# The Yamaha NS-10 Phenomenon

WHY DO RECORDING ENGINEERS STILL USE THIS OLD MONITOR? ANSWERING THIS QUESTION, FREELANCE SPEAKER DESIGNER PHIL WARD EXAMINES THE CRUCIAL DIFFERENCES BETWEEN CLOSED-BOX AND REFLEX PORT LOADING

PHIL WARD

The new *CLA-10* is a dead-ringer for the Yamaha *NS-10* nearfield monitor. This clone, created by US ProAudio manufacturer Avantone, has once again drawn attention to the phenomenon of Yamaha's ubiquitous and persistent studio monitor.

It's probably no exaggeration to say that most contemporary music recorded in the last thirty years or so will have been replayed through a pair of *NS-10*s at some stage during production. In the ProAudio world, where countless contemporary nearfield monitors could do the job of an *NS-10*, the venerable Yamaha still appears in almost every photograph of a smiling engineer at a mixing desk. So what's going on? Not only should the *NS-10* be no more than a small footnote in the history of speaker design, but there's precious little consensus regarding its abilities, or an understanding of why it's still found in almost every rock-oriented recording studio.

## A History Lesson

Initially launched as a consumer hi-fi speaker, to understand its phoenix-like rise from hi-fi failure to domination as nearfield monitor, one has to appreciate the context. The early 1980s, when the *NS-10* first began appearing in studios, was a transitional time in music recording. Recording engineers were becoming more creatively involved in the production process, and could call the shots with the record companies. Some even became stars in their own right. The freelance life beckoned, but a freelancer needs his own tools, so the new 'name' recording engineers travelled light with a few items that normally included a pair of those compact Yamaha *NS-10*s.

Why *NS-10*s? Why not Acoustic Research *AR18*s, Mordaunt-Short *MS20*s, or indeed a number of other models? It is often said that one reason behind the success of the *NS-10* may be down to recording engineer Bob Clearmountain. The story goes that Clearmountain (one of the first of that new breed of name engineers) wanted to carry a pair of monitors that was representative of typical domestic hi-fi speakers, to check how a mix might sound in a home setting. It is also sometimes said (usually by those who consider the abilities of the *NS-10* to be a closed book) that Clearmountain chose the *NS-10* because it was the worst sounding speaker he could find.

The trouble is that this usual explanation is not really true. A more likely story (recounted by engineer Nigel Jopson in a letter published in *Resolution* magazine in 2007) does involve Clearmountain, but differs in almost every respect. Jopson's *NS-10*s were given to him by a producer just back from mixing a project at The Power Station in New York, after hearing that Rhett Davies and Clearmountain had used a pair there while mixing Roxy Music's *Avalon* album. However, Jopson goes on to recount that Clearmountain himself recalls that *NS-10*s were recommended to him by another engineer, Bill Scheniman, who was the first engineer to bring a pair to New York, having used them at Sunset Studios in LA. In turn, Scheniman recalls that the *NS-10* pair at Sunset belonged to Grag Ladanyi, who had been convinced of their worth earlier while working in Tokyo. A key element in the *NS-10*'s acceptance was therefore Bill Scheniman and an unknown engineer in Tokyo.

In what respect was the *NS-10* so well suited to the nearfield monitor role? What was it that those engineers heard which convinced them that the *NS-10* was worth overturning previous monitoring choices? And why is the *NS-10* still so widely used today?

## NS-10 Technology and Measurements

Fast forward to 2001 – ironically the year in which Yamaha discontinued the *NS-10* – when studio and monitor designer (and past *HIFICRITIC* contributor) Philip Newell, Julius Newell, and Southampton University's Dr. Keith Holland presented a research paper to the Institute of Acoustics that constituted probably the only objective investigation of the *NS-10* phenomenon.

The Newell/Holland paper was based on acoustic measurements (in Southampton University's very large anechoic chamber) of 36 different nearfield monitors. At the end of the exercise, the *NS-10* stood out like the proverbial sore cliché. While its frequency response wasn't particularly flat and the low frequency extension was restricted compared to many others, it was outstanding in terms of time domain and group delay distortion.

During my work with Acoustic Energy on its *AE22* nearfield monitor, we repeated some of

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Newell and Holland's time domain measurements of the *NS-10* with similar results, so I've reproduced some of the curves. A relatively small measuring environment allowed for acoustic accuracy only down to around 150Hz so, in *Fig 4*, data below that frequency was generated through analysis of the *NS-10*s low frequency electro–acoustic parameters and calculating its response.

