

Technical Specification for the Delivery of Live Television Programmes to SVT

Version 5.0

Delivery of Live Television Programmes to SVT

This document includes the technical parameters that High Definition (HD) and Standard Definition (SD) programmes, delivered **live**, must meet to be acceptable by SVT. It is set out as follows:

- Part 1 – Video and Sound quality and Quality Control (QC) requirements;
- Part 2 – Additional technical requirements for **Live** programme delivery;
- Part 3 – Additional SVT-specific requirements.

If comparing documents, SVT uses the same naming of the sections' headings as those used by Digital Production Partnership (DPP) Broadcasters in the UK, *but SVT's requirements in the sections differ.*

The current version of this document is available via http://www.svtb2b.se/?page_id=1952.

An *informative* small checklist, regarding **Live** delivery of television programmes to SVT, may be found via the same weblink as above. However, *it is this large technical specification that is the normative document.*

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Part 1 – General Requirements

Technical Requirements

Assessment of quality is highly subjective, and therefore dependent on the nature of the programme. Some of the quality requirements are expressed in relative terms ('reasonable', 'not excessive' etc.), and it will be necessary to make a judgement as to whether the quality expectations of the intended audience will be fulfilled.

Photosensitive Epilepsy and Quality Control

SVT is not subject to prevent photosensitive epilepsy by regulation – see section 3.2.

Radio Act – Access for People with Disabilities

SVT is subject to the provisions of the Radio Act to terms set out in the charter between SVT and the state. Hence, programme makers are required to consider the needs of people with hearing or visual impairments *especially regarding dialogue, voiceovers and when mixing sound*, as well as when generating onscreen text, subtitles and graphics.

1. Video Technical Requirements

1.1. Video Formats

1.1.1. Ultra-High Definition

Ultra-High Definition (UHD) programmes are not accepted by SVT.

1.1.2. High Definition

Independently of SVT's current transmission format 720p/50, SVT requires delivery of programmes in each programme's native production video format. The native production video format should preferably be chosen in the following priority order.

50 Hz motion portrayal programmes delivered for SVT transmission must be:

- 1280 x 720 pixels in an aspect ratio of 16:9;
- 50 frames per second, progressive scan – known as 720p/50;
- colour sub-sampled at a ratio of 4:2:2;
- specified in ITU-R BT.1847.

Or (optionally, regarding 50 Hz motion portrayal):

- 1920 x 1080 pixels in an aspect ratio of 16:9;
- 25 frames per second (50 fields) interlaced – known as 1080i/25;
- colour sub-sampled at a ratio of 4:2:2;
- specified in ITU-R BT.709.

25 Hz motion portrayal programmes delivered for SVT transmission must be:

- 1920 x 1080 pixels in an aspect ratio of 16:9;
- 25 frames per second, progressive scan (or progressive scan segmented frame) – known as 1080p/25 (or 1080PsF/25);
- colour sub-sampled at a ratio of 4:2:2;
- specified in ITU-R BT.709.

1.1.3. Standard Definition

Where agreed by SVT, legacy SD programmes delivered for SVT transmission must be:

- 720 x 576 pixels with the centred 702 x 576 pixels in an aspect ratio of 16:9;
- 25 frames per second (50 fields) interlaced – known as 576i/25;
- colour sub-sampled at a ratio of 4:2:2;

- specified in ITU-R BT.601.

Note: SD video has a picture area with a minimum of 702 x 576 pixels, where the 702-pixel wide picture must be centred in the active 720-pixel wide line. The picture information may extend the full width of the 720-pixel wide line, providing the image shape is not distorted.

1.2. Signal Parameters

In a video signal, each primary component (R', G' and B') should lie between 0 and 100% of the video range between expected black level and expected peak level.

1.2.1. Video Level Tolerance

The recommendations in EBU R 103, Video Signal Tolerance in Digital Television Systems, must be followed.

The R'G'B' components and the corresponding Luminance (Y') signal, should not normally exceed the "Preferred Min. / Max." range in the table below.

Measuring equipment should indicate an 'Out-of-Gamut' occurrence only after the error exceeds 1% of an integrated area of the active image.

System Bit-depth	(Narrow) Range in Digital Code Values		
	Expected Video Range	Preferred Min. / Max.	(Total Video Range)
8-bit	16 - 235	5 - 246	(1 – 254)
10-bit	64 - 940	20 - 984	(4 – 1019)

Colour gamut 'legalisers' should be used with caution as they may create artefacts. It is recommended not to 'legalise' video signals before all signal processing has been carried out.

1.2.2. High Dynamic Range

High Dynamic Range (HDR) programmes are not accepted by SVT.

1.2.3. Blanking

HD images must fill the active picture area. No 'blanking errors' are permitted.

A two-pixel tolerance is permitted during complex overlay sequences where key signals, graphic overlays or other effects do not fully cover the background image. Where animated key signals or overlays cause moving highlights at the edge of the active image it is preferable to blank these pixels completely. A note of the timecodes and reasons for these errors should accompany the delivered programme.

1.2.4. Field Dominance

Cuts in interlaced scanned material must happen on frame boundaries (i.e. between field 2 and field 1). Motion on PsF (Progressive scan Segmented Frame) material must occur between segment 2 and segment 1. Be aware though, that certain legacy SD video codecs, e.g. the DV-based (SMPTE ST 314), internally use a structure where field 2 is supposed to be presented before field 1.

It is preferred to shoot with progressive scan for 50 Hz motion portrayal (e.g. 720p/50), hence also, possible to shoot material at 1080p/50. When this is done, the correct Two-Frame Marker phasing (SMPTE ST 2051) must be maintained to not introduce cuts between field 1 and field 2 if subsequently converting to interlace scanned video formats – e.g. 576i/25 or 1080i/25.

1.3. Video Line-Up

1.3.1. ITU-R BT.2100 UHD Programmes

ITU-R BT.2100- and ITU-R BT.2020-based Ultra-High Definition (UHD) programmes are not accepted by SVT.

1.3.2. SMPTE ST 2036-1 UHD, HD and SD Programmes

Ultra-High Definition (UHD) programmes, e.g. SMPTE ST 2036-1 based, are not accepted by SVT.

Regarding HD and SD programmes, the use of colour bars for File delivery is optional. If used, 100% colour bars (100/0/100/0) that fill the active picture area must be used. Legacy SMPTE pattern bars are not acceptable.

1.4. Origination

50 Hz motion portrayal material should preferably be originated with progressive scan (or, optionally, with interlaced scan).

50 Hz and 25 Hz motion portrayal may be mixed within a 50 Hz motion portrayal programme if it is required for editorial reasons or the nature of the programme requires material from varied sources.

EBU R 118, Tiering of Cameras for use in Television Production, is used to assess the suitability of cameras. Cameras for HD programmes must meet or exceed the parameters of HD Tier 2J.

1.4.1. DSLR Cameras

DSLR cameras are only acceptable for time-lapse sequences, stop-frame animation and other specialist requirements such as infra-red and hostile conditions. They are not suitable for use as video cameras unless they have EBU R 118 test report results that meet or exceed the HD Tier 2J requirements. Exceptions can be made for covert shoots or dangerous locations at the discretion of SVT.

1.4.2. Drones and Remotely Operated Cameras

Cameras attached to devices such as drones must meet the requirements in EBU R 118 unless agreed with SVT in advance.

Unless a drone or remote rig has adequate image stabilisers it is recommended that the camera attaché has a higher resolution than needed to allow electronic stabilisation to be carried out during post-production.

Programme producers are required to ensure drones and other remotely operated cameras are only controlled by trained operators. Producers should be aware of specific local and territorial restrictions and regulations.

1.5. Film for HD and UHD Acquisition

Super-16 Film is not considered to be HD no matter what processing or transfer systems are used.

The following 35 mm Film types and stock are acceptable for HD acquisition:

- 3 perf – any exposure index although an exposure index of 250 or less is preferred;
- 2 perf – only if daylight stock with an exposure index of 250 or less is used.

To avoid causing problems with HD transmission encoding, film should be well exposed and not forced more than one stop.

Requirements regarding Ultra-High Definition (UHD) acquisition are not specified by SVT.

1.6. Post Production

Electronically generated moving graphics and effects (such as rollers, DVE moves, wipes, fades and dissolves) must be generated and added with 50 Hz motion portrayal to prevent unacceptable judder in 50 Hz motion portrayal programmes.

Regarding programmes delivered in 1080p/25 (or 1080PsF/25), all moving graphics and effects must be generated and added with 25 Hz motion portrayal.

1.6.1. Video Codecs used for Post Production

Intra-frame based post-production codecs used to edit HD programmes should be at least 160 Mb/s. It is however acceptable to use the native camera codec provided the codec is constant throughout the production workflow.

