Final Report

BORRISTON
LABORATORIES, INC.

Co-Carcinogenicity of Foundry Particulates Silica and Silica Sand Substitutes

Volume 1

NIOSH Contract No. 21-79-0036
Borriston Project No. 0105

Initiation Date: April 21, 1980
Termination Date: January 26, 1983
Issue Date: March 23, 1984

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A Subsidiary of Dynamac International, Inc.

50272-101			
REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. Recipient's Accession No. PB84 241975
4. Title and Subtitle: Co-Carcinogenicity Of Foundry Particulates Silica And Silica Sand Substitutes, Volume 1, Final Report			5. Report Date: 84/03/23
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address: Borriston Laboratories, Inc. 5050 Beech Place Temple Hills, MD 20748			10. Project/Task/Work Unit No.
			11. Contract(C) or Grant(G) No. (C) 210-79-0036 (G)
12. Sponsoring Organization Name and Address: Division of Biomedical and Behavioral Science, NIOSH, U.S. Department of Health and Human Services, Cincinnati, Ohio			13. Type of Report & Period Covered: Final Report 4/21/80 to 1/26/83
			14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

A carcinogenicity assay of silica (14808607) and silica sand substitutes was conducted. Male Syrian-Golden-hamsters were administered silica sand and 10 silica sand substitutes alone or with benzo(a)pyrene (50328) (BP) by intratracheal instillation weekly for 15 weeks. Doses ranged from 0.7 to 3.0 milligrams per 0.2 milliliters of saline. Animals were observed for an additional 77 weeks. Moribund and all surviving animals were killed after 92 weeks. Complete necropsies were conducted. The silica and silica sand substitutes were not carcinogenic to the hamster respiratory tract. When given with BP, silica sand and the substitutes, except for an aluminum (7429905) silica formulation, caused a significantly higher incidence of respiratory tumors than BP alone. Malignant tumors were induced in all parts of the respiratory tract, and consisted primarily of adenocarcinomas, adenosquamous carcinomas, squamous cell carcinomas, and adenomas. Silica and the silica sand substitutes did not induce any fibrogenic activity in the lungs. No pathological changes were seen in any other organs. The authors conclude that silica and silica sand substitutes by themselves are not carcinogenic to the hamster respiratory tract. When instilled with BP, they show a definite cocarcinogenic response.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

NIOSH-Publication, NIOSH-Contract, Industrial-exposures, Animal-studies, Carcinogenicity, Airborne-particles, Foundry-sands, Silica-dusts, Tumorigens, Histopathology, Mortality-data, Contract-210-79-0036

c. COSATI Field/Group

18. Availability Statement:	19. Security Class (This Report)	21. No. of Pages: 192
	20. Security Class (This Page)	22. Price

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

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FINAL REPORT STATEMENT

PROJECT NUMBER 0105 was audited on 12/5/83 through 12/19/83 (Draft Final Report), and 3/14/84 (Final Report) by the Quality Assurance Unit and it was concluded that the Final Report accurately reflects the raw data for this project. Discrepancies were reported to management on 12/19/83 and 3/14/84, respectively.

Christine Lefevre
QUALITY ASSURANCE UNIT
DATE: 3/14/84

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I. ABSTRACT

A co-carcinogenicity study of foundry particulates: silica sand and silica sand substitutes, was performed at Borriston Laboratories, Inc., by intratracheal instillation in hamsters. The silica sand substitutes evaluated were Olivine, from two geographical sources, Chromite Sand, and Zirconium Silicates from two geographical sources and Aluminum Silicates of three types. The study was conducted from April 21, 1980 to January 26, 1982.

The co-carcinogenicity potential of these sands was evaluated in combination with the administration of the carcinogen benzo(a)pyrene [B(a)P]. The relative fibrogenic activity of these materials in an animal model was compared to a reference quartz (Minusil).

Male Syrian golden hamsters were exposed intratracheally to silica sand and silica sand substitutes alone and in combination with B(a)P once weekly for fifteen consecutive weeks. B(a)P alone was used as the negative control. B(a)P + Ferric Oxide was used as the positive control. Minusil was utilized as the positive control for fibrogenic potential, and saline was used as the vehicle control. Each treatment and control group consisted of 50 hamsters.

Silica sand and silica sand substitutes were found to be non-carcinogenic in the hamster respiratory tract. A definite co-carcinogenic effect was seen for the Silica Sand. All silica sand substitutes, except for the Aluminum Silicate (60), exhibited a definite co-carcinogenic response. Aluminum Silicate (60) produced a weak co-carcinogenic effect when compared to the other sands.

The total respiratory tract tumor bearing animals in the Particulate + B(a)P groups were statistically significantly higher than those seen in their B(a)P controls. The tumor incidences of the Particulate + B(a)P were similar to that of the Ferric Oxide + B(a)P (positive control) group. The percentage of hamsters with tumors of the larynx, trachea and lungs and bronchi were higher in the Particulate + B(a)P groups than the Particulate control. Both benign and malignant tumors were seen in all segments of the respiratory tract. Benign tumors, mostly epithelial polyps, were predominant in the upper respiratory tract (larynx and trachea). Malignant tumors were predominantly

seen in the lungs and bronchi. Histologically these were identified as adenocarcinomas, squamous cell carcinomas, adenosquamous carcinomas, carcinomas, and sarcomas of various types.

In this study, the silica sand and silica sand substitutes did not induce any fibrogenic activity in the hamster lung. Compared with the Saline control, pulmonary granulomatous inflammation was seen with increased incidence in the Silica Sand, Minusil, Minusil + Ferric Oxide and Aluminum Silicate (48) treated animals. This finding was statistically significant.

No treatment related effects were seen in the other organ systems in this study. The stomach tumors seen in this study were mostly forestomach papillomas, frequently seen in this model system. Other lesions identified such as amyloidosis, heart thrombosis and chronic nephropathy are commonly seen in hamsters and are attributed to the aging process.

INTRODUCTION

In the United States during 1978, there were over 400,000 production workers employed by more than 4,400 foundries. Ferrous type castings accounted for 85 percent of the total castings produced by these foundries; the remaining castings were aluminum (10%), zinc (2%), copper (2%), and magnesium (1%) (Palmer and Scott, 1981).

The foundry process basically involves the following steps: melting and alloying the metal; preparing the sand mold and cores; pouring of the molten metal into the mold; cooling of the mold and castings; shakeout, where the hot castings are separated from the molds; and finishing by blasting and grinding the castings with abrasives.

The molds used for metal casting are usually composed of silica sand. However, the tradition of using silica sand for metal casting is slowly being changed to the use of non-silica aggregates because of increased demands for improved cast surfaces and closer dimensional tolerances, and because of the physical, chemical and biological limitations of silica sands.

The performance of some non-silica mold/core materials had been evaluated as early as the 1920's. However, their use was not established until casting designs became more complex and producers could supply aggregates of more uniform and consistent quality. Early use of these non-silica sands was investigated primarily for their characteristics and properties at elevated temperatures. Wettability by steel, thermal expansion, heat diffusitivity, refractory characteristics and cost are the major factors when considering their use (Kotzin, 1981). Silica sand substitutes, such as Olivine, have been reported to reduce some adverse biological effects such as silicosis, and routine use of Olivine in place of silica sand was established in the 1940's in the Scandinavian countries (Tubich, 1967).

The major non-silica aggregates presently used throughout the metal casting world include Zirconium Sand, Olivine Sand, Chromite Sand and Aluminum Silicates (Kotzin, 1981). However, little is known about the biological effects of these materials.

Recent epidemiological studies have concluded that there is a significant excess of lung cancer, as well as nonmalignant respiratory disease among foundry workers (Egan, et al., 1977). Palmer and Scott (1981), in their review article addressing the cancer problem, discussed the possible agents responsible for contributing to the hazard. These included various classes of carcinogens such as polynuclear aromatic hydrocarbons, metals and other organic compounds, cigarette smoking, and promoters/co-carcinogens, such as irritants and particulates.

The co-carcinogenic effect of particulates has been well established by use of the intratracheal instillation model for studying lung co-carcinogenesis. Ferric oxide (Saffiotti, 1968), carbon (Farrell and Davis, 1972), titanium dioxide (Stenback, et al., 1976), magnesium oxide (Stenback, et al., 1975), and amorphous silica (Stenback and Rowland, 1979) in combination with the carcinogen, benzo(a)pyrene (B(a)P) significantly increase the number of pulmonary tumors, compared to B(a)P alone. However, the results with aluminum oxide (Farrell and Davis, 1972; Stenback, et al., 1976) and manganese dioxide (Stenback and Rowland, 1979) do not show a co-carcinogenic effect.

This study was designed to focus on two aspects of the pulmonary pathology experienced by foundry workers, silicosis and cancer, as caused or modified by foundry aggregates. The purpose of this study was threefold:

1. To assess the co-carcinogenic potential of Silica Sand. Since the co-carcinogenic effect of particulates in combination with B(a)P administration cannot be generalized, it is necessary to study each material.

2. To assess in an animal model the co-carcinogenic potential of Silica Sand substitutes including, Olivine from two geographical sources, Chromite Sand, Zirconium Silicates from two geographical sources, and Aluminum Silicates of three types.

3. To assess the relative fibrogenic activity of these materials as compared to a reference quartz (Minusil).

III. MATERIALS AND METHODS

A. TEST MATERIALS

A total of ten (10) sands (see below) which had been prepared for the study were received from the sponsor in separate plastic bottles on March 18, 1980. At receipt, each sand sample was assigned a Borriston compound number. The samples were stored in the dark at room temperature in the containers in which they were received.

Materials	BRL Identification	BRL NO.
Ottawa Silica Sand, Sil-Co-Sil	Silica Sand	233
Control Silica Sand, Min-U-Sil	Minusil	234
Zirconium Silicate Sand (Australia)	Zirconium (Au)	235
Zirconium Silicate Sand (Florida)	Zirconium (Fl)	236
Chromite Sand	Chromite Sand	237
Olivine Sand (North Carolina)	Olivine (Nc)	238
Olivine Sand (Washington)	Olivine (Wa)	239
Aluminum Silicate Sand Remasil 48 PR 200C	Aluminum (48)	240
Aluminum, Silicate Sand Remasil 60 PR 200C	Aluminum (60)	241
Aluminum Silicate Sand Remasil 70 PR 325	Aluminum (70)	242
Ferric Oxide	Ferric Oxide	232

The following information as to the supplier of the sands as well as the particle size analyses and surface area analyses of the samples were supplied by the sponsor following completion. Preparation and analyses of the samples have been described in detail by Stettler et al., (1981).

SAND MATERIAL AND THEIR SOURCES

Materials	Sources
Ottawa Silica Sand, Sil-Co-Sil 395, -325 GFN	Ottawa Silica Company P.O. Box 577 Ottawa, Illinois 61350
Control Silica Sand, Min-U-Sil, 5 µm	Pennsylvania Glass Sand Corporation 3 Penn Center Pittsburgh, Pennsylvania 15235
Zirconium Silicate Sand (Australia), -325 GFN, Non-calcined	Continental Mineral Processing Co. 11817 Mosteller Road Cincinnati, Ohio 45241
Zirconium Silicate Sand (Florida) -325 GFN, Calcined	Continental Mineral Processing Co. 11817 Mosteller Road Cincinnati, Ohio 45241
Chromite Sand, GFN 55/60 Manufacturer: American Colloid	Carpenter Brothers, Inc. 606 W. Wisconsin Avenue Milwaukee, Wisconsin 53203
Olivine Sand (North Carolina), GFN 70	IMC Chemicals Group, Inc. P.O. Box 207 Terre Haute, Indiana 47808
Olivine Sand (Washington), GFN 70	IMC Chemicals Group, Inc. P.O. Box 207 Terre Haute, Indiana 47808
Aluminum Silicate Sand Remasil 48 RP 200C	Remet Corporation P.O. Box 278 Chadwick, New York 11319
Aluminum Silicate Sand Remasil 60 RP 200C	Remet Corporation P.O. Box 278 Chadwick, New York 11319
Aluminum Silicate Sand Remasil 70 RP 325, Coarse Grind	Remet Corporation P.O. Box 278 Chadwick, New York 11319

PARTICLE SIZE AND SURFACE AREA ANALYSES

Material	Specific Gravity	Median Diameter (μm)	Mass Median[e] Diameter (μm)	Mass Median[f] Aerodynamic Diameter (μm)	Surface Area (m^2/g)
Silica Sand	2.66	2.61	4.43	7.23	1.88
Minusil	2.66	0.83	3.25	5.06	2.99
Zircon Sand (Au)	4.65	1.98	3.32	7.16	2.41
Zircon Sand (Fl)	4.65	1.95	3.11	6.70	2.26
Chromite Sand	4.45	1.31	4.06	8.57	1.01
Olivine Sand (Nc)	3.30	0.41	5.46	9.92	1.02
Olivine Sand (Wa)	3.30	0.98	4.05	7.36	1.71
Aluminum 48[a]	2.65	2.60	4.52	7.35	1.47
Aluminum 60[b]	2.78	2.62	3.79	6.72	1.46
Aluminum 70[c]	2.85	2.36	3.46	5.84	1.11
Ferric Oxide[d]	5.24	0.27	0.6	1.37	6.90

[a]Minerology - 62% mullite, 38% cristobalite plus glass

[b]Minerology - 80% mullite, 20% glass

[c]Minerology - 87% mullite, 3% alumina, 10% glass

[d]Fisher Scientific Co. (certified grade, red anhydrous--Lot 785156)

[e]Calculated from circular equivalent diameter, assuming the particles were spheres

[f]Calculated as Mass Median Diameter times the square root of the density

Benzo(a)pyrene [B(a)P; 99+% pure; "gold label"; lot number 02087; Aldrich Chemical Company, Milwaukee, Wisconsin] was used for this study. The purity of the B(a)P was analyzed by infrared scan, gas chromatography and ultraviolet and fluorescence spectroscopy by the supplier.

