

## 7. The BBC influence

*By the 1970s, when the BBC's live FM radio music broadcasts were setting a breathtakingly high standard as a hi-fi source, its unique research and design facility influenced hi-fi product design too. Developed by the BBC for its own use, the LS3/5A speaker was an instant hit when Rogers (quickly followed by the other BBC-licensed builders) first offered it to the public in 1975. To own the LS3/5A was to buy into the whole BBC ethos.*

*Now, 30 years on, and long out of production, the original LS3/5A retains its hold, despite innumerable imitators and most recently an LS3/5A 'V2' with different drive units. But to read Trevor Butler's 1989 HFN/RR feature, telling the story up to the arrival (controversial among enthusiasts) of the 11 ohm version in 1988, is to understand just how this BBC creation came about – and why the magic could never be repeated.*

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**A little legend: the story of the BBC LS3/5A** *by Trevor Butler (HFN/RR, Jan '89)*

There can hardly be another single box which has provoked as much emotive comment, or given rise to so many myths and misunderstandings, as the BBC LS3/5A. The very name has caused confusion, but in fact it simply follows the BBC's coded equipment format. In this, cabinets have the prefix 'CT', filters 'FL', and loudspeakers 'LS', hence the first two letters

The figure '3' in the code indicates that the design is primarily for outside broadcast (OB) use. A figure '5' would mean studio broadcasting, as LS5/9. The number '5' after the stroke is the model number, the LS3/5 supplanting previous OB speakers like the LS3/1. So we arrive at LS3/5 which was the title of the initial model. Later the 'A' was added to indicate the first and only design alteration to the original specification. Any further specification change would result in a 'B'; but that hasn't happened, and isn't likely to, for reasons which will become apparent.

The concept of this speaker was to suit those BBC environments where monitoring on headphones was not satisfactory and yet there wasn't sufficient room for a 'Grade I' monitor. A Grade I monitor can be used for critical tonal balancing of programme material, setting of microphone positioning, etc. Current Grade I monitors are the LS5/8 and LS5/9. A Grade II monitor may be used for checking the quality of programme, but balance and mic positioning are normally Grade I-checked unless there is no alternative. It was recognized that what would be required was

a small Grade II unit with some sacrifice of bass response and loudness reproduction, this being justified for the sake of achieving compactness. The likely users were, for instance, the production control areas of television OB control vans, where the producer needs to listen at a lower level than that used for the actual mixing.

There was no suitable available commercial unit, and so the Research Department of the BBC was asked to design one at its headquarters in Kingswood Warren. Less than a week elapsed between this request and the first prototype being offered for field trials and evaluation. This came about because the LS3/5 was based around an experimental loudspeaker which had been developed for some preliminary work on acoustic scaling tests at Kingswood.

By using one-eighth scale models, and one-eighth wavelengths (ie, 8-times frequencies), recordings can be made by which the merits of particular acoustic techniques can be assessed without the expense of a life-size environment. Naturally, though, this implies that the entire model reproduction chain, of tape player, loudspeaker, microphone and recorder, must be capable of operating at very high quality with a frequency range of 400Hz to 100kHz, in order to be able to model accurately a typical bandwidth of, say, 40Hz to 15kHz.

The model speaker, which the BBC used from 1972 until 1980, represented a major step in the modelling process. Although it had its limitations, primarily in terms of its tonal quality and maximum power handling, components of this small loudspeaker were found to be of a sufficiently high quality to help fulfil the demand for the unusually compact monitor needed in outside broadcast use. This was therefore packaged and called the LS3/5 and showed the model experimenters to have achieved good results.

A small number of these units were made in-house by the BBC and used in television mobile control-rooms, where they gave satisfactory service. The BBC got to the stage of inviting applications to make the LS3/5 under license by outside manufacturers. Indeed, Rogers issued a press release on 19th February 1974 which proudly announced that they would be exhibiting the new design at SONEX '74, an exhibition to be held that April. They offered a photograph and a provisional specification: 25W power handling with  $\pm 3$ dB, 80-20,000Hz and  $\pm 4$ dB 60-20,000kHz. Crossover frequency was quoted at 3kHz and the units were a 110mm bass driver with a Plastiflex doped Bextrene cone and a 27mm Mylar dome tweeter. The price was £52 each plus VAT!

