

Union Carbide Corporation
Chemicals and Plastics
Institute, West Virginia

Special Report
Medical Department
1 August 1973

ASBESTOSIS

SUMMARY

The Medical Department, early in 1973, completed the first survey including a comprehensive medical examination and obtained chest X-ray films on 70 Institute Plant workers who possibly have had or are still having exposure to asbestos-containing materials such as insulation, as required by law. The local radiologists who make and read X-ray films regularly for the Institute Plant diagnosed 20 cases (29%) of pneumoconiosis (asbestosis). The films on these 20 positive cases were interpreted by an impartial out-of-town radiologist who confirmed 11 cases (16%) as positive for pneumoconiosis. The law further requires this survey to be completed annually and the Medical Department will comply. It behooves the plant administrators to attempt to eliminate the hazard from asbestos.

INTRODUCTION

The William-Steiger Occupational Safety and Health Act (OSHA) of 1970 emphasized the need for standards to protect the health of workers exposed to a potential hazard; e.g., asbestos. Exposure to asbestos may result in pneumoconiosis, a disease of the lungs that produces symptoms, abnormal physical findings and X-ray changes of the lungs. The condition is progressive and may result in partial or total permanent disability. Asbestos exposure is believed also to induce neoplasms; i.e., mesothelioma of the pleura or lung -- a tumor with an unfavorable prognosis.

In 1972, the National Institute for Occupational Safety and Health (NIOSH) published a criteria document, "Occupational Exposure to Asbestos," which simply is the criteria for a recommended standard. OSHA, in 1972, accepted the recommendations of NIOSH and adopted the recommended standards into the law. The medical requirements now are contained in Section 1910.93a(J).

Since asbestos is a component of insulating materials which are widely used in industry, it is believed that some Corporation on-site Plant 512 employees had or may still be having exposure to asbestos or asbestos-containing materials. If so, the law requires that these individuals be included in a medical surveillance program conducted at company expense.

MEDICAL SURVEILLANCE

Medical management, as described *in toto* in the law, includes many facets but most important at present is (1) an attempt to ascertain the names of all employees who have had or may still be having exposure to asbestos and, after compiling the list, (2) to complete a comprehensive medical examination on each of those individuals.

For the former, the Medical Department sent an inquiry to various plant department heads, production managers and superintendents. Replies included the names of 42 insulators, 2 laborers and 8 sheetmetal workers in the Maintenance Department and the names of 18 operators in the Steam Plant Department. Insulators,

of course, handle asbestos-containing insulation, sheetmetal workers use asbestos in fabricating and joining ductwork, Steam Plant operators handle two filter materials containing diatomaceous earth* in the condensate filters and laborers in at least one plant maintenance area clean up debris after maintenance insulators complete jobs in the area.

The comprehensive medical examination, to be completed annually as outlined in OSHA Section 1910.93a(J) (3), includes as a minimum the following:

- (1) A history to elicit symptoms of respiratory disease,
- (2) A Pulmonary Function Test, including Forced Vital Capacity (FVC) and Forced Expiratory Volume at one second (FEV_{1.0}), and
- (3) A chest Roentgenogram (posterior-anterior, 14 x 17 inches).

In addition to the above, NIOSH also recommended the inclusion of additional procedures as follows:

- (1) A history to describe smoking habits, details of past exposure to asbestos and their dusts and the presence or absence of pulmonary, cardiovascular and gastrointestinal symptoms, and
- (2) A physical examination with special attention to pulmonary rales, clubbing of fingers and other signs related to cardiopulmonary systems.

The Medical Department developed a form (MD-4), which included entries for all the above components, plus body temperature, pulse rate at rest, blood pressure, height, weight, hemoglobin and hematocrit to compile a record of the examination.

CHEST X-RAYS

Since July, 1950, all Institute Plant employees have had their chests X-rayed, at company expense but not on company time, regularly. Formerly, this was accomplished as part of a periodic physical examination, offered on a voluntary basis to all employees by the plant Medical Department, and since December, 1969, as a component of Multiphasic Health Screening, offered to all employees, again on a voluntary basis, every two years.