Normal saline (0.9% sodium chloride in water; sterile; non-pyrogenic; Abbott Laboratories, Chicago, Illinois) was used as the vehicle.

B. TEST ARTICLE PREPARATIONS

1. Particulate Suspensions. An appropriate amount of the particulate (sand) was weighed immediately prior to each treatment and placed in a sterile flask. The correct volume of saline was added and the mixture was stirred for 10 minutes on a magnetic stirrer.

2. B(a)P + Saline Suspensions. B(a)P was prepared by dry grinding in a Fisher Scientific Model #155 mullite mortor at 100 rpm for 24 hours. Fresh Saline suspension of this ground material were prepared weekly by ball milling for 7 days under optimum sterile conditions by using a Fisher model #753 Jar Mill at 290 rpm with porcelin jars fitted with teflon coated sealed tops and stainless steel balls. The porcelin jars, covers, and stainless steel balls were steam autoclaved in a Markel-Forge Sterilizer, for 30 minutes (15 psi and 240° F) just prior to ball milling. The resulting B(a)P + saline suspension was stored in the dark at 5° C during the week of dosing. Any remaining suspensions were discarded at the end of each week.

3. B(a)P + Particulate Suspensions. An appropriate volume of B(a)P + saline suspension was pipetted from the stock suspension into a sterile flask. The correct amount of sand was weighed and added to the B(a)P + saline suspension. The mixture was stirred for 10 minutes on a magnetic stirrer. This procedure was performed daily just prior to instillation for the scheduled treatment group.

All suspensions prepared as described above were kept homogenous by continuous magnetic stirring during the course of the instillation.

4. Particle Size Analyses of B(a)P + Saline Suspension.

Particle size analyses of the B(a)P/saline suspension was determined by Coulter Electronic Inc., Hialeah, Florida. The sample was dispersed by ultrasonication for one minute and analysed on a Coulter Counter (Model TAII) using a biaperture technique which counts individual particles rather than agglomerates.

The results of the microscopic analyses revealed that the B(a)P particles were well dispersed in the suspension and the particle size distribution was identified as shown below:

Size (≤μm):	10	9	8	7	6	5	4	3	2	1
Percent:	80	75	70	64	58	50	40	30	19	7

C. TEST ANIMALS

A total of 1520 out bred male Syrian golden hamsters, 4-6 weeks of age, were received in one shipment from Charles River Breeding Laboratories, Newfield, New Jersey on March 26, 1980. Upon receipt, they were examined for general health and five from each shipping crate, (25-30 hamsters per crate) were weighed. All hamsters appeared clinically normal and were introduced into quarantine.

Hamsters were housed individually in polycarbonate cages with sterile San-i-cel® bedding. The cages were suspended from stainless steel racks equipped with filter sheets. The cages and bedding were changed weekly and filter sheets changed bi-weekly.

Feeders and fresh water bottles were provided weekly. Purina® Lab Chow #5001 and water via water bottles were available ad libitum. Analyses of the feed is presented in Appendix 1.

Hamsters were housed in a temperature controlled (22+3°C) room with a manually controlled 12-hour light/dark cycle. The relative humidity of the room generally ranged from 30 to 70%, although it was not controlled. Room air was exchanged at a rate of 10-15 air changes per hour and was not recirculated.

D. QUARANTINE PERIOD

Hamsters were quarantined for a period of 26 days (from March 26 through April 20, 1980). During the quarantine period all groups were observed twice daily for dead and moribund animals. Clinical observations were taken once

daily. Fecal sample analyses for intestinal parasites was performed on 7 percent of the hamster population on a random basis. No parasites were present. Gross necropsies performed on the sixty hamsters that died during this period did not reveal any gross abnormalities.

E. RANDOMIZATION

Randomization was performed using a computer generated random number table. The mean body weights for all groups were similar ranging from 78 to 82 g.

At randomization, hamsters in good health were selected for study and 50 hamsters were assigned to each of the 26 groups. After randomization, each hamster received a unique permanent identification number and was ascribed a group color-coded cage card identifying the animal by project number, animal number, sex, treatment group, and date of initiation.

F. TREATMENT GROUPS

The allotment of hamsters to treatment groups was as follows:

GROUP NO.[a]	TREATMENT[b]	DOSAGE OF PARTICULATE[c] (mg)
1[d]	Saline (vehicle control)	none
2[d]	Saline + B(a)P (negative control)	none
3	Ferric Oxide Control	3.0
4[d]	Ferric Oxide + B(a)P (positive control)	3.0
5	Silica Sand Control	1.1
6	Silica Sand + B(a)P	1.1
7	Minusil Control	0.7
8	Minusil + B(a)P	0.7
9	Zirconium (Au) Control	0.9
10	Zirconium (Au) + B(a)P	0.9
11	Zirconium (Fl) Control	0.9
12	Zirconium (Fl) + B(a)P	0.9
13	Chromite Sand Control	2.1
14[d]	Chromite Sand + B(a)P	2.1
15[d]	Minusil + Ferric Oxide Control	0.7 + 3.0
16	Minusil + Ferric Oxide + B(a)P	0.7 + 3.0
17	Olivine (Nc) Control	2.1
18	Olivine (Nc) + B(a)P	2.1
19	Olivine (Wa) Control	1.2
20	Olivine (Wa) + B(a)P	1.2
	Aluminum Silicates (Aluminum):	
21	Aluminum (48) Control	1.4
22	Aluminum (48) + B(a)P	1.4
23[d]	Aluminum (60) Control	1.4
24	Aluminum (60) + B(a)P	1.4
25	Aluminum (70) Control	1.9
26	Aluminum (70) + B(a)P	1.9

[a]Group size = 50 hamsters

[b]All B(a)P groups instilled with 3.0 mg B(a)P plus amount of particulate shown

[c]All doses instilled in 0.2 ml saline

[d] Mis-sexed and/or escaped animals were excluded from study for histopathological evaluation, survival analyses and statistical analyses. The animal numbers are listed below:

Group	Animal No.
1	17263, 17275 (Escaped)
2	17315, 17320 and 17321 (Escaped)
4	17395 (Mis-sexed); 17441 (Escaped)
14	17917 (Escaped); 17922 (Mis-sexed)
15	17982 (Mis-sexed)
23	18384 (Escaped)

G. TEST ARTICLE ADMINISTRATION

Treatment groups, originally consisting of 50 hamsters each, (see explanation on page 11) were intratracheally instilled either with the particulates alone or in combination with 3.0 mg B(a)P in saline. The suspensions were administered by intratracheal instillation according to the method of Saffiotti, et al. (1968). An instillation volume of 0.2 ml was used and the suspensions were kept homogeneous by continuous stirring during the course of instillation. The dose of each material indicated for each treatment group was determined from the surface area data presented under the Test Material section. Doses were based upon the estimated maximum tolerated dose of Minusil taken as unity. For example, the estimated tolerated dose of Minusil (0.7 mg) would have a total surface area of 0.0021 m^2 (0.0007 g x 2.99 m^2/g), and a comparable dose of chromite sand with a surface area of 1.01 m^2/g would be 0.0021 $m^2 \div 1.01$ $m^2/g = 2.1$ mg. Ferric Oxide + B(a)P was used as the positive control for co-carcinogenesis and Minusil was used as the positive control for fibrogenesis. The Ferric Oxide + Minusil group was included to test the combined effect. In addition, saline alone was used as the vehicle control and B(a)P in saline was used as the negative control. The treatment schedule involved a once per week instillation for 15 consecutive weeks. Hamsters were anesthetized with an intraperitoneal injection of 0.4 ml of 1% Brevital Sodium® solution prior to instillation.

H. OBSERVATIONS

Hamsters were observed twice daily, 7 days per week for dead and morbid animals throughout the study. Clinical signs of illness were observed once weekly throughout the study. Body weights were taken weekly, prior to instillation during the first 15 weeks of treatment and at 2 week intervals thereafter. Hamsters in moribund condition were killed.

I. TERMINATION AND NECROPSY

All surviving hamsters were killed in January 1982, (21 months after initiation), by an overdose of Brevital Sodium®. A terminal body weight was recorded prior to sacrifice.

Complete necropsies were performed on those animals that died, were killed when moribund or killed at study termination. Lungs were weighed at necropsy on all hamsters during the course of the study. Each necropsy consisted of an examination of the external body surfaces and orifices. The carcass was then opened and the following organs and tissues were examined *in situ*, dissected from the carcass, re-examined (including cut surfaces and mucosal linings), and preserved in 10 percent neutral buffered formalin:

Adrenals
Brain
Costochondral Junction
Esophagus
Eyes
Gallbladder
Heart
Kidney
Large Intestines
Larynx
Liver
Lungs and Bronchi
Mammary Gland
Mandibular Lymph Nodes
Mesenteric Lymph Nodes
Muscle (thigh)
Nasal Cavity
Pancrease
Pituitary
Prostate
Salivary Gland
Sciatic Nerve
Seminal Vesicles
Skin
Small Intestines
Spinal Cord
Spleen
Sternebrae (plus marrow)
Stomach
Testes (with epididymides)
Thymus
Thyroids and Parathyroids
Trachea
Urinary Bladder
Tissue Masses
Lymph Nodes
Gross Lesions

The trachea and lungs were removed *en bloc* and infused with 10 percent neutral buffered formalin until the lungs were filled to normal inspiratory volume and then submerged in formalin for fixation. At the time of necropsy, location, size, number, shape, and color, of all gross lesions were recorded. Location, size, shape, and texture of tumors observed in the respiratory tract of the hamsters were also recorded.

J. HISTOLOGY

Following a fixation period of no less than 48 hours, tissues were trimmed in preparation for complete histologic processing. Tissues were automatically processed using a Tissue-Tek III V.I.P. automated tissue processor (LAB-TEK Division, Miles Laboratory, Inc., Elkhart, Indiana). Processed tissues were embedded in paraffin using a Tissue-TEK II embedding system (Miles Laboratories, Inc.), sectioned at approximately 5 microns on a

Lietz Rotary Microtome (Scientific Products, Columbia, Maryland), and the sections mounted on glass slides. The slides were stained with hematoxylin and eosin.

K. HISTOPATHOLOGY

Hematoxylin and eosin-stained Sections of those organs and tissues listed under the Termination and Necropsy section of the methodology were examined microscopically by a Board-certified veterinary pathologist. Eyes were examined only if grossly abnormal and the spinal cord was examined in animals where neurologic signs had been present.

