plots. This is because the equipment used to plot them will have a limit to the plot resolution.
ii) The resolution of the scanner may impose a limit on the quality of the image that can be captured.

Ideally, 5cm/sec and 1:50,000 is the smallest acceptable display scale, but the selection process may be controlled by the version that is available.

Recommendation 2.2

The standard scale of 10cm/sec and 1:25,000 is preferred, but if it is unavailable the largest available substitute scale should be chosen.

One important fact to consider when selecting a seismic section to scan as a substitute for the original hardcopy source is that it may be vectorized in the future; as a guide, the greater the number of traces/cm displayed on the original hardcopy the better the results will be if the scanned image is vectorized to SEGY.

This will be relevant if a digital processed version is not available and only a physical hardcopy version of the line exists.

2.3 DISPLAY TYPE

The vast majority of seismic hardcopy is displayed in black and white 'Variable Area Wiggle' display.

Some surveys are only displayed in 'Dual Polarity' greyscale shading; in this case the section will have to be scanned with different settings to the ones that may be used for capturing black and white hardcopy sections.

Colour sections may be available, while not as common as black and white or dual polarity sections this may be the only option available.

Recommendation 2.1

The vast majority of seismic hardcopy is displayed in black and white 'Variable Area Wiggle' display, this is the preferred option.

If a black and white section is not available, a ‘dual polarity’ version should be selected in preference to a colour section.

3.0 SCANNING

Scanning of seismic films is normally undertaken by using 'large format' scanners that accept media input of various widths up to 48 inches or more. The media is rolled past the scanning cameras by means of pinch rollers. Final edge detection when the scanner reaches the end of the film or paper means that varying lengths of media can be scanned automatically.

Historically, the best practice was to scan sections such that the left margin goes into the scanner first to accommodate longer sections. This produces an image in ‘Portrait’ orientation with the time zero of the section on the right, and the first trace at the top of the image; once scanned the section can be rotated to the traditional ‘Landscape’ mode as it is more convenient for the user when an image file opens if it is ‘normally orientated’.

3.1 MEDIA

Hardcopy sections are plotted on a range of media including film, sepia and paper, in varying shades, qualities and copy generations. On the whole, film is preferred to paper for scanning, but attention should be paid to choosing the section in the best condition when there is more than one copy available.

Seismic sections can be damaged with rips, tears and folds. Scanners often have difficulties handling irregular media, so these problems should be remedied before scanning. Folds should be folded back on themselves to reduce sheet distortion. Rips and tears should be taped over with clear tape. Damaged edges can be cut straight with scissors (as long as none of the image is cut out).

The only available section may be marked with hand-drawn colour interpretations or other blemishes; if possible these should be erased or otherwise removed before scanning without damaging the hardcopy section. But, where this is not possible the marks can be removed digitally after scanning.

In this scenario the hardcopy section should be scanned in colour and the interpretation removed using an image editing software package. It is often better to scan the section and the removal of the interpretation is left to a specialist service provider, should the digital image be vectorized.

Recommendation 3.1

Hardcopy sections on film or sepia are preferred to paper for scanning.

Hardcopy sections with interpretation marks should only be selected for scanning if other sections are not available.

3.2 RESOLUTION

Scanners commonly offer both optical resolutions and interpolated resolutions in their scan settings. The optical resolution is the maximum physical resolution that the

scanner can produce from its cameras. Images with resolutions different from the optical resolution of the scanner are created by mathematically interpolating a smaller or larger display from the image at the optical resolution. The actual clarity of this interpolated image is not improved, and as this process is software based it can be applied to the image at a later date if required.

Another important consideration associated with the setting of an appropriate resolution level is the capacity of the scanned image to support the regeneration of an industry-standard SEG-Y digital file. SEG-Y files may be produced from poor quality, low resolution images but better images produce a more accurate digital reconstruction.

