

Sound Talk®

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Scotch® Magnetic Tape

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THE HANDLING & STORAGE OF MAGNETIC RECORDING TAPE

Much of the world's entertainment and historical events are being preserved on magnetic recording tape. Professional recording studios and tape duplicators, historians and educators, audiophiles and home recordists are all concerned about the permanence and recoverability of the information that is invisibly stored on a thin plastic ribbon.

The preservation of both operating and historical recordings is the primary concern. But, another factor of real importance is the prevention of damage to the recording tape, not just so the information will be safeguarded but so that the maximum use may be obtained from every reel of tape. Both of these factors are economic in nature.

If stored information is unrecoverable because of either lack of safeguards by operating personnel or major catastrophe during storage, the result could be anything from temporary inconvenience to a complete loss of a recording library. If reels of tape are failing before their normal life expectancy, operating expense is increased. Of course, this, too, is undesirable.

This issue of SOUND TALK will discuss in depth the considerations and practices that 3M Company considers of greatest importance to the user of magnetic recording tape. If every one of the many suggestions were followed completely, an ideal situation would exist. Since many recording facilities will function adequately with less than the ideal, you may wish to adopt only a portion of the recommendations. Some of the precautions may be considered too time-consuming or too costly for a given application. In short, it can be said that the overall performance of magnetic recording is directly proportional to the care that is exercised in the two important topic areas: HANDLING & STORAGE.

THE BASIC FACTS

Modern magnetic tape coatings have the ability to retain the intelligence placed on them during the recording process for an infinite amount of time. The recorded information does not tend to fade or weaken with age. It is essentially permanent and will remain unchanged until actually altered by an external Magnetic Field. This erasing of the tape may be done *intentionally*, so that the tape can be used for another recording, or *accidentally*, by operator error or poor storage procedures. Later in this paper the matter of accidental erasure will be more fully discussed.

Even though the magnetic signal will not deteriorate, the physical properties of the recording medium are susceptible to damage. As a general rule, the problems encountered with recording tape performance are predominantly physical in nature. Therefore, it is important to preserve the tape in a form that will make it physically possible to recover the recorded information

when needed. Poor handling habits or faulty procedures can render a tape useless because of physical damage. A great deal can be said about the physical preservation of recording tape; and to make the information more meaningful, each of several topics will be treated separately.

THE RECORDING AREA

Ideally the equipment room of a recording studio or professional recording facility should approach, as closely as possible, a "clean room" environment. By definition, this area is characterized by the absence of normally expected airborne dust and lint. The design of the recording equipment area should be such that reasonable control of temperature and relative humidity can be exercised. Variations of temperature should be held within $\pm 5^\circ$ F. of a pre-selected value and the relative humidity should be kept constant to within $\pm 10\%$. In broad terms, this would be a temperature in the 70's and a relative humidity of about 40%.

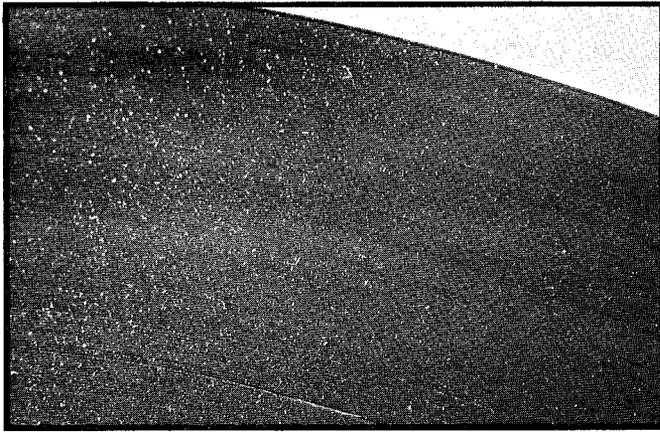


FIGURE 1. ENLARGED VIEW OF DUST CONTAMINATION ON A REEL OF TAPE.