L. STATISTICAL ANALYSES.

The following statistical analyses was performed on data derived from this study:

I. Survival Analyses. Survival rates were statistically compared using a chi-square analysis.

1. Saline Control vs Particulate Control
2. Saline + B(a)P vs Particulate + B(a)P
3. Particulate Control groups vs Particulate + B(a)P
4. Minusil Control vs Particulate Control
5. Zirconium (Au) vs Zirconium (Fl) ± B(a)P
6. Olivine(Nc) vs Olivine(Wa) ± B(a)P.
7. Aluminum (48) vs Aluminum (60) vs Aluminum (70) ±B(a)P
8. Ferric Oxide + B(a)P vs Minusil + B(a)P vs Minusil + Ferric oxide + B(a)P.
9. Silica Sand or Minusil ± B(a)P vs Aluminum (48, 60, 70) + B(a)P.

II. Body Weight Analyses. The mean body weights of Particulate + B(a)P groups were statistically compared to the Particulate Control groups at all recorded intervals, using a two tailed Students t-test.

III. Lung Weight Analyses. The mean lung weights were statistically compared using a Student's t-test. The following group comparisons were made:

1. Saline Control vs Particulate Control.
2. Saline + B(a)P vs Particulate + B(a)P.
3. Particulate Control vs Particulate + B(a)P.

IV. Tumor Analyses. Tumor incidences were statistically analyzed using a two-tailed Fisher's exact test. In conducting the Fisher's analyses, a ratio of number of tumor bearing animals (numerator) to the effective number at risk (denominator) was performed for each set of groups compared. The same procedure was followed for the groups where a particular type of control sand was compared either with another type of sand or with the addition of B(a)P. The granulomatous inflammation, hyperplasia of the respiratory tract and stomach tumors were also analysed using the same procedure; i.e., a ratio of number affected (numerator) to the effective number at risk (denominator).

The number at risk was determined as the number of survivors at the time of death of the first animal in either of the two groups which was found (upon histological confirmation) to have a tumor in the respiratory system. This procedure was used since the diagnosed tumors were non-observable during the in-life phase of the study and therefore, the time of appearance could not be determined.

Only primary lung tumor bearing animals were used for the life table analyses. Only primary lung tumors were used for tumor incidences and tumor types. Animals with metastasised lung tumors were not used. Malignant lymphoma in the lung was not counted as a lung tumor since this tumor does not originate from lung tissue; therefore, hamsters which had malignant lymphoma as the only diagnosed lung tumor were not considered as tumor bearing animals for the purpose of lung tumor analyses. Animals with leukemia in the lung were also not considered.

1. Laryngeal Tumor Bearing Animals:

   Particulate Control vs Particulate + B(a)P.

2. Tracheal Tumor Bearing Animals:

   Particulate Control vs Particulate + B(a)P.

3. Lung Tumor Bearing Animals:

   Particulate Control vs Particulate + B(a)P.

4. Total Respiratory Tract Tumor Bearing Animals:

   a. Particulate Control vs Particulate + B(a)P.
   b. Saline + B(a)P vs Particulate + B(a)P.
   c. Ferric Oxide + B(a)P Control vs Particulate + B(a)P.
   d. Silica Sand + B(a)P vs Minusil + B(a)P.
   e. Zirconium (Au) + B(a)P vs Zirconium (Fl) + B(a)P.
   f. Olivine (Nc) + B(a)P vs Olivine (Wa) + B(a)P.
   g. Aluminum (48) + B(a)P vs Silica Sand + B(a)P
      " " vs Minusil + B(a)P
      " " vs Aluminum (60) + B(a)P
      " " vs Aluminum (70) + B(a)P
   h. Aluminum (60) + B(a)P vs Silica Sand + B(a)P
      " " vs Minusil + B(a)P
      " " vs Aluminum (70) + B(a)P
   i. Aluminum (70) + B(a)P vs Silica Sand + B(a)P
      " " vs Minusil + B(a)P
      " " vs Aluminum (48) + B(a)P
      " " vs Aluminum (60) + B(a)P
   j. Minusil + Ferric Oxide + B(a)P vs. Ferric Oxide + B(a)P
   k. Minusil + Ferric Oxide + B(a)P vs Minusil + B(a)P
   l. Ferric Oxide + B(a)P vs Minusil + B(a)P

V. Granulomatous Inflammation in the Lung. The incidences of pulmonary granulomatous inflammation in the lung for each Particulate Control was compared to that of the Saline Control using a two tailed Fisher's Exact test.

VI. Hyperplasia of the Respiratory Tract: The numbers of non-respiratory tract tumor bearing animals with hyperplasia of the larynx, trachea, lungs and the total respiratory system were compared, using a two-tailed Fisher's Exact test. The analyses compared each Particulate Control to its respective Particulate + B(a)P counterpart.

VII. Hyperplasia and Tumors of the Stomach: A two tailed Fischer's Exact test, was used to analyze the number of hamsters with hyperplasia, tumors and hyperplasia with tumors in the stomach. Each Particulate Control was compared to its respective Particulate + B(a)P counterpart.

IV. RESULTS

A. Survival:

Survival data are presented in Figure 1 and the probabilities of survival are presented in Table 1. The results of the chi-square analyses performed on survival data are presented in Table 2. Each analysis is discussed below:

1. Saline Control vs Particulate Control Groups

   Comparison between the various particulate groups and the Saline Control revealed significantly decreased survival for the Silica Sand and Minusil + Ferric Oxide ($p<0.01$) groups. The survival of all other Particulate groups was comparable to that of the Saline Control group.

2. Saline + B(a)P vs Particulate + B(a)P Groups

   Significantly decreased survival was observed for hamsters treated with Minusil + Ferric Oxide + B(a)P as compared to the Saline + B(a)P group at $p<0.01$. The survival rates of hamsters treated with Chromite Sand + B(a)P and Olivine (Wa) + B(a)P were significantly lower than the Saline + B(a)P group at $p<0.05$. All other Particulate + B(a)P groups showed similar survival as compared to the Saline + B(a)P group.

3. Particulate Control Groups vs Particulate + B(a)P Groups

   Comparison between each Particulate Control group and its respective Particulate + B(a)P counterpart revealed a significantly lower survival rate for hamsters treated with Minusil, Zirconium (Au), Chromite Sand, and Olivine (Nc) in combination with B(a)P as compared to hamsters treated with each particulate alone at $p<0.01$. Hamsters treated with Zirconium (F1) + B(a)P and Aluminum (60) + B(a)P had decreased survival as compared to their respective particulate alone group at $p<0.05$. The survival of hamsters treated with Saline, Ferric Oxide, Silica Sand, Minusil + Ferric Oxide, Olivine (Wa),

Aluminum (48) and Aluminum (70) in combination with B(a)P was comparable to that of their respective particulate alone group.

4. Minusil Control vs Particulate Control Groups

Significantly decreased survival was noted for hamsters treated with Silica Sand and Minusil + Ferric Oxide as compared to that of the Minusil Control group at $p<0.01$.

5. Zirconium (Au) vs Zirconium (F1)

No differences in survival were noted between the two Zirconium Silicates when administered alone or in combination with B(a)P.

6. Olivine (Nc) vs Olivine (Wa)

No differences in survival were observed between hamsters treated with Olivine (Nc) and Olivine (Wa) when administered alone or in combination with B(a)P.

7. Aluminum (48) vs Aluminum (60) vs Aluminum (70)

No differences in survival were observed between hamsters treated with the three Aluminum Silicates when administered alone on in combination with B(a)P.

8. Ferric Oxide + B(a)P vs Minusil + B(a)P vs Minusil + Ferric Oxide + B(a)P

No differences in survival were noted for hamsters treated with Ferric Oxide, Minusil or Minusil + Ferric Oxide in combination with B(a)P.

9. Silica Sand + B(a)P vs Minusil + B(a)P vs Aluminum + B(a)P

No differences in survival were noted for hamsters treated with Silica Sand, Minusil, Aluminum (48), Aluminum (60) or Aluminum (70) in combination with B(a)P.

B. BODY WEIGHTS

The mean body weights for all recorded intervals are presented in Table 3 and Figure 2. The results of the two tailed student's t-test are presented in Table 4. The analyses indicate that the body weights of hamsters treated with Particulates + B(a)P were significantly lower than their counterparts receiving the particulates alone at $p<0.05$.

During the 15 week instillation period, animals receiving the Particulate + B(a)P showed a lower body weight compared to the Particulate group. At the completion of the instillation, animals regained some of their body weight and only certain groups were affected. In general, hamsters receiving the Particulate +B(a)P exhibited a lower body weight as well as a lower body weight gain during the course of the study. These body weight changes appeared to be sporadic and did not correspond with either the survival, clinical signs or treatment.

C. LUNG WEIGHTS

The mean lung weights and the results of the statistical analyses are presented in Table 5.

1. Saline Control vs Particulate Control Groups

   Significantly increased mean lung weights were observed for the Silica Sand, Minusil, and Minusil + Ferric Oxide treated hamsters as compared to that of the Saline Control. The mean lung weights of all other Particulate groups were comparable to the Saline Control lung weights.

2. Saline B(a)P vs Particulate + B(a)P Groups

   Significantly increased mean lung weights were observed for the Ferric Oxide + B(a)P, Silica Sand + B(a)P, Minusil + B(a)P, Zirconium (Au) + B(a)P, Chromite Sand + B(a)P and Minusil + Ferric Oxide + B(a)P groups when compared to the Saline + B(a)P group. The mean lung weights of all other Particulate + B(a)P Groups were comparable to the Saline + B(a)P group.

3. Particulate Control Group vs Particulate + B(a)P Groups

Increased mean lung weights were observed for all Particulate + B(a)P groups compared with their respective control (particulate alone). The exception was the Silica Sand groups which had similar lung weights with and without B(a)P.

D. CLINICAL OBSERVATIONS

The clinical observations (incidences of signs) are presented in Appendix 2. Each hamster was observed weekly during the course of the study. Wheezing, dyspnea, polypnea were the most frequently observed clinical signs. However, these findings appeared not to correlate with either survival or pathologic findings. Sporadic incidences of other clinical signs such as thin and hunched appearance, alopecia, rough hair coat, piloerection, sores on the skin, desquamation, opaque eyes, squinted eyes, ataxia, tremors, enlarged abdomen and soft feces were also noted. These sporadic incidences were observed throughout the study and did not follow any set pattern.

E. TUMORS OF THE RESPIRATORY TRACT

The probability of respiratory tract tumor bearing animals by site, distribution of tumors by site, tumor incidences, the distribution of tumor types, the time of appearance of a first tumor and the mean latency period (the time determined as though the tumor appeared on the day of necropsy) are summarized in Tables 6-12. Each table is described in detail below as to its contents.

The probability of animals with tumors of the respiratory tract for each treatment group is presented in Table 6. Cumulative incidences of respiratory tract tumors for each treatment group along with a composite for the Ferric Oxide, Minusil and B(a)P combinations are presented in Figure 3.

A summary and comparison of the total tumor bearing animals with the total number of respiratory tract tumor bearing animals (RESP. TBA) and non-respiratory tract tumor bearing animals (Non-RESP. TBA) for each treatment group is presented in Table 7 and Figure 4.

The incidences of respiratory tract tumors in hamsters with the number of RESP. TBA, percentage of RESP. TBA, total number of tumors in the larynx, trachea, lungs and bronchi, total tumors, the time of appearance of the first tumor, and mean latency period are presented in Table 8. The mean latency period is also presented in Figure 5.

The distribution of RESP. TBA by site (percentage of animals with tumors of the larynx and trachea, lung and bronchi, and overlap of the entire system) with the total corrected percentage of RESP. TBA are presented in Table 9, and Figure 6.

The distribution of tumor types: polyps, benign tumors (papillomas and adenomas), malignant tumors (carcinomas and others) are presented in Table 10 and Figure 7.

The incidence of respiratory tract tumors in the Particulate Control groups are presented in Table 11.

The incidences of respiratory tract tumors by site (larynx, trachea, each lung lobe, lungs and bronchi) and morphology are presented in Table 12.

The life tables for laryngeal, tracheal and lung tumor bearing animals are presented in Appendix 3.

F. PATHOLOGY

Histopathology was conducted for those organs listed under the Termination of Necropsy section of the methodology. Animals that escaped from cages during the study as well as those mis-sexed were not included. A listing of these animals are presented in Section F under Materials and Methods.