Before getting deeper into the acoustic measurements of the *NS-10*, however, as Newell and Holland pointed out, one fundamental reason why its time domain response is significantly better than most nearfield monitors at LF is simply that it's a closed box loudspeaker. To illustrate the comparison between a closed box and a reflex-loaded speaker, I've generated two LF simulation curves, showing frequency response and group delay. (See also Colloms article: *Loudspeaker Rhythm and Timing, HIFICRITIC Vol 7 No 4 page 34*.)

The simulation in *Fig 1* is based on the cabinet volume and driver parameters of the *NS-10*, its limited bass extension (-3dB @ 70Hz), slightly humped response and slow roll-off are clearly apparent, while the group delay reaches a maximum of around 3.7mS at 70Hz. *Fig 2* shows what might have happened if the designer Akira Nakamura had decided to aim for extended low frequency bandwidth. Based on a 12litre box volume with a similar driver, low frequencies could easily have reached -3dB at 57Hz, as many contemporaries do. But the group delay increases to almost 11mS at 60Hz – around three times that of the closed box *NS-10*.

This means that a bass guitar fundamental at 60Hz will arrive at the listening position around 9ms after the second harmonic at 120Hz. Expressed in distance, the low fundamentals of the bass guitar (and parts of the drum kit) appear to be located nearly 4m behind the rest of the band. The problem with low frequency group delay for sound engineers is not just that it influences mix decisions (kick drum/bass guitar balance in particular) but that it varies widely between speakers. Unlike low frequency level, which can be adjusted *via* EQ, once its influence has been 'printed' in the mix, it can't be undone.

Reflex loading significantly delays low frequency output, and results in output continuing significantly after the input signal has stopped, and adds several distortion mechanisms, such as dynamic compression, pitch fluency and noise that simply do not occur in closed-box speakers. These again are effects that can influence mix decisions but, because they are non-linear and are time-domain in nature, come without an 'undo' function at the mastering stage.

Closed-box loading explains why the *NS-10*'s time-domain response is good at low frequencies, but as Newell and Holland also discovered, the excellent performance continues into the vital midrange. *Fig 3* shows a 'waterfall plot' of an *NS-10M* from 200Hz up to 20kHz, illustrating how quickly the output from a speaker dies away after a full range signal stops suddenly. Whereas the *NS-10*'s waterfall performance indicates a speaker that

*Fig 1*

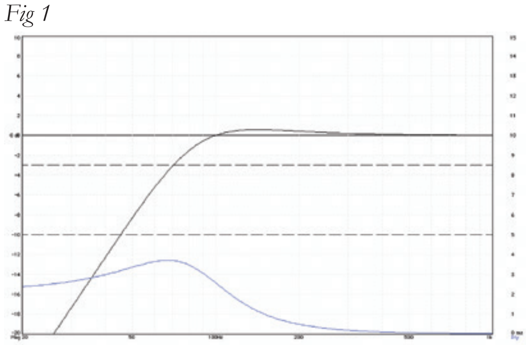


*Fig 2*

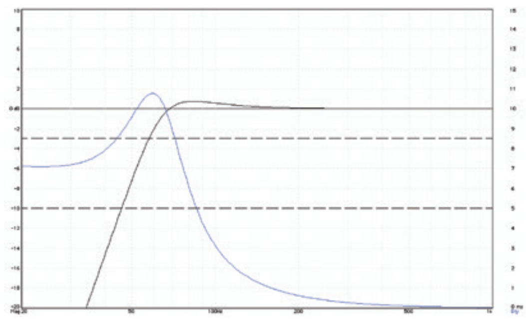


*Fig 3*

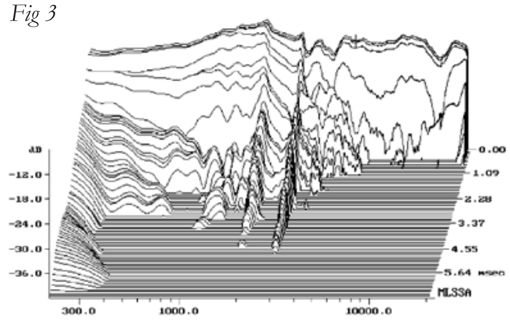
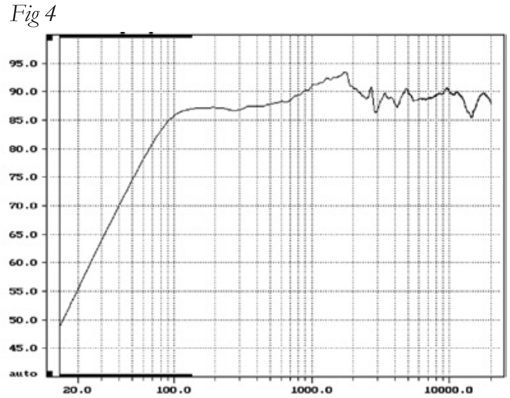



*Fig 4*



achieves -40dB decay within 6ms, most speakers will take twice that long, and many (especially those designed to maximise low frequency extension) will take longer still.