It is doubtful that smoke will contaminate the tape, but ashes can. Therefore, smoking should not be allowed directly over the machines or when handling tape. Food and drink should also be prohibited. Minute food particles can easily be transmitted to the tape and tape decks from the operator's hands. A spilled drink will contaminate not only the tape but also seriously affect a machine's operation.

The integrity of the equipment area should be maintained by periodic cleaning of shelves and floors. When vacuum equipment is used for cleaning, the exhaust from this unit must be located outside the room.

Aside from the direct benefits gained from a well maintained, clean, temperature and humidity controlled environment, the psychological effect upon the employees is of great importance. It is found that operators exercise more care and are more concerned with quality when working in an environment such as just described.

When recording on location or at home, it may be difficult to control the surrounding environmental conditions. Contamination (dust, dirt, debris) can enter the tape transport and cause tape damage. The only positive method of preventing contaminated tape is to eliminate the entry of foreign material into the machine. It is recommended that the recorder (and playback unit) always be covered during storage and as much as possible during operation. Some equipment manufacturers provide, or have available, some type of dust cover which covers the tape drive mechanism and effectively seals out contamination. Many of the protective covers permit the machine to be operated while they are in place and are ideal for use in uncontrolled environment.

TAPE STORAGE

The temperature and humidity of the tape storage area should closely approach that of the work area. The smaller the environmental change experienced by the tape, the better will be its operation and reliability. As a general rule, a temperature between 60° and 80° F. and a relative humidity between 40% and 60% is recommended. If the environmental conditions of the storage area vary widely from the recording area, allow time for the tape to reach temperature and humidity equilibrium before putting it into use.

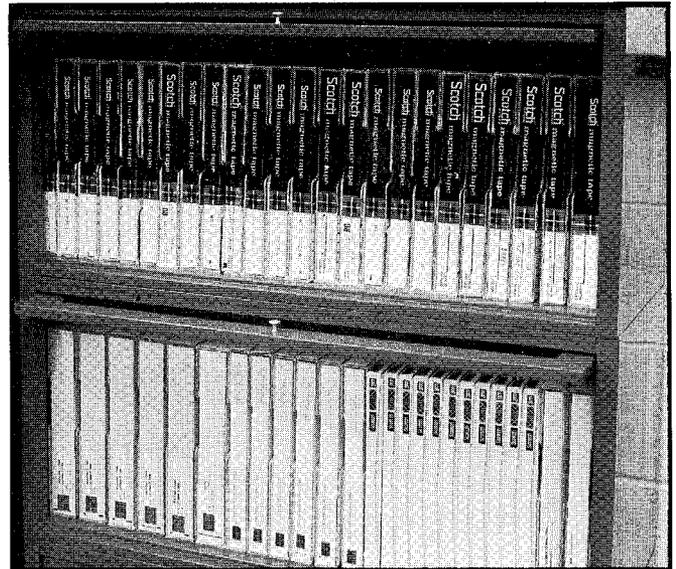


FIGURE 2. EXCELLENT STORAGE METHOD FOR WIDE WIDTH PROFESSIONAL TAPES.

Recording tape, especially cartridges and cassettes, stored or casually laid on the dashboard or in the glove compartment of an automobile can be damaged by the heat generated by strong sunlight. The molded cases used for some cartridges and cassettes can be permanently distorted if subjected to high temperatures. Both cartridges and cassettes use splices within their tape rolls which can be affected by heat. The splices may separate, and the adhesive may soften and "ooze" from the edges of the splice and stick to adjacent tape layers. The exposure of the splice adhesive will also collect any contamination present in the case, causing additional problems.

Protection from accidental erasure while in the storage area is easily accomplished and is, ironically, of little concern. There are two reasons why this is true. First of all, fields strong enough to cause erasure are just not normally found in an "office or home" atmosphere.

Secondly, if the tape is kept as little as 3 inches away from even a strong magnetic source, this spacing should be sufficient to offer adequate protection. During storage, the tape must be enclosed in a container (original box, plastic case, tape canister) for several reasons. One reason is to provide protection from physical damage. Another reason for using a container is obviously protection of the reel from dust.