Principal pathologic changes attributed to the compound administration were observed in the larynx, trachea, and lungs and

bronchi. Pathologic changes observed in the respiratory system included pulmonary granulomatous inflammation, hyperplasia, crystalline deposits and aspiration pneumonia. Pathologic changes including tumors were also seen in the other organ systems. The total respiratory tract and non-respiratory tract tumor bearing animals along with the total tumor bearing animals are listed in Table 7, and Figure 4. Tumors of the respiratory system were present in hamsters instilled with the Particulates + B(a)P as well as in the positive and negative control groups. A low incidence of tumors was seen in three of the sands when instilled alone. The tumors seen were both benign and malignant in character.

A summary of all tumor bearing animals and type of tumors observed are presented as "Tumor Inventory" in Appendix 4. A group summary of histopathological findings is presented in Appendix 5 and a summary of individual histopathology is presented in Appendix 6.

1. RESPIRATORY TRACT TUMOR INCIDENCES AND INDUCTION TIME

Incidences of respiratory tract tumors (total and by site) and the number of tumor bearing animals are presented in Table 8. The percentage of the types of tumor bearing animals (total and by site) are presented in Table 9. The incidences of the types of tumors seen (classified as polyps, benign, and malignant) are presented in Table 10.

a. Saline Control. No respiratory tract tumors were observed in the vehicle control group.

b. Saline + B(a)P. Twenty-two tumor bearing animals (47%) were present in this group. The distribution of these animals by tumor site (expressed as a percentage) was: larynx + trachea, 13%; lungs and bronchi, 30%; and an overlap of the entire system, 4%.

A total of 40 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 5; trachea, 3; and lungs and bronchi, 32. Eleven of the tumors were classified as polyps, one as benign, and 28 as malignant. The time of appearance of the first tumor was 37 weeks and the mean latency period for the group was 72.6 weeks.

c. Ferric Oxide + B(a)P. Thirty-five tumor bearing animals (76%) were present in this group. The distribution of these animals by tumor site (expressed as a percentage) was: larynx + trachea, 7%; lungs and bronchi, 52%, and an overlap of the entire system, 17%.

A total of 80 respiratory tract tumors were diagnosed and their distribution by site were as follows: larynx, 5; trachea, 6; and lungs and bronchi, 69. Ten tumors were classified as polyps, 5 as benign, and 65 as malignant. The time of appearance of the first tumor was 36 weeks and the mean latency period for the group was 70.2 weeks.

d. Silica Sand + B(a)P. Thirty-six tumor bearing animals (77%) were present in this group. The distribution of these animals by tumor site (expressed as a percentage) was: larynx + trachea, 13%; lungs and bronchi, 28%; and an overlap of the entire system, 36%.

A total of 98 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 13; trachea 13; and lungs and bronchi, 72. Seventeen were classified as polyps, 24 as benign, and 57 as malignant. The time of appearance of the first tumor was 31 weeks and the mean latency period for the group was 66.5 weeks.

e. Minusil + B(a)P. Forty-four tumor bearing animals (90%) were present in this group. The distribution of these animals by

site (expressed as a percentage) was: larynx + trachea, 2%; lungs and bronchi, 67%; and an overlap of the entire system, 20%.

A total of 123 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 10; trachea, 2; and lungs and bronchi, 111. Nine tumors were classified as polyps, 23 as benign, and 91 as malignant. The time of appearance of the first tumor was 23 weeks and the mean latency period for the group was 68.5 weeks.

f. Zirconium(Au) + B(a)P. Forty-three tumor bearing animals (88%) were present in this group. The distribution of these animals by site (expressed as a percentage) was: larynx + trachea, 4%; lungs and bronchi, 61%; and an overlap of the entire system, 22%.

A total of 126 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 8; trachea, 8; and lungs bronchi, 110. Thirteen tumors were classified as polyps, 5 as benign, and 108 as malignant. The time of appearance of the first tumor was 33 weeks and the mean latency period for the group was 62.8 weeks.

g. Zirconium (Fl) + B(a)P. Thirty-six tumor bearing animals (77%) were present in this group. The distribution of these animals by site (expressed as a percentage) was: larynx + trachea, 4%; lungs and bronchi, 45%; and an overlap of the entire system, 28%.

A total of 95 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 9; trachea, 9; and lungs and bronchi, 77. Twelve tumors were classified as polyps, 4 as benign, and 79 as malignant. The time of appearance of the first tumor was 40 weeks and the mean latency period for the group was 68.3 weeks.

h. Chromite Sand + B(a)P. Thirty-seven tumor bearing animals (80%) were present in this group. The distribution of these animals by site (expressed as a percentrage) was: larynx + trachea, 9%; lungs and bronchi, 33%; and an overlap of the entire system, 39%.

A total of 87 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 12; trachea, 13; and lungs and bronchi, 62. Sixteen tumors were classified as polyps, 7 as benign, and 64 as malignant. The time of appearance of the first tumor was 29 weeks and the mean latency period for the group was 62.3 weeks.

i. Minusil + Ferric Oxide + B(a)P. Thirty-eight tumor bearing animals (81%) were present in this group. The distribution of these animals by site (expressed as a percentage) was: larynx + trachea, 4%; lungs and bronchi, 55%; and an overlap of the entire system, 21%.

A total of 95 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 10; trachea, 4; and lungs and bronchi, 81. Nine tumors were classied as polyps, 13 as benign, and 73 as malignant. The time of appearance of the first tumor was 39 weeks and the mean latency period for the group was 66.7 weeks.

j. Olivine(Nc) + B(a)P. Forty tumor bearing animals (85%) were present in this group. The distribution of these animals by site (expressed as a percentage) was: larynx + trachea, 4%; lungs and bronchi, 47%; and an overlap of the entire system, 34%.

A total of 107 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 14; trachea, 7; and lungs and bronchi, 86. Seventeen tumors were classified as polyps, 4 as benign, and 86 as malignant. The time of

appearance of the first tumor was 26 weeks and the mean latency period for the group was 65.7 weeks.

k. Olivine (Wa) + B(a)P. Thirty-nine tumor bearing animals (85%) were present in this group. The distribution of these animals by site (expressed as a percentage) was: larynx + trachea, 13%; lungs and bronchi, 46%; and an overlap of the entire system, 26%.

A total of 83 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 8; trachea, 11; and lungs and bronchi, 64. Twelve tumors were classified as polyps, 1 as benign, and 70 as malignant. The time of appearance of the first tumor was 28 weeks and the mean latency period for the group was 60.5 weeks.

l. Aluminum(48) + B(a)P. Thirty-eight tumor bearing animals (76%) were present in this group. The distribution of these animals by site (expressed as a percentage) was: larynx + trachea, 6%; lungs, and bronchi, 34%; and an overlap of the entire system, 36%.

A total of 108 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 12; trachea, 12; and lungs and bronchi, 84. Sixteen tumors were classified as polyps, 6 as benign, and 86 as malignant. The time of appearance of the first tumor was 17 weeks and the mean latency period for the group was 67.8 weeks.

m. Aluminum(60) + B(a)P. Thirty-one tumor bearing animals (63%) were present in this group. The distribution of these animals by site (expressed as a percentage) was: larynx + trachea, 10%; lungs and bronchi, 27%; and an overlap of the entire system, 27%.

A total of 71 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 13; trachea, 7; and lungs and bronchi, 51. Sixteen tumors were classified as polyps, 5 as benign, and 50 as malignant. The time of appearance of the first tumor was 14 weeks and the mean latency period for the group was 69.6 weeks.

n. Aluminum (70) + B(a)P. Thirty-seven tumor bearing animals (82%) were present in this group. The distribution of these animals by site (expressed as a percentage) was: larynx + trachea, 4%; lungs and bronchi, 42%; and an overlap of the entire system, 36%.

A total of 80 respiratory tract tumors were diagnosed and their distribution by site was as follows: larynx, 11; trachea, 8; and lungs and bronchi, 61. Fifteen tumors were classified as polyps, 10 as benign, and 55 as malignant. The time of appearance of the first tumor was 29 weeks and the mean latency period for the group was 66.9 weeks.

o. Particulate Control groups. Table 11 summarizes the tumor incidences, tumor types and the induction time seen in the particulate control groups.

A total of five (5) tumor bearing animals were observed in the particulate control groups. In the Ferric Oxide control there was one animal (3%) with one benign tumor in the larynx which appeared at week 62. In the Minusil control there was one animal (3%) with a single malignant tumor in the lung appearing at week 68. In the Zirconium (F1) group there were two (2) tumor bearing animals (10%). The time of appearance of the first tumor was 86 weeks with a mean latency of 89.0 weeks. There were 2 benign and 2 malignant tumors for a total of 4 tumors. In the Aluminum (70) group there was one animal (8%) with 3 tumors in the lungs and bronchi appearing at study week 92.

In the Zirconium (F1) group there was one animal with a metastatic osteosarcoma and one animal with leukemia. In the Olivine (Wa) group, a metastatic osteosarcoma in the lung of one animal was observed. These animals were not considered as respiratory tract tumor bearing animals since the tumors did not originate from the lung and leukemia is not a lung tumor. All other particulate control groups were free of respiratory tract tumors.

2. RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY

The incidences of tumors observed in the Particulate + B(a)P groups, according to their segmental distribution in the respiratory system and morphologic classification are presented in Table 12. The tumors were classified as epithelial polyps, squamous cell carcinomas, adenosquamous carcinomas, carcinomas, adenomas, adenocarcinomas, and sarcomas of various types. Other metastatic tumors of the above morphologic types, melanomas, and neoplasms, not otherwise specified (NOS), were also observed.

a. Larynx. The laryngeal tumors (90 total) predominantly were epithelial polyps. The incidences were similar among the groups. In addition, 28 squamous cell carcinomas, 5 carcinomas, 5 adenocarcinomas and 1 sarcoma were also observed. No malignant neoplasm was seen in the Saline + B(a)P group. The first laryngeal tumor appeared at the 14th week in the Aluminum (60) + B(a)P group.

b. Trachea. The tracheal tumors (62 total) predominantly were also epithelial polyps. Except for the Minusil + B(a)P group, where only a single polyp was seen, the distribution was similar among the groups. In addition, 16 squamous cell carcinomas, 6 adenosquamous carcinomas, 3 carcinomas, 13 adenocarcinomas, 1 carcinosarcoma, 1 sarcoma and 1 neoplasm (NOS) were observed. The incidences of tracheal neoplasia observed in the Particulates + B(a)P groups were higher than the incidences in the B(a)P control group with the

exception of the Minusil + B(a)P group which had only two tumors. The first tracheal tumor appeared at the 28th week in the Olivine (Wa) group.

c. Lungs and Bronchi. In the lung, adenocarcinomas were observed most frequently with a total of three hundred and seventy two (372) seen among all the groups. Adenosquamous carcinomas (222), squamous cell carcinomas (176) and adenomas (103) were also frequently observed. In the lungs and bronchi, in contrast to the large number of polyps observed in the larynx and trachea, only 21 bronchiolar epithelial polyps were detected. The incidences of tumors among the Particulates + B(a)P groups were considerably higher than the B(a)P control group, but comparable to the postive control group. The highest number of squamous cell carinomas (35) was seen in the Zirconium (Au) and the lowest number (6) in the Aluminum (60) group. The highest number of adenosquamous cell carcinoma (25) was seen in the positive control group and the lowest number (9) in the Olivine (Nc) group. Of the adenocarcinomas, the highest number (61) was seen in the Minusil group and the lowest (15) in the Aluminum (60) group. The first lung tumor was seen in the Minusil group at the 23rd week.

The total number of tumors (all types) was higher in the Particulate + B(a)P groups compared to the B(a)P Control and was comparable to the positive control group. The greatest neoplastic response occured in the Minusil and Zirconium (Au) groups, 111 and 110 tumors, respectively. The least neoplastic response occured in the B(a)P control and Aluminum(60) groups, 32 and 51 tumors, respectively.

The tumors discussed above were distributed throughout the lung. The neoplastic changes most frequently involved the left lobe. Majority of the tumors were seen in the left lobe. The second most frequently affected lobe was the right diaphragmatic lobe. The cardiac lobe appeared to have the lowest number of tumors.

