# Computer Talk

A Technical Service to the Industry from the makers of Scotch® Magnetic Tape

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# THE HANDLING & STORAGE OF COMPUTER TAPE

*As increasing quantities of the world's business records are being kept not in books and file drawers, but on magnetic computer tape, there is a growing concern about the permanence and recoverability of these vital facts that are invisibly stored on a plastic ribbon.*

*The preservation of both operating and historical files 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 complete business collapse. If reels of tape are failing and being retired long before their normal life expectancy, operating expense is increased. Of course, this, too, is undesirable.*

*This issue of COMPUTER TALK will discuss in depth, the considerations and practices that 3M Company considers of greatest importance to the Computer user. If every one of the many suggestions were followed completely, an ideal situation would exist. Since many facilities can function adequately with less than the ideal, you may wish to adopt only a portion of our recommendations. Some of the precautions may be considered too time-consuming, or too costly for a given application. In short, we can say that the overall reliability of the Computer operation 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. It can be said, far and away, the reports of problems encountered with computer tape performance are predominantly physical in nature. Since this is the case, we must be concerned with preserving the tape in a form that will make it physically possible to recover the recorded information when needed. Poor handling habits or faulty storage procedures can render a tape useless because of physical damage. A great deal can be said about the physical preservation of computer tape and to make the information more meaningful, each of several topics will be treated separately.

## THE WORK AREA

The location in which the tape is actually used should approach, as closely as is practicable, a "clean-room" environment. By definition then, this area is characterized by are absence of normally expected airborne dust and lint. Various air-conditioning filtration systems are available to accomplish this cleaning.

Whenever possible, maintain the room air pressure at a somewhat higher level than the surrounding area. This positive internal pressure will prevent dust infiltration through doors and windows that are not absolutely air tight and, of course, is most important in preventing dust from entering when a door is opened. To additionally insure against dust contamination, lint-free smocks are worn by personnel associated with the manufacturing and testing of computer tape.

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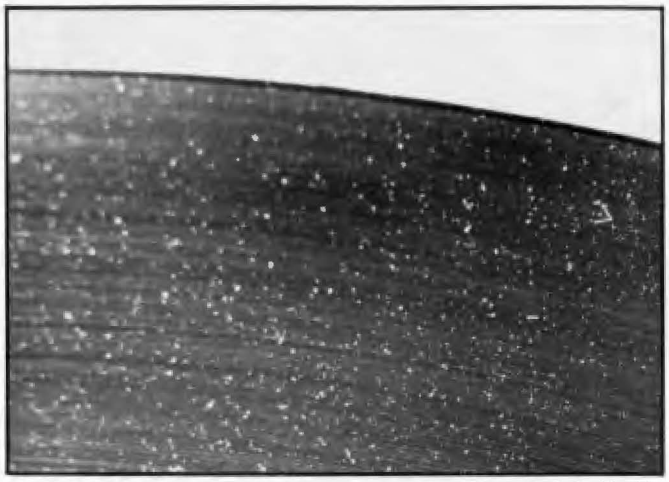


AN ENLARGED VIEW OF DUST CONTAMINATION ON A REEL OF TAPE.

The design of the computer area should be such that reasonable control of temperature and relative humidity can be exercised. Variations of temperature should be held to within ±5° F., of a pre-selected value and the relative humidity should be kept constant to within ±10%. Our general recommendation would be an environment that is comfortable for the operating personnel, as this is also ideal for the tape. In broad terms this would be a temperature in the 70's and a relative humidity of about 40%.

Smoking should not be allowed. It is doubtful if the smoke will contaminate the tape, but ashes can. Food and drink should also be prohibited. Minute food particles can easily be transmitted to the tape and tape transports from the operator's hands. A spilled drink will contaminate not only the tape but possibly the entire room.

Paper stock and cardboard are known to produce fiber-lint that, if uncontrolled, could defeat the attempt to keep the area dust free. Recognizing the fact that printers, card readers, and card punching equipment are all part of the computer system and are generally located in the vicinity of the tape drives, a word of caution is in order.

To reduce paper dust and fiber lint contamination, the equipment that uses paper should be located in the area of the least positive internal air pressure and the tape drives should be located in the area of highest pressure. This will insure that any contaminants generated by the paper handling will move in a direction away from the tape and tape transports thus reducing the possibility of contamination.