Alas, though, there were to be early problems. Although the BBC had

confidence in the KEF B110 bass unit at the time, when a subsequent batch of in-house LS3/5s was needed it was found that the low- and high-frequency units had undergone significant changes and a re-design of the speaker would be required before production could resume. Accordingly, the speaker was passed on to the BBC's Designs Department, then located in Great Portland Street, with a request to modify it so that it would once again be suitable.

The trouble was in three areas: the B110 had changed, exciting the cabinet in a different way, producing a coloration both from the LF unit and the cabinet; and the HF unit had developed a pronounced 'lispy' quality.

In an attempt to ensure that cabinet resonance would not cause problems, the side panels had each been damped with a bituminised pad, and the top and bottom panels likewise, except that two layers were required here. In addition, a PVC edging was applied to the chassis of the LF unit to de-couple it from the front panel and seal the join. In order to damp the air modes of resonance inside, all internal surfaces were lined with polyurethane foam. The cabinet was sealed to prevent air leaks, which might produce extraneous sounds from the high pressures produced – indeed, even the screw holes were made airtight. The cabinet problems were associated with the softwood parana pine fillets which connected the back panel to the front; these had an insufficient impedance and were therefore replaced with beech. The back panel was re-specified from the precious sandwich of spruce to multi-ply birch, thus obviating the voids often associated with spruce. This then became the CT4/11A.

The opportunity was also taken to sort out the treble lisp of the tweeter. It was felt that this unit, the KEF T27 SP1032, was vulnerable because it was exposed and could easily be damaged during rigging at a venue. It was decided to incorporate a protection grille and a suitable one was found, with some modification, from a Celestion HF2000. The tweeter is surrounded by a thick felt strip mounted on the baffle in order to prevent acoustic discontinuity presented by the edge of the cabinet setting up an interference pattern, since the T27 radiating surface is small and the radiator nearly omni-directional. The addition of the protection grille was wholly beneficial as it raised the output at higher frequencies and help cure the lisp. The effect of the Tygan cover on the front was taken into account in the design, and the loudspeaker should always be used with the grille on, to avoid discontinuities in the upper presence region.

Having carried out these changes, the crossover had to be adjusted to compensate and a new type, FL6/23, replaced the original FL6/16.

Sporting these alterations, the first variant of the LS3/5 was born – the LS3/5A. The ‘A’ suffix was necessitated because although the LS3/5A sounded similar to the LS3/5, the differences were significant enough for it not to be possible to use a mixed pair for stereo listening. Since only small quantities of the LS3/5 had been built, this did not present much of a problem and only 20 units had to be considered obsolete.

For those not fully acquainted with it, the design is still now very much as it was then, with just a few slight enhancements which came about over the years, as will be explained.

There were a few noted difficulties in 1977, and almost every summer saw the reject rate at the manufacturers rise slightly. The early 1980s saw a change when the surround-dip was seen to have moved slightly. This was resolved when the crossover resonator controlling it was tuned to a lower frequency and the damping resistor changed. Any alteration like this is issued by the BBC to the current manufacturers and is incorporated into their license. There have also been some adjustments to the value of the tweeter coupling capacitor; these are part of the relative balance adjustment. As the material of the tweeter alters, the ‘Q’ changes and there is a mild ‘tippling’ of the response. This coupling capacitor affects the shape of the network and decides whether it is under or over damped. To adjust the treble balance, an output from a tapped transformer on the FL6/23 is adjusted, and the coupling capacitor changed to maintain the crossover frequency.

## Re-assessment

The major re-assessment of 1987 was widely reported in the specialist press; but this time the alterations had been requested primarily by the manufacturers. As one of the licensees (Richard Ross of Rogers) explained: over the years, whilst it had been possible to make an LS3/5A which sounded and measured within spec, and which was acceptable, the number of units, in particular the woofers which were within tolerance, varied. Because of the particular design of the LS3/5A, the B110s, although being to KEF’s standards, happened to have the point where their tolerance was most variable occurring at the most critical point in the speaker’s design. In hot summers the reject rate of the bass units could be anything from 10% to 85%, and, for the licensees, this was not satisfactory from an economic standpoint.