The medical "firm" presently called Doctors Elkin, Kugel and Deardorff, Inc., has been taking chest X-rays on Plant 512 employees and providing professional interpretation of the films since the inception of the program. The Plant Medical Director requested in 1950 that the chest X-ray interpretations be fully explanatory and as complete as possible. The first film obtained on each employee (usually as a component of the preplacement examination) resulted in an interpretation that satisfied this request. However, follow-up films on many employees (and some have had as many as 12 or 14 in the 25-year period) have resulted in interpretations such as, "The previously noted minor abnormalities . . . are again evident but comparison with an old chest X-ray of 14 months earlier shows no change. The heart, lungs and thoracic cage show no other pathology."

*Two trademarked products called CELITE. The red-labeled product contains diatomaceous earth plus chrysotile asbestos fiber and the blue-labeled product contains diatomaceous earth.

The Medical Department was not satisfied completely with the latter interpretations, particularly since the present survey was to evaluate the employee from a specific standpoint -- mainly asbestosis. Therefore, the Medical Department stamped the X-ray orders as follows: "COMPLETE NEW INTERPRETATION REQUESTED" and "ASBESTOSIS SURVEY."

The roentgenologists in the medical "firm" providing this service agreed and also advised that each film interpreted would be classified according to the UICC/Cincinnati Classification of Radiographic Appearances of Pneumoconioses.

PNEUMOCONIOSES

In 1867, F. A. Zenker, the Professor of Pathology at the University of Dresden coined the term "*pneumono koniosis*" to describe changes in the lungs due to all types of inhaled dusts. He proposed the term, now shortened by common usage to pneumoconiosis, after publishing the medical history and pathological findings of the brick-red-colored lungs of a 31-year-old female factory worker who died of respiratory disease. This patient had worked with iron oxide which had been inhaled into the lungs so Zenker also coined the term "*siderosis*" from the Greek word for iron. It may be interesting to the reader to know that one Plant 512 sheetmetal worker's X-ray was interpreted as pneumoconiosis, presumptively due to asbestos, but a careful work history indicated that the diagnosis should be siderosis rather than asbestosis. Based on Zenker's original proposal, any lung disease due to dust is classified as a pneumoconiosis.

There are many trades or occupations potentially associated with pneumoconioses and consequently there are many materials or compounds that are capable of causing a pneumoconiosis. The specific type of pneumoconiosis is usually named for the compound causing the disease, has a synonym named for the occupation or is named for the person first describing the disease, such as:

Berylliosis	-	beryllium
Bagassosis	-	bagasse (dried sugar cane fiber)
Chalcosis	-	copper
Silicosis	-	silicon dioxide
Talcosis	-	talc
Coal Worker's Pneumoconiosis	}	coal dust
Black Lung		
Miner's Asthma		
Collier's Lung		
Anthrocosis		
Farmer's Lung	}	dust from moldy silage or dust from threshing grain
Thresher's Lung		
Siderosis	}	iron
Grinder's Disease		
Shaver's Disease	-	bauxite fume
Asbestosis	-	asbestos

ASBESTOSIS

Even under very severe dust conditions, it may take five to ten years of exposure for asbestosis to develop. The onset is usually insidious with only shortness of breath and vague chest pains. Bronchitis and increased sputum are not a feature of the early stages of the disease. Lung function tests may show only a lowering of the total vital capacity.

The radiographic diagnosis may be more reliable and exacting in the early stages rather than by the symptomatology or the physical findings, particularly the latter, because these develop later. Pleural thickening which is not a feature of other kinds of pneumoconioses but can and does occur from many other diseases, happens early and may be the only radiographic change noted in early asbestosis. As the disease progresses, the next earliest change is usually seen at the lung bases. The normal vascular pattern is replaced or obscured by small, irregular, fine, medium or coarse opacities. In time, these become more profuse and extend to the upper lung field zones. Eventually, presented radiographically, may be the hazy appearance of the entire lungs -- the so-called "Ground Glass" appearance. This, of course, is a late sign. Another late radiographic sign that rarely occurs under 20 years of exposure is calcification of the pleura -- a striking feature -- and this may occur in the absence of any other clinical features. Eventually the outline of the left cardiac border may become ill-defined and produce, in severe cases, the classical "Shaggy" heart appearance.