1.6.2. Film Motion or 'Film Effect'

It is not acceptable to shoot with 50 Hz motion portrayal interlace scan and add a film motion effect in post-production. Where film motion is a requirement, progressive capture in 25 Hz motion portrayal (25p or 25PsF) is the only acceptable method.

Conversion from 50 progressive frames per second material to 25 progressive frames per second is permitted, preferably by dropping every other frame, provided that the frame rate conversion process does not produce excessive motion judder or image softening or visible frame blending; and that an appropriate camera shutter speed has been used.

1.6.3. Frame Rate Conversion

When standards converted material is included in a programme, e.g. from 60/1.001 Hz motion portrayal to 50 Hz motion portrayal, motion compensated (sometimes known as Motion Predictive or Motion Vector) standards conversion is required.

Use of non-linear editing platform hardware or software standards conversion is not permitted for whole programmes, but may be used for short inserts at the discretion of SVT.

De-interlacing processing should be carried out via multi-field (five-field or greater) de-interlace or motion compensated de-interlace.

Speed change is the preferred method of changing between 24/1.001 fps and 25 fps standards. Due attention must be given to the audio, i.e. resampling.

Content acquired at 24/1.001 fps which has been converted to 60/1.001 (interlace as well as progressive) via the '2:3:2:3 pull down' process, should first have the repeated fields/frames removed to produce the original frame rate. The resulting video can then be replayed faster at 25 fps.

1.6.4. Up-Conversion to UHD

Requirements regarding Ultra-High Definition (UHD) are not specified by SVT.

1.7. Picture Aspect Ratio

All HD programmes must fill a 16:9 screen vertically and horizontally without geometric distortion. The following exceptions may be allowed, but SVT must give permission before shooting commences.

1.7.1. 'Cinemascope Ratios' as Letterbox

Programmes may be delivered with an active picture in cinema ratios (e.g. 2.39:1 or 1.85:1), centred vertically between black bars in a 16:9 frame, filling the width of the frame according to SMPTE RP 199 with no geometric distortion.

1.7.2. Floating Images

Short sequences of images surrounded by black borders (floating images) may be used for artistic effect. However, widescreen consumer TV sets operating in Auto Zoom / Auto Mode often interpret large black borders at the top and bottom of the screen as letterbox, so are likely to enlarge the picture. The resulting unpredictable zooming can be annoying for the viewer and undermine the artistic intent. If used, the black space around floating images must be consistent across sequences of images.

1.7.3. 'Pillar-Boxed' HD Material

Some pillar-boxed material is acceptable where it has been acquired on a medium that has the capability to be transferred to a legitimate HD resolution, for example, 35mm film shot using 4 perf at an aspect ratio narrower than 16:9. The pictures must be centrally framed in a 16:9 raster according to SMPTE RP 199 with no geometrical distortion.

1.8. Archive Material

Archive material must meet all the technical requirements in this document, including those for up-converted SD video where relevant.

1.8.1. General Quality

Archive material must be taken from the best available source, and any improvement or restoration work which could reasonably be expected must be done (for example grading, dropout repair or audio equalisation).

1.8.2. Up-Converted SD Material

Care must be taken with SD archive material to deliver the best possible quality after up-conversion. In general, standard definition pictures must look no worse than the original after being up converted, post processed and down converted for delivery on SD services. Only high quality up-conversion processes will achieve this.

Standard definition video contains a half-line at top and bottom on alternate fields. This must be removed on up-conversion to HD, or it will be visible flickering at top and bottom of the HD frame.

Any VITC or switching signals visible at the top of SD material must be removed.

Any line blanking from SD signals must not appear in the HD conversion.

1.8.3. Picture Aspect Ratio

Archive material should be zoomed to fill the 16:9 raster where possible without compromising the artistic intention, the image quality or composition, alternatively it may be presented in a pillar-box format, which:

- may be of an intermediate ratio between 4:3 and 16:9, but must be of consistent width across sequences;
- must be centrally framed in the 16:9 raster according to SMPTE RP 199;
- must show no geometrical distortion;

- must have clean and sharp pillar-box edges (i.e. any video or film edge artefacts may need to be blanked);
- must be black outside the active picture.

1.8.4. Safe Areas

Any archive captions or on-screen-text already in the archive material should be kept within the caption safe area if possible. Exceptions should be noted and accompany the delivered programme.

1.9. Use of Lower Resolution Images

To maintain a high standard and meet audience expectations, the amount of material of a lower resolution than the commissioned format is limited to 25% of the programme's total duration. Lower resolution material must not be used for large uninterrupted sections of the programme, unless agreed by SVT.

1.9.1. Non-UHD Material

Requirements regarding Non-UHD Material are not specified by SVT.

1.9.2. Non-HD Material

Some HD programmes will contain some material from standard definition originals, and sources that do not meet the HD requirements. This material is all called 'non-HD' in this document.

Non-HD material includes material acquired using the following methods or formats:

- All codecs with bit rates below those specified in EBU R 118 for HD Tier 2L;
- Cameras that do not meet the requirements of EBU R 118 for HD Tier 2J;
- Film that does not meet the required standard in section 1.5.

1.10. 3D

SVT does not accept stereoscopic 3D programmes.

1.11. Safe Areas for On-Screen Text

All on-screen text must be clear and legible and must be within the safe areas specified.

All font sizes must be legible after down conversion.

There is one primary caption safe area defined for 16:9 materials at SVT:

- The 16:9 graphics safe area for 16:9 presentation according to EBU R 95.

At the discretion of SVT, programmes such as feature films and some acquisitions may be excluded from this requirement.

1.11.1. Text Size

The minimum, 576 line-based, SD font height is 20 SD lines. Therefore, where burnt-in HD-text will be down converted, the minimum height of the text should be no less than:

- 25, 720 line-based, HD lines/pixels (to be legible after down conversion to SD);
- 40, 1080 line-based, HD lines/pixels (to be legible after down conversion to SD).

1.11.2. In-Vision Captions for Foreign Language Assets

Foreign dialogue should be free from burnt-in subtitles, i.e. should not have In-Vision Captions.

1.11.3. Safe Areas for SD On-Screen Text

Graphics Safe Area for 720 x 576 (Interlace)	Defined as percentage (%) of active picture	Pixels (inclusive). First pixel numbered 1	TV line numbers (inclusive). Line numbering as per ITU-R BT.601
16:9 Graphics Safe	90% of Width 90% of Height	37 – 684 30 – 547	- 38 – 295 (F1) & 351 – 608 (F2)

1.11.4. Safe Areas for HD On-Screen Text

Graphics Safe Area for 1280 x 720 Progressive	Defined as percentage (%) of active picture	Pixels (inclusive). First pixel numbered 1	TV line numbers (inclusive). Line numbering as per ITU-R BT.1847
16:9 Graphics Safe	90% of Width 90% of Height	65 – 1216 37 – 684	- 62 – 709

Graphics Safe Area for 1920 x 1080 Interlace/PsF	Defined as percentage (%) of active picture	Pixels (inclusive). First pixel numbered 1	TV line numbers (inclusive). Line numbering as per ITU-R BT.709
16:9 Graphics Safe	90% of Width 90% of Height	97 – 1824 55 – 1026	- 48 – 533 (F1) & 611 – 1096 (F2)

Graphics Safe Area for 1920 x 1080 Progressive	Defined as percentage (%) of active picture	Pixels (inclusive). First pixel numbered 1	TV line numbers (inclusive). Line numbering as per ITU-R BT.709
16:9 Graphics Safe	90% of Width 90% of Height	97 – 1824 55 – 1026	- 96 – 1067

1.11.5. Safe Areas for UHD On-Screen Text

Ultra-High Definition (UHD) programmes are not accepted by SVT.

2. Audio Technical Requirements

2.1. Dialogue

It is the responsibility of the producer to ensure that dialogue is easy to hear and understand by a first-time viewer who is using consumer equipment. Even viewers with slightly impaired hearing must be able to understand what is being said.

SVT receives many complaints about unclear dialogue, especially when background music and effects have been used. Remember, the audience has not seen the programme before transmission and has not seen a script. If background music or sound effects are necessary, the sound mix must be made with great care. Use the so-called ‘interleaving technique’ (the music or sound effect is established in the pause between the spoken words, but is adequately attenuated during dialogue).

Ensure that the background sound is low enough that hearing-impaired audience clearly can hear what is being said. Speech and dialogue must have the highest priority!

Normal speech must be mixed with an even loudness level throughout the programme. Normal speech should be levelled close to -23 LUFS (0 LU on the relative scale) measured with the Short-term Loudness meter. However, the Programme Loudness target must be fulfilled (except regarding deliberately low loudness) and has priority over the dialogue level recommendation. Regarding dialogue mixing practises, see section 9.2 in EBU Tech 3343.