At the same time as the licensees were finding it difficult to make consistent units, the BBC was encountering its own problems. At the end of 1987 it was noticed that the units were tending to drift towards the

limit of acceptability. Specifically, they were found to be about 2dB up at an octave around 1kHz, a particularly critical area for balance. There had always been a slight lift on the LS3/5A here, but now it started to become objectionable. It should be stressed that the units were still operating within limit for a Grade II monitor, but would have been unacceptable in a Grade I.

The crux of the matter was again the 'surround-dip', the precise frequency of which varies by a few hundred Hertz over time. This had become interactive with the box resonance to the extent that action was needed. A change had to be brought about so that speakers could be manufactured which the BBC would find acceptable, to provide them with the consistent loudspeaker they designed and wanted.

The BBC referred the matter to KEF, who set their Special Products Division to work. The problem was traced to variations in the consistency of the Neoprene used in the making of the SP1003 B110, and so a new B110 was specifically designed for the LS3/5A. This uses a PVC surround, more consistent and temperature-stable than the Neoprene but less compliant. A new spider voice-coil assembly was therefore required to give the new drive the same sensitivity as the older one, in order to achieve the bass performance. This is the B110 SP1228.

Crossover design is always a source of great debate and this has certainly been the case with the LS3/5A. Changes have been made, as reported, but the main specification and overall sound balance of the speaker have remained the same.

### Crossover

A book could be written on this subject so far as the LS3/5A is concerned. The network is of unusual complexity. L1 and R1 are employed to equalize the rising axial response and frequency characteristic of the bass unit, while the group C5, L2, and R2 compensate for a hump in this characteristic. For the tweeter, L3 acts as a shunt inductor and as an autotransformer to allow for differing levels of sensitivity. C2 is adjusted to keep the crossover frequency constant and R3 is there to prevent ringing, with R4 and C6 to adjust the frequency response at the upper end.

The SP1228 has a considerably smoother response than the older-type B110, and hence needs gentler crossover equalization. It was decided therefore that the crossover could not only be re-designed to compensate for the change to the drive unit, but could also incorporate new technology. In essence, the equalisation is very much the same, with a similar-looking circuit. The earlier design used the already-mentioned

tapped auto-transformer as part of the high-pass filter and to adjust the level of the tweeter in 1dB steps, but it was noticed that as the tweeter sensitivity was becoming increasingly consistent (to within 0.5dB), a simpler constant impedance resistive attenuator could be used to give the  $\pm$ 1dB of adjustment in 0.5dB steps. One consequence of the simpler equalization is that the overall impedance has been reduced from the previous 15ohm nominal to 11ohm nominal.

KEF analysed the effect of component tolerances on the overall response and found that by tightening these in the most critical areas an improvement in consistency could be achieved. In previous units it had been possible to obtain a 2dB variation. For example, if the network was +1dB in the critical area and the accompanying drive unit was also +1dB the two compounded. KEF decided that by opting for computer-aided matching, it was possible to select components so that if the network was +1dB a drive unit with a -1dB figure would be chosen to give 0dB overall change. The new crossover is the FL6/38, SP2128.

Therefore KEF was able to offer matched components to the manufacturing licensees even though the company does not manufacture the speaker in its entirety itself. It so happens that all three current licensees use the KEF matched parts. At the end of the day, it has to be said that KEF did a superb job. They were issued with a BBC LS3/5A reference unit (No 6) of 1975 vintage and produced a set of 1988 parts which sounded so similar that they were within Grade I limits, and could be made much more consistently. Hence, LS3/5A remains.

Spendor used to make its own complete crossover units and says that it could start again if they situation called for it. It has now adopted the iron-dust inductors (not to be confused with ferrite) and has dispensed with its previous silicon-iron E & I transformer winding. The E & I laminations tend to be more costly, and the opportunity to buy the matched KEF sets was taken.