Early in the disease, despite a few symptoms -- shortness of breath and vague chest pains -- there is an absence of abnormal clinical findings except for the early X-ray changes. Except for the X-ray evidence and the elicitation of the exposure history, the diagnosis is difficult to make. Even after the diagnosis of pneumoconiosis is established, the etiology of the disease is even more difficult to make. Complicating factors are exposures in previous occupations, exposures in "moonlighting" ventures, hobbies, cigarette smoking and many others. As the disease progresses, there can be noted definite abnormal findings. There may be wheezing and fine basal rales. The fingers, and occasionally the toes, may be clubbed and with a careful occupational history to pinpoint continued exposure, a definitive diagnosis can be advanced. In addition, the radiographic appearance will worsen and helps confirm the diagnosis.

THE COMPREHENSIVE MEDICAL EXAMINATION

During January, 1973, the Medical Department mailed requisitions to 70 Plant 512 employees so they could obtain, at company expense, on their own time, a chest X-ray. When the interpretations were received by the Medical Department, the employee was given an appointment to complete the remaining components of the examination. The employee was asked to complete the front of Form MD-4; i.e., the brief work history, the medical history and the smoking history. The nurse obtained the employee's blood pressure, body temperature, respiratory rate, pulmonary function and other pertinent procedures. The medical technologist performed a hemoglobin and hematocrit on the employee's blood specimen. After obtaining and recording the above information, including the X-ray report, the employee was examined by the physician.

On completion, the employee was told the results -- either he had no problem or he had pneumoconiosis. If the latter, the employee was requested to complete Form MD-5 -- a detailed history of his occupational experiences -- in an attempt to obtain additional information that would pinpoint the etiology of his pneumoconiosis.

EXAMINATION RESULTS

Of the 70 Institute Plant employees examined, the first was completed on 29 Jan 73 and the last was completed on 15 May 73. The physician was absolutely amazed, or perhaps a better word, astounded, to find that five of the first six men scheduled to be examined (five insulators and one sheet-metal worker) had had their X-rays classified as positive for pneumoconiosis. Some of these workers had symptoms -- shortness of breath, coughing and rales -- and some of them had abnormal physical findings; e.g., diminished chest expansion, wheezing and increased respiratory rate. However, all five of the men with positive X-rays do now or did smoke cigarettes excessively during most of their lifetime and this history, plus the information obtained on prior chest X-rays, had resulted in previous diagnoses of chronic obstructive lung disease; e.g., pulmonary emphysema, chronic bronchitis, etc. It was a further source of amazement to the examining physician that when the roentgenologist was requested to interpret the X-ray from the viewpoint of diagnosing pneumoconiosis, he could now readily diagnose this specific condition.

Undoubtedly, if this survey had been started ten years ago, some of the cases diagnosed presently as pneumoconiosis might have become evident at that time. However, in recent years, X-ray equipment has been improved considerably and with a new so-called "Grid" the X-ray films produced now show greater detail than previously, allowing diagnoses to be more definitive. The examining physician, who has practiced occupational medicine for 25 years, has been aware of the existence of pneumoconiosis and asbestosis for many years. In addition, he was well aware that some plant employees worked in the plant at trades where they could easily have opportunities for exposure to asbestos. For some unknown reason, the author never considered that plant employees could be having exposures to asbestos that might be harmful. It is with some regret that this admission must be made and the author's position is untenable.

Concurrently, the same roentgenologists have been interpreting X-ray chest films on these same employees periodically for many years. Of course, the radiologists did not know that these employees were working with materials that are capable of causing pneumoconiosis but they have never indicated in past interpretations that pneumoconiosis was a possibility. These physicians readily admit that they have missed diagnoses and their explanations of why this happened seems logical and acceptable. One of their explanations is that comparing the newest film with the one immediately preceding is somewhat like being closely associated with a person dieting. The change is so gradual that it is not noticed until finally, after much weight is lost or the film is so different, i.e., attention is directed to the drastic end result, then it is quite obvious and apparent that there is a considerable difference.*

What has happened previously cannot be altered but of the 70 Institute Plant employees participating in this survey, 20 employees (28.6%) were diagnosed as now having pneumoconiosis. A table following shows the pertinent statistics:

*Physicians and hospitals who take X-rays legally may destroy any films after five years but the written reports (medical records) must be retained. Therefore, chest X-ray films made 20 years ago are not available for comparison with recent films.