2.2. Loudness

All programmes must be mixed to comply with the EBU recommendation EBU R 128.

Programmes mixed according to the old standard will only be accepted by prior agreement with SVT. In that case, the old standard for measuring programme audio levels was the EBU Tech 3205 recommendation for Quasi Peak Programme Meters and was rendered on the Nordic Scale. 0 dBu corresponded to -18 dBFS and the integration time was set to 10 ms. Typical peak levels regarding normal speech hovered between 0 to +6 dBu and maximum programme peak level was not exceeding +11 dBu.

The programme metadata element ‘Audio Comments’ must be used to note whether the programme, with prior agreement, has been mixed according to the old “Nordic Scale” standard.

2.2.1. Loudness terms

EBU R 128 terms used in this document, how they are measured and the delivery requirements, are listed in the table below.

All programmes must be compliant with the ‘Programme Loudness’ and ‘Maximum True Peak’ requirements. Other parameters are given for guidance only.

Term	Description	Measurement	Reference
LU	Loudness Unit	1 LU \approx 1 dB change in loudness	EBU Tech 3343
LUFS	Loudness Unit relative to Full Scale	LUFS	EBU Tech 3343
LRA	Loudness Range	LU	EBU Tech 3342
Delivery Requirements:			
Programme Loudness (EBU Tech 3341 & 3)	Loudness measured over the duration of the whole programme	LUFS	Non-live: -23.0 LUFS \pm0.5 LU (See Note 1 below). Live (including as-live): -23.0 LUFS \pm1.0 LU (See Note 1 below).
Maximum True Peak (EBU Tech 3341 & 3)	The maximum value of the audio signal waveform.	dBTP (True Peak)	It is recommended that the maximum true peak level should not exceed -3 dBTP . Content will fail if the maximum true peak exceeds -1 dBTP .
Loudness Range, for guidance only:			
Loudness Range (EBU Tech 3342 & 3)	Describes the perceptual dynamic range measured over the duration of the whole programme.	LU	Programmes should aim for an LRA of no more than 18 LU .
Loudness Range of Dialogue	Dialogue must be acquired and mixed so that it is clear and easy to understand with minimum interference from background sounds.	LU	Speech content in factual programmes should aim for an LRA of no more than 6 LU . A minimum separation of 8 LU between dialogue and background is recommended. (See Note 2 below).
<p>Note 1: Although the target loudness is -23 LUFS, in exceptional circumstances other deliberately lower target levels may be permitted by agreement with SVT. Deliberately lower target levels must be agreed with SVT before the final mix and the metadata element ‘Low Loudness Flag’ must be used. ‘Low loudness flag’ is further described in EBU Tech 3343, chapter 6.1.1.</p> <p>Note 2: During audio parts where dialogue and background are mixed simultaneously, measure dialogue and background separately and calculate the difference.</p>			

In addition, regarding Short-Form Content:

Term	Description	Measurement	Reference
Delivery Requirements:			
Maximum Permitted Short-term Loudness Level	The maximum short-term loudness (S) of the programme.	LUFS	-18.0 LUFS (+5.0 LU on the relative scale). (See Note below).
Loudness Range, for guidance only:			
Loudness Range (EBU Tech 3342 & 3)	Describes the perceptual dynamic range measured over the duration of the content.	LU	Not applicable.
Note: Short-Form Content is defined as a programme of short duration, typically shorter than 30s (but up to approximately 2 minutes duration). In addition to promotional items, interstitials, stingers, bumpers and similar very short items belong to this category. Reference: EBU R 128 Supplement 1.			

2.2.2. Guidelines for True Peak Audio Levels

The following table is *only for guidance* on the true peak levels of diverse types of audio. At all times dialogue must be distinct and clear.

Material	Recommended Maximum Peaks
Dynamically Uncompressed Music	-3 dBTP
Dynamically Compressed Music (depending on degree of compression)	-10 dBTP
Heavy M & E (gunshots, warfare, aircraft, loud traffic, etc.)	-3 dBTP
Background M & E (office/street noise, light mood music etc.)	-18 dBTP

2.3. Metering Requirements

Meters must comply with the specifications in EBU Tech 3341. Programmes must be measured using the EBU Integrated (I) mode and the measurement must be applied to the whole programme (EBU Tech 3343). The optional LFE channel must be excluded from all measurements.

2.4. Stereo Audio Requirements

Stereo tracks must carry sound in the A/B (Left/Right) form.

If mono originated sound is used, it must be recorded as dual mono, so that it may be handled exactly as stereo. It must meet all the stereo standards regarding levels, balance and phase.

2.4.1. Stereo Line-Up Tones

The use of line-up tones for File delivery is optional. When used, each stereo audio pair must have either EBU stereo or GLITS line-up tone (not a mix of both). Tone must be 1 kHz (2 kHz is acceptable on M&E channels), sinusoidal, free of distortion and phase coherent between channels.

Audio files of GLITS and EBU stereo tones may be downloaded from the DPP website, <http://dpp-assets.s3.amazonaws.com/wp-content/uploads/2014/01/DPPLineUpTones.zip>.

Digital Audio Reference level is defined as 18 dB below the maximum coding value (-18 dBFS).

2.4.2. Stereo Phase

Stereo programme audio must be capable of down-mixing to mono without causing any noticeable phase cancellation.

2.5. Surround Sound Requirements

Surround sound should be delivered as discrete tracks, i.e. preferably not as ‘Dolby E’.

For programmes carrying surround sound (>2.0) it is optional to deliver an additional stereo (2.0) mix. SVT transmits a stereo audio stream in conjunction with a multichannel audio stream, but it is made from an in-house mix-down of the multichannel audio with Audio Metadata applied – i.e. stereo listeners will receive either a mix-down from the surround channels generated in SVT’s playout chain or a mix-down generated in their receiver.

2.5.1. Surround Line-Up Tones UHD Programmes

Ultra-High Definition (UHD) programmes are not accepted by SVT.

2.5.2. Surround Line-Up Tones HD Programmes

The use of line-up tones for File delivery is optional. When used, all surround tracks must carry BLITS tone, as described in EBU Technical Paper 3304. An audio file of BLITS tone may be downloaded from the DPP website, <http://dpp-assets.s3.amazonaws.com/wp-content/uploads/2014/01/DPPLineUpTones.zip>.

2.5.3. AES Sample Timing

Very small timing differences between audio tracks in a surround programme will not be heard unless the stereo down-mix is monitored acoustically. An error of as little as one or two samples between the Left, Right and Centre channels can cause phasing and comb filtering for those listening in stereo.

Timing differences between audio channels must be no more than 0.2 samples (i.e. the timing between each channel of the six audio tracks of a surround sound signal).

2.6. Surround Sound Mixing Requirements

To help programme makers meet their responsibilities, it is important that all transmitted audio can be easily and clearly monitored by both Editorial and Technical staff during the production process.

2.6.1. Dialogue in a Surround Mix

For speech intelligibility reasons, it is preferred to use the centre channel for dialogue, a.k.a. a “film style”. Note that it is not precluded to mix dialogue in left or right front channels for certain artistic purposes. Mixing techniques such as “centre spread”, is allowed. In exceptional cases such as music mixing, sometimes known as “music style” with singing voice placed mainly in left and right front channels with just a little of the singing voice in the centre channel, could be accepted. Dialogue with almost equal levels in all front channels should be avoided, since it is not down-mix compatible.

When down-mixed to stereo (with down-mix metadata applied), the down-mix must have similar loudness of dialogue in relation to music and effects compared to when listening to the surround mix.

2.6.2. General Mixing Requirements

Viewers of the HD channels listening in stereo (or mono) will either hear a receiver derived automated down-mix of a surround sound programme using the Dolby Metadata parameters or an in-house derived down-mix. Some HD platforms only transmit AC-3 audio switching between Stereo or Surround. Some HD platforms also includes a Stereo stream, as well that is an automated down-mix derived in-house.

The stereo mix is not transmitted on the Standard Definition channel(s) either. SD channels only transmit an automated down-mix. The audio parameters controlled by the metadata include: centre and rear down-mix levels, and the extent of any dynamic range control applied. Therefore:

- it is essential to check the automated down-mix using a monitoring system that applies or simulates the metadata settings. Any external processor (e.g. a Dolby DP570) must be set to apply the programme’s metadata;
- pre-mixed stereo content should be up-mixed, where appropriate, to match the surround sound to maintain the audio image throughout a surround broadcast. A method of up mixing approved by the broadcaster must be adopted, which anchors dialogue to the front and disperses effects around the image;
- up-mixed material must also down-mix to stereo and mono with no audible artefacts. The injudicious use of phase shifting and delay within some up-mixing algorithms may become more noticeable in the subsequent receiver down-mix process, and result in unacceptable down-mixed audio.

