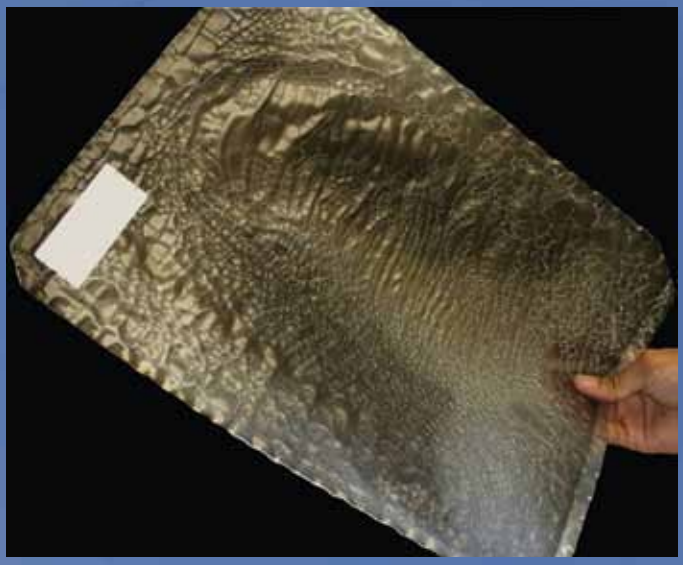
A White Paper

Safeguarding Legacy Employee X-Rays

at Decommissioned Industrial Manufacturing Sites.

Chemical Decomposition Threatens Loss of Medical/Legal Employee Records.



Executive Summary:

Obsolete industrial manufacturing sites pose tremendous and challenging post-closure responsibilities associated with decommissioning these plants. Employee X-ray preservation is one facet in a myriad of issues that need to be addressed. As sites are identified for closure, numerous technical, business and personnel issues must be managed. Most require specialized processes and expertise from diverse areas such as records management and environmental remediation. Today, these complex processes are underway in both government and industry. The focus of this report is on the risk of chemical breakdown of employee X-ray films over time and solutions to retain their clinical integrity as evidence.

Introduction

Sustainability initiatives have become an integral part of our culture. The core mission of this global movement is to protect our environment, keep mankind safe and our existence sustainable. Executives leading sustainability must also be concerned with maintaining records of hazardous work conditions of the past and the corporate health and safety practices during that time.

Any entity, government or corporation that maintains employee X-rays because of suspected employee exposure to known toxic work environments and possible future litigation, must maintain secure storage of the X-rays for an undetermined length of time.

Evidentiary Content Can be Lost Forever

Employee X-rays require permanent retention – unlike traditional film based medical exams with a defined statutory retention period. Because most of these images predate the transition to digital imaging of the 1990s, typically they are saved on hard copy film.

Many sustainability executives may not be aware that X-ray film can degrade over time. The type of film typically used to produce X-ray images has varied over the years and has implications for both storage conditions and life expectancy.

Whatever the film type, the film base (plastic) and photographic emulsion of X-rays can chemically change over time due to many factors, including storage environment. The X-ray image can degrade or even fracture from the film base, rendering the image unreadable. For some film media, steps may be taken to help prolong the life of films.

However, for cellulose acetate films common in the 50s and 60s, the plastic base itself will chemically decompose, producing a harsh vinegar odor,

Today, for industries that are subject to a variety of environmental regulations, like industrial chemicals, the emphasis is on the development of new manufacturing processes to protect employee health and safety and reduce our carbon footprint.

Unfortunately, currently many corporations are faced with the unintentional negative consequences of manufacturing processes during the early Twentieth Century. Technology and process knowledge was developing with great speed. This rapid advancement, however, resulted in toxic production processes that not only impacted our natural environment but also exposed many employees to hazardous work conditions.

Following this, during an era of greater awareness of and concern for employee health and safety as well as the environment, measures were taken to improve work conditions and monitor employee health. This process may have included periodic employee X-rays to insure there was no evidence of disease that could have been caused by the work environment. In such cases, these X-rays may have been considered permanent and retained well after the employee retired or even died.

known as vinegar syndrome. Since legacy X-ray films are often stored without monitoring in the least desirable space – perhaps on open shelves or stacked boxes – the odor of degrading film may not be obvious. As a result, the X-ray images as evidentiary content can be lost forever unless the problem of vinegar syndrome is addressed.

X-Ray Films Storage Guidelines

While little can be done to protect films against vinegar syndrome, records managers can follow best practices for film storage as recommended by the National Archives bulletin on Managing X-ray Films as Federal Records.

Regardless of the base, the black-and-white silver image is vulnerable to excessive heat and moisture and to harmful gases such as sulfur dioxide and nitrogen oxides often found in modern urban and suburban environments. Organic compounds such as gelatin containing the photographic emulsion become susceptible to fungal growth in storage areas where the relative humidity (RH) exceeds 60 percent.

Aging X-ray films become brittle and break easily. Physical handling is extremely detrimental. If handling is required, wearing white cotton lint-free gloves is suggested.