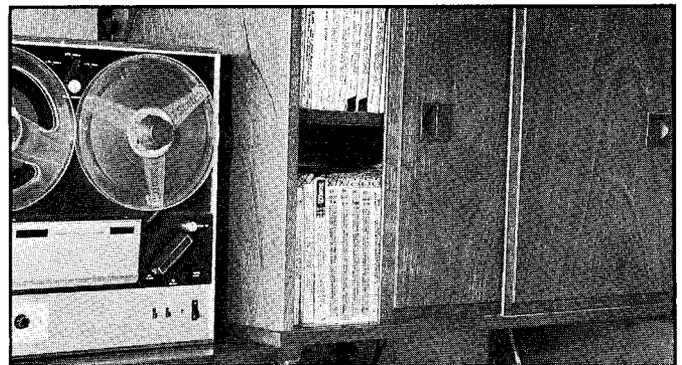


FIGURE 3. TAPE STORAGE AT HOME.

The closed containers should be placed into storage on edge, so that the reel is in an upright position. While they may also be stored individually, lying flat, tape boxes should never be stacked so high that there is a possibility of crushing or distorting the bottom container from the excessive weight of the stack, since this could cause edge damage to the reel of tape in that canister. For long term storage, additional protection from dust and moisture can be gained by sealing the container in a plastic bag. It is generally considered good practice to clean the container before using it so that dust that has accumulated during storage will not contaminate the recorder or tape.

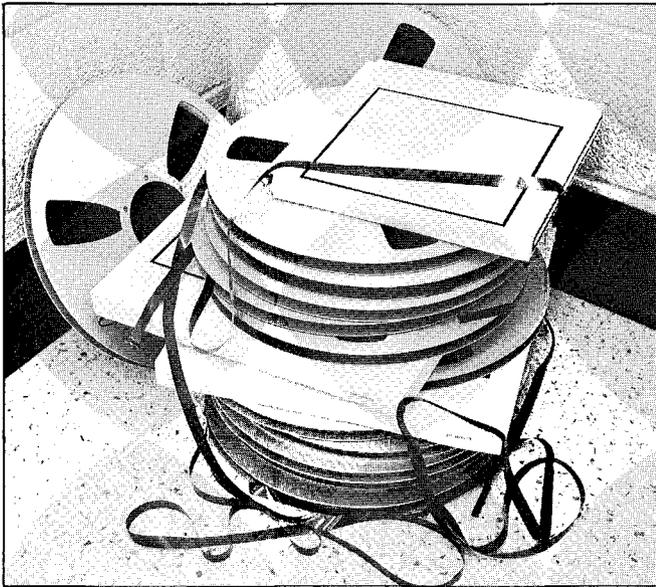


FIGURE 4. OBVIOUSLY THE WRONG WAY TO STORE TAPE.

The care exercised in preparing tapes for storage is every bit as important as the excellence of the storage area. Of primary importance is the way the tape is wound on the reel, since poor winding can result in distortion of the tape's backing.

A wind tension that is relatively low is recommended. Three to four ounces per $\frac{1}{4}$ inch of tape width is sufficient to render a firm, stable wind on an NAB hub or reel configuration. This tension, while great enough, does not result in high pressures within the roll that could permanently distort the backing. Backing distortion, caused by extreme pressures within the tape pack, may result if a roll of tape wound too tightly is subjected to an increase in temperature while in storage.

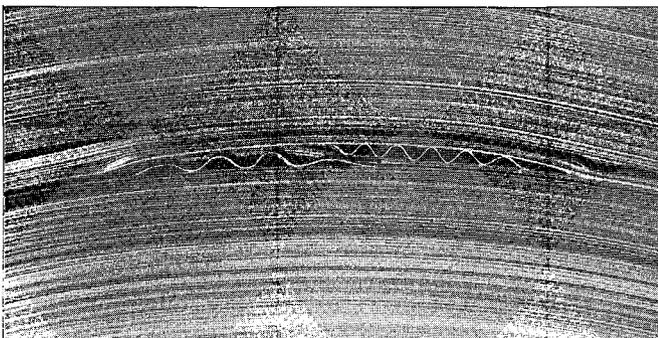


FIGURE 5. CINCHED TAPE. NOTICE DISTORTION OF TAPE LAYERS.