For general surround sound (e.g. audience reaction) phase-coherence invariably benefits both the wrap-around effect in 5.1 and the stereo down-mix. Coincident microphone techniques (e.g. crossed-pairs) tend to outperform spaced mono microphones in this context.

2.6.3. Stereo and Centre Channel Monitoring

It is essential that the mono and stereo down-mixes of a surround programme are monitored in at least equal measure to the surround mix. A large majority of viewers will be listening in stereo rather than 5.1.

2.6.4. Consistency of Image

When a surround programme contains mono content interleaved with stereo pre-recorded items, it is important to maintain the consistency of the sound image and prevent the effect of dialogue appearing to jump between Centre Only and Phantom Centre (Left/Right) only.

2.7. Dolby Metadata Settings

Programmes must be delivered together with Audio Metadata.

Use the Excel-file (the 'Programme Metadata File'), based on a template provided by SVT via http://www.svtb2b.se/?page_id=1952, that includes specific Dolby and Loudness metadata items.

Audio Metadata values, including SVT's subset of Dolby metadata values, must remain constant throughout a programme.

For the time being, SVT uses two alternative pre-sets of Dolby Metadata for transmission: one regarding stereo 2.0 and another regarding multichannel 5.1. Where Dolby Digital is used for transmission, the following fixed metadata values are used:

- Downmix to Lo = L + (C - 3 dB) + (Ls - 3 dB)
- Downmix to Ro = R + (C - 3 dB) + (Rs - 3 dB)
- DRC profile = Music Light

2.7.1. Guidance for Acquired Programmes and Movies

Acquired programmes and movies must be received with metadata according to section 2.7. above. If no metadata exists, the following parameters are anticipated by SVT:

Parameter	Value
Dialogue Level	-23 dB
Line Mode Compression	Music Light
RF Mode Compression	Music Light
Centre Down-Mix Level	-3 dB
Surround Down-Mix Level	-3 dB
Surround 3 dB Attn.	Disabled
Dolby Surround Mode	Not indicated
Preferred Stereo Down-Mix	Lo/Ro Preferred
Surround Phase Shift	Disabled

2.8. Sound to Vision Synchronisation

The relative timing of sound to vision should not exhibit any perceptible error. Sound must not lead or lag the vision by more than 5 ms.

2.8.1. Audio / Video Sync Markers

The following, regarding sync markers, is optional.

To assist in maintaining A/V sync through the post-production process, a 'sync plop' should be used which must meet the following conditions:

- the sync plop must be between timecode 09:59:57:06 and 09:59:57:08;
- the audio plop must be 1 kHz tone in all channels (82.5 Hz in the LFE channel) at -24 dBFS (-18 dBFS is acceptable for stereo programmes);

- the duration of the vision flash must be 2 frames to allow it to pass through standards conversion successfully;
- the duration of the audio plop must be 1 frame, starting on the first frame of the vision flash. It must be synchronous across all audio channels and with the video flash (within ± 5 ms).

If an end sync plop is used it must be no closer than 10 seconds to the end of the programme and comply with the relevant points above.

Note: The above is applicable in the case of 50 Hz motion portrayal via interlaced video (25i) as well as 25 Hz motion portrayal via progressive scan (25p) or progressive scan segmented frame (25PsF). Regarding 50 Hz motion portrayal via progressive scan video (50p) – see the table in section 4.1. in the document ‘Technical Specification for the Delivery of Television Programmes as Files to SVT’.

3. Quality Control (QC)

It is the responsibility of the production company to ensure programmes meet the technical and editorial requirements of the commission.

3.1. General Quality

All programmes are expected to reach a high standard of video and audio quality. This does not mean low quality material cannot be used. Archive and specialist low quality material used in context is acceptable. If there is any doubt, contact SVT for advice.

3.1.1. General Video Quality

The picture must be well lit and reasonably, but not artificially, sharp.

The picture must be free of excessive noise, grain and digital compression artefacts.

The picture must be free of excessive flare, reflections, lens dirt, markings and obstructions (e.g. lens hood), and lens aberrations.

Movement must appear reasonably smooth and continuous, and must not give rise to distortions or break-up to moving objects, or cause large changes in resolution.

The picture must be free of excessive black crushing and highlight compression. Hard clipping of highlights (e.g. by legalisers) must not cause visible artefacts on screen.

There must be no noticeable horizontal or vertical aliasing, i.e. jagged lines, or field-rate or frame-rate fluctuations in fine detail.

Colour rendition, especially skin tones, must be consistent throughout, and provide a realistic representation of the scene portrayed unless it is altered as an editorially essential visual effect.

The picture must be stable and continuous – i.e. no jumps, movements, shifts in level or position. There should be no flash frames or very short shots unless editorially essential.

There must be no visible contouring / artefacts caused by digital processing. Quantisation noise must not be apparent.

There must be no noticeable spurious signals or artefacts e.g. streaking, ringing, smear, echoes, overshoots, moiré, hum, cross-talk etc.

3.1.2. General Audio Quality

Sound must be recorded with appropriately placed microphones, giving minimum background noise and without peak distortion.

The audio must be free of spurious signals such as clicks, noise, hum and any analogue distortion.

The audio must be reasonably continuous and smoothly mixed and edited.

Audio levels must be appropriate to the scene portrayed and dynamic range must not be excessive. They must be suitable for the entire range of domestic listening situations.

Surround and Stereo audio must be appropriately balanced and free from phase differences which cause audible cancellation in mono.

The audio must not show dynamic and/or frequency response artefacts due to the action of noise reduction or low bit rate coding systems.

Audio that has previously been lossy bit reduced must not be used, due to causing cascade coding artefacts.

3.1.2.1. Speech intelligibility (audibility)

Speech intelligibility (audibility) must be ensured, with the minimum of interference from music and sound effects. If SVT determines that the speech intelligibility is insufficient, the programme is rejected and sent back for re-mix. Alternatively, will SVT add subtitles to parts with poor intelligibility. SVT has the full mandate to make this decision.

3.1.3. UHD Programmes

Ultra-High Definition (UHD) programmes are not accepted by SVT.

3.2. Photosensitive Epilepsy (PSE)

Flickering or intermittent lights and certain types of repetitive visual patterns can cause serious problems for viewers who are prone to photosensitive epilepsy. Children and teenagers are particularly vulnerable.

SVT is not subject, by regulation, to prevent photosensitive epilepsy.

3.2.1. PSE testing

See supplement 'A Product Guide for File-Based Photo Sensitive Epilepsy Testing' in the document 'Technical Specification for the Delivery of Television Programmes as Files to SVT'.

3.2.2. PSE – broadcast warnings

Verbal and/or on-screen text warnings may be used at the beginning and during the programme if demonstrable attempts have been made to correct or replace the images, and the relevant content is completely integral and necessary to the context of the programme, and permission to use the relevant content has been cleared by SVT.

3.2.3. UHD Programmes

Ultra-High Definition (UHD) programmes are not accepted by SVT.

3.3. Automated Quality Control (AQC)

To carry out Automated Quality Control (AQC) is not mandated, but recommended. Any device that carries out AQC tests based on the EBU QC Test Items, see <https://ebu.io/qc/>, can be used.

If AQC is carried out, the production company must ensure that all technical and editorial warnings or comments are acted on or noted. Mandatory requirements must be acted on or rectified. An AQC report in PDF form, to be delivered with the programme, is not mandated, but recommended.

3.4. Eyeball Quality Control

Eyeball QC check is mandatory to ensure video and audio quality are consistent throughout.

Listening evaluations guarantee full speech intelligibility. Evaluation must be performed at a low listening level (e.g. 57 dBC SPL/channel), using loudspeakers with a linear frequency response.

Notes of the timecodes and reasons for errors must accompany the delivered programme in a separate Excel-file (the 'Programme Metadata File') based on a template provided by SVT via http://www.svtb2b.se/?page_id=1952.

The video metadata elements 'Video comments' and 'Audio comments' must be used for these notes.

3.5. File Compliance (File delivery only)

A File Compliance check confirms that the file itself meets the technical requirements. A compliance check is carried out by SVT before a programme file can be accepted.

Part 2 – Live Delivered Programmes

Live Requirements

This part of the document details the additional technical requirements that programmes must comply with for delivery of **Live** programmes.

4. Definitions and Responsibilities

4.1. Definitions

A **Live programme** is any programme that is not delivered (by tape or) by file, and requires some form of communications link for delivery.