3. MORPHOLOGIC CLASSIFICATIONS OF RESPIRATORY TRACT TUMORS.

The morphologic classification of the respiratory tract tumors seen in this study are analogous to those previously described and illustrated in the literature with other studies of respiratory tract carcinogenesis in hamsters. A description of the specific types of tumors seen is given below:

a. Epithelial polyp. was observed as a excrescence of epithelial cells in the form of a mound or papilliferous projection into the lumen of the larynx, trachea, bronchus or bronchiole. Basement membranes were not violated and the epithelium grew in an outward or luminal direction. Epithelium was generally well differentiated; however, foci of disorganized intraepithelial growth was sometimes found.

b. Squamous cell carcinoma. did not differ greatly from that which occurs in other organs. Branching cords or glandular formations of layered eqithelium with squamous differentiation near the epithelial surface was commonly observed. Keratinization was common and lamellated pearls were sometimes formed. Intercellular bridges were not always visible suggesting a moderate degree of differentiation.

c Adenosquamous carcinoma. as the designation implies, is a combined neoplasm having features of both adenocarcinoma and squamous cell carcinoma. Either prominent areas of squamous differentiation were found or the neoplastic epithelium had a transitional morphology between glandular and squamous epithelium. Traditional properties of malignancy were also employed to classify these neoplasms.

d. Adenoma. was characterized by proliferation of fairly well differentiated, regular to swollen epithelial cells that lined or filled the alveolus. Nuclei were usually enlarged and cell polarity

was retained with respect to basement membranes. Compression of surrounding normal tissue was usually observed at some point on the periphery of the mass.

e. Adenocarcinoma. appeared as a solid, glandular, or combined proliferation of hyperchromatic epithelium. The masses occurred as isolated neoplasms in the lung parenchyma and near major airways. Occasional tumors were cystic and the large masses often had foci of necrosis. Varying degrees of cytologic atypia and on increased incidence of mitoses were found in the more anaplastic areas of the neoplasms. Anaplasia, local aggregation, and sometimes vasular invasion attested to the malignant nature of the lesions.

f. Sarcoma. was classified as histiocytic, reticulum cell, fibrosarcoma, undifferentiated, and sarcoma NOS. The incidence of these neoplasms was minimal.

4. RESPIRATORY TRACT HYPERPLASIA.

The number of non-respiratory tract tumor bearing animals with hyperplasias of the larynx, trachea and lung are presented in Table 13. For the larynx and trachea no statistical significance was found in the number of hamsters with hyperplasia in the Particulate + B(a)P groups as compared to be Particulate Control group. For the lung, the occurrence of hyperplasia was significantly higher ($p=0.01207$) only in the Aluminum (60)+B(a)P group (7/44) as compared to its particulate control (0/43).

Hyperplasia was seen in animals with or without respiratory tract tumors. Alveolar/bronchiolar hyperplasia was characterized mainly by proliferation of well differentiated, low cuboidal epithelium along the alveolar septa. Compression of normal lung parenchyma at the periphery of the lesion was lacking. The distinction between large foci of alveolar/bronchiolar hyperplasia and adenoma was not always clear cut. Small amounts of alveolar bronchiolar hyperplasia were most commonly seen

in the Particulate + B(a)P groups and only occasionally found in the particulate control group. The distribution tended to parallel that of tumor development.

A distinct transitional state (e.g. foci of atypia or malignancy within an otherwise benign process) between hyperplasia and neoplasia was not observed; however, it is reasonable to assume that such progression might occur, especially if one espouses the concept that non-neoplastic proliferative lesions have the ability to transform to an autonomous neoplasm.

5. PULMONARY GRANULOMATOUS INFLAMMATION.

The incidences of hamsters with pulmonary granulamous inflammation are presented in Table 14 and Figure 8. The Fisher's analyses data are presented in Table 15.

Granulomatous inflammation was detected in all groups. However, the greatest incidences occurred when Silica Sand, Minusil, and Minusil + Ferric Oxide and Aluminum (48) were instilled alone or in combination with B(a)P.

Hamsters with pulmonary granulomatous inflammation in the Silica Sand, Minusil, Minusil + Ferric Oxide and Aluminum(48) groups were statistically higher than the Saline Control.

The lesion consisted principally of numerous alveolar macrophages, hypertrophy of the alveolar lining cells and variable amounts of neutrophils and lymphocytes. Alveolar septa were often thickened within the areas of inflammation. In the lung parenchyma, phagocytosis of particulate material was prominent. This response was associated with the particulate (dust) deposits in the lung.

6. OTHER RESPIRATORY TRACT PATHOLOGY.

In addition to the tumors, granulomatous inflammation and hyperplasia, the other common findings in the lungs were crystalline or granular deposits in the distal airways, aspiration pneumonia, squamous metaplasia, and congestion.

Crystalline or granular deposits were seen in all the dust instilled groups. The deposits were present in the region of the terminal bronchioles, respiratory bronchioles and alveoli. The particulate material appeared dark brown or black at low magnification, but consisted of angular, slightly refractile, yellow-brown bodies at higher magnification.

Low incidences of aspiration pneumonia, characterized by acute inflammation and the presence of foreign material, generally food or bedding origin, were noted in a few animals in the Particulate + B(a)P groups, except for the Minusil + Ferric Oxide group. The incidences of pneumonia did not have an effect either on the survival or the clinical signs observed. Pneumonia is a common occurrence in dust instilled animals in this model system.

Other pathological findings of the respiratory system were sporadic, non-specific and are commonly seen in the Syrian golden hamsters.

7. HYPERPLASIA AND TUMORS OF THE STOMACH

The number of hamsters observed with hyperplasia, tumors, and hyperplasia with tumors are presented in Table 16. Fisher's analyses data are presented in Table 17.

Hyperplasia alone, was seen in all the groups except in the Minusil, Zirconium (F1), Olivine (Nc), Aluminum (48), and Aluminum (70) control groups. Stomach tumors appeared to be more prevalent in the Particulates + B(a)P groups than the Particulate Control groups. When the incidences of hyperplasia were combined with the tumor incidences, the effect of B(a)P administration appeared to be dramatic. However, this is not a significant finding for this study since stomach tumors have been reported in the literature of respiratory tract carcinogenesis studies with the administration of B(a)P.

Fisher's analyses showed statistically significantly increased number of hamsters with hyperplasia alone, when Minusil, Zirconium (F1), Olivine (Nc) and Aluminum (70) were administered with B(a)P. Statistically significantly increased numbers of hamsters with stomach tumors alone were

seen when Zirconium(Au) and Chromite sand were instilled with B(a)P. The number of hamsters with hyperplasia and stomach tumors was higher when Minusil, Zirconium (F1), both the Olivine sands, and all three Aluminum silicates were instilled with B(a)P. These findings were statistically significant.

Hyperplasia of the stomach involved the non-glandular portion (fore-stomach) and occured as focal or diffuse areas of acanthosis with or without hyperkeratosis. The most frequently observed were the fore-stomach papillomas, (total of 35) predominantly occuring in the B(a)P groups. These fore-stomach papillomas projected from the mucosal surface into the gastric lumen and consisted of a core of fibrovascular connective tissue lined by keratonizing squamous epithelium. Two squamous cell carcinomas and one adenocarcinoma were also observed as malignant tumors in the stomach.

8. OTHER LESIONS

The incidences of non-respiratory tract lesions observed are presented in Table 18.

Amyloidosis, a common, naturally occuring degenerative disease of aging hamsters, was a frequent observation among all groups. The number of animals with amyloidosis in the kidney, and adrenals, were higher than those in the liver and thyroids. In this study, the incidences and distribution of amyloidosis seen throughout the organ systems were not different from that reported for male hamsters in the literature.

In the kidneys, chronic nephropathy was observed in all the treated as well as the Saline Control groups. No pattern or treatment related effects were observed. This lesion was characterized by diffuse tubular changes consisting of dilatation, cast formation and atrophy. In addition, interstitial fibrosis and chronic inflammation were common. Occasionally, sclerotic changes of the glomeruli and Bowmen's capsule were associated with the tubular and interstitial lesions. Like amyloidosis, chronic nephropathy is also related to the aging phenomenon in hamsters.

In the heart, thrombosis was the most frequent finding, occuring with comparable incidence for all the groups except for the positive control and Olivine (Wa) + B(a)P groups, where none were observed. Heart thrombi were usually found in the atrium and were generally organizing. The thrombi were associated with an inflammatory lesion in the myocardium. This lesion is also commonly found in aging hamsters.

In the liver, multiple cystic structures lined by flattened bile duct epithelium and filled with a greenish fluid were frequently observed as liver cysts.

In the spleen, hyperplasia was generally observed only in the Particulate + B(a)P hamsters. This response might represent a primary effect of B(a)P on the spleen or a systemic immunologic response to neoplasia which occured commonly with B(a)P treatment.

In the sternum and rib junction, as well as in the bone marrow and femur, low incidences of hyperplasia were observed in all groups, except the Zirconium (Au) + B(a)P group. Six incidences of hyperplasia in the sternum and rib junction and five incidences in the bone marrow and femur were observed in this group.

Other lesions such as hyperplasia of the thyroid, atrophy of the thymus and testes and subcutaneous edema were also observed. The incidences of such lesions were sporadic and not treatment related.

9. NON-RESPIRATORY TRACT TUMORS.

The incidences of non-respiratory tract tumors observed are presented in Table 19. The morphologic classification of these tumors are presented in the Tumor Inventory (Appendix 4).

In evaluating the incidences, distribution, and types of tumors seen in the other organs, no significant differences were seen as compared to the historic data available on spontaneous tumors in hamsters. In this study, as reported in previous studies, the most frequent tumors were the adrenal cortex adenomas and carcinomas. Other types of tumors were

sporadic, and appeared in a comparable manner among all the groups. None of the tumors seen in the other organs indicated a treatment related effect.

G. STATISTICAL ANALYSES RESULTS.

Fisher's exact analyses of the respiratory tract tumor bearing animals were evaluated for statistical significance between the silica sand and silica sand substitutes when instilled with or without B(a)P. Fisher's exact test was selected as it is more appropriate for this type of study and also because of the number of comparisons made. Results of the analyses are presented in Tables 20 thru 30. Both the 1-tail and 2-tail values are presented in the tables. However, a two-tailed probability value of 0.01 was used to judge significance and is so indicated in the aforementioned table by the symbol "S".

1. Laryngeal Tumor Bearing Animals

The Particulate Control vs Particulate + B(a)P treated groups were compared for laryngeal tumor bearing animals. The analyses data are presented in Table 20. No statistical significance was observed for laryngeal tumor bearing animals between the Saline Control (0/38) and B(a)P control group (5/44). The number of laryngeal tumor bearing animals in each Particulate + B(a)P group was statistically significantly higher than their respective control.

2. Tracheal Tumor Bearing Animals.

The Particulate Control vs Particulate + B(a)P groups were compared for tracheal tumor bearing animals. The analyses data are presented in Table 21. No statistical significance was observed between the Saline Control and B(a)P Control. No statistical differences were seen between the Minusil + B(a)P and Minusil + Ferric Oxide + B(a)P groups when compared to their respective controls. All other Particulate + B(a)P groups showed a statistically significantly increased number of tracheal tumor bearing animals when compared to their own control.

3. Lung Tumor Bearing Animals.

The Particulate Control vs Particulate + B(a)P groups were compared for lung tumor bearing animals. The analyses data are presented in Table 22. The number of lung tumor bearing animals was statistically significantly higher in each Particulate + B(a)P group as compared to their own Particulate Control group.

4. Total Respiratory Tract Tumor Bearing Animals.

The number of total respiratory tract (larynx + trachea + bronchi and lung) tumor bearing animals were compared for the following sets.

a. Particulate Control vs Particulate + B(a)P. Analyses data for this set are presented in Table 23. A statistically significantly higher number was observed in the Particulate + B(a)P groups as compared to their Particulate Control group.

b. Saline + B(a)P Control vs Particulate + B(a)P. Analyses data for this set are presented in Table 24. No statistical difference ($p=.022568$) was observed between the Saline + B(a)P and Aluminum (60) + B(a)P groups. Statistical significance was found between the other Particulate + B(a)P groups and the Saline + B(a)P group.

c. Ferric Oxide + B(a)P control vs Particulate + B(a)P. Analyses data for this set are presented in Table 25. The number of tumor bearing animals in the positive control and Particulate + B(a)P groups were similar. No statistical significance was observed for this set.

d. Silica Sand + B(a)P vs Minusil + B(a)P.

e. Zirconium (Au) + B(a)P vs Zirconium (Fl) + B(a)P.

f. Olivine (Nc) + B(a)P vs Olivine (Wa) + B(a)P.