Just as there is the possibility of problems if the tape tension is too great, too low a wind tension can cause difficulty too. If the wind is too loose, slippage can occur between the tape layers on the reel. This "cinching," as it is called, can distort the tape by causing a series of creases or folds in the area that has slipped. When the roll is unwound, the surface will be wrinkled. When an attempt is made to use the tape again, the wrinkles and creases will disrupt the necessary intimate contact between the tape and the head. Because the tape is repeatedly lifted from the head, the result will be a series of signal variations. If the tape is properly rewound immediately after cinching, there is a good possibility that the information may be saved.

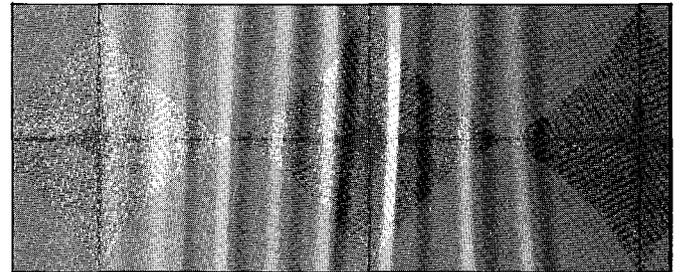


FIGURE 6. TAPE DAMAGE CAUSED BY CINCHING. THIS STRAND OF TAPE CLEARLY SHOWS THE WASHBOARD-LIKE WRINKLES.

Some recorders now in use do not have a method of adjusting wind tension; therefore, care must be taken while operating these machines. Sensible operation of "Fast Forward, Rewind and Start" controls can eliminate the sharp stress loading associated with starting and changing tape directions. Tape distortion and "cinching" can be reduced by allowing a minimum slack loop when threading and starting the machine. It is also good practice to allow the spinning tape reels to completely stop before changing tape direction.

Along with proper tension, another important consideration is wind "quality." The successive layers of tape should be placed on the reel so that they form a smooth wind with no individual tape strands exposed. A smooth wind offers the advantage of built-in edge protection.

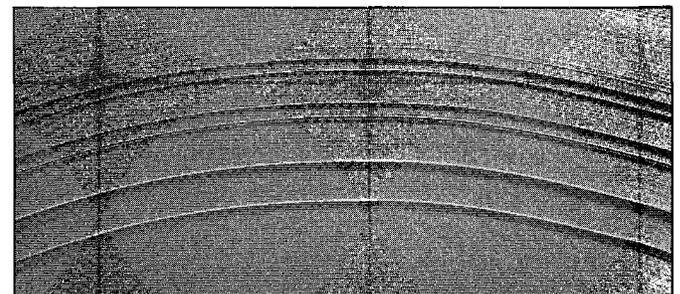


FIGURE 7. SCATTERED WIND. INDIVIDUAL TAPE STRANDS ARE EXPOSED AND VULNERABLE TO DAMAGE.

A scattered wind will allow individual tape edges to protrude above the others. Since there is no support for these exposed strands, they are vulnerable to damage.

It is sometimes suggested that tapes in storage be rewound at specific intervals, such as every 6 to 12 months, to relieve internal pressures. This would be recommended for tapes of marginal quality or for those with other

than heavy duty binder systems. For modern day tapes with polyester backings and advanced binders, this periodic rewind might not be necessary.

A good practice, however, is to select a random sample from various areas of the library for visual inspection. The reels chosen can be examined for loose winds and dust accumulations. They should be checked for rippled edges and other signs that indicate the presence of physical distortion. If anything is found that indicates a problem may exist, additional samples should be inspected to ascertain what percentage of the library may be affected.

If the above recommendations concerning the storage environment and the actual preparation for storage are followed, no serious problems should be encountered even in long term storage.