A best practice rule-of-thumb is that there should ideally be at least 7 pixels between the seismic traces. This isn't always possible, but there is a definite benefit in scanning seismic at high resolutions as the increased pixel count enables vectorising software to properly differentiate amplitude levels.

Recommendation 3.2

It is best to scan at the maximum optical resolution of the scanner.

A minimum optical resolution of 400 DPI can be used to scan a seismic section, but the preferred option is to use the maximum optical resolution.

3.3 THRESHOLDING

Most seismic sections are plotted on film in black and white, and if the sections are of a good quality, black and white scanning (1 bit) is an option, but due to subtleties in the ageing and fading of hardcopy sections some degree of "shading" or greying of either the black or the white background can occur.

Furthermore, this effect may not be constant across the section. Scanning in colour may seem to be a good solution to this problem because shading nuances in the image are fully captured; however, scanning in colour produces extremely large file sizes which can be very difficult to manage. Colour scanning is unnecessary where there are only two colours in the original section; "Shading" on sections can be accommodated through the use of "dynamic" or "adaptive" thresholding (see below) but care should be taken when using this function.

The cameras in scanners record the image in varying degrees of colour from light to dark. To produce a black and white image, a decision must be made about where the threshold between black and white lies. This is known as "Thresholding", and is important in producing a quality image from the scanner.

There are two common types of thresholding:

(1) Manual Thresholding: The scanner operator selects the threshold position (normally displayed as a value between 1 and 256). The image can be previewed and once a threshold level has been chosen the entire section is scanned with this setting.

(2) Adaptive (Dynamic) Thresholding: The scanner operator sets a general thresholding preference and the scanning software also takes the varying darkness or lightness across the image into account when thresholding.

Adaptive thresholding has the advantage of adjusting to the dark areas of seismic and light areas of text and label information, whereas manual thresholding can often lead to loss of those parts of the image that are darker or lighter than the average.

Even with adaptive thresholding, care has to be taken when a section has large variations of dark and light areas. Should the adaptive thresholding setting be set too light or too dark it can obliterate some of the image. This problem is typically seen as white holes appearing in dark areas of the scan because the setting has been set too light.

Threshold manipulation if not performed correctly or if it is not suitable for the section can ruin a scanned image

Some scanners offer a 'Dither' or ‘Black and White Photo’ function that mimics shading in the black and white image by varying the density of black dithered dots in the image. From far away the image appears to be clear but seen close-up it is a mass of dots and this option should not be used.

Recommendation 3.3.1

If the threshold has to be manipulated there is the potential for the loss of data from a scanned black and white section; sections with a wide variance in the shading across the image that cannot be successfully captured by scanning in binary (1bit) should be scanned as an 8 bit greyscale image.

If there is any doubt over the image quality of the scanned black and white hardcopy section, then it should be captured at the maximum optical resolution of the scanner or at a minimum of 400 DPI as an 8 bit greyscale image.

Dual Polarity Displays

Dual Polarity greyscale sections have the amplitude of both the positive peaks and negative troughs of the seismic as shades of grey. If they are not scanned in a greyscale or colour format, and are thresholded to black and white, the shading will be lost. File sizes can get very large when optical resolutions are used on Dual Polarity sections.

Recommendation 3.3.2

Dual Polarity sections should be scanned at the maximum optical resolution of the scanner or at a minimum of 400 DPI as an 8 bit greyscale image.

Colour Displays

The information contained in colour seismic section displays should only be captured using a colour format scan; use of the threshold facility in a black and white scan will not capture all the information and should not be used. It is recommended that colour sections or sections with colour interpretations are not selected if other versions are available.

Recommendation 3.3.3

Colour sections should be scanned at the maximum optical resolution of the scanner or at a minimum of 400 DPI as a 24 bit colour image.

4.0 QUALITY CONTROL

4.1 SCANNING

There are several procedures to be aware of when scanning.