Analyses data for the above three sets (d, e, and f) are presented in Table 26. No statistical differences were observed for these sets.

g. Aluminum (48) + B(a)P vs Silica sand + B(a)P
" " vs Minusil + B(a)P
" " vs Aluminum (60) + B(a)P
" " vs Aluminum (70) + B(a)P

The analyses data for this set are presented in Table 27. No statistical significance was observed when Aluminum (48) + B(a)P was compared to the above sands + B(a)P.

h. Aluminum (60) + B(a)P vs Silica Sand + B(a)P
" " vs Minusil + B(a)P
" " vs Aluminum (70) + B(a)P

The analyses data for this set are presented in Table 28. A statistical significance was observed when Aluminum (60) + B(a)P (31/49) tumor bearing animals were compared with the Minusil + B(a)P group (44/49). The latter treatment was more effective in inducing total respiratory tract tumors. No statistically significant differences were found when Aluminum (60) + B(a)P tumor bearing animals were compared with either the Silica Sand + B(a)P or Aluminum (70) + B(a)P.

i. Aluminum (70) + B(a)P vs Silica Sand + B(a)P
" " vs Minusil + B(a)P
" " vs Aluminum (48) + B(a)P
" " vs Aluminum (60) + B(a)P

The analyses data for this set are presented in Table 29. No statistical significance was observed when Aluminum (70) + B(a)P was compared to the above sands + B(a)P.

j. Minusil + Ferric oxide + B(a)P vs Ferric oxide + B(a)P

k. Minusil + Ferric oxide + B(a)P vs Minusil + B(a)P

l. Ferric oxide + B(a)P vs Minusil + B(a)P

The analyses data for the above sets (j, k, and l) are presented in Table 30. No statistically significant differences were observed for these sets.

5. STATISTICAL SIGNIFICANCE SUMMARY: The statistically significant findings observed in the analyses of respiratory tract tumor bearing animals are summarized below:

1. The number of laryngeal tumor bearing animals in the Particulate + B(a)P treatment were significantly higher than the Particulate alone treatment.
2. The number of tracheal tumor bearing animals in the Particulate + B(a)P treatment were significantly higher than the Particulate alone treatment.
3. The number of lung tumor bearing animals in the Particulate + B(a)P treatment were significantly higher than the Particulate alone treatment.
4. The number of total respiratory tract tumor bearing animals in the Particulate + B(a)P treatment were significantly higher than the Particulate alone treatment.
5. The number of total respiratory tract tumor bearing animals in the Minusil + B(a)P treatment was significantly higher than those seen in the Aluminum (60) + B(a)P treatment.
6. The number of total respiratory tract tumor bearing animals in the Particulate + B(a)P treatment were significantly higher than the B(a)P Control treatment, except for the Aluminum (60) + B(a)P treatment.

V. DISCUSSION

Experimental studies on the factors controlling the mechanisms of induction and development of lung cancer have been made possible by the establishment of an appropriate model in which bronchiogenic carcinoma is produced by a treatment closely related to the condition of human exposure to respiratory carcinogens. Such a model is the intratracheal instillation method developed by Saffiotti and co-workers (Saffiotti et al., 1968) which has been proven to be effective in inducing high incidences of both benign and malignant respiratory tract tumors. The morphology, tumor location and the pathogenic mechanism involved in the induction of tumors in this model are similar to that of human lung cancer.

The animal of choice for the model is the Syrian golden hamster, a species that develops practically no spontaneous lung tumors and is very resistant to chronic pulmonary infections. The morphology of the hamsters respiratory tract is similar to that of the humans, except for a sparsity of bronchiolar glands.

The carcinogen most frequently used in this intratracheal model is the widely found environmental contaminant benzo(a)pyrene, B(a)P, which when instilled alone as fine particulates (Stenback and Rowland, 1978) has been shown to induce a low incidence of respiratory tract tumors. B(a)P, at the dose level used, with the model produces no interfering acute toxic effects.

Administration of B(a)P in combination with the co-carcinogen, Ferric Oxide (Fe_2O_3), has been shown to be very effective in inducing respiratory tract tumors. In addition to Ferric Oxide the co-carcinogenic effect of other particulates has been well established. Carbon (Farrel and Davis, 1972), magnesium oxide (Stenback et al 1975), titanium dioxide (Stenback and Rowland, 1976) and amorphous silica (Stenback and Rowland, 1979) in combination with B(a)P significantly increased the number of lung tumors compared to B(a)P alone. However, the results with aluminum oxide (Farrel and Davis, 1972; Stenback and Rowland, 1976), and manganese dioxide (Stenback and Rowland, 1979) did not show a co-carcinogenic effect.

In this study, silica sand and silica sand substitutes (Olivine Sands, Chromite Sand, Zirconium Silicates, and Aluminum Silicates) were evaluated for their co-carcinogenic effect in combination with B(a)P. Ferric Oxide + B(a)P was used as a positive co-carcinogen control.

The survival in this study in general was excellent. The study duration was 92 weeks and the survival at termination was higher than other studies reported in the literature. It is common in respiratory carcinogenesis studies for hamsters instilled with carrier agents in combination with B(a)P to have a lower survival than was the case here. In hamsters treated with the B(a)P and dust, suffocation due to neoplastic involvement of the respiratory system is a frequent occurrence and decreases survival. In this study, the rate of survival of the Particulates + B(a)P groups were lower than the particulate control. This is attributed to tumor related deaths. Compared to the saline control, only the Silica sand and Minusil + Ferric Oxide Control groups showed a lower percent of survival.

The body weight of hamsters in the particulate + B(a)P groups was lower than the Particulate Control groups. These differences are attributed to the treatment, survival and tumor burden. The increase in Minusil + Ferric Oxide group over the Saline Control is attributed to the Minusil since no difference from the control was observed when Ferric Oxide was instilled alone.

The increase in the lung weights of certain Particulate + B(a)P groups as compared to the Saline + B(a)P or Particulate Control groups is due to the tumor burden produced by the addition of B(a)P.

The clinical observations observed in this study did not show any relevance to the treatment, survival or tumor incidences. Wheezing, dyspnea and polypnea were the most frequent observations. Other sporadic incidences of clinical signs seen are common in hamsters.

In this study, the type of tumors seen thoughout the respiratory system and their histopathological features were essentially analogous to those previously described and illustrated for this model in previously reported works (Saffiotti et al., 1968). Histopathological evaluation of all organs revealed the respiratory system to be the target for pathological alterations. The principal pathological changes attributable to the compound administration occurred in the larynx, trachea, bronchi and lung. Benign and

malignant tumors were seen in all segments of the respiratory system. The morphologic characteristics of the respiratory tract tumors seen were similar to those previously observed in this model system. Treatment induced tumors were always of respiratory tract origin as opposed to metastases from other organs. In addition to tumors, other pathologic changes such as pulmonary granulomatous inflammation, hyperplasia, crystalline (dust) deposits in the distal airways and aspiration pneumonia were common findings.

Pathological alterations observed in other organ systems (non-respiratory tract lesions and tumors) were not directly related to treatment. These findings occur spontaneously in hamsters as is evident from historic data.

Silica Sand when instilled alone did not induce any tumors in the respiratory tract. However, a co-carcinogenic response was seen in combination with B(a)P. A statistically increased number of animals with total respiratory tract tumors was found in this Particulate + B(a)P group (36/47) as compared to the Saline + B(a)P group (22/47). The number of tumor bearing animals and morphologic type seen in this particulate + B(a)P group was similar to that of the positive control group Ferric Oxide + B(a)P.

No fibrosis or hyperplasia of the respiratory system was observed when Silica Sand was instilled alone. However, a statistically significantly higher incidence (88.0%) of pulmonary granulomatous inflammation was seen in this group as compared to the Saline Control group (4.2%). This finding was comparable to the Minusil control group (84.0%). No other significant findings were observed in the hamster lungs treated with silica sand.

In another study, Stenback and Rowland, 1979, demostrated the co-carcinogenic effect and lack of fibrogenic potential of amorphous silica in hamsters. The lack of fibrogenic response was attributed to the small particles (1-10 μm) of silica used in that study. A possible explanation for these findings is that following the small particles' penetration through the walls of the respiratory bronchioles and alveoli, they are phagocytized by tissue macrophages. Except for a mild histiocytic reaction in the first few days, the dust-laden macrophages essentially lay inactive during the life of the animal. The median diameter of the silica sand used in the present study

was 2.61 μm. Therefore, the lung pathology observed in this study may also be related to particle size and the movements of the particles in the respiratory system.

A definite co-carcinogenic response was observed for all the silica sand substitutes except Aluminum (60). Aluminum (60), compared to the other particulates produced a weak co-carcinogenic response. The number of tumor bearing animals in the Aluminum (60) + B(a)P groups was not statistically different from that of the Saline + B(a)P group. All other Silica Sand substitutes + B(a)P groups had a statistically increased number of tumor bearing animals.

The morphologic characteristics of the of tumors seen in the silica sand substitutes + B(a)P groups were similar to those seen in the positive control and Silica Sand + B(a)P groups. No statistical differences in the number of tumor bearing animals were found between the Zirconium Sands, Olivine Sands, and the Aluminum Silicates when instilled with B(a)P. The number of tumor bearing animals in the Minusil + Ferric Oxide + B(a)P group was similar to those seen in the Minusil + B(a)P and Ferric Oxide + B(a)P groups. The morphologic characteristics and the segmental distribution of the tumors were comparable for all silica sand substitutes when instilled with B(a)P. The upper respiratory tract (larynx and trachea) lesions were predominantly epithelial polyps. The lungs and bronchial tumors were predominantly malignant. Although tumors occurred in all lobes of the lung, the left lobe and the diaphragmatic lobe were most frequently affected. A possible explanation for this finding is that exposure to these lobes is greater since they are the largest lobes morphologically, and histologically have the greatest bronchiolar diameter. Stenback and Rowland (1978) in their studies with Talc and B(a)P instillation also observed a greater number of tumors in the left and diaphragmatic lobes.

The incidence of respiratory tract hyperplasia was statistically evaluated only for non-respiratory tract tumor bearing animals. The number of hamsters with hyperplasia in the Aluminum (60) + B(a)P group was significantly higher than that seen in the Aluminum (60) Control. It is interesting to note that while Aluminum (60) was not an effective co-carcinogen with B(a)P, this treatment did produce a higher incidence of hyperplasia. The survival of the

Aluminum (60) + B(a)P group was significantly lower than that of its particulate control. If these hamsters had survived longer, it is possible that a transition from hyperplasia to neoplasia may have occurred, thereby increasing the co-carcinogenic response. Silica sand subsitutes when instilled alone were not carcinogenic in the hamster respiratory tract. The low incidence of tumors seen in the Zirconium (Au) and Aluminum (70) groups were of no significance. Hyperplasia of the respiratory system was seen sporadically but was not treatment related. This a common finding in dust instilled animals (Rowland et al, 1980).

The silica sand subsititutes failed to induce fibrosis. The reason for the absence of fibrosis is this study is not clear. The mode of action and the physical and chemical properties of the sands tested could have contributed to this; however, further investigation in this area is needed. Statistically significant occurances of pulomonary granulomatous inflammation were seen only in the Silica Sand, Minusil, Minusil + Ferric Oxide and Aluminum (48) groups when compared to the saline control.

Hyperplasia and tumors of the stomach were seen in hamsters instilled with the particulates with or without B(a)P. These lesions were more prominent in animals instilled with B(a)P. This may be related to the ingestion of the instilled compound and a subsequent tumor enhancing effect.

The incidence of non respiratory tract lesions such as amyloidosis, chronic nephropathy, heart thrombosis, splenic hyperplasia, and liver cysts were sporadic and not treatment related. Amyloidosis is a common, naturally occurring degenerative disease of aging hamsters. Chronic nephropathy and thrombosis of the heart are also associated with the aging process. Splenic hyperplasia could be attributed to B(a)P since virtually none were found in the absence of B(a)P.

Tumors of the other organs were also observed both in experimental animals and in controls. Comparable incidences and types of these tumors appeared throughout the groups. These tumors are spontaneous and are common to hamsters as they have been reported in the literature of hamster pathology.