WHEN TAPES ARE SHIPPED

It is sometimes desirable to send recorded tapes from one location to another. There are certain precautions that apply to the shipment of recording tapes that should be followed to insure safety in transit.

Logically, the first consideration would be the physical protection of the tape while being transported. The outer shipping container into which the tapes are placed must afford the necessary strength and rigidity to protect the tape or tapes from damage caused by dropping or crushing. While a container that is 100% water-tight would not be necessary, it must nevertheless provide a reasonable degree of water resistance. It should, for example, be capable of protecting the contents from being damaged if, during shipping, it is left on a loading dock in the rain.

While it is good practice to always secure the free end of a reel of tape, it is particularly important when preparing reels for shipping. A short length of pressure sensitive tape is all that is necessary.

While the purely physical shipping precautions are not unique to magnetic tape but are considered good practice in preparing any item of value for transport, there is another consideration that is of prime importance. Since the tape is a carrier of magnetic information, measures must be taken to protect the reels from accidental erasure.

Laboratory conducted tests have determined what would constitute adequate protection from stray magnetic fields of a magnitude which may possibly be encountered in transit. It was found that field strengths within the tape of 50 oersteds or less caused no discernible erasure.

The average bulk degausser, purposely designed to produce a maximum external field that is used to erase tape while still on the reel, produces a field of 1500 oersteds. Sources of magnetic energy to which tape being shipped might be subjected would be motors, generators, transformers, etc. These devices are designed to contain their magnetic fields to accomplish some type of work. With this in mind, it is safe to assume that field strengths of more than 1500 oersteds would not be encountered in ordinary shipping situations.

Because field intensity decreases rapidly with distance from the source, the 50 oersted point (mentioned earlier as not affecting the tape) is reached at a distance of 2.7 inches from a 1500 oersted source. From this it can be seen that the easiest and least costly method of obtaining erasure protection is by insuring a degree of physical spacing from the magnetic source. It is suggested that tape being prepared for shipment be packed with bulk spacing material such as wood or cardboard between the tape boxes and the outer shipping container.

Based on the information in the paragraphs above, 3 inches of bulk spacing should give adequate protection and virtually eliminate any potential for erasure. This magnetically protective spacing can also be justified because of the excellent protection gained against physical damage to the contents.

Tape in transit may be subjected to temperature extremes. Temperatures as low as -40° F. might be encountered in the cargo hold of high flying aircraft. A temperature of 120° F. could be encountered in a motor vehicle in the summer sun. It must again be emphasized that all incoming tape should be allowed to reach environmental equilibrium before being used.

GOOD OPERATING HABITS

The container in which the tape is stored is probably the cleanest area in the recording studio; and, of course, this is the reason that tapes should remain in the box until actually placed on the tape deck and be returned to the container immediately after use. To maintain the cleanliness of the container, it should be closed when the tape has been removed for use.

The hub is the strongest and most stable part of the reel. *Always handle the reel by the hub and not the flanges.* If this single fact is remembered, you will never be guilty of squeezing the reel flanges together when picking up a roll of tape or when handling it.

It has been said that careless handling and poorly adjusted tape decks are the two predominant reasons why tapes fail prematurely. If strict attention is paid to these two areas, immediate benefits will be noted in increased tape life, and the threat of information loss will be substantially reduced.

When handling tapes, use utmost caution to insure that the tape does not become contaminated by fingerprints. Simply stated, fingerprints are nothing more than deposits of body oils and salts. These oils will not attack the oxide-binder system, but they will form excellent "holding-areas" for dust and lint.

Fingerprints on the backing are just as serious as on the coating because dirt deposits will transfer from the backing of one wrap to the coating of the next wrap on the reel. When a reel that has been contaminated in this manner is put into use, the tape deck itself can be affected and will spread this contamination to other clean reels of tape that are used after the dirty reel.

This is one of the reasons for stressing the importance of visually inspecting the tape deck after each roll of tape is run to determine if cleaning is necessary. If the deck becomes contaminated with dust or wear products

from the tape, complete contamination of an entire roll of tape can easily be the result. Contaminants can collect on heads and guides and be dumped along the backing or coating surface of the tape. This contamination will then be wound into the reel under pressure, causing it to adhere firmly to the surface. Each one of these deposits will appear as a dropout or group of dropouts the next time the tape is used.

