# Reel to reel tapes info

When reel-to-reel tape was still a studio/consumer product, BASF followed a naming convention that defined the product type. In 1984 it became clear that open reel tape was only going to be a professional product in the future, and the naming convention changed with the introduction of "SM 910"--Studio Master 910. The US market named the consumer products differently, and that accounts for addition confusion. The general run down of products and naming conventions follows.

The product type was first defined by a two-letter designation describing the playing length, followed by a number defining the total thickness of the tape in microns. If the tape were back-coated, an "R" for "rueckseite" followed the playing length. The final letters, if they appeared, described the type of coating.

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SP 50 = standard play for 50-micron tape with 1.5 mil base film; 1200' reels
LP 35 = long play for 35-micron tape with 1.0 mil base film; 3600'/1800' reels
DP 26 = double play for 26-micron tape with 0.75 mil base film; 2400' 7" reels
TP 18 = triple play for 18-micron C-60 cassette tape; 15,000' pancakes
QP 12 = quadruple play for 12-micron C-90 cassette tape; 23,700' pancakes
XP 9 = extreme play for 9-micron C-120 cassette tape; 10,800' pancakes
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"LH" stood for "low noise, high output" oxide used for better than average performance. "LHL" was a formulation for low printthrough, and "LHS" was an advanced oxide with slightly higher coercivity intended for consumer use at slower 3.75/7.5 ips recordings rather than the more common 15 ips speeds used in the studios. So the SPR50 LHL from the late 1970s was a 1.5 mil backcoated studio tape with lower printthrough than normal.

For the US, the names differed a bit:

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Performance = 3600'/1800' reels of LP35 standard oxide
Studio = 3600'/1800' reels of LP35 LHS for slower consumer speeds
Professional = 3600'/1800' of backcoated LPR35 LH for professional use
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In the mid 1980s, it was "clear" to the marketing departments that open-reel was dead as a consumer product. In the US, the product managers tossed out scores of unopened boxes of open reel tape into a dumpster. I climbed in and rescued them all for preservation and my own use. The professional group continued to sell the product, of course, and the naming conventions changed to distinguish the use of the product.

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LM 920 Loop Master chrome tape in 1- and half-inch width for loop bins
LM 921 Loop Master bin tape with an improved formulation
SM 910 Studio Master tape in widths from quarter inch to 2 inch; 50 microns
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SM 911 Studio Master tape with reduced modulation noise that replaced 910
SM 468 Studio Master tape inherited from Agfa; very high coercivity
SM 900 Studio Master tape to compete with Ampex 499 and 3M 996
LPR 35 a throw back to the old naming convention for 1 mil tape
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It should be noted that BASF, unlike Agfa, Ampex, and 3M, never used the polyurethane infamous for breaking down over time and causing sticky tapes. I've used a lot of open reel tape over the years, and there is no other tape that outperforms BASF mechanically. Maxell made a great open reel tape; but in published, independent comparison tests for electro-acoustic properties of consumer open reel tapes, BASF was the regular winner. All of the tapes I salvaged years ago still wind perfectly with no significant rub off and no sign of shedding.

The story I heard was that our chemical group refused to use the questionable polyurethane binder, not because of environmental concerns about longevity, but because Agfa-Gevaert held a license for it. They refused to pay Agfa for anything. That's why PEM 469 and 469 had shedding problems and SM 468 and SM 911 / LPR 35 LH(S) did not.

If you're not having a problem with the sample you have and all of the others come from the same lot, then you may have product that Agfa produced with a different binder. They caught on quickly to the breakdown and were one of the first to promote the heat treatment for temporary salvage. I'd keep the tape and watch it closely for awhile. If no problems show up, you've got a great tape.

After we bought Agfa, I wanted to stay with PEM 469 because it was already in use in some studios. The problem was that Agfa had a very small market share compared to Ampex and 3M, and PEM 469 had a reputation sullied by the binder breakdown. We decided to bring in SM 911 and 900 instead and price it slightly below Ampex and 3M. That was the biggest mistake of my career at BASF. No one was interested. Fortunately, no one noticed either. So I changed my mind and raise the price 15% above Ampex and 3M. That's when the studios got curious. (A "cheap" European tape is not interesting; but an expensive Porsche/Mercedes/BMW/Audio image is intriguing--especially when the client, not the studio, pays for the tape.) That's when sales really began to increase. Once 3M dropped out, we had the future wide open--until BASF sold the tape division off and fired all the experienced people.