VI CONCLUSION

In this study, silica sand and silica sand substitutes instilled intratracheally to male Syrian golden hamsters were found not to be carcinogenic in the hamster respiratory tract. When instilled with the carcinogen B(a)P, silica sand and silica sand substitutes exhibited a definite co-carcinogenic response. However, one of the silica sand substitutes, Aluminum (60), was not as effective as compared to the other sands in producing this response. No fibrogenic response was induced by the silica sand and silica sand substitutes evaluated in this study.

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TABLE 1

PROBABILITY OF SURVIVAL

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

GROUP 1

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	49	0	0	0.0000	1.0000	100.00
10	49	0	1	0.0204	0.9796	97.96
15	48	0	1	0.0408	0.9592	95.92
20	47	0	1	0.0612	0.9388	93.88
26	46	0	1	0.0816	0.9184	91.84
34	45	0	1	0.1020	0.8980	89.80
37	44	0	1	0.1224	0.8776	87.76
38	43	0	1	0.1429	0.8571	85.71
39	42	0	2	0.1837	0.8163	81.63
43	40	0	1	0.2041	0.7959	79.59
45	39	0	1	0.2245	0.7755	77.55
58	38	0	1	0.2449	0.7551	75.51
59	37	0	1	0.2653	0.7347	73.47
61	36	0	1	0.2857	0.7143	71.43
71	35	0	1	0.3061	0.6939	69.39
73	34	0	1	0.3265	0.6735	67.35
74	33	0	1	0.3469	0.6531	65.31
75	32	0	1	0.3673	0.6327	63.27
76	31	0	1	0.3878	0.6122	61.22
80	30	0	2	0.4286	0.5714	57.14
81	28	0	3	0.4898	0.5102	51.02
82	25	0	1	0.5102	0.4898	48.98
83	24	0	1	0.5306	0.4694	46.94
85	23	0	2	0.5714	0.4286	42.86
88	21	0	1	0.5918	0.4082	40.82
89	20	0	2	0.6327	0.3673	36.73
90	18	0	1	0.6531	0.3469	34.69
92	17	17	0	0.6531	0.3469	0.00

SALINE CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 2

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	47	0	0	0.0000	1.0000	100.00
37	47	0	1	0.0213	0.9787	97.87
38	46	0	1	0.0426	0.9574	95.74
39	45	0	1	0.0638	0.9362	93.62
42	44	0	2	0.1064	0.8936	89.36
44	42	0	1	0.1277	0.8723	87.23
51	41	0	2	0.1702	0.8298	82.98
53	39	0	2	0.2128	0.7872	78.72
55	37	0	1	0.2340	0.7660	76.60
57	36	0	1	0.2553	0.7447	74.47
58	35	0	1	0.2766	0.7234	72.34
60	34	0	3	0.3404	0.6596	65.96
65	31	0	1	0.3617	0.6383	63.83
66	30	0	1	0.3830	0.6170	61.70
67	29	0	1	0.4043	0.5957	59.57
69	28	0	1	0.4255	0.5745	57.45
72	27	0	1	0.4468	0.5532	55.32
74	26	0	1	0.4681	0.5319	53.19
75	25	0	1	0.4894	0.5106	51.06
76	24	0	1	0.5106	0.4894	48.94
77	23	0	1	0.5319	0.4681	46.81
79	22	0	1	0.5532	0.4468	44.68
80	21	0	1	0.5745	0.4255	42.55
81	20	0	1	0.5957	0.4043	40.43
82	19	0	2	0.6383	0.3617	36.17
87	17	0	2	0.6809	0.3191	31.91
88	15	0	1	0.7021	0.2979	29.79
90	14	0	1	0.7234	0.2766	27.66
91	13	0	1	0.7447	0.2553	25.53
92	12	12	0	0.7447	0.2553	0.00

SALINE + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 3

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
23	50	0	1	0.0200	0.9800	98.00
24	49	0	1	0.0400	0.9600	96.00
25	48	0	1	0.0600	0.9400	94.00
29	47	0	1	0.0800	0.9200	92.00
30	46	0	2	0.1200	0.8800	88.00
32	44	0	1	0.1400	0.8600	86.00
33	43	0	1	0.1600	0.8400	84.00
34	42	0	1	0.1800	0.8200	82.00
43	41	0	1	0.2000	0.8000	80.00
44	40	0	1	0.2200	0.7800	78.00
49	39	0	1	0.2400	0.7600	76.00
52	38	0	1	0.2600	0.7400	74.00
55	37	0	1	0.2800	0.7200	72.00
56	36	0	1	0.3000	0.7000	70.00
61	35	0	1	0.3200	0.6800	68.00
62	34	0	2	0.3600	0.6400	64.00
69	32	0	1	0.3800	0.6200	62.00
70	31	0	1	0.4000	0.6000	60.00
76	30	0	1	0.4200	0.5800	58.00
78	29	0	3	0.4800	0.5200	52.00
81	26	0	5	0.5800	0.4200	42.00
83	21	0	1	0.6000	0.4000	40.00
85	20	0	1	0.6200	0.3800	38.00
86	19	0	1	0.6400	0.3600	36.00
87	18	0	1	0.6600	0.3400	34.00
90	17	0	2	0.7000	0.3000	30.00
91	15	0	1	0.7200	0.2800	28.00
92	14	14	0	0.7200	0.2800	0.00

FERRIC OXIDE CONTROL

TABLE 1 (CONTINUED)

PROBABILITY OF SURVIVAL

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

GROUP 4

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	48	0	0	0.0000	1.0000	100.00
13	48	0	2	0.0417	0.9583	95.83
36	46	0	1	0.0625	0.9375	93.75
40	45	0	1	0.0833	0.9167	91.67
47	44	0	1	0.1042	0.8958	89.58
48	43	0	1	0.1250	0.8750	87.50
49	42	0	1	0.1458	0.8542	85.42
50	41	0	3	0.2083	0.7917	79.17
51	38	0	1	0.2292	0.7708	77.08
52	37	0	1	0.2500	0.7500	75.00
54	36	0	1	0.2708	0.7292	72.92
57	35	0	1	0.2917	0.7083	70.83
58	34	0	2	0.3333	0.6667	66.67
59	32	0	1	0.3542	0.6458	64.58
60	31	0	1	0.3750	0.6250	62.50
61	30	0	1	0.3958	0.6042	60.42
62	29	0	1	0.4167	0.5833	58.33
63	28	0	1	0.4375	0.5625	56.25
65	27	0	1	0.4583	0.5417	54.17
66	26	0	2	0.5000	0.5000	50.00
67	24	0	1	0.5208	0.4792	47.92
69	23	0	1	0.5417	0.4583	45.83
70	22	0	1	0.5625	0.4375	43.75
71	21	0	1	0.5833	0.4167	41.67
74	20	0	1	0.6042	0.3958	39.58
76	19	0	1	0.6250	0.3750	37.50
79	18	0	2	0.6667	0.3333	33.33
81	16	0	2	0.7083	0.2917	29.17
82	14	0	2	0.7500	0.2500	25.00
83	12	0	1	0.7708	0.2292	22.92
86	11	0	1	0.7917	0.2083	20.83
87	10	0	1	0.8125	0.1875	18.75
90	9	0	1	0.8333	0.1667	16.67
92	8	8	0	0.8333	0.1667	0.00

FERRIC OXIDE + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 5

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
8	50	0	1	0.0200	0.9800	98.00
15	49	0	1	0.0400	0.9600	96.00
22	48	0	1	0.0600	0.9400	94.00
24	47	0	1	0.0800	0.9200	92.00
28	46	0	2	0.1200	0.8800	88.00
32	44	0	1	0.1400	0.8600	86.00
36	43	0	1	0.1600	0.8400	84.00
40	42	0	1	0.1800	0.8200	82.00
42	41	0	2	0.2200	0.7800	78.00
43	39	0	1	0.2400	0.7600	76.00
46	38	0	1	0.2600	0.7400	74.00
49	37	0	1	0.2800	0.7200	72.00
54	36	0	1	0.3000	0.7000	70.00
58	35	0	1	0.3200	0.6800	68.00
60	34	0	1	0.3400	0.6600	66.00
61	33	0	1	0.3600	0.6400	64.00
65	32	0	1	0.3800	0.6200	62.00
68	31	0	4	0.4600	0.5400	54.00
71	27	0	3	0.5200	0.4800	48.00
74	24	0	2	0.5600	0.4400	44.00
75	22	0	1	0.5800	0.4200	42.00
77	21	0	2	0.6200	0.3800	38.00
78	19	0	2	0.6600	0.3400	34.00
79	17	0	1	0.6800	0.3200	32.00
80	16	0	2	0.7200	0.2800	28.00
81	14	0	2	0.7600	0.2400	24.00
82	12	0	4	0.8400	0.1600	16.00
86	8	0	1	0.8600	0.1400	14.00
88	7	0	1	0.8800	0.1200	12.00
89	6	0	2	0.9200	0.0800	8.00
92	4	4	0	0.9200	0.0800	0.00

SILICA SAND CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 6

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
7	50	0	1	0.0200	0.9800	98.00
21	49	0	1	0.0400	0.9600	96.00
26	48	0	1	0.0600	0.9400	94.00
31	47	0	1	0.0800	0.9200	92.00
35	46	0	1	0.1000	0.9000	90.00
36	45	0	1	0.1200	0.8800	88.00
39	44	0	1	0.1400	0.8600	86.00
40	43	0	1	0.1600	0.8400	84.00
41	42	0	3	0.2200	0.7800	78.00
42	39	0	1	0.2400	0.7600	76.00
46	38	0	1	0.2600	0.7400	74.00
47	37	0	2	0.3000	0.7000	70.00
50	35	0	1	0.3200	0.6800	68.00
51	34	0	1	0.3400	0.6600	66.00
56	33	0	1	0.3600	0.6400	64.00
57	32	0	2	0.4000	0.6000	60.00
58	30	0	4	0.4800	0.5200	52.00
59	26	0	1	0.5000	0.5000	50.00
63	25	0	1	0.5200	0.4800	48.00
65	24	0	1	0.5400	0.4600	46.00
66	23	0	1	0.5600	0.4400	44.00
68	22	0	1	0.5800	0.4200	42.00
70	21	0	1	0.6000	0.4000	40.00
71	20	0	1	0.6200	0.3800	38.00
73	19	0	1	0.6400	0.3600	36.00
74	18	0	1	0.6600	0.3400	34.00
77	17	0	1	0.6800	0.3200	32.00
78	16	0	2	0.7200	0.2800	28.00
79	14	0	1	0.7400	0.2600	26.00
80	13	0	1	0.7600	0.2400	24.00
81	12	0	1	0.7800	0.2200	22.00
82	11	0	2	0.8200	0.1800	18.00
83	9	0	2	0.8600	0.1400	14.00
84	7	0	1	0.8800	0.1200	12.00
86	6	0	2	0.9200	0.0800	8.00
90	4	0	1	0.9400	0.0600	6.00
92	3	3	0	0.9400	0.0600	0.00

SILICA SAND + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 7

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
26	50	0	2	0.0400	0.9600	96.00
32	48	0	2	0.0800	0.9200	92.00
34	46	0	1	0.1000	0.9000	90.00
38	45	0	1	0.1200	0.8800	88.00
39	44	0	1	0.1400	0.8600	86.00
40	43	0	1	0.1600	0.8400	84.00
43	42	0	1	0.1800	0.8200	82.00
45	41	0	2	0.2200	0.7800	78.00
47	39	0	1	0.2400	0.7600	76.00
57	38	0	1	0.2600	0.7400	74.00
63	37	0	1	0.2800	0.7200	72.00
67	36	0	1	0.3000	0.7000	70.00
68	35	0	1	0.3200	0.6800	68.00
73	34	0	1	0.3400	0.6600	66.00
74	33	0	1	0.3600	0.6400	64.00
75	32	0	1	0.3800	0.6200	62.00
76	31	0	1	0.4000	0.6000	60.00
80	30	0	2	0.4400	0.5600	56.00
81	28	0	1	0.4600	0.5400	54.00
82	27	0	1	0.4800	0.5200	52.00
83	26	0	2	0.5200	0.4800	48.00
86	24	0	1	0.5400	0.4600	46.00
92	23	23	0	0.5400	0.4600	0.00