Rogers had for years used various ferrite and iron-dust cores, because its research showed that they were more economical and gave superior saturation qualities compared with the radiometal or grain-orientated strip steel, given that in the transformers there are quite small gaps with quite high fluxes, whereas in the ferrites there are big air gaps and a lot of magnetic material. Although there are probably a few more turns and the DC resistance rises slightly, the saturation properties are considerably enhanced. Rogers decided that with modern crossover techniques, it was simpler to make a 2 or 3% tolerance iron-dust core inductor than to make a gapped radiometal choke. This is partly because the design is

complicated and any opportunity to make things less so should not be avoided.

It would perhaps have been simpler in the long term for the BBC to have completely re-designed the speaker, and to have produced an LS3/5B, but they did not want nor could they afford this option, since some three-and-a-half thousand of the existing design were in use up and down the country. And design change had to produce similar results, and the same response, because future models would end up alongside existing ones. Even today, when a batch is taken to a location, it does not matter whether some are from one generation and some from another – they should all be capable of matching as stereo pairs. That in essence is the whole purpose of the design, consistency through production and during use, anywhere. To sum up then, the recent changes have offered no enhancements in terms of specification, simply a means to provide better consistency in production to maintain the speaker's standard. This is now back on 'median' and so may sound a little different from those latter 'older models' of just pre-Christmas 1987, but will sound the same as earlier production runs.

The impedance has altered slightly, post-modifications. Whereas the original was a nominal 15ohms the newer model is nearer to a nominal 11ohms. Looking at the nomograph, we can see the original as 15ohms, using the old equalizer and with the old bass unit which had about a 7ohm resistance. The new bass unit has a lower DC resistance but, with the new equaliser, the curves are very similar in shape, although the average level is now more like 11ohms. This still means that the LS3/5A is voltage rather than current driven and needs an amplifier that will swing volts and produce reasonable power levels, but not into low impedances.

So an LS3/5A circa 1977/78 will not in any particular way be better or worse than one from 1983 or now. The consensus of opinion, from those who understand balance, is that the system is the same and offers the same qualities as it always has, in terms of its tonal characteristics.

In detail, the latest models are now marginally smoother because irregularities of the high treble have been sorted out, and the coloration has been reduced by a small degree with the new surround, but not so as to affect the tonal balance, because the perception of localised coloration is all part of the balance of the loudspeaker system and its equalisation. So if the tonal coloration were reduced to an extent in, say, the 1kHz region where it was noticeable, it could highlight colorations elsewhere.

The new design offers only, in real terms, a better consistency, executed by KEF to maintain the standard. No enhancement in terms of the

specification was made, although commentators say the loudspeaker now sounds a little better because it is back on the median. Essentially it produces the same sound. This has been backed by tests carried out at the BBC and with manufacturers, with regard to the unit's stereo capability.

The total number of LS3/5As made since the first licence was granted is estimated to be around 60,000 pairs so it is not surprising that a huge interest has been generated around the world. In the BBC, the speaker has found many uses from the one-man OB to the control and balance of experimental quadraphonic transmissions from the Promenade Concerts several years ago; and in BBC Local Radio Stations, the design provides the main cubicle monitoring. Even so, the design has its fallbacks, like the passive and complicated equaliser in the crossover to restore the loss of low frequency caused by the cabinet size and limited cone area.

### Licensees

The very history of the speaker has interesting connections with licensees who have been allowed to manufacture them. After early production runs at the BBC's own Equipment Department in Chiswick, the Corporation permitted a number of companies to apply to produce the speakers under licence, as it is obliged to do under its Charter.

The licence fee is a means of recouping the original development cost, not purely a way of cutting unit costs by mass-production, and the money is recovered by the Director of Engineering and not BBC Enterprises, the commercial arm of 'Auntie', which has taken over other money-making areas like publications and records. Recently, as many as four companies had licences although in essence only two actually had a production line at that time. This situation came about when Harbeth, formed by H D Harwood who was working on the LS3/5A at BBC Research Department, was granted a licence, while Rogers, Spendor and Goodmans were also permitted to manufacture. Goodmans, in fact, had ceased production and did not re-apply for its licence when the renewal time came, and Harbeth had yet to start making any.