# cassette tape info

A data sheet for a tape has almost all the explanations of tape differences. However, they are hard to understand because of all the curves. Tape experts can judge a tape's electro-acoustic performance from a data sheet and estimate what it will sound like on a machine calibrated for a different tape and know what adjustments need to be made in order to align a deck to the tape described on the data sheet. The only quality parameters not mentioned on a data sheet are mechanical ones: rub-off, adhesion to the base film, stiction, surface polish, and so forth. (If I ever get time, I'll finish the paper on how to read a data sheet.)

1) Frequency response curve--although data sheets are full of curves, those curves represent the effect that bias current has on the output of number of signals at different frequencies. None of the curves is flat. If the sheet shows that a sweep of 12.5 kHz is 6 dB below the output for 315 Hz at -20 dB below the reference level, then the record pre-emphasis must be boosted by 6 dB at 12.5 kHz in order for "flat" response. I have nver seen the type of frequency response curve familiar to consumers on a tape data sheet because that type of curve is reliant on the hardware.

2) MOL is a very important characteristic, but it is offset by noise. Metal tapes have very high MOL values, but they also have poor noise levels. Their signal-to-noise ratios are often little or no better than those for high performance Type II tapes with lower MOL values and lower noise. MOL is a function of magnetic pigment, coating thickness, loading values (ratio of pigment to binder), and uniformity of particles and alignment. The values given in remanence figures correspond to MOL.

3) SOL defines short wavelength output at the point where an increase in input level no longer produces any increase in output because the tape saturates, that is, the high signal level begins to erase the output. This point is hard to define, so greater precision is given when two tones having a frequency difference of 6% are recorded simultaneously and the intermodulation between the two reaches 26.6 dB. SOL values are largely dependent on coercivity. The harder it is to coerce or force a particle to switch its magnetic poles, the harder it is for the particle to self-erase. Type IV metal tapes have the highest coercivity and, therefore, the highest SOL values for cassette tapes. For open-reel tape, SOL is less critical because the higher tape speeds increase the room for wavelengths and dramatically reduce the effect of self-erasure. However, note that "consumer" tapes often show slightly higher values of coercivity because they are designed for acceptable performance at 3.75 and 7.5 ips rather than the studio speeds of 15 or 30 ips.

4) Noise--there are several different measures of noise. Bias noise (a function of particle uniformity and alignment), modulation noise (a function of uniformity of dispersion within a coating, particle uniformity, and surface smoothness), and DC noise (particle shape and distribution). These noises depend on the tape design and processing far more than on any hardware. Chromium dioxide tapes are the best for all of these types of noise because the particle is a "perfect" shape--a long, thin glass-like rod with no external deformities. The shape makes the pigment easy to disperse and align in a coating and gives chrome the low noise values it has. Metal particles, although extremely small and nicely shaped, are very difficult to align because of their enormous coercivity. Coercivity gives metal tape the highest SOL values and excellent MOL values, but those values are reduced by the very high noise levels. For standard oxides, lower noise is a function of the pigment processing to reduce deformities of the particles (often called "dendrites"--Greek for "tree" because the uniformities look like branches coming from a tree trunk) and of the milling process to isolate and evenly disperse the particles within the coating. Ions of cobalt can be added to some standard oxide particles to raise their coercivity at the risk of some instability unless processing steps are taken to reduce the risk of lost remanence from physical forces (the magnetostrictive effect).

5) Uniformity is critical for tape, but what you described is a function of physical stability within a cassette housing, which brings up all sorts of other issue. Tape uniformity can mean two things: A) no deviation from batch to batch; and B) no deviation from beginning to end or from width to width. BASF held very tight specifications for batches of tape so that sensitivity at 315 Hz, for example, did not vary more than +/- 0.5 dB and for 10 kHz more than +/- 1.0 dB for millions of

kilometers of duplication tape. This was because duplicators did not want to have to realign equipment for every batch that was delivered for their music cassettes. The beginning of a 23,000-ft cassette pancake should have exactly the same values at the end of the pancake so that the first cassette from the roll should sound exactly like the last cassette.

In studio production, it was even more critical because the sensitivity across a 2-inch width of tape should not vary at all because multiple tracks had to remain in balance. BASF used a knife coating method, and the knife was controlled by a computer that sensed output of the coating and automatically adjusted thickness for uniformity of output. The values of thickness could change slightly through a reel or pancake, but the sensitivity did not. (I believe that Ampex and 3M also used the knife method while the Japanese used gravure coating. Stories about Nakamichi selecting only "center cuts" from TDK production may indicate why BASF/Agfa, Ampex, and 3M produced 1-inch and 2-inch mastering tapes and not the Japanese.