The integrity of the computer area should be maintained by periodic cleaning of shelves and floors. There are special liquid cleaners now available for this purpose that leave no residue. The floors should not be waxed because normal foot traffic abrades the wax, causing fine dust that could contaminate the entire room. 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.

## THE STORAGE AREA

The temperature and humidity of the 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, we recommend a temperature between 60° and 80° F., and a relative humidity between 40% and 60%.

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" 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.

The hub is the strongest and most stable part of the reel. Not only should the reels always be handled by the hub, but in storage, they should be supported by their hubs. This is one of the two basic reasons why the reel should be returned to its cannister before being placed into storage. The cannister is designed so that the reel actually hangs by the hub with no weight on the flanges. The other reason for using the cannister is obviously protection of the reel from dust.

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, the cannisters 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, as this could cause edge damage to the reel of tape in that cannister. For long term storage, additional protection from dust and moisture can be gained by sealing the cannister in a plastic bag. It is generally considered good practice to clean the cannister before bringing it into the computer room so that dust, that has accumulated during storage, will not be transported to, and contaminate the clean room.

AN EXCELLENT EXAMPLE OF A LIBRARY SHOWING PROPER TAPE STORAGE.

In the interest of storing more tape in a given area (thus reducing storage cost per unit) some users have chosen a plastic ring or collar device that wraps around the outer diameter of the reel to allow the reel to be hung in the storage facility without the use of a standard cannister.

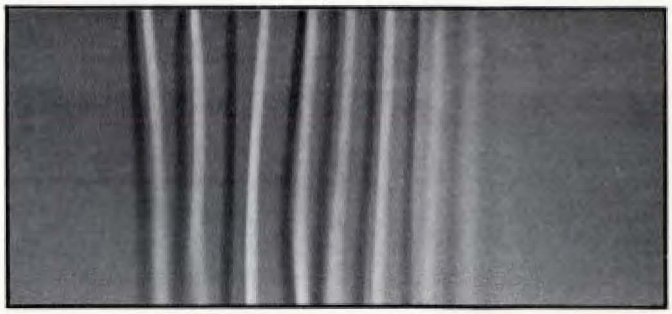
While this device will suffice in many applications, it must be remembered that this constitutes a trade-off situation. Additional space is gained for storage, but the reel is being supported by the flanges and not the hub. The plastic ring or collar may seal well enough to prevent dust from settling on the tape during storage, but the outer surface of both flanges is vulnerable to dust accumulation. When the ring is removed, and the tape is put into use, the dust that has collected on the flanges is free to deposit itself on the tape. With the introduction of the slim-line type of cannister, additional storage space can be gained without sacrificing the benefits of a closed container. For this reason, it is the most preferable container.

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, as poor winding can result in distortion of the tape's backing.

We recommend a wind tension that is relatively low. Six to eight ounces per ½ inch of tape width is sufficient to render a firm, stable wind. This tension, while great enough, does not result in high pressures within the roll that could permanently distort the polyester backing. Backing distortion, caused by extreme pressures within the tape pack may result if a roll of tape wound too tightly was subjected to an increase in temperature while in storage.

CINCHED TAPE. NOTE THE COMPLETE FOLD OVER OF ONE TAPE STRAND.

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 continuous errors. If, immediately after an occurance of cinching, the tape is properly rewound, there is a good possibility that the information may be saved.



TAPE DAMAGE CAUSED BY CINCHING. THIS 1" LONG STRAND OF ½" COMPUTER TAPE CLEARLY SHOWS THE WASHBOARD-LIKE WRINKLES.

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.

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.

SCATTERED WIND. INDIVIDUAL TAPE STRANDS ARE EXPOSED AND 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.

Some users have purposely placed "control tapes" in storage with the normally used tapes. These controls are periodically inspected both visually and electronically for data errors. Each installation can decide the

number of samples or controls necessary to accurately establish the condition of the library. This decision will be predicated on the library size and the importance of the data stored.