How Acetate X-Ray Film Degrades

Cellulose acetate used as a base material for photographic emulsions was first introduced in 1948 and was commonly used until the late 1960s. The chemical instability of this film was not recognized until the 1980s. Since that time, it has been recognized that over the years, the X-ray cellulose acetate plastic film base breaks down and releases acetic acid, the principle ingredient in vinegar, hence the term vinegar syndrome. A vinegar odor is noticeable in the initial stage of decomposition. As the condition progresses, the plastic film base becomes brittle and eventually shrinks. As shrinkage proceeds, the emulsion separates from the plastic film base. Once vinegar syndrome begins it cannot be arrested and the X-ray image will eventually become unreadable. Additionally, films in advanced stages of decomposition can damage nearby records in good condition. Research shows that high temperature and moisture advance the rate of deterioration. Cold dry storage can only slow down the rate of deterioration, but will not stop it.

Vinegar Syndrome - A Relatively Unknown but Serious Threat

In a traditional healthcare setting such as a hospital or imaging center, the normal statutory retention requirement for adult X-rays is five to ten

FILM TYPE	USE PERIOD	OVERVIEW
Nitrate-Based	1910s to 1930s	These early nitrate-based films are highly flammable and known to be combustible under extreme high heat and high humidity storage conditions. They should be handled with extreme care.
Acetate-Based	1920s to 1960s	Developed to replace nitrate films, this product was called "safety film" because its acetate film base is flame resistant. At the time, this film was considered a revolutionary improvement over existing nitrate based film. In time, however, the film proved unstable through chemical decomposition. Its breakdown accelerates when stored in high temperature and high humidity conditions. Once decomposition begins, the process is autocatalytic and cannot be stopped. The acetate base shrinks and the film emulsion begins to separate from the base, ultimately destroying the image.
Polyester-Based	1950s to Present	When polyester was developed it quickly became the standard for films, replacing acetate-based products. Polyester films are the most stable and resistant to chemical decomposition under varied storage conditions as it ages over time.

years. The retention time is based on federal and state mandates, along with hospital risk management policy. Because of the comparatively short relative retention time, even many medical professionals are unfamiliar with the effects of vinegar syndrome.

How to Preserve Valuable Employee X-Rays

If employee X-rays were conducted after 1948 when cellulose acetate was introduced, the condition of X-ray studies stored should be thoroughly evaluated by professionals for vinegar syndrome. A firm specializing in radiology library management can provide a complete survey analysis and recommend an appropriate solution. If a determination is made that X-ray quality has or is likely to degrade, a preservation program will typically involve the following key components that capitalize on digital imaging technology.

Film Digitization: X-ray films are digitized (scanned) to produce a legal Digital Imaging and Communications in Medicine (DICOM) electronic image. Digital conversion services are provided either on the customer site or in a commercial operations center. The scanning process produces high resolution, medical grade digital images of X-ray film studies in the industry standard DICOM format for storage and viewing.

Image Indexing: Patient demographic and exam data from the film study and associated documents are captured as an integral component of the image header and maintained in a relational database to support on-demand retrieval.

Image Storage: The digital images and their associated index are temporarily stored on a secure image management network until quality control and verification policies are met. Image and index data is copied either to an encrypted

portable hard drive for uploading to the customer's information system or is installed on the client network as a pre-configured server. Secure cloud-based storage at outsourced distributed data centers is another alternative to onsite storage and/or to meet disaster recovery requirements.

Image Viewing: To facilitate electronic image viewing, a medical DICOM viewer may be integrated with any of the storage options.

PHI: Secure transport and storage of the records must be maintained at all times to prevent loss, damage, or inadvertent disclosure of Protected Health Information (PHI) and in accordance with HIPAA and HITECH. Access to the records will be restricted to authorized personnel directly working with the records.

CASE STUDY –

SourceHOV XRP²

X-Ray Preservation Program

SourceHOV was recently retained by a U.S. government agency to preserve employee X-rays from decommissioned hazardous production sites. The X-ray film libraries at these sites were in various stages of vinegar syndrome decomposition. Because there was no known way to stop the X-ray film from disintegrating, indexing and digitizing the films was the only way to maintain the original X-rays in their current state.

With more than 25 years of experience in digitizing X-ray films, SourceHOV was able to successfully capture the images and return them to the customer in permanent digital form. Each X-ray was scanned on a high resolution digitizer and converted to DICOM digital format following the procedures detailed above. In this case, special attention was needed in the production environment to minimize exposure to acetic acid fumes. In addition, the films needed to be stored in a refrigerated environment before they were prepped for scanning. X-rays that were to be digitized at the operations center were transported by refrigerated truck and stored at 40˚F and 30 percent relative humidity. Specialized equipment was required at the operations center for cold storage and film handling.

A remote production environment was also created for a site that required the X-ray film digitization onsite. Systems and procedures were put in place to ensure security, and safety mandates were met in accordance with HIPAA, OSHA and EPA.

This project was a result of the government's post-closure responsibilities associated with decommissioned sites.

Reference: NARA – National Archives: http://www.archives.gov/records-mgmt/publications/managing-xray-films.html

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