Another licensee manufacturer, Spendor, founded by the late Spencer Hughes who had worked with Dudley Harwood at the BBC, did not apply for a licence at the first opportunity. The company was then already working to full capacity, but when a 'vacancy' next arose it did apply, encouraged by the fact that Mr Hughes knew the design and all that would be entailed, by association with it.

Rogers was involved almost from the start **and now own** the Chartwell brand, a company also previously licensed to make the LS3/5As. The



parent company, Swisstone, acquired the defunct Chartwell, a previous competitor, in 1978, having merged with Rogers in 1975. Manufacturing to quantity demands, Rogers announced in 1979 that it had sold its ten-thousandth pair and proclaimed the LS3/5A the world's most successful small loudspeaker, with its total to date standing at 33,534 pairs.

The latest company to be permitted to manufacture is Harbeth, now under the control of Alan Shaw. Samples from its first batch were passed by the BBC and are now eligible for full production; all are of the computer-optimised type. This initial sampling process, a condition of all licensees, is to assure the BBC that their speakers are being made correctly. The licensee selects two units from the initial batch to send to the BBC. One of these is kept by the Corporation as that licensee's working reference, while the other is tweaked so that it matches the BBC's own reference, a unit from the very first in-house batch. This second speaker is then returned to the licensee and becomes the reference for all subsequent units to be compared with.

Earlier companies to have been licensed by the BBC have not fared as well. It is agreed that the LS3/5A is not an easy product to make properly and must be marketed correctly. Some names have fallen by the wayside because they found the market was not as large as they forecast, and some found it too difficult to make to the BBC's tight tolerances. These problems could be because people expect more than they see for a £250 loudspeaker, and that without the correct marketing, sales are just not realised.

Names like Audiomaster, who launched its models in April 1976, had a rather short-lived licence span, while RAM never got any units out on the street: they went bankrupt before the production line got underway. Falcon, who were making crossovers for Goodmans, made a batch for ailing RAM company and then found itself having to distribute the boards directly because RAM was not in any position to pay for them. A flurry of activity was seen from JPW, but no quantities to speak of ever materialised. Constant checking of the licensee's production is carried out, and there are some tales of 'nasties' being found. There's the case of a unit coming in for evaluation with a thicker-than-usual grille material causing a two-octave 1.5dB dip. Needless to say it was swiftly returned!

Of the three current manufacturers, Spendor says that although a percentage of its production line ends up in the UK, 80% of sales are to the export trade, the areas being mainly Europe, the USA and the Far East, including Japan and Taiwan. Rogers also exports to Japan, Europe, North America, Hong Kong and Singapore, with even more sales to Japan

than to the United Kingdom, where, whilst a quantity goes to the BBC, the hi-fi retail outlets get through a fair volume too. Despite the advances of other designs, the LS3/5A remains a reference-standard loudspeaker in its class.

### Acknowledgements

I am indebted to BBC Engineering for ensuring the accuracy of this article. Within the BBC, the work of two people, T Somerville and D E L Shorter, must be considered as having laid the foundation for current standards. The particular work on the LS3/5A was carried out by Messrs H D Harwood of Research Department and both M E Whatton and R W Mills of Designs Department.

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*Peter Thomas, founder and chief designer of PMC, on LS3/5A impedance:*

I do have some knowledge of many aspects of the design as I was part of the group concerned with the work at the BBC in the '70s and '80s, albeit that most of my involvement was with the cabinet design and manufacture rather than the electronics.

‘There is some confusion regarding LS3/5A versions and impedances. The variance of figures in the industry could well have had something to do with the different methods magazines used to determine the “nominal” impedance. The load presented to an amplifier by the loudspeaker depends on both the crossover and the drive unit, and will vary with frequency. Different measurement and averaging techniques will also tend to give slightly different numbers. The nominal 15 ohms quoted for the first version LS3/5A is higher than the impedance of the drive units because of the crossover circuitry. (To provide a reasonable low frequency extension of the complete loudspeaker’s frequency response, the crossover in the LS3/5A introduces significant loss above a few hundred Hertz. This is achieved by using series resistance, so the overall input impedance of the loudspeaker is somewhat higher than that of the drive unit alone).