Table 1.--X-ray and Examination Findings of 70 Workers Presumably Exposed to Asbestos		
	Positive X-rays	Negative X-rays
Total number insulators	13	29
Total number sheetmetal workers	2	6
Total number laborers	1	1
Total number Power House operators	4	14
Total number employees	20	50
Total number with symptoms	12	15
Total number with reduced FVC*	11	12
Total number with abnormal PE findings	6	4

*Forced Vital Capacity

Individuals reading this report would have no difficulty understanding the codes used to classify the radiographic appearances of pneumoconiosis (asbestosis) if they are familiar with the UICC/Cincinnati Classification. However, for the benefit of those not familiar with the system, the X-ray interpretations of the 20 positive films can be categorized into the following:

- 6 - Category 0, or highly suspicious of asbestosis (3 employees with only pleural thickening and 3 with Code 0/1).
- 10 - Category 1, or minimal asbestosis (5 employees with Code 1/0, 1 with Code 1/1 and 3 with Code 1/2).
- 4 - Category 2, mild to moderate asbestosis (2 employees with Code 2/1 and 2 with Code 2/2).

There were no films of Institute Plant employees interpreted as Category 3 (severe or advanced asbestosis) during this survey.

Of the 20 employees having positive X-rays, there were 12 (60%) who complained of shortness of breath and coughing, while in the group of 50 employees with negative X-rays, 15 (30%) had symptoms. In the former group, 11 (55%) had reduced Forced Vital Capacity while in the latter, only 12 (24%) were reduced from their predicted normal. The employees with abnormal physical findings (reduced chest expansion, rales or ronchi) numbered 6 (30%) of the 20 with positive X-rays, while in the negative group, only 4 (8%) had abnormal findings. It would appear that percentagewise, at least, the employees with X-rays positive for pneumoconiosis manifested a significant increase in symptoms, reduced vital capacity and abnormal findings over the negative group.

SIGNIFICANCE

It is obvious to the physician that without the assistance of the chest X-ray, it would be most difficult to make a conclusive diagnosis of asbestosis, particularly in a worker who has only very minimal, mild or moderate disease. The radiologist's contribution is perhaps the greatest factor in establishing a diagnosis of pneumoconiosis. Yet, his radiological diagnosis and his classification of the degree of illness represents his opinion only and is subject to question. Unfortunately, his interpretation is not selective enough to diagnose the precise etiology of the pneumoconiosis.

To substantiate this comment, it may be worthwhile to elaborate on the case of an insulator who has worked with asbestos-containing material for only four years and a complication is that he worked for two years with a coal cutting and loading machine. His occupational history revealed further that he was in the armed service four years as an electrician and spent six years in a master mechanic's school. Prior to his most recent and present job as an insulator, he was employed ten years as a chemical operator.

The radiologist reading this employee's chest X-ray films classified them as UICC 2/1 q CO OD (dense pericardial calcifications) Grade 3. He reported that the pericardium was calcified both about the anterior and posterior circumferences of the heart and was 2 to 5 mm in thickness. The fine nodular fibrosis in the lungs was compatible with pneumoconiosis. The UICC classification is interpreted as Category 2 (mild to moderate pneumoconiosis), q (rounded opacities up to about 1.5 mm in diameter), CO (abnormality of cardiac size or shape) and OD (other significant disease) in reference to the pericardial calcification. The radiologist told me personally that this worker, if exposed to asbestos, presumably had asbestosis, but he was unable to correlate the findings of pericardial calcification with this diagnosis and didn't understand the connection, if any existed.

There appears to be little, if any, question that this insulator does have pneumoconiosis but whether it is a result of two years' exposure in the coal mines and a coal worker's pneumoconiosis, or 14 years working at the Institute Plant and an asbestosis, or possibly a pneumoconiosis resulting from a combination of these two work experiences is anyone's guess. Also, since we are using and paying for the services of these radiologists, their classification of this worker's chest X-ray films, Code 2/1, and definition, Category 2 (moderate pneumoconiosis), should be accepted without question. The author, however, was disturbed by the description of the pericardial calcification and further disturbed by the radiologist's statement that he couldn't explain its etiology or connection with the pneumoconiosis. Therefore, arrangements were made to send these two films (posterior-anterior view and right lateral view) to the USPHS in Cincinnati for an interpretation by their consulting radiologists.

These physicians are representatives of one of the three groups that collaborated to establish the UICC/Cincinnati classification system and they are considered to be the world authorities on the subject of pneumoconiosis. Their interpretation of these films were: (1) Pneumoconiosis 0/1 in all six zones, (2) slight generalized cardiac enlargement and (3) extensive pericardial calcification. Their general consensus of opinion was that the pericardial changes were due to cardiovascular disease rather than due to dust exposure. The author is not convinced that this insulator has asbestosis, although he certainly has a pneumoconiosis.