There was a very distinct difference between tapes not only in pigment but also in processing. Now that there are only a few producers making only a few types, the differences are fewer that they used to be.

# the end

BASF AG tried to unload the tape division to RAKS, the Turkish company, in September, 1996; but there was a riot when German workers found out. The deal was called off. In October of the same year, BASF AG convinced Kohap, the Korean chemical company, that buying a magnetic tape company made good sense for vertical integration. The argument was that demand for VHS video tape would remain strong with continuing but slow growth until demand peaked in 2010--that's last year!--with a slow decline in subsequent years. The BASF management actually believed it and forced anyone with a different opinion to keep quiet. Kohap fell for it.

Kohap arranged to keep the BASF logo for five years, with the "by EMTEC" qualification in place until such time that EMTEC would appear in the white rectangle in the logo. EMTEC was the subsidiary fully owned by Kohap, except in the United States where BASF management sold rights to distribute EMTEC products to Joseph Ryan (professional products, which was the only profitable division) and Sigmar Tullman (computer products). The reason for this odd approach was that the Department of Justice could not stop these "independent" distributors from their business if BASF were found guilty of price fixing for a third time. Kohap was not aware of this arrangement and was furious when they found out. In 1998 Kohap bought the professional and computer business back, but Mr. Ryan, who had named his company "JRPro Sales" after himself, had in six months brought the professional division to such losses that EMTEC could never recover. Korea fell into a severe recession a few years later, and Kohap was forced to sell off EMTEC to investment bankers. Once these bankers saw the books, they were appalled. It didn't take long for them to break the company apart and sell off whatever they could to anyone interested. Imation and Aurex bought some equipment and raw materials. Most of the rest went to scrap.

BASF had an operation just across the German border in France where audio and video tapes were loaded into housings molded and assembled in the same plant. I don't know why these cassettes are labeled "Made in Korea" unless they are part of an arrangement with SKC. SKC, Aurex, and BASF were all engaged in price fixing bulk audio tape in 1994 and 1995, and there were meetings in Seoul, Korea even in early 1997. S.K. Moon from SKC attended the first meetings and was fired for refusing to attend any more. He sued SKC in the state of California, and that's when the U.S. Justice Department got wind of the arrangement. Two weeks after Moon sued SKC, BASF Magnetics announced the fire sale to Kohap and fired Terry O'Kelly, the only BASF director who refused to participate in any illegal meetings at all. Since Kohap had no tape production, loading, or packaging equipment at all in Korea, these cassettes are either from SKC or from Saehan, another supplier to BASF in those days. Even though there was a loading and packaging operation in France, if the cassettes say "Made in Korea," they would have to have come from either SKC or Saehan.

The reason for the long story is that it had a lasting affect on tape production. In 1996 BASF Magnetics in the U.S. was expanding its professional division, and a number of Quantegy executives had asked O'Kelly if they could be part of that expansion. They all knew that VHS and audio cassettes had a limited life, but pro audio/video could be based on tape products if there were a reliable source. BASF had hired top sales people from Quantegy, Fuji, and Sony in the summer of 1996; and there was every reason to believe that BASF could easily become the largest and most stable tape supplier in the world. The threat of the price fixing lawsuit destroyed all that. BASF replaced O'Kelly with Ryan, the new sales people quit and sued BASF for "misrepresentation," and what was formerly the most profitable division began to bleed money. 3M had abandoned tape; Quantegy was struggling; and now BASF shot itself in the face. Recording studios watched all of this and decided that a move to digital was the safest bet. Analogue tape recording did not have to die off as quickly as it did.

# sticky shed syndrome

The sticky-shed syndrome is a function of a breakdown in the polyurethane binder used for the magnetic coating due to hydrolysis--allowing water molecules to attach themselves to the magnetic pigment. The "baking" method merely drives the water molecules out of the coating for a temporary fix. Repeated bakings are less effective because the heat itself may stress the coating chemistry. The only association with backcoating that I am aware of is coincidence--the binder used was expensive and used almost entirely on premium tapes that were always backcoated. The problem is the oxide coating, not the backcoating.

Calendering is a process of using rollers filled with either hot or cold water or oil--the choices varied depending on the type of coating--that squeeze the magnetic surface of the magnetic coating to flatten and polish it. Backcoating is applied after calendering because the surface of the backcoat must be rough enough to allow air to pass across its surface in order to provide smooth winds at high speeds.

I don't know enough about molecular chemistry to offer any expert opinion about the effectiveness of using NuFinish to resolve the problem, but I do know that surface finishes were applied to some tapes after coating and calendering for specific applications. The composition of NuFinish is designed to add a quick-drying lubricant to the surface of paint and to use micro- or nano-particles to fill in scratches so that the paint surface looks smooth.