These programmes will fall under the following sub-categories:

- **Live** – The programme output from the remote location goes straight to air via SVT’s playout facility.
- **Compliance Live** – As Live but a short delay exists in the signal path to allow for intervention by SVT for compliance or legal reasons.
- **As Live** – The programme is produced on-site as if it were live, but the output recorded and played-out at a delayed time (or date) in the schedule. Recording and playout may occur at the production site, or at SVT’s playout facility.
- **Late Delivery** – The programme is produced and edited very close to its scheduled time, and as such, (tape or) file delivery to SVT’s playout facility is not practical. Delivery is via a link or permanent line from another facility.

Point of delivery is the location or building to which the live programme is commissioned to deliver, usually SVT’s central routing facility MCR (Master Control Room).

Permanent Link is any dedicated path from the location to the point of delivery that uses land-based circuits that are permanently assigned for use by SVT.

Contribution Link is any path from the location to the point of delivery that is not a dedicated or permanent link, such as a bookable circuit, a satellite feed, or microwave link.

Resilience Level is the level of resilience (back-up) that a live programme is required to have. The level of resilience is a requirement of SVT, and may vary depending upon the production – see section 6.1.6.

4.2. Responsibilities

The production should have a technical contact available as far as is possible in advance of the programme, to allow SVT to confirm technical planning, and for dealing with any queries.

There must be a technical contact available at the source during the programme itself and throughout the line-up period.

The technical contact for the programme is responsible for making sure;

- the programme meets the general overall Technical Specification outlined in Part 1 of this document;
- the cue and communications circuits are adequate and fully operational;
- the video and audio signals are continuous and stable throughout the broadcast period;
- resilience levels meet SVT’s requirements;
- the signal leaving their site and incoming to SVT can be passed through the playout and transmission chain without the need for further technical intervention unless previously agreed using pre-booked facilities (excludes any synchronisation required at the broadcaster’s point of delivery);
- there is sufficient monitoring in place to confirm the signal quality from the location to the point of delivery;
- all sources are stable and synchronous at all times;
- pre-recorded inserts are the same aspect ratio, resolution and match the quality of the live material.

Line-up signals must be available at least 30 minutes prior to the programme start time although it is strongly recommended that contact on the day is made well in advance of line-up and all possible links are tested as soon as technically possible.

Line-up for News contribution may be done using less time for calibration and checking, however, a minimum of at least 10 minutes is necessary.

4.3. Cue and Communication

A dedicated, stand-alone technical telephone number must be provided and distributed well in advance of the transmission. This should be a fixed landline telephone.

For direct contributions into network transmissions, a feed of the source production talk-back will be required at the playout facility. A dedicated, land-based, “4-wire” circuit offers flexibility and should be considered the minimum requirement.

Talk-back (open or keyed, depending on SVT’s choice) must be offered to playout for the duration of the programme and should be available from thirty minutes before the start of transmission.

It is preferable to arrange instantaneous or low-latency video/audio return or cue paths to sources. Return audio or video cue circuits of the programme may be necessary for programmes that require two-way communication between centres. It is important to consider the latency and reliability of the cue path especially when the programme has live interviews.

Due to the latency of a Digital Terrestrial or Digital Satellite off-air signal (up to 6 seconds), off-air cueing should be considered as a last resort and for contingency purposes only.

It is acceptable to use mobile telephones for communication during the line-up period but during transmission use of mobile phones should be agreed in advance and they should not be relied on as the only means of communication.

4.4. Photosensitive Epilepsy (PSE) and Live Programmes

SVT is not subject to prevent photosensitive epilepsy by regulation. However, programmes should be checked during rehearsals before transmission.

- If the situation is not under the control of production or there is any chance a programme might cause PSE, it is the responsibility of the programme’s producer to arrange for a warning announcement or caption to be used before and during the transmission.
- Although normally PSE warnings cannot be authorised by a programme producer, Live transmissions are the only exception. If there is any doubt, especially where stage lighting is not under the control of the production, it is better to give a verbal or caption warning.

4.5. Generator Provision

Unless otherwise agreed, Production companies should ensure OB suppliers, or remote locations, have UPS/Generator provision so the live programme transmission can be maintained in the event of any loss of power at the remote location. Critical systems should always be protected by UPS and if generator power is used it should be a dual system which allows synchronous changeover. This provision should be fully tested prior to transmission to ensure the functionality is fit for purpose.

5. Link Specifications

5.1. UHD Links

Ultra-High Definition (UHD) programmes are not accepted by SVT.

5.2. HD Links

The quality of the link from the remote location to SVT’s point of delivery has a major effect on the quality of the programme seen by the audience. The content, genre and workflow requirements of the programme are the primary factors that determine the bandwidth of the link.

For instance, programmes that feed into post production via the link will usually require a higher link specification than programmes that are completed on site, where the link is only used for transmission. The same can apply to programmes that are archived via a link.

Link specifications are always a trade-off between quality, cost and available bandwidth. However, the link should never be considered in isolation. In addition to the type and settings of the link encoder, the use of location radio cameras, and the transmission compression used by SVT, must be considered. Where there is any doubt, programme production companies should ask their link provider to speak to SVT’s technical contacts.

In all instances, the delivered picture format shall be:

- With 50 Hz motion portrayal, preferably:

- 1280 pixels wide x 720 pixels high;
- 16:9 Aspect Ratio, Full Frame (no Letterboxing/Pillar-boxing);
- 50 frames per second, delivered as 50 progressive frames per second.
- Or, still with 50 Hz motion portrayal, optionally:
 - 1920 pixels wide x 1080 pixels high;
 - 16:9 Aspect ratio, Full Frame (no Letterboxing/Pillar-boxing);
 - 25 frames per second, delivered as 50 interlaced fields per second.

The target quality level of compressed programme material is divided into three categories:

- Grade A – Programme material of prime events like concerts, demanding sports and other events where high quality is important – i.e. the main quality target, in line with internationally accepted contribution quality.
- Grade B (SVT specific) – When it is judged that some quality may be sacrificed due to technical or economic reasons.
- Grade C (SVT specific) – For programme material that will not be post-processed and where the content motivates that some quality loss may be acceptable due to technical limitations.

Contribution of programmes in Standard Definition quality (legacy equipment) is described in section 5.5.

Any external reference source at the remote site should be locked to GPS.

Latency of the programme feed must be less than 5 seconds, unless required by exceptional technical considerations.

The types of links used for any Live HD programmes shall fall into the following categories:

5.2.1. Uncompressed via Optical Fibre

1.485 Gbps HD-SDI connection, SMPTE 292M, (often known as 1.5 Gbps HD-SDI). This remains uncompressed along its route to the point of delivery.

Wherever possible, practical, or cost-effective, programmes should use an uncompressed 1.485 Gbps HD-SDI connection.

In all instances where the signal can be carried uncompressed, multichannel and/or stereo audio for the programme should be carried as discrete linear PCM (unless 'Dolby E' is requested by SVT).

Uncompressed contribution links fall under category Grade A.

5.2.2. Compressed via Optical Fibre

Links that provide a 1.485 Gbps HD-SDI connection at the point of delivery, but which use compression/decompression along their route.

Locations with optical Ethernet access should use compression encoders and decoders that allow HD-SDI to be transferred with 10-bit JPEG2000 compression over IP-protocol using MXF encapsulation of compressed data. The circuit must be single-hop or managed to guarantee the necessary quality of service.

Locations with access to other single hop fibre connections should use compression codecs that use nominal video bitrates of:

Grade A	JPEG2000	10-bit	140 Mbps
	AVC/H.264	Long GOP 4:2:2, 10-bit	45 Mbps
	MPEG-2	Long GOP, 4:2:2, (8-bit)	60 Mbps

Grade B	JPEG2000	10-bit	110 Mbps
	AVC/H.264	Long GOP 4:2:2, 10-bit	32 Mbps
	MPEG-2	Long GOP, 4:2:2, (8-bit)	42 Mbps

Grade C	JPEG2000	10-bit	80 Mbps
	AVC/H.264	Long GOP 4:2:0, 10- or 8-bit	16 Mbps
	MPEG-2	Long GOP, 4:2:0, (8-bit)	22 Mbps

5.2.3. Compressed via Satellite Link

Where fibre is not available, links via satellite may be used. The following are permissible and achievable largely by using DVB-S2 modulation schemes. Modulation schemes should be carefully chosen so that the increase in transponder capacity (in MHz) required to deliver the optimal video bitrate (in Mbps) does not come at the cost of a decreased robustness of signal.