Scanners need regular maintenance:

(1) Scanner cameras need to be aligned and calibrated correctly, otherwise 'stitching' lines, that are visible as steps or misalignments in the image will appear in the resulting images.
(2) Scanners have glass viewing strips that can get dirty and scratched reducing the clarity of the resulting image. The scanner operator should watch out for black or white lines running parallel to the scanning direction in the image. All surfaces should be regularly cleaned and the glass replaced if needed.
(3) Output from the scanner light sources can fade over time and reduced light will diminish the scanner's capacity to discriminate between colours.

Many different hardcopy material types have been used for plotting seismic sections. In some the image is more clearly visible on the back and the best approach with these is to scan the reverse side of the film and to use an image editing program to 'mirror' the image back to the normal 'readable' display.

Films and sepias can be slippery and can attract dirt and dust from a build-up of static electricity and the resulting image will be distorted if the pinch rollers of the scanner lose their grip on the sections.

Recommendation 4.1

The scanner operator should take a quick overview of each image after it is scanned as it is a better approach than inspecting images at a later date when the original section may not be available to be re-scanned.

5.0 FILE FORMATS

There are many file formats available for scanned images but there are very few that are acceptable. An image format must provide good compression otherwise the file sizes of

large images can be very unwieldy, but with the progression in technology the issues surrounding file sizes are not as restrictive as they once were.

The section below provides a description of the common file formats available for scanned images which can be used in conjunction with the recommendations for 1 bit black and white, 8 bit greyscale and 24 bit colour images made in this document.

5.1 BLACK AND WHITE (1 BIT) IMAGES

5.1.1 TIFF FORMAT

The TIFF (Tagged Image File Format) using CCITT Group IV (G4) compression is the standard file format for document imaging of 2D black and white images. There are several synonyms for this format, but “Group 4” or “G4” is normally included in the name used.

This format has several advantages over other common image file formats:

(1) It is non-proprietary and is supported by most image viewing and editing programs;
(2) The compression offered is 'non-lossy' – the image itself is not degraded by the compression algorithm used so an image compressed and then uncompressed will be identical to the original (this is often not the case with other formats such as JPEG);
(3) The compression offered with CCITT Group IV (G4) format is relatively high. The disk space used by a typical seismic section can be reduced by a factor of 80% compared to an uncompressed TIFF or Bitmap format; and
(4) The original scanning resolution is also recorded in the file for use at a later date.

Typical file sizes for a black and white (1 bit) image of a seismic section are:

Uncompressed Bitmap format..... 100 MB
Tiff Group IV format ..... 12 MB
PDF format (Group IV)..... 12 MB

5.1.2 PDF FORMAT

PDF (Portable Document Format) is an industry standard file format for black and white images that offers good compression (normally using Group IV). PDF also offers storage for multi-page text and colour images. However, the software available to create PDF files will often automatically resize large images before compressing them. This appears to be due to an upper limit on allowed image dimensions in the PDF format and the fact that the format appears to be designed for compiling office document images which are normally no greater than A3 size. Additionally, the scanning resolution information is commonly missing from PDF files so it is difficult to

know the original document scale. The PDF document format is not to be used when scanning hardcopy sections.

5.2 GREYSCALE (8 BIT) IMAGES AND COLOUR (24 BIT) IMAGES

5.2.1 PNG FORMAT

Another file format is needed for the few dual polarity sections that are scanned in 8 bit greyscale.

PNG (Portable Network Graphics) format is a popular non-proprietary and 'non-lossy' format for colour and greyscale images. File sizes will be typically halved compared with uncompressed files.

5.2.2 JPEG FORMAT

Another common choice is the original JPEG (Joint Photographic Experts Group) format which is the industry standard for non black and white images. Despite being a ‘lossy’ format – where the image itself is changed by the compression process, the quality is still generally good and the compression can reduce the file size by 95% or more.