Magnetic tape is little more than magnetic paint on plastic film. In fact, the first tapes were reddish brown because the ferric oxide used was very similar to that used in inexpensive paints. Barns are red or reddish-brown because the color pigment used in those paints is iron oxide--cheap, stable (it's already rusted!), and effective. Applying a paint finish to a magnetic tape is not that far off the mark.

Those who have tried it claim that it allows tapes formerly cursed with the binder breakdown to not only run without sticking but to be able to reproduce themselves effectively, even after long periods of time. That would be significant. If that works predictably for every binder-failed tape that needs to be transferred to another medium, it would be a better solution than baking a tape. However, if the treated tape is to be kept as a master, then one must investigate some other considerations: 1) does the treatment work for all the various binders that have failed (Ampex, Agfa, 3M); 2) does the treatment last for all the various binders; 3) does the treatment lead to any other deterioration; 4) does the treatment have any effect on headwear; 5) does the treatment have an effect on gap life?

Micro- and nano-particle technology have come a long way since tapes have been manufactured, as has polymer technology. It would not be a surprise to me that developments meant for auto paint finishes would also work for magnetic paint finishes. It's a pity BASF got out of tape so soon because they are also a very large auto paint supplier.

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The code works this way:

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SP50/52 = single play on 1.5-mil base film; total thickness from 48-50 microns
LP35 = long play on 1.0-mil base film; total thickness from 35-36 microns
DP26 = double play on .75-mil base film; total thickness 26-29 microns
TP18 = triple play for cassette C-60 tape or super-thin open-reel
QP12 = quadruple play for cassette C-90 tape
XP9 = extended play for cassette C-120 tape
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For reels, the lengths are:

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7-inch reel 10.5-inch reel
1200 feet 2400 feet SP50
1800 feet 3600 feet LP35
2400 feet DP26
3600 feet TP18
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If there is an "R" after the length designation, the tape is backcoated. The next two or three digits designate the type of coating. "SPR50 LHL" was a studio tape on 1.5-mil film with a total coating thickness of 52 microns, including the backcoating. The oxide was Low noise, High output, with Low print levels.

The gray cases or black cases were used for a number of different "domestic" or consumer open-reel products. SP52 was a "general purpose" tape with average performance. Although LP35 LH and LPR35 LH would seem to differ only in the backcoating, they used different manufacturing processes so that the former was an average tape while the backcoated version was a much higher performance tape suited for 7.5 or 15 ips recording. LHS tape had a higher coercivity designed for good performance at 3.75 or 7.5 ips recording speeds. Over the years oxides and processes changed more often than the names, so it is sometimes hard to equate performance with just a name.

Although BASF did not suffer from binder breakdown, the standard LH formulation--called "Performance" in the U.S.--did have some slight granular rub-off of the oxide. LPR35 and LP35 LHS were as clean as a whistle--I have never found oxide on guides or heads when using those tapes.

# Ampex and SSS

Unlike Ampex, who used polyurethane in their binder mix, when the SSS issue came to light in the early 1990s, in a meeting (organised by Ampex BTW) between the tape manufacturers and the ARP, BASF stated they only ever used polyethylene in their binder and their tests showed it did not suffer from hydrolysis. This tape may be suffering from other break down cased by poor storage. It’s likely to be heading for 40+ years old as it is. The boxes may look ok but if the RH of the storage area is too low or it’s subject to extremes of dry heat or cold, that could affect it. BTW Ampex made more 456 than any other tape from any other manufacturer by a long margin and for a long time. Over that period they bought binder in from a number of suppliers, 3M being one.

The issue that causes SSS is hydrolysis. All PE binder suffers from this but the “string length” of the PE strands dictate how quickly this occurs. Test made on short string PE showed it could suffer from hydrolysis within 48 hours. But long stringed PE binder was inconsistent in its coating of the backing making the tape surface bumpy. Medium string was the compromise. But until Ampex installed gas spectroscopy equipment in their production plants in 1981 to check the consistency of string length, the previous binder mixes they used had a variable mixture of string lengths. Hence not all 456 suffers extreme SSS, but due to the late introduction of the GS inspection kit in the manufacturing lifespan of the product, the chance that Ampex products do suffer SSS is likely. Coupled to this is storage conditions: The ideal temp and RH, both or which, the tape manufacturers recognised that the users of their products were very unlikely to have in their tape stores. And you thought reel to reel was just a bit of rust moving over a bit of metal to make a sound!

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