Tape contamination caused by fingerprints can be reduced by remembering not to touch the tape unnecessarily. Frequent cleaning of the tape deck will reduce the chance of spreading contamination from one reel of tape to others in the library. A cotton swab or lint-free pad moistened with Genesolve-D (an Allied Chemical Trademark) or Freon TF (a DuPont Trademark) or similar cleaner is recommended for cleaning all components along the tape path. If other types of cleaning agents are used, they should be given time to thoroughly dry before loading the tape. This will prevent damage, should the cleaner have any tendency to attack the magnetic tape. Accumulation of tape wear products on the transport can be largely eliminated by using a high reliability tape.

Empty reels should be thoroughly inspected and cleaned before winding tape on them for storage. Reels with hub damage, such as a plastic burr, or with dirty hubs can cause tape distortion exactly as outlined in the preceding paragraphs. Maintaining reel integrity cannot be over emphasized since valuable information can be lost, not because of tape failure but because the tape was distorted by a dirty reel.

One of the most serious and more common forms of tape failure is generally categorized as edge damage. Damaged edges can be caused by the reel, the tape deck or the operator. A broken or badly distorted reel can quickly damage a tape. The effect of a broken or cracked flange is easily noticed since the tape will exhibit a series of nicks or mutilated areas along one edge, and the cause can be easily detected because of the obvious defect in the reel. A bent or distorted reel, however, can also cause damage to one or both edges if the tape is allowed to rub against the flange when being used. A similar type of edge damage will also occur if any of the deck components are misaligned.

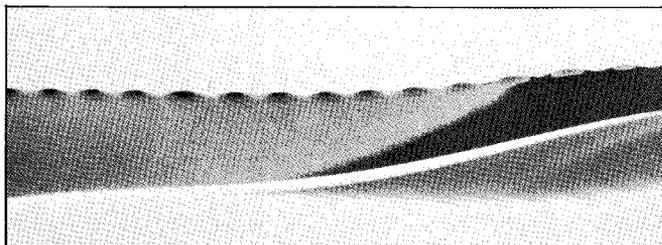


FIGURE 8. SEVERE EDGE DAMAGE.
NOTE THE WAVELIKE WRINKLES ALONG EDGE OF TAPE.

Either of these faults can result in complete failure of a roll of tape. Not only will the edge track be lost, but the debris generated from the edge damage can be redeposited onto the surface of the tape across the entire width. An examination of the edges of a tape that has been damaged in this manner would disclose an accumulation of backing oxide debris.

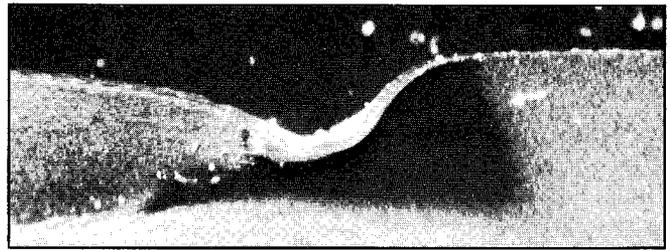


FIGURE 9. MICROSCOPIC VIEW OF A DAMAGED EDGE.
AFFECTED AREA EXTENDS ABOUT 15 MILS INTO TAPE.

While this type of damage is serious, it is sometimes difficult to ascertain its cause or even to notice the effect until the damage is severe. Operators must acquire the habit of physically inspecting the deck in the area of the guides and heads for an excessive build-up of oxide or backing debris. This is generally the first clue that something is wrong. Excessive dropouts on an edge track or loss of high frequencies may also indicate that an alignment or tracking problem exists.

It is also good practice to observe the physical condition of the tape. A sure sign of developing edge damage would be a lip or distortion on the edge being injured. When wound on the reel, the effect of this lip will be cumulative and can stretch the backing. The stretched backing will be rippled and will not conform to the recorder heads the next time the reel is used.