Again, we say that if our recommendations as to 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

As data processing centers are expanded and added at different geographical locations, it is sometimes necessary to send recorded tapes from one installation to another. There are certain precautions that apply to the shipment of computer 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 cannisters 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. While in storage, either a hold down sponge or a vinyl strip may be used. During shipping, it is advisable to use both of these devices. We recommend this because there is some tendency for the vinyl strip to pull loose when subjected to very cold conditions. The hold down sponge, if used alone, could be jarred loose if the shipment were handled roughly; but the combination of the strip and the sponge seems to function idealy.

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.

Our laboratory has conducted tests to determine what would constitute adequate protection from stray magnetic fields of a magnitude that might possibly be encountered in transit. It was found that field strengths within the tape of 50 oersteds or less caused no discernable 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, we feel it is safe to assume that field strengths of more than 1500 oersteds would not be encountered in ordinary shipping situation.

Because field intensity decreases rapidly with distance from the source, the 50 oersteds 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.

We suggest that tape being prepared for shipment be packed with bulk spacing material such as wood or cardboard between the cannisters and the outer shipping container. Based on the information in the paragraphs above, we feel that 3 inches of bulk spacing would give adequate protection, and virtually eliminate any potential 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 easily 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.

## OPERATOR EDUCATION

The cannister in which the tape is stored is probably the cleanest area in the computer center, and of course, this is the reason that tapes should remain in the cannister until actually placed on the tape drive and be returned to the container immediately after use. To maintain the cleanliness of the cannister, the cover should be replaced when the tape has been removed for use. The cannister should not be opened outside of the clean-room environment.

We mentioned earlier, in connection with tape storage, that the hub is the strongest and most stable part of the reel. This fact is the reason why operators should always handle the reel by the *hub* and not the flanges. If this single fact is remembered, operators 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 drives are the two predominant reasons why computer 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, operators should 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 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 drive 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 why we stress the importance of visually inspecting the tape handler after each roll of

tape is run to determine if cleaning is necessary. If the transport 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.

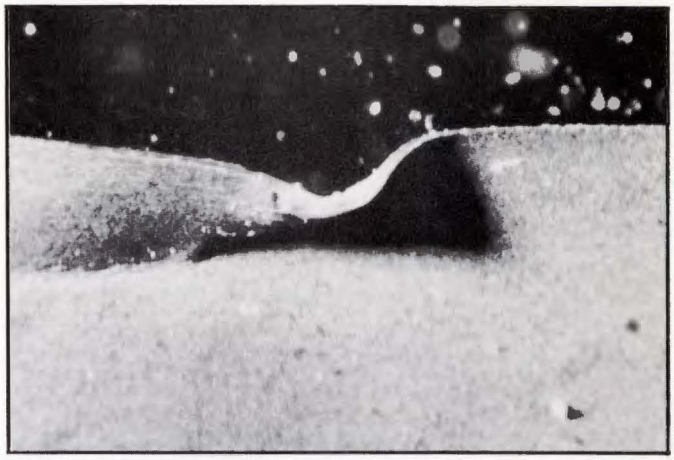
Tape contamination caused by fingerprints can be reduced by remembering not to touch the tape unnecessarily and can be eliminated through the use of lint-free gloves. Frequent cleaning of the tape drive will reduce the chance of spreading contamination from one reel of tape to others in the library. 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 elements of the tape path on the handler. If other types of cleaning agents are used, they should be given time to thoroughly dry before loading the tape. This will prevent damage to the tape 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 paragraph above. Maintaining reel integrity cannot be over emphasized as valuable information can be lost not because of tape failure, but because the tape was distorted by a dirty reel.

In the section dealing with shipping computer tape, we mentioned that the tape should be allowed to come to temperature equilibrium before being used. If a reel of tape that has been subjected to extremely low temperature is put into use before it is given the time to return to normal environmental conditions, it may become physically distorted when used. When the roll is subjected to the start-stop action in use, the individual tape layers can shift due to momentum and result in severe "cinching". This can also happen if a carton containing very cold tape is dropped or handled roughly. We again emphasize our recommendation that incoming tape be allowed to stabilize for 24 hours before being put into use. We do not recommend using artificial means to hasten this stabilization period.

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, tape drive, 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 as 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 warped or distorted reel, however, can also cause damage to one or both edges when the tape is allowed to rub against the flange when being used. A similar type of edge damage will also occur if the transport is misaligned.