Single-hop satellite links should have a nominal video bitrate of:

Grade A	DVB-S2	AVC/H.264	Long GOP 4:2:2	10-bit	45 Mbps
	DVB-S	MPEG-2	Long GOP 4:2:2	(8-bit)	60 Mbps

Grade B	DVB-S2	AVC/H.264	Long GOP 4:2:2	10-bit	32 Mbps
	DVB-S	MPEG-2	Long GOP 4:2:2	(8-bit)	42 Mbps

Grade C	DVB-S2	AVC/H.264	Long GOP 4:2:0	10- or 8-bit	16 Mbps
	DVB-S	MPEG-2	Long GOP 4:2:0	(8-bit)	22 Mbps

Proposed codec settings are listed in section 5.9. and Appendix D.

Where the link directly feeds a second compressed link, the signal should not be decoded back to baseband but passed to the second link as a transport stream.

Stereo audio should be carried as MPEG-1 Layer II (stereo) at 384 kbps. Multichannel audio may under certain conditions be carried with phase coherence as multiple MPEG-1 Layer II stereo audio pairs at 384 kbps each, see section 5.6.2., or may have to be carried as Dolby E (see Appendix C).

5.2.4. Compressed via Microwave Point-to-Point Link

In some locations a point-to-point microwave link may be used as an alternative to satellite links. Microwave links can be used for short hops from the location to a fixed fibre link point or where a satellite up-link has to be remote from the production location. Where microwave links are used to feed a second compressed link, the signal should not be decoded back to baseband but passed to the second link as a transport stream.

The payload on the link should have a nominal video bitrate of:

Grade C	AVC/H.264	Long GOP 4:2:0	10- or 8-bit	16 Mbps
	MPEG-2	Long GOP 4:2:0	(8-bit)	22 Mbps

Consult SVT if multi-hop microwave links or combination microwave/satellite links are to be used.

Stereo audio should be carried as MPEG-1 Layer II (stereo) at 384 kbps or linear PCM. Multichannel audio may under certain conditions be carried with phase coherence as multiple MPEG-1 Layer II stereo audio pairs at 384 kbps each, see section 5.6.2., or may have to be carried as 'Dolby E' (see Appendix C).

5.3. Picture Quality & Bit Rates (concatenation issues)

Different devices and contribution links use different compression codecs. A 'codec map' must be produced, listing all codecs (including the bitrates) through which a programme signal passes before arriving at the point of delivery.

This means one must produce a list of all the compression rates used along the route of the signal's delivery, even if only one encoder/decoder pair is used.

Pictures viewed at the point of delivery should be free from visible compression artefacts when viewed on a broadcast style flat screen 40-inch display at normal viewing distance (3H, where H is the height of the visible screen-size).

To allow further processing (recording, editing etc.) especially if the signal is comprised of any additional contribution links, the highest bitrate possible must be used.

Maintaining as high a bitrate as possible throughout the production and playout process is especially pertinent when considering that the signal has to then undergo further compression and decompression in the transmission chain delivering the final product to the viewer.

5.4. Standards Conversion

Only very high-quality motion compensation (sometimes known as Motion Predictive or Motion Vector) standards converters can be used. Where a programme requiring frame-rate and standards conversion is supplied via a contribution link of less than 100Mbps, the standards conversion must be done before the contribution link.

5.5. SD Links (if required)

Where Compressed Standard Definition contribution is used, it should be compressed using MPEG-4 or MPEG-2 Long GOP. The GOP structure and encoder setup are the same as the HD requirements in section 5.9. The payload on the link should have a nominal video bitrate of:

Grade A	AVC/H.264	Long GOP 4:2:2	10-bit	16 Mbps
	MPEG-2	Long GOP 4:2:2	(8-bit)	22 Mbps

Grade B	AVC/H.264	Long GOP 4:2:2	10-bit	11 Mbps
	MPEG-2	Long GOP 4:2:2	(8-bit)	16 Mbps

Grade C	AVC/H.264	Long GOP 4:2:0	10- or 8-bit	6 Mbps
	MPEG-2	Long GOP 4:2:0	(8-bit)	9 Mbps

Proposed codec settings are listed in section 5.9. and Appendix D.

Standard Definition video is 702 x 576 pixels, and the 702-pixel wide picture must be centred in the active 720-pixel wide line. This leaves 9 pixels to the left and 9 pixels to the right unused. (This is a result of a legacy inherited from PAL analogue TV signals).

The picture information may extend the full width of the 720-pixel wide line, providing the image shape is not distorted.

Stereo audio should be carried as MPEG-1 Layer II (stereo) at 384 kbps. Multichannel audio may under certain conditions be carried with phase coherence as multiple MPEG-1 Layer II stereo audio pairs at 384 kbps each, see section 5.6.2., or may have to be carried as 'Dolby E' (see Appendix C).

5.6. Audio

5.6.1. Stereo Audio

In all instances where the signal can be carried uncompressed, stereo audio for the programme should be carried as discrete linear PCM. If the signal must be carried in a compressed format, Stereo audio should be carried as MPEG-1 Layer II (stereo) at 384 kbps.

5.6.2. Multi-Channel Audio

Multichannel audio (surround sound) should normally be discrete PCM where there is sufficient bandwidth available in the link to the point of delivery.

Dolby E should be used for multi-channel audio when bandwidth is limited or at the request of SVT. Settings for Dolby E encoding are in Appendix C.

Use of the Low Frequency Effect Channel (LFE) channel is optional. Use of the LFE channel should comply with ITU-R BS.775.

There should be no sample timing differences between the individual channels of a surround signal.

Each stereo pair or multi-channel group (the 6 audio tracks of a surround sound signal) must be transported in a single SMPTE ST.302 PES to maintain the phase relationship between channels.

Audio Metadata must be supplied, see section 2.7. Use VANC mapping according to SMPTE ST 2020 and Dolby Metadata for Dolby E – see Appendix C.

Some encoder/decoder hardware support phase coherence between MPEG-1 Layer II audio pairs that together form a carrier of multichannel audio. If used, care must be taken to ensure that the phase coherence is preserved. Audio metadata is not carried in such streams and must therefore be supplied by other means, see section 2.7.

5.6.3. Audio Track Allocation

It is difficult to prescribe the exact audio track layout for all live programmes. International, host broadcaster, local requirements and link bandwidth may vary the audio layout requirements.

SVT and other broadcasters (e.g. all broadcasters in the UK) are working towards the standard audio layout below. However, in many situations this layout is not yet implemented due to legacy requirements – *see Appendix B regarding SVT's current audio track allocation.*

AES	Track	<u>Proposed Standard</u>
1	1	Main Stereo L
	2	Main Stereo R
2	3	M&E Stereo L
	4	M&E Stereo R
3	5	Main Front L
	6	Main Front R
4	7	Main Centre
	8	Main LFE
5	9	Main Surround L
	10	Main Surround R
6	11	M&E Front L
	12	M&E Front R
7	13	M&E Centre
	14	M&E LFE
8	15	M&E Surround L
	16	M&E Surround R

It is assumed that clean commentary tracks (e.g. Commentary 1 and Commentary 2) are received via additional contribution links.

5.6.4. Commentary Lazy Talkback

Spill of crowd or general background noise picked up by the commentary microphones contribute acoustically to the width of the front image.

In sports coverage (and other programmes produced in very noisy locations) it is important to ensure that there is some residual crowd sound in the centre channel, to minimise the audible 'hole' that otherwise results when a commentary microphone is muted, for example by the activation of 'Lazy Talkback'.

5.6.5. AV Synchronisation

AV sync should be checked via the audio desk (not just the links truck in the case of OBs) at least once a day.

Any professional AV sync equipment is acceptable but systems that can be used across all audio tracks (up to 16) simultaneously are preferred.

AV sync timing through the audio desk to the point of delivery should be ± 5 ms.

AV sync timing should also be within ± 5 ms from any remote sources into a studio or an OB including non-live inserts from (tape or) file.

Any external reference source at a remote site should be locked to GPS.

5.6.6. AV Synchronisation – Radio Link Cameras

Radio link cameras are always a compromise between delay and image quality. Image quality should always be the overriding consideration. Where radio and cabled cameras are mixed covering a location with lip-sync, and it is not possible to delay the

audio, the radio camera should not have a delay greater than 40 ms compared to the cable cameras. The director is responsible for making sure any visible lip-sync issues are kept to a minimum.

Where all cameras use radio links, the audio must be delayed matching the video. To minimise the issues caused by open talkback, and presenter switched talkback, the AV sync can be ± 20 ms.

5.7. TOD timecode

Programmes should use local time of day timecode pertinent to the venue and this should be carried in the VANC unless requested otherwise by SVT.

5.8. Ancillary Data (VANC)

Where required the following lines must be used for ancillary data:

Line	Data	Comments
9	SMPTE ST 2020	Main use: Surround sound metadata
11	SMPTE ST 2016	Main use: AFD
12	OP47	Subtitles (if required)

These lines should not be used for other data unless agreed by SVT for a specific event or programme.