If tape in this condition is properly rewound immediately before being put into storage, it may be possible to salvage the roll. If this is not done, the backing will be permanently stretched and will not recover. This will result in the entire roll having to be discarded.

Operating personnel should use care in handling the reels of tape. It is important that the reel be picked up in a manner that will not cause the flanges to be squeezed together. When the reel is mounted on the recorder, pressure should be applied only to the hub and never to the flange. If the flanges are forced against the tape, this could result in edge damage. This is particularly true if the roll has a scattered wind, since the exposed edges of the misaligned strands can be folded over and creased.



FIGURE 10. PROPER METHOD OF MOUNTING A REEL ON A DECK.
APPLY PRESSURE TO THE HUB AND NOT THE FLANGES.

It is strongly recommended that operators be constantly on the alert for signs of potential trouble. This can best be accomplished by understanding what to look for and by making continuing inspections of both tape and deck a habit.

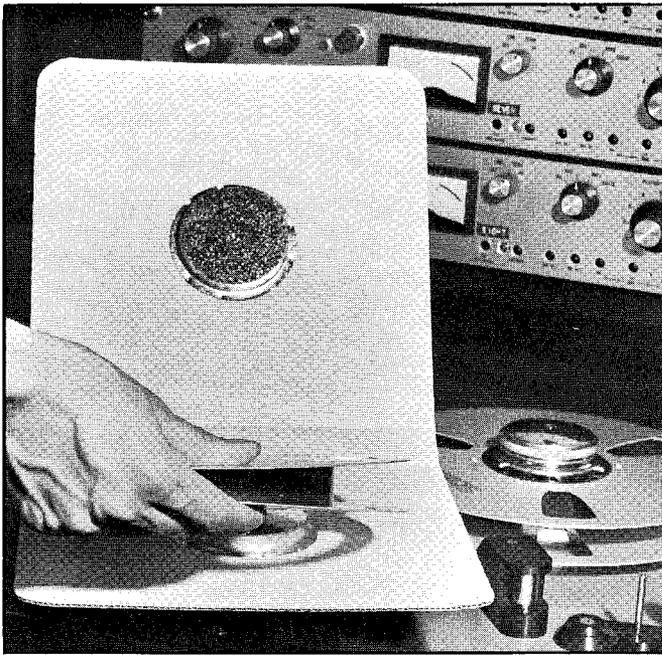


FIGURE 11. IMPROPER HANDLING OF TAPE REEL.
SQUEEZING THE FLANGES MAY CREATE SERIOUS TAPE DAMAGE.

MAJOR CATASTROPHE

The discussion, to this point, has been devoted to precautions and suggestions involving the day to day routine use of recording tape. Topics have been explored concerning areas in which the tape is used and stored and recommendations for operator education have been made. The final area of concern, while a remote possibility, is nevertheless of utmost importance because it affects not just a single reel of tape or an isolated recorder but the entire recording operation. This section will be devoted to two forms of major catastrophe: *Fire & Nuclear Radiation*.

For a substance to burn, there must be a breakdown of the organic materials contained in it. The organic materials in Magnetic Tape are the plastic backing and the binder. To burn, these must first vaporize — thus increasing their exposure to the oxygen in the atmosphere — and then rapidly oxidize to form light and heat. An ample supply of oxygen is required to sustain burning.

Since Magnetic Tape contains no “built-in” oxidizer, it cannot burn in the absence of air. Simply stated, its behavior can be closely compared to the way in which a tightly wound roll of paper would burn.

While the “self-ignition” temperature of polyester backed tape is in the neighborhood of 1000° F., temperatures below that point can still cause damage. Polyester film will shrink 1½ % at 300° F. and 25% at 325° F. Acetate film, because of its sensitivity to heat, will exhibit greater shrinkage and backing distortion and is more susceptible to heat damage than polyester. If a roll of tape is heated to the approximate temperatures listed below, certain effects would be noted when the roll had cooled.

250° F. — Backing distortion.