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 back 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 loose polyester fibers and loose oxide.

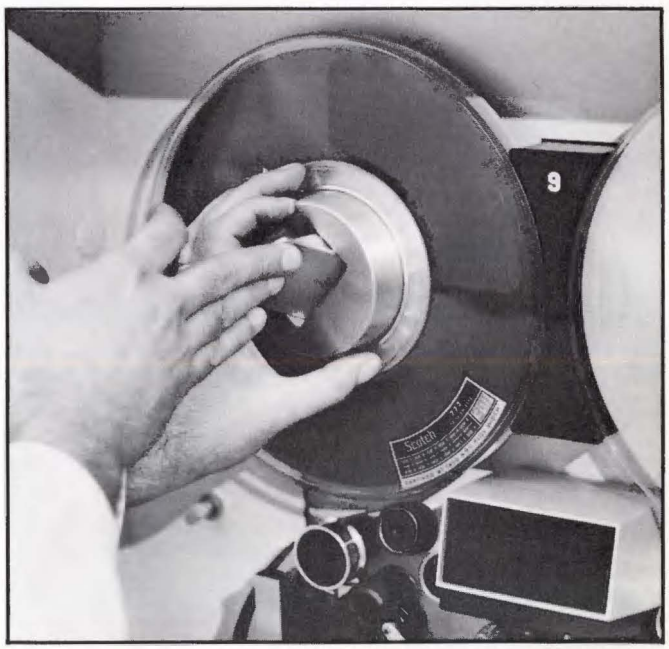


MICROSCOPE VIEW OF A DAMAGED EDGE. AFFECTED AREA EXTENDS ABOUT 15 MILS INTO TAPE.

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. We suggest that operators acquire the habit of physically inspecting the transport in the area of the guides and heads for an excessive buildup of oxide or backing debris. This is generally the first clue that something is wrong. Excessive errors on an edge track may also indicate that an alignment 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 record or read heads the next time the reel is used.

If a reel in this condition is rewound immediately before being put into storage, it may be possible to salvage the



WHEN MOUNTING A REEL ON THE TAPE DRIVE, APPLY PRESSURE TO THE HUB AND NOT THE FLANGES.

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 tape drive, 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, as the exposed edges of the misaligned strands can be folded over and creased. If the tape is stored using collars, care must be exercised when removing or replacing the reel as it is easy to inadvertently squeeze the reel flanges during this operation.

WHEN REMOVING THE REEL, CRADLE IT BETWEEN THE HANDS AND DO NOT LIFT OFF BY THE FRONT FLANGE.

We strongly recommend 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 handler a habit.

## MAJOR CATASTROPHY

Our discussion, to this point, has been devoted to precautions and suggestions involving the day to day, or routine use of computer tape. We have explored topics concerning areas in which the tape is used and stored, and have made recommendations for operator education. Our final area of concern, while we hope remote in possibility, is nevertheless of utmost importance because it effects not just a single reel of tape or an isolated transport, but the entire Computer operation. We will devote this section to two forms of major catastrophy; *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. 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 as it will flake when touched. The temperature limitation of present day tapes are a function of the organic components and not a function of the gamma ferric oxide pigment.

Winding and storing magnetic tape properly will lessen the possibility of damage in the event of fire as 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 $CO_2$ – type of fire extinguisher for combating burning magnetic tape. $CO_2$ – 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" would depend on the quality of the wind 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 would 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 rewound a minimum of two times. This will aid the drying operation and will also help the rolls to return to equilibrium faster.

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.

We, once again, must stress the importance of keeping rolls of tape in their cannisters. The cannister, if closed properly, will keep the water spray from a sprinkler system from reaching the tape. It will also tend to protect the tape from the radiant heat of a nearby fire.

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, we can say 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. This is slight enough to not be termed serious and would not prevent information retrieval.

This amount 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 here, as well.

As can be seen from the above discussion, when speaking of major catastrophy, heat and fire damage are considered much more serious than the effects of nuclear radiation. We conclude by reiterating our initial statement. 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 additional information on this topic is desired, it is available by simply writing to:

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Additional copies of this paper are available from your 3M representative, or by writing to the address above.

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