‘The first version of the LS3/5A uses a bass driver with a higher resistance and inductance than the later version, so it appeared to present a higher impedance load to an amplifier. The later version of the bass driver also needed slightly less correction to its frequency response, so the crossover has less effect on the input impedance. These effects combine to give the nominal “11 ohm” version.

‘A recent eBay item would show this, as the speakers (Rogers) had a photographed label indicating 15 ohms, whereas astute investigation of

the photograph of the speaker itself would suggest the units used might have led to a different impedance – this fact was questioned by a bidder and a further statement relating to a previous repair (hence a resulting impedance change) was added to the details of the item.

‘The type of bass driver used in the two versions can be determined by looking closely at the loudspeaker with the front grille removed – both the outer surround material and the actual plastic cone appear visibly different. You can also tell by the different crossover and the SP1003/SP1228 label.

‘The loudspeaker began as an LS3/5 (not externally available, although I have a pair myself) and the LS3/5A was an update (significantly changed). A further update was made still carrying the LS3/5A label.

‘Parameters are, I believe, as follows:

‘LS3/5: input impedance 9 ohm, B110/A6362 bass/mid at 4 ohm (rubber surround), T27/A6340 tweeter at 4 ohm

‘LS3/5A, first version: input impedance 15 ohm, B110/SP1003 at 8 ohm (rubber surround), T27/SP1032 at 8 ohm

‘LS3/5A, second version (1988): input impedance 11 ohm, B110/SP1228 at 6 ohm (neoprene surround), T27/SP1032 at 8 ohm.’

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*US writer **Allen Edelstein** in praise of Rogers' bigger BBC-based monitors:*

‘The Studio 1 is a development of the Rogers Studio Monitor speaker (I have the brochure in front of me now) which was a BBC LS3/6 with the approved addition of a Celestion HF2000 super tweeter to the Celestion HF1300 for extra extension and especially better dispersion at high frequencies (the Spendor BC1 added an STC super tweeter early in production for the same reason, though I think the HF2000 was smoother and more extended).

‘The LS3/6 used a development of the 8 inch midrange from the LS5/6 (12 inch woofer, 8 inch mid, both slot loaded, HF1300), the first Bextrene-coned speaker, to produce a smaller monitor of similar quality. The driver was rated at a whopping 25 watts (it used a very light paper voice coil former I believe) and there was a recommendation of a maximum of 40 watts. I’m sure this is what led to the Studio 1, the need for more power handling, and there goes the BBC approval. I’ll bet it also allowed Rogers to save money on the crossover and the insane quality control demanded by the BBC. Remember, a prime factor in BBC monitors was consistency speaker to speaker – you should be able to randomly choose two speakers of a model and still have a fine stereo pair.

'The Spondor BC1 was a development of the LS3/6 programme though not an official one. The work on the LS3/6 was stopped before it was finished (it was later completed and the Rogers was the result). Spencer Hughes left the BBC with the knowledge of the work and the BC1 was his application of the research to a real speaker.

'I heard the Rogers once. It was lovely, with a subtle warmth in the best sense. It was rich but, given the time, still felt as uncolored as any dynamic speaker. I think the bass was tighter than the BC1 (a problem throughout its lifespan) and the top octave was superior.

'Since I'm on the subject of BBC monitors, the most interesting one I ever heard was the LS5/8. It was certainly a very interesting design. It used a slot-loaded 12 inch polyprop woofer (the first time polyprop was used, I think) crossed over electronically about 1800Hz to a 1.25 inch Audax tweeter. I had a pair on loan from the American importer (he sold around three pairs a year at \$6000, in around 1980, which was a lot then). It was typical BBC but with better bass, loudness, and dynamics and a little less "BBC sound" (there is a subtle BBC coloration).'