320° F. — Softening of both the backing and binder with some “blocking” or adhesion of adjacent layers.

550° F. — Darkening and embrittlement of the backing and binder.

1000° F. — Charring of the backing and binder.

When charring occurs, the tape cannot be unwound from the reel, since it will flake when touched. The temperature limitation of present day tapes is a function of the organic components and not a function of the gamma ferric oxide.

Winding and storing magnetic tape properly will lessen the possibility of damage in the event of fire, since tape is a poor conductor of heat. It is sometimes possible to recover information from a tape receiving slight fire damage by carefully rewinding it at minimum tension. The information it contains should be transferred immediately to another reel of undamaged tape.

We recommend the CO₂- type of fire extinguisher for combating burning magnetic tape. CO₂- is clean and this type of extinguisher contains no chemicals that could harm the tape. If water reaches the tape, it will probably not cause complete failure but there may be some evidence of “cupping” or transverse curvature. The amount of “cupping” will depend on the quality of the wind, backing material and the length of time the roll was exposed. If the wind is loose or uneven, the water can more easily reach the oxide surface and the cupping will be more pronounced. The tape should be removed from the water as soon as possible and certainly within 24 hours.

After removal, the rolls should be allowed to dry on the outside at normal room temperature and then be re-wound a minimum of two times. This will aid the internal drying and will also help the rolls to return to equilibrium faster. If moisture is allowed to remain within the roll, severe blocking can be the result.

If a temperature increase is also incurred while the tape is water soaked, steam or at least high humidity will be present. This is more likely to cause damage than water alone. A temperature in excess of 130° F. with a relative humidity above 85% may cause layer to layer adhesion as well as some physical distortion.

Once again, the importance of keeping rolls of tape in their containers must be emphasized. The container, if closed properly, will help keep the water spray of a sprinkler system from reaching the tape.

To prevent fire involving magnetic tape, store tape in a non-combustible area and make sure that no combustible materials are stored in the vicinity. An example of a “non-combustible” area would be a room with metal shelves and sheet metal walls. For maximum fire security, store magnetic tape in a fireproof vault that is capable of maintaining a desirable internal temperature and relative humidity for a reasonable length of time.

As a general statement, it can be said that magnetic tape will be unaffected by Nuclear Radiation until the dosage approaches a level 200,000 times greater than that which would cause death in 50% of the exposed humans. Radiation of this level (100 megarep) would tend to increase the layer-to-layer signal transfer or “print-through” by about 4 db but would not prevent information retrieval.

Nuclear Radiation at the above level will also have some physical effect on the tape coating and backing. The backing will show significant embrittlement, and it is expected that the wear life could be reduced by as much as 60%. It is reasoned that whatever Electro-Magnetic Field might result from a nuclear detonation would not be of sufficient intensity to adversely affect the tape; therefore, the threat of signal erasure is virtually non-existent. The effect of Neutron bombardment would no doubt be limited to activation of the iron-oxide in the coating. This would produce a radioactive isotope that itself might become a source of further radiation, but it is theorized that such activation would not produce a change in the overall magnetic properties of the coating.

Radioactive dust or fallout is not capable of producing the dosage necessary to adversely affect magnetic tape. The recommendations made earlier to protect the tape from normal contamination are applicable, as well.

Recent laboratory tests concerning exposure of recorded tapes to x-ray have determined that the recorded signal is not affected by even severe exposure to this source of radiation. The tests involved a commonly used recording tape with several different frequencies recorded on it.

The x-ray machine was operating with 200 MA at 110 KV, and a 6 second exposure time at a 36 inch distance was used. Testing and measuring the signal output before and after exposure indicated no signal loss or degradation.

As can be seen from the above discussion, when speaking of major catastrophe, heat and fire damage are considered much more serious than the effects of radiation.

Under proper storage conditions, magnetic tape has the ability to retain intelligence for an indefinite period of time; of greatest importance is the physical preservation of the medium so that adequate head to tape contact can be maintained when the tape is again put into use.

If at any time you have specific questions about this topic, simply write to:

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