One of the physicians of the local radiology "firm" was given the report from the USPHS group and each of the other four radiologists of the "firm" then reviewed the films independently without knowledge of the USPHS group's opinion. They all agreed separately with the original reading and collectively disagreed with our world authorities. These films now should be interpreted by a third group or a "C" reader.

Our local radiologists have taken an intense interest in the Institute Plant's small series of pneumoconiosis X-rays and offered to meet with the corporation's local physicians and review with us all of the films they have reported as positive.

RADIOLOGY CONFERENCE

On 30 May 73, Doctor T. Spencer (Plant 511), Doctor Q. Hull (Plant 514) and the author met with three of the five radiologists to review and discuss the X-rays on the twenty Institute Plant employees believed to have asbestosis. As each film was reviewed by the radiologists, the author presented a brief work history on the employee. This session proved to be informative.

Without having the written interpretations and UICC classifications available, the three radiologists attempted to collectively interpret and classify each of the 20 films. Unfortunately, 17 of the 20 positive films had been interpreted initially by the two radiologists who could not attend. The three radiologists present could not seem to agree on individual interpretations or classifications and, in addition, could not re-interpret some of the films in the same manner or same classification that was recorded initially. The radiologists present were in agreement that probably most of the films had been overread.

The author suggested that all the positive films be sent to an impartial radiologist for his interpretation and classification. The Charleston radiologists would thus be the "A" readers and another physician would be the "B" reader. The latter would provide his opinion without knowledge of our radiologist's report. This suggestion was received favorably and Doctors Elkin, Kugel and Francke suggested Doctor Benjamin Felson, Professor of Radiology, University of Cincinnati Medical College. The author was pleased with this suggestion since Doctor Felson is perhaps the world's leading authority on pneumoconiosis. Accordingly, the films were sent to Doctor Felson, who will interpret and classify them for a fee.

FINAL RESULTS

The X-ray films were sent to the "B" reader for interpretation and his findings, in part, and his diagnoses of the 20 positive cases are listed in Table 2. For comparison, the information provided by the "A" readers is tabulated also.

Of course, not all the information included in the radiologists' interpretations is included in the table because this would tend to confuse the non-medical recipients of this report. Entries in the interpretation, although important in establishing or arousing suspicion of the diagnosis of pneumoconiosis, especially asbestosis, such as pleural thickening, pleural calcification and lung zones involved, purposely are omitted from the table.

Of the 70 employees participating in the survey, the "A" readers believed that 20 had a pneumoconiosis, an asbestosis or, even though the actual diagnosis was not included in the report, all 20 interpretations were classified and categorized, which implied that some of the features of a pneumoconiosis were thought to be visible on the film. The author assumed that all 20 cases were suspect until proven otherwise.

The "B" reader diagnosed six cases as "normal chest" and two others as "probably normal chest," although the latter were categorized by the "B" reader as "pneumoconiosis" so there is still some element of suspicion. One case (No. 10) the "B" reader interpreted as an "abnormal chest" but his finding indicated healed disease whose etiology was not dust.

The "A" reader interpreted four cases (Nos. 3, 5, 9 and 15) as "pneumoconiosis, cause unknown," and would not definitely state asbestosis since the pleural findings -- thickening and calcification -- were not present and the "B" reader came to the same conclusion; i.e., diagnosing "pneumoconiosis" in the first three cases but concluding that the fourth case (No. 15) had a "normal chest X-ray."

Of the eight cases the "B" reader diagnosed as "normal," or "probably normal," while the "A" reader implied or diagnosed "pneumoconiosis" or "asbestosis," the most interesting comparison was Case No. 7 and Case No. 14. The interpretation of the X-rays of Case No. 7 by the "A" readers was "asbestosis" and Case No. 14 as "possible asbestosis or inflammatory disease residua," with the radiologist favoring the latter diagnosis. Yet the "B" reader believed both of these to be completely "normal." It is interesting that Case No. 2 and Case No. 12 were interpreted and classified as to category and opacity type almost exactly alike by the two readers. Unfortunately, the "A" readers did not advance a definitive diagnosis in 13 cases and had they done so, the comparison between their interpretations and those provided by the "B" reader would be more useful. Other than the "normal chest" diagnoses, the greatest differentiation was between the interpretations of the type opacity by the two readers. The "A" readers tended to read rounded type opacities (p, q or r), while the "B" reader interpreted irregular opacities (s, t or u). This is a minor difference but it certainly emphasizes that interpretation of X-rays is qualitative and there can and will be differences of opinion.