Typical file sizes of a dual polarity seismic section scanned in 8 bit greyscale are:

Uncompressed format..... 250 MB
PNG compressed format..... 125 MB
JPEG compressed format (100% Quality)... 120 MB
JPEG compressed format (90% Quality)..... 50 MB
JPEG compressed format (75% Quality)..... 20 MB
JPEG compressed format (50% Quality)..... 15 MB

JPEG compression offers much reduced file sizes which are easier to move and store. After comparing different compression quality settings and the resultant image file sizes and image quality, this compromise is one worth making

The JPEG format has a maximum image size of 65535 x 65535; at a resolution of 400DPI the maximum image length is 492cm. If the section to be scanned is longer than the permitted length allowed by a JPEG image, the scanned image should be saved as a TIFF format with CCITT Group IV (G4) compression. The resulting TIFF image file will be increased but the full length of the hardcopy section will be captured.

Care should be taken when selecting the JPEG format to be used when saving a scanned image; the user should ensure that the ‘original’ JPEG format is selected. An option to save the scanned image to a JPEG 2000 format may be available but this format cannot be viewed by all software packages.

Recommendation 5.0

The image from black and white hardcopy sections that can be captured successfully by scanning as a binary (1bit) image should be scanned at the maximum optical resolution of the scanner or at a minimum of 400 DPI and saved as CCITT Group IV (G4) TIFF format.

Black and white hardcopy sections displaying data that cannot be accurately captured by scanning as a binary (1bit) image should be scanned at the maximum optical resolution of the scanner or at a minimum of a 400 DPI 8 bit greyscale JPEG format image with baseline (DCT) compression and a quality setting of 75%.

Dual Polarity scans should be scanned at the maximum optical resolution of the scanner or at a minimum of a 400 DPI 8 bit greyscale JPEG format image with baseline (DCT) compression and a quality setting of 75%.

Colour sections or sections with colour interpretation that cannot be removed before scanning should be scanned at a minimum of 400DPI and saved as a colour (24bit) JPEG format image with baseline (DCT) compression and a quality setting of 75%.

Seismic sections that are too long to be captured as a JPEG image should be saved as a TIFF format with CCITT Group IV (G4) compression.

6.0 SUMMARY OF SCANNING RECOMMMENDATIONS

6.1 DISLAY SCALE SELECTION

The display scale of the section selected may be dictated by the only version available, but where multiple scales are available and it is possible to make a selection:

1) The preferred choice is a section with a vertical display scale of 10cm/sec and a horizontal scale of 1:25,000.

2) If this is unavailable then choose the largest available substitute scale however the minimum acceptable scale is recommended to be a vertical scale of 5cm/sec and a horizontal scale of 1:50,000.

6.2 SCANNING RESOLUTION AND FORMAT

The scanning resolution should be determined and adopted as below.

1) The minimum resolution of a scanned image should be 400DPI, but where possible it is recommended that the maximum optical resolution of the scanner is used.
2) If the section is of the variable area wiggle type (the most common) and the quality of the seismic displayed is good, the section should be scanned at a minimum of 400dpi optical resolution to a 1 bit black and white TIFF format image with CCITT Group IV (G4) compression.

3) If adaptive thresholding is used make sure that the settings are not too dark or too light over the complete length of the section. All ‘Peaks and Troughs’ should be clear and visible and should not be lost by the selected threshold blurring out the adjacent ‘Peaks or Troughs’. Save the file to a TIFF format with CCITT Group IV (G4) compression.

4) If there is any doubt as to the quality of the captured image when scanned to a binary file, the section should be scanned and saved as a 400DPI 8 bit greyscale JPEG format image with baseline (DCT) compression and a quality setting of 75%.

5) If the seismic section is of the less common dual polarity type, scan the section at a minimum of 400DPI 8 bit greyscale and save the file to a JPEG format image with baseline (DCT) compression and a quality setting of 75%.

6) Colour sections or sections with colour interpretation that cannot be removed should be scanned at a minimum 400DPI as a 24bit colour image and saved as a JPEG format.

7) The scanned image should be viewed immediately to look for any distortion or alien lines in the image. If there is a problem the scanner should be cleaned and the section scanned again.