5.9. Codec Requirements, SD and HD programmes

5.9.1. MPEG-2 Encoders – additional requirements

- GOP (Group-of-Pictures) should be 30 frames (50p) and 15 frames (25i). This represents a good balance between coding efficiency (requiring long GOPs) and error resilience (requiring short GOPs).
- B-frames should not be used as these are typically coded at a lower quality than I and P frames and will lead to poor picture quality in the home. Note: not all encoders on the market allow B-Frames to be disabled, so please check before accepting the unit.
- GOP structure should be /IPPPPPPPPPPPPPPPPPPPPPPPPPPPPP/ (50p) and /IPPPPPPPPPPPPP/ (25i).
- 4:2:2 colour subsampling should be used to avoid colour smearing when concatenated with the 4:2:0 emission coders used for broadcast transmission.
- “Intra-DC precision” should be set to 11 bits. 11 bits are required in the DCT (Discrete Cosine Transform) domain in order to accurately convey an 8-bit video signal. This is not normally a user setting but should be checked with an analyser before accepting the encoder.

5.9.2. H.264 Encoders – additional requirements

- 10-bit video is preferred. There is no bitrate penalty.
- GOP length should be 30 frames (50p) and 15 frames (25i), in line with MPEG-2.
- B-frames and hierarchical B-frames are permitted.
- 4:2:2 colour subsampling is preferred, but 4:2:0 may be acceptable.

5.9.3. H.265 (HEVC) Encoders

Use of HEVC/H.265 must be discussed and approved by SVT in advance.

Part 3 – SVT Live

This part of the document details SVT's contact and delivery information and any specific or genre based technical requirements for **Live** and **As Live** programmes.

6. SVT Live and As-Live Programmes

6.1. Live Programme Delivery

6.1.1. Technical Contacts

See section 6.1.2. and 6.1.3.

6.1.2. Circuit Bookings

The SVT point of delivery is currently the Master Control Room (MCR) in the "TV House", Oxenstiernsgatan 34 in Stockholm. However, as new buildings come on-line programmes may be required to deliver to other locations. Unless otherwise agreed, it should be assumed MCR is the required point of delivery.

The production company is responsible for the costs of all communications and for ensuring all circuits are booked from the source to the point of delivery. Bookings of circuits should be directed to SVT's contribution booking office in SVT Master Control Room (MCR).

The production company should also inform the MCR of the full route preferably two weeks in advance, or as soon as a circuit route has been decided before the programme production date.

- SVT Master Control Room (MCR):
 - Stockholm: mcr@svt.se / +46 8 784 75 50 / +46 8 784 75 51 / Every day 06:00-23:30.

For deliveries outside these hours MCR should be informed 28 days in advance.

Facilities for down linking satellite circuits to MCR in Stockholm are available at commercial rates. SVT also has permanent circuits to MCR.

6.1.3. Play-out Point of Contact

The Duty Engineering Managers (DEMS) in MCR are the main operational point of contact working closely with the playout editors. Technical enquiries affecting immediate delivery should be made to:

- Duty Engineering Managers (DEMS) in SVT Master Control Room (MCR):
 - Stockholm: mcr@svt.se / +46 8 784 75 50 / +46 8 784 75 51 / Every day 06:00-23:30.

6.1.4. Schematic Diagram

When requested, the Production company should provide a schematic diagram to the specific commissioner at SVT documenting the end to end signal path, including back up circuits, between the remote location and SVT preferably two weeks before the transmission date. This should include circuit numbers and contact details for key Technical / Production Staff working on the live programme.

6.1.5. Codec Map

If requested, a Codec Map documenting all codecs (including bit rates) through which a signal passes before arriving at the SVT Point of Delivery, should be sent to the specific commissioner at SVT.

6.1.6. Resilience Levels

Resilience levels will be discussed with each live programme during the commissioning stage. However, as a guide, programmes will need to meet the following:

OPTION A: Programmes with a major Swedish and International public interest

Main and Backup links are geographically and electrically separate as far as possible. Where satellite is used, there are two separately located uplink trucks, powered differently from each other. The source should be able to continue in some form, during a break down or power loss affecting some facilities. The programme producers must discuss the contingencies for alternate content should all facilities be affected.

OPTION B: Live Primetime Programmes (e.g. Saturday early evening)

Main and Backup links and power supplies have some commonality, which creates an accepted single-point-of-failure risk. Reserve links could be lower quality or even SD. A reserve power supply should be available; however, it only needs to be capable of supplying the minimum infrastructure to keep some of the programme on air. The programme producers should discuss alternate content should all facilities be affected.

OPTION C: All other programmes including live links into studio programmes

A single link, with no backup is acceptable. There only need be minimal alternate power supply and mobile phones can be used as alternate communication devices. SVT may provide alternate content in the event of programme failure. The Production is responsible for filling any loss of link into a live studio programme to meet the scheduled duration.

6.2. Surround Audio Requirements

SVT has no additional requirements or instructions beyond compliance to section 2.5. thru section 2.7. and Appendix C (regarding Dolby E).

6.3. End Credits

SVT has no additional requirements beyond compliance to the 'Safe Areas for On-Screen Text' – see section 1.11.

Regarding use of branding and trademarks, contact your commissioner at SVT. In addition, see http://grafiskmanual.svt.se/?page_id=2356.

6.4. UHD Programmes

Ultra-High Definition (UHD) programmes are not accepted by SVT.

6.5. 3D Delivery

SVT does not accept stereoscopic 3D programmes.

6.6. Operational Guidelines for Live OBs & Studios

SVT has not created operational guidelines.

7. Live Programme Line-up

7.1. Procedure Check list

SVT has not created a procedure checklist.

7.2. Dolby Surround Metadata

SVT has no additional requirements or instructions beyond compliance to section 2.5. thru section 2.7. and Appendix C (regarding Dolby E).

Appendix A – Version Control

DPP File:

Version	Date	Part and section	Required/Information	Update
UK DPP v5.0 Live	March 2017	All	Required	See Change Log via https://www.digitalproductionpartnership.co.uk/what-we-do/technical-specifications/uhd-hd-sd-programmes/

SVT File:

Version	Date	Part and section	Required/Information	Update
SVT v1.3	February 2016	All	Required	-
SVT v5.0 Live	March 2018	All	Required	File-, Live- and News-requirements are now published in three separate documents. Tape-requirements no longer exist. Naming of headings, of parts and sections, now follow those in UK DPP v5.0 File alt Live. <i>SVT's requirements are though different.</i>

Appendix B – Audio Track Layout for Live Delivery

The tables below give the current audio track layouts in contribution links, where SVT is different from the proposed future 16 track layout – see section 6.7.3.

The abbreviation “M&E” stands for “Music & Effects” (without dialogue) which is also known as “International Sound”.

It is assumed that clean commentary tracks (e.g. Commentary 1 and Commentary 2) are received via additional contribution links.

These tables are subject to change over time.

SVT’s current 4-track layouts

AES	Track	SVT 4-A	SVT 4-B	SVT 4-C	SVT 4-D
1	1	Main Stereo L	M&E Stereo L	Main Stereo L	M&E Stereo L
	2	Main Stereo R	M&E Stereo R	Main Stereo R	M&E Stereo R
2	3	M&E Stereo L	-	Main Dolby E	M&E Dolby E
	4	M&E Stereo R			

SVT’s current 8-track layouts

AES	Track	SVT 8-A	SVT 8-B	SVT 8-C	SVT 8-D
1	1	Main Stereo L	M&E Stereo L	Main Front L	M&E Front L
	2	Main Stereo R	M&E Stereo R	Main Front R	M&E Front R
2	3	Main Front L	M&E Front L	Main Front C	M&E Front C
	4	Main Front R	M&E Front R	Main LFE	M&E LFE
3	5	Main Front C	M&E Front C	Main Surround L	M&E Surround L
	6	Main LFE	M&E LFE	Main Surround R	M&E Surround R
4	7	Main Surround L	M&E Surround L	Main Stereo L	M&E Stereo L
	8	Main Surround R	M&E Surround R	Main Stereo R	M&E Stereo R

SVT’s current 16-track layouts (legacy)

AES	Track	SVT 16-A	SVT 16-B
1	1	Main Stereo L	Main Front L
	2	Main Stereo R	Main Front R
2	3	M&E Stereo L	Main Front C
	4	M&E Stereo R	Main LFE
3	5	Main Front L	Main Surround L
	6	Main Front R	Main Surround R
4	7	Main Front C	Main Stereo L
	8	Main LFE	Main Stereo R
5	9	Main Surround L	M&E Stereo L
	10	Main Surround R	M&E Stereo R
6	11	M&E Front L	-
	12	M&E Front R	
7	13	M&E Front C	
	14	M&E LFE	
8	15	M&E Surround L	
	16	M&E Surround R	