As indicated earlier in this report, it may take many years of exposure to asbestos-containing material for asbestosis to develop and become evident; i.e., satisfy the X-ray diagnostic criteria. Table 2 shows that the insulators with many years of company service and exposure had the highest incidence of positive films (Cases 1, 2, 3, 4 and 9). The Steam Plant operator (Case No. 18) with the most years of company and presumably the same number of years exposure to diatomaceous earth and asbestos was a suspect case of asbestosis. The information on Table 2 also indicates that the sheetmetal craft in the Institute Plant is not a hazardous trade from the asbestosis standpoint. Although Case No. 3 was diagnosed as pneumoconiosis by both the "A" and "B" readers, his work history would indicate that the problem is not asbestosis. This 64-year-old employee has worked at the sheetmetal trade in the Institute Plant for the last seven years with no known exposure to asbestos. However, he had respiratory symptoms, reduced vital capacity and diagnoses of chronic bronchitis and emphysema prior to his assignment in the sheetmetal craft. In addition, he worked for many years as a blacksmith, a tool dresser, a welder and a grinder. His descriptions of the coal dust, vapors, metal fumes and dust to which he has been exposed would lead one to believe his pneumoconiosis probably is of etiology other than asbestos.

Table 2.—UICC/Cincinnati Radiographic Classifications - Comparisons							
Case #	Emp. Init.	Years Exposed	Craft	Reader "A"		Reader "B"	
				Code* Type	Diagnosis	Code* Type	Diagnosis
1	RMB	32	In	1/2 q	?	2/1 s	Asbestosis
2	REB	30	In	2/2 s	Asbestosis	2/2 t	Asbestosis
3	ABC	8	SM	1/2 q	Pneumoconiosis	1/0 ?	Pneumoconiosis
4	HFC	25	In	1/0 p	?	2/3 s	Asbestosis
5	RC	4	In	2/1 q	Pneumoconiosis	0/1 t	Pneumoconiosis
6	DEE	2	SP	1/0 q	?	0/1 s	Probably normal chest
7	JLH	30	SM	? ?	Asbestosis	0/0 ?	Normal chest
8	HCH	7	In	0/1 q	?	-- -	Normal chest
9	AK	17	In	2/1 s	Pneumoconiosis	1/0 s	Pneumoconiosis
10	FLM	8	In	1/0 ?	?	-- -	Healed TBC or histoplasmosis
11	HHM	2	L	0/0 ?	?	0/0 ?	Asbestosis
12	CM	6	SP	2/2 t	?	2/2 u	Asbestosis
13	BEP	31	In	1/1 p	?	? t	Asbestosis
14	CQR	6	In	0/- ?	Possible asbestosis or inflammatory dis.	-- -	Normal chest
15	LCS	11	In	1/0 q	Pneumoconiosis	-- -	Normal chest
16	EWT	16	SP	1/2 q	?	-- -	Normal chest
17	WBT	25	In	0/1 q	?	1/1 s	Asbestosis
18	LIU	30	SP	0/1 t	?	0/0 ?	Suspect Asbestosis
19	CEU	4	In	1/0 q	?	0/1 t	Probably normal chest
20	HFV	8	In	1/1 q	?	-- -	Normal Chest

In - Insulator SM - Sheetmetal Worker SP - Steam Plant Operator L - Laborer

? - No answer reported for the entry in the table.

*Radiographic appearances of pneumoconioses (including asbestosis) are classified into four categories: 0, 1, 2 and 3 and subclassified into codes. Thus Category 0 includes 0/-, 0/0 and 0/1. The number left of the slant mark is the Category and the number to the right, the degree or extent. Category 1 includes 1/0, 1/1 and 1/2, Category 2 includes 2/1, 2/2 and 2/3 and Category 3 is graded into 3/2, 3/3 and 3/4. Types represent the size of the opacity; i.e., rounded opacities are graded as p, q or r and irregular opacities are graded s, t or u.