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*The late **Spencer Hughes**, founder of Spondor, wrote this letter to HFN/RR in 1980:*

'Dear Sir,

'The Spondor BC1 was not, as it has so many times been described, a development of the BBC loudspeaker type LS3/6. Perhaps a short history of the lead into, and the development, of the two systems may be of interest.

'From the very early days, even before hi-fi, the BBC has designed its own monitor loudspeaker systems as commercial systems were not, and most are still not, accurate enough for broadcast work. These designs were based on available units matched by, what were in those days, very complex crossover networks and mounted in custom designed cabinets.

'During the mid-1960s, the development work carried out by the BBC had advanced to a stage which was beyond the capabilities of the available paper pulp cone bass units. The decision was taken to investigate the possibilities of using some form of plastic as a cone and surround material. It was assumed that plastic would be a consistent material unlike paper pulp, which to some degree seemed to depend on the mood of the pulp stirrer. Over the years it has been found that it was not quite that easy.

'The section of the BBC Research Department involved in this operation was headed by Mr D E L Shorter, now retired, with Mr H D Harwood now of Harbeth Acoustics, second in command and myself completing

the investigating team. Some two years were spent making 12in unit cones in a variety of shapes and from a range of plastics; this could be a story on its own. The first successful unit was made from the now well-known Bextrene and used in the development of the BBC studio monitor type LS5/5. This loudspeaker was described in an article written by Mr H D Harwood in the March 1968 issue of *Wireless World*.

‘My part, as a laboratory technician, in the operation, was to do most of the actual work both on the plastic investigation and the development of the LS5/5. With that experience I decided that it should be possible to make a loudspeaker from scratch in the home environment. With the aid of our electric fire, a compressor working in reverse and an iron bedstead the first vacuum former was built. Bins full of malformed cones were produced before any measure of success was achieved and the first 8in unit was produced. This unit turned out to be almost certainly the first commercial 8in Bextrene driver and still arguably the best.

‘The first pair of BC1s was constructed using these units and Celestion HF1300 units. The cabinets were smaller than the current model and initial listening tests indicted that the performance could be improved by an increase in size, hence the present design. At this point it was all being done for fun.

‘The second pair of BC1s was made for a friend who took them to Merrow Sound of Guildford. The third pair was sold to Merrow Sound and Spendor was on the way to a small niche in the audio world.

‘Now some difficulties were beginning to arise as under the terms of my contract with the BBC, the design had to be offered to them. Fortunately the “Pop” era had just started and the main request was for more power, so the BC1 was turned down. Around about this time there was a special requirement within the BBC for one pair of speakers about the size of the BC1s. Being a kind soul, I suggested that my design could be used, so I was given the task of producing an official version of the BC1, later designated the LS3/6.

‘This design used an 8in unit made by Research Department, the Celestion HF1300 and a redesigned crossover. The main change in the crossover was the addition of a large multi-tap autotransformer to allow adjustment of levels between the two units, normal BBC practice at that time.

‘Some months later BC1s were fitted with an amplifier mounted in the back panel and the 4001G super tweeter added. This addition was for purchase tax reasons, but it did have two extra gains. Firstly, it improved the overall dispersion characteristics, secondly, from the broadcasting

angle, it made any 625-line breakthrough to be more easily detected.

Now the LS3/6 was offered to a number of commercial companies and eventually taken by Rogers, then under the control of Jim Rogers. With approval, and a little assistance from the BBC, Rogers added the Celestion HF2000.

As Spondor was now a commercial company it was agreed that a royalty should be paid to the BBC for each BC1 produced. This was in recognition of the work I had done on the loudspeaker whilst still employed by the BBC.

To perhaps prove the order of development of the two systems, it is of note that out of over two thousand BC1s supplied to the professional market there are over six hundred in operation with the BBC and as far as I know very few, if any, LS3/6 speakers.

In addition to the above, the name Spondor is derived from the first names of myself and my wife Dorothy. Mrs Hughes provided practical assistance in the early days with her coil-winding expertise and now as Managing Director is responsible for all accounting, sales and general management. Derek Hughes, the son, another ex-BBC employee, deals with an amplifier design and assists me with research and development and general running of the factory.

Yours, Spencer Hughes