The waterfall plot shows that Nakamura could justifiably consider that in this respect his design using the *NS-10* bass/mid driver is a success, though I suspect that commercial success may primarily have come from its unusual feature – the now iconic white cone. However, the *NS-10*s cone wasn't only unusual in being white, but also how it was manufactured. It was not pressed in a mould but was formed and glued from a flat sheet, and so is straight–sided. This 'curl and join' technique has two consequences for the output. First, a straight-sided cone generally results in a driver with a rising frequency response; secondly, while straight sides maximise piston rigidity and would normally impart a strong 'bell-mode' resonance, the glue join at the seam adds welcome damping. (The characteristic rising response of a straight-sided cone is clearly apparent in *Fig 4*, which illustrates the *NS-10*'s mid-prominent amplitude response, measured at 1m halfway between the bass/mid unit and tweeter.) (Some argue that the rising response compensates for the coupled acoustics of the customary monitor desk location.)

## Using NS-10s

Objectively the *NS-10* is therefore actually a pretty good speaker in the time domain. But if it is so good on this, why do people so often express dislike? I suspect both practical and psychoacoustic answers may be found to this particular conundrum.

First psychoacoustics: thanks to the time domain accuracy and mid-forward balance, the *NS-10* is extremely revealing, and will let you know in no uncertain terms if a recording is poor. Mix engineers have to work harder to make things sound good on the *NS-10*, less because it sounds poor, but rather because even these days recorded music is often a poor approximation of the real thing, and the *NS-10* will reveal the discrepancy. A typical quote in a ProAudio forum on the subject may well read: "…if it sounds good on *NS-10*s, then it'll sound good on anything." That's not because the *NS-10* is poor, but because it is effective at revealing the fundamental compromises inherent in recorded music. So if an engineer has worked hard at a mix on *NS-10*s and overcome those compromises, the mix will translate well to other systems because it is then by definition a good mix.

And the practical problems? The *NS-10*s have a mid-strong balance, little deep bass extension, and by no means the smoothest sounding tweeter. (The impedance is relatively low too, which may challenge some amplifiers.) And the mid-heavy/bass-light balance is especially apparent if the *NS-10*s are not mounted close to a suitable boundary, such as a mixing desk or a rear wall, to provide reinforcement.

*NS-10*s are just as revealing of any shortcomings in a monitoring chain – desk, interface or amplifier – as they are of a mix, and also don't take very kindly to being driven to high levels either. While Newell and Holland showed that they have very low levels of distortion (relative of course to their bandwidth and maximum potential SPL), they do suffer from thermal compression. This will not only result in lower sensitivity in response to high drive levels, but upsets the frequency responses of the crossover filters as the resistance of the driver voice-coil increases. *NS-10*s driven too hard by a poor amplifier fed by a sub-standard monitor amplifier and mounted without boundary reinforcement might well sound indifferent to the point of being unpleasant.

## The Final Question

One question remains: why has no nearfield monitor manufacturer succeeded in producing an effective replacement for the *NS-10* (leaving Avantone shamelessly to create a clone today). It is, after all, not rocket science to design a small closed-box speaker with reasonable power handling and a good time domain performance. First, the market-driven desire for greater bass extension from small boxes has produced a generation of monitors with really poor low frequency time-domain performance, and that poor performance has become the norm.

Secondly, those responsible for conceiving and marketing nearfield monitors seem not to understand well enough how monitors are used, and how important the time-domain performance is. Furthermore, most users don't really appreciate how important a monitor's low frequency timing is, and it took a group of academics to examine what it was about the *NS-10* that worked so well. And since Yamaha's post-*NS-10* nearfield monitors are all reflex-loaded, that baby has been well and truly thrown-out with bathwater.

Thanks to Phil Knight for help with the *NS-10* measurements and to Chris Binns for advice on the text. An extended version of this article first appeared in *Sound On Sound* magazine.

(The ongoing commercial success in the hi-fi sector of the tiny sealed-box BBC *LS3/5a* design from the 1970s is arguably further evidence of the importance of group delay and the relevance of sealed-box loading – Ed) (See also corrected group delay in the sealed-box *Kii THREE*, reviewed in *HIFICRITIC Vol12 No4*.)

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