Appendix C – Dolby E

Dolby DP571 (or equivalent Dolby E encoder):

- The first DP571 in the chain must be set to "internal" metadata source.
- Metadata from an external source cannot be edited in a DP571 – you must set the metadata source to internal and rebuild it from scratch if this is required.
- A Dolby E stream uses 75 Ω unbalanced connections – if the loop-through connectors on a DP571 are not feeding another device they should be terminated.
- The most important DP571 setup parameters to check are:
 - Program Config (should be 5.1 + 2 for most things).
 - The Frame Rate. (The factory default is 29.97 fps; SVT's defaults are 25 fps for both 25i and 50p video – there is no 50-fps setting for 50p in DP571. If Dolby E is to be used with 50p video (or 59.94p video), it is subsequently necessary to decode to linear PCM audio before splicing/editing).
 - The Bit Depth (should be 20 bits).
 - The Dolby E Metadata Source (internal or external).
 - Dolby D metadata is enabled (note – if this setting appears in the DP571 menu the unit is running out of date firmware and MUST be updated).
- The "Bit Depth" setting does not refer to the number of bits used by the audio signals but the number of bits available in the AES-3 channel used to transmit the Dolby E signal. Six channels of audio can be transmitted down a 16-bit link while 8 channels must be transmitted down a 20-bit link.
- The gain of a Dolby E stream must not be changed – it will break.
- A Dolby E stream suffers one frame of delay on each encode and decode. The SVT standard is to align the stream to be "sync encoded" at each point in the chain.
- For tape delivery the stream must be laid so that the encoded audio is in sync with the video and any stereo audio. The Audio Advance function will be used to move the stream 1 frame ahead of the video before decoding. As Audio Advance applies to all audio tracks, the stereo audio will be delayed by 1 frame to compensate.
- For live or as live programmes the stream must be timed so that the encoded audio is in sync with the video and any stereo audio. It is the responsibility of the area receiving the stream to compensate for the decoding delay.
- The DP571 has a "reversion mode" which tells the unit what Dolby E and Dolby Digital metadata parameters to use in the event of a metadata failure. This should be set to "last used". This setting guards against temporary metadata failure – if failures occur the Dolby Digital encoding should not be affected.
- In the "Metadata Params" menu there are eight programs where metadata can be changed. The number of active programs depends on the "Program Config" setting. If Program Config is set to the default 5.1+2 value, then Program 1 will contain the metadata for the 5.1 stream. Program 2 will set the metadata for the additional stereo pair. If the Program Config is set to 8X1 then Program 1 will set the metadata for channel 1, Program 2 for channel 2, Program 3 for channel 3 etc. It is worth noting that all eight programs remain viewable even if the selected channel configuration does not make use of them.

Appendix D – Parameters for Satellite Contribution

HD-contribution (informative)

Allocated Bandwidth	Video Encoding		Video Standard		Sampling	GOP Length		DVB Standard	Modulation	Symbol Rate	Roll Off	FEC		Pilot	TS Bit Rate (188)	Video Bit Rate	Audio Bit rate per 2 ch pair
	Codecs Levels/Profiles	Bandwidth	Video Standard	Bit Depth		GOP Length	Codecs Levels/Profiles					Bandwidth	FEC				
Grade A	H264 L4.1	24 MHz	HD 720p	4:2:2	10	30	DVB-S2	8 PSK	19200	0.25	3/4	on	41808	38500	384		
	H264 L4.1	24 MHz	HD 1080i	4:2:2	10	15	DVB-S2	8 PSK	19200	0.25	3/4	on	41808	38500	384		
	MPEG-2	36 MHz	HD 720p	4:2:2	8	15	DVB-S2	8 PSK	27750	0.25	3/4	on	60416	56217	384		
	MPEG-2	36 MHz	HD 1080i	4:2:2	8	15	DVB-S2	8 PSK	27750	0.25	3/4	on	60416	56217	384		
Grade B	H264 L4.1	18 MHz	HD 720p	4:2:2	10	30	DVB-S2	8 PSK	14400	0.25	3/4	on	31356	27500	384		
	H264 L4.1	18 MHz	HD 1080i	4:2:2	10	15	DVB-S2	8 PSK	14400	0.25	3/4	on	31356	27500	384		
	MPEG-2	24 MHz	HD 720p	4:2:2	8	15	DVB-S2	8 PSK	19200	0.25	3/4	on	41808	38500	384		
	MPEG-2	24 MHz	HD 1080i	4:2:2	8	15	DVB-S2	8 PSK	19200	0.25	3/4	on	41808	38500	384		
Grade C	H264 L4.1	9 MHz	HD 720p	4:2:0	10/8	30	DVB-S2	8 PSK	7200	0.25	3/4	on	15678	13500	384		
	H264 L4.1	9 MHz	HD 1080i	4:2:0	10/8	15	DVB-S2	8 PSK	7200	0.25	3/4	on	15678	13500	384		
	MPEG-2	12 MHz	HD 720p	4:2:0	8	15	DVB-S2	8 PSK	9875	0.25	3/4	on	21503	19500	384		
	MPEG-2	12 MHz	HD 1080i	4:2:0	8	15	DVB-S2	8 PSK	9875	0.25	3/4	on	21503	19500	384		

Regarding the number of B-frames in the GOP, see section 5.9.

SD-contribution (informative)

Grade	Allocated Bandwidth		Video Encoding		Video Standard		Sampling	Bk Depth	GOP Length	DVB Standard	Modulation	Symbol Rate	Roll Off	FEC	Pilot	TS Bit Rate (188)	Video Bit Rate	Audio bitrate per 2 ch pair
	Bandwidth	Codecs Levels/Profiles	H264 L4.1	SD 576i	4:2:2	8	10	12	DVB-S2	8 PSK	7200	0.25	3/4	on	15678	13000	384	
Grade A	9 MHz		H264 L4.1	SD 576i	4:2:2	8	10	12	DVB-S2	8 PSK	7200	0.25	3/4	on	15678	13000	384	
	18 MHz		MPEG-2	SD 576i	4:2:2	8	8	12	DVB-S	QPSK	13333	0.25	7/8	on	21503	19500	384	
Grade B	6 MHz		H264 L4.1	SD 576i	4:2:2	8	10	12	DVB-S2	8 PSK	4937	0.25	3/4	on	10750	9000	384	
	9 MHz		MPEG-2	SD 576i	4:2:2	8	8	12	DVB-S	QPSK	6111	0.25	3/4	on	15678	13500	384	
Grade C	4.5 MHz		H264 L4.1	SD 576i	4:2:0	8	10/8	12	DVB-S2	8 PSK	3600	0.25	3/4	on	7830	7250	256	
	6 MHz		MPEG-2	SD 576i	4:2:0	8	8	12	DVB-S	QPSK	4434	0.25	3/4	on	7151	6250	256	
	Bandwidth	Codecs Levels/Profiles	Modulation		Modulation		Modulation		Modulation		Modulation		Modulation		Modulation		Multiplexing (kbps)	

Regarding the number of B-frames in the GOP, see section 5.9.

Supplements

Technical Supplement for the delivery of Surround Sound Television Programmes

The supplement by Digital Production Partnership, <https://www.digitalproductionpartnership.co.uk/>, is not applicable in SVT context regarding File or Live delivery. However, proposed 'Dolby E' settings are described in the document 'Technical Specification for the Delivery of Live Television Programmes to SVT'.

Technical Supplement for the delivery of Programmes with High Dynamic Range

The supplement by Digital Production Partnership, <https://www.digitalproductionpartnership.co.uk/>, is not applicable in SVT context. Programmes with High Dynamic Range (HDR) are not accepted by SVT.

Technical Supplement for the delivery of 3D Television Programmes

The supplement by Digital Production Partnership, <https://www.digitalproductionpartnership.co.uk/>, is not applicable in SVT context. 3D Television Programmes are not accepted by SVT.

Quality Control Requirements

The supplement by Digital Production Partnership, <https://www.digitalproductionpartnership.co.uk/>, is not applicable in SVT context. Delivery to SVT may involve, but does not mandate, the specific 'AS-11 UK DPP File Format Check', the specific 'DPP AQC Content Check' nor the specific 'DPP Eyeball QC Content Check'. SVT's requirements regarding Quality Control (QC) are specified in section 3.

Eyeball QC Report (Template)

The supplement by Digital Production Partnership, <https://www.digitalproductionpartnership.co.uk/>, is not applicable in SVT context. Delivery to SVT may include, but does not mandate, the specific 'Eyeball QC Report' by the DPP.