MINUSIL CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 8

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
3	50	0	1	0.0200	0.9800	98.00
23	49	0	1	0.0400	0.9600	96.00
24	48	0	1	0.0600	0.9400	94.00
29	47	0	1	0.0800	0.9200	92.00
41	46	0	1	0.1000	0.9000	90.00
42	45	0	1	0.1200	0.8800	88.00
47	44	0	1	0.1400	0.8600	86.00
48	43	0	1	0.1600	0.8400	84.00
49	42	0	3	0.2200	0.7800	78.00
51	39	0	1	0.2400	0.7600	76.00
52	38	0	1	0.2600	0.7400	74.00
55	37	0	1	0.2800	0.7200	72.00
58	36	0	2	0.3200	0.6800	68.00
60	34	0	1	0.3400	0.6600	66.00
61	33	0	1	0.3600	0.6400	64.00
64	32	0	1	0.3800	0.6200	62.00
65	31	0	1	0.4000	0.6000	60.00
66	30	0	1	0.4200	0.5800	58.00
67	29	0	1	0.4400	0.5600	56.00
68	28	0	2	0.4800	0.5200	52.00
70	26	0	3	0.5400	0.4600	46.00
71	23	0	3	0.6000	0.4000	40.00
72	20	0	1	0.6200	0.3800	38.00
73	19	0	1	0.6400	0.3600	36.00
74	18	0	1	0.6600	0.3400	34.00
75	17	0	1	0.6800	0.3200	32.00
77	16	0	1	0.7000	0.3000	30.00
78	15	0	1	0.7200	0.2800	28.00
79	14	0	3	0.7800	0.2200	22.00
80	11	0	2	0.8200	0.1800	18.00
82	9	0	1	0.8400	0.1600	16.00
83	8	0	1	0.8600	0.1400	14.00
84	7	0	2	0.9000	0.1000	10.00
90	5	0	1	0.9200	0.0800	8.00
91	4	0	1	0.9400	0.0600	6.00
92	3	3	0	0.9400	0.0600	0.00

MINUSIL + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 9

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
25	50	0	1	0.0200	0.9800	98.00
30	49	0	1	0.0400	0.9600	96.00
33	48	0	2	0.0800	0.9200	92.00
41	46	0	1	0.1000	0.9000	90.00
42	45	0	1	0.1200	0.8800	88.00
43	44	0	1	0.1400	0.8600	86.00
45	43	0	2	0.1800	0.8200	82.00
46	41	0	1	0.2000	0.8000	80.00
47	40	0	1	0.2200	0.7800	78.00
50	39	0	1	0.2400	0.7600	76.00
51	38	0	1	0.2600	0.7400	74.00
52	37	0	1	0.2800	0.7200	72.00
53	36	0	1	0.3000	0.7000	70.00
55	35	0	1	0.3200	0.6800	68.00
59	34	0	1	0.3400	0.6600	66.00
61	33	0	1	0.3600	0.6400	64.00
63	32	0	1	0.3800	0.6200	62.00
69	31	0	1	0.4000	0.6000	60.00
70	30	0	1	0.4200	0.5800	58.00
74	29	0	1	0.4400	0.5600	56.00
76	28	0	1	0.4600	0.5400	54.00
80	27	0	1	0.4800	0.5200	52.00
81	26	0	2	0.5200	0.4800	48.00
85	24	0	1	0.5400	0.4600	46.00
90	23	0	2	0.5800	0.4200	42.00
91	21	0	4	0.6600	0.3400	34.00
92	17	17	0	0.6600	0.3400	0.00

ZIRCONIUM (Au) CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 10

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
32	50	0	1	0.0200	0.9800	98.00
33	49	0	2	0.0600	0.9400	94.00
35	47	0	2	0.1000	0.9000	90.00
36	45	0	1	0.1200	0.8800	88.00
40	44	0	1	0.1400	0.8600	86.00
43	43	0	1	0.1600	0.8400	84.00
45	42	0	2	0.2000	0.8000	80.00
47	40	0	2	0.2400	0.7600	76.00
48	38	0	1	0.2600	0.7400	74.00
50	37	0	1	0.2800	0.7200	72.00
51	36	0	1	0.3000	0.7000	70.00
52	35	0	4	0.3800	0.6200	62.00
55	31	0	1	0.4000	0.6000	60.00
56	30	0	2	0.4400	0.5600	56.00
57	28	0	1	0.4600	0.5400	54.00
58	27	0	2	0.5000	0.5000	50.00
59	25	0	1	0.5200	0.4800	48.00
61	24	0	1	0.5400	0.4600	46.00
63	23	0	1	0.5600	0.4400	44.00
65	22	0	3	0.6200	0.3800	38.00
70	19	0	1	0.6400	0.3600	36.00
72	18	0	1	0.6600	0.3400	34.00
75	17	0	3	0.7200	0.2800	28.00
76	14	0	1	0.7400	0.2600	26.00
78	13	0	1	0.7600	0.2400	24.00
80	12	0	1	0.7800	0.2200	22.00
81	11	0	1	0.8000	0.2000	20.00
83	10	0	1	0.8200	0.1800	18.00
86	9	0	1	0.8400	0.1600	16.00
87	8	0	1	0.8600	0.1400	14.00
88	7	0	1	0.8800	0.1200	12.00
89	6	0	1	0.9000	0.1000	10.00
90	5	0	1	0.9200	0.0800	8.00
91	4	0	1	0.9400	0.0600	6.00
92	3	3	0	0.9400	0.0600	0.00

ZIRCONIUM (Au) + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 11

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
14	50	0	1	0.0200	0.9800	98.00
23	49	0	1	0.0400	0.9600	96.00
24	48	0	1	0.0600	0.9400	94.00
29	47	0	1	0.0800	0.9200	92.00
34	46	0	1	0.1000	0.9000	90.00
37	45	0	2	0.1400	0.8600	86.00
38	43	0	1	0.1600	0.8400	84.00
40	42	0	1	0.1800	0.8200	82.00
42	41	0	1	0.2000	0.8000	80.00
49	40	0	1	0.2200	0.7800	78.00
52	39	0	1	0.2400	0.7600	76.00
54	38	0	1	0.2600	0.7400	74.00
62	37	0	1	0.2800	0.7200	72.00
72	36	0	2	0.3200	0.6800	68.00
76	34	0	1	0.3400	0.6600	66.00
77	33	0	3	0.4000	0.6000	60.00
78	30	0	1	0.4200	0.5800	58.00
79	29	0	2	0.4600	0.5400	54.00
80	27	0	1	0.4800	0.5200	52.00
81	26	0	2	0.5200	0.4800	48.00
83	24	0	1	0.5400	0.4600	46.00
84	23	0	1	0.5600	0.4400	44.00
85	22	0	1	0.5800	0.4200	42.00
86	21	0	3	0.6400	0.3600	36.00
91	18	0	1	0.6600	0.3400	34.00
92	17	17	0	0.6600	0.3400	0.00

ZIRCONIUM (F1) CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 12

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
12	50	0	1	0.0200	0.9800	98.00
15	49	0	1	0.0400	0.9600	96.00
27	48	0	1	0.0600	0.9400	94.00
40	47	0	3	0.1200	0.8800	88.00
41	44	0	2	0.1600	0.8400	84.00
43	42	0	1	0.1800	0.8200	82.00
45	41	0	1	0.2000	0.8000	80.00
46	40	0	1	0.2200	0.7800	78.00
47	39	0	1	0.2400	0.7600	76.00
48	38	0	1	0.2600	0.7400	74.00
52	37	0	1	0.2800	0.7200	72.00
54	36	0	2	0.3200	0.6800	68.00
55	34	0	1	0.3400	0.6600	66.00
56	33	0	2	0.3800	0.6200	62.00
59	31	0	1	0.4000	0.6000	60.00
61	30	0	1	0.4200	0.5800	58.00
64	29	0	1	0.4400	0.5600	56.00
65	28	0	3	0.5000	0.5000	50.00
66	25	0	1	0.5200	0.4800	48.00
67	24	0	2	0.5600	0.4400	44.00
69	22	0	1	0.5800	0.4200	42.00
70	21	0	2	0.6200	0.3800	38.00
71	19	0	1	0.6400	0.3600	36.00
77	18	0	1	0.6600	0.3400	34.00
78	17	0	1	0.6800	0.3200	32.00
79	16	0	1	0.7000	0.3000	30.00
80	15	0	1	0.7200	0.2800	28.00
81	14	0	1	0.7400	0.2600	26.00
83	13	0	1	0.7600	0.2400	24.00
84	12	0	2	0.8000	0.2000	20.00
85	10	0	1	0.8200	0.1800	18.00
86	9	0	1	0.8400	0.1600	16.00
89	8	0	1	0.8600	0.1400	14.00
91	7	0	1	0.8800	0.1200	12.00
92	6	6	0	0.8800	0.1200	0.00

ZIRCONIUM (Fl) + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 13

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
9	50	0	1	0.0200	0.9800	98.00
10	49	0	1	0.0400	0.9600	96.00
12	48	0	1	0.0600	0.9400	94.00
13	47	0	2	0.1000	0.9000	90.00
16	45	0	1	0.1200	0.8800	88.00
18	44	0	1	0.1400	0.8600	86.00
24	43	0	1	0.1600	0.8400	84.00
25	42	0	1	0.1800	0.8200	82.00
28	41	0	1	0.2000	0.8000	80.00
35	40	0	1	0.2200	0.7800	78.00
36	39	0	3	0.2800	0.7200	72.00
40	36	0	1	0.3000	0.7000	70.00
43	35	0	1	0.3200	0.6800	68.00
54	34	0	1	0.3400	0.6600	66.00
58	33	0	1	0.3600	0.6400	64.00
69	32	0	1	0.3800	0.6200	62.00
72	31	0	1	0.4000	0.6000	60.00
74	30	0	1	0.4200	0.5800	58.00
79	29	0	1	0.4400	0.5600	56.00
80	28	0	3	0.5000	0.5000	50.00
82	25	0	1	0.5200	0.4800	48.00
84	24	0	3	0.5800	0.4200	42.00
90	21	0	1	0.6000	0.4000	40.00
91	20	0	2	0.6400	0.3600	36.00
92	18	18	0	0.6400	0.3600	0.00

CHROMITE SAND CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 14

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	49	0	0	0.0000	1.0000	100.00
14	49	0	1	0.0204	0.9796	97.96
26	48	0	1	0.0408	0.9592	95.92
29	47	0	1	0.0612	0.9388	93.88
31	46	0	1	0.0816	0.9184	91.84
35	45	0	2	0.1224	0.8776	87.76
37	43	0	1	0.1429	0.8571	85.71
39	42	0	1	0.1633	0.8367	83.67
41	41	0	2	0.2041	0.7959	79.59
43	39	0	1	0.2245	0.7755	77.55
44	38	0	1	0.2449	0.7551	73.51
45	37	0	1	0.2653	0.7347	73.47
46	36	0	1	0.2857	0.7143	71.43
48	35	0	1	0.3061	0.6939	69.39
49	34	0	2	0.3469	0.6531	65.31
53	32	0	1	0.3673	0.6327	63.27
54	31	0	2	0.4082	0.5918	59.18
55	29	0	1	0.4286	0.5714	57.14
56	28	0	4	0.5102	0.4898	48.98
58	24	0	3	0.5714	0.4286	42.86
59	21	0	1	0.5918	0.4082	40.82
62	20	0	1	0.6122	0.3878	38.78
63	19	0	1	0.6327	0.3673	36.73
69	18	0	1	0.6531	0.3469	34.69
71	17	0	2	0.6939	0.3061	30.61
72	15	0	2	0.7347	0.2653	26.53
76	13	0	1	0.7551	0.2449	24.49
77	12	0	2	0.7959	0.2041	20.41
79	10	0	2	0.8367	0.1633	16.33
80	8	0	2	0.8776	0.1224	12.24
81	6	0	1	0.8980	0.1020	10.20
85	5	0	1	0.9184	0.0816	8.16
90	4	0	2	0.9592	0.0408	4.08
92	2	2	0	0.9592	0.0408	0.00

CHROMITE SAND + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 15

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	49	0	0	0.0000	1.0000	100.00
16	49	0	1	0.0204	0.9796	97.96
17	48	0	1	0.0408	0.9592	95.92
30	47	0	1	0.0612	0.9388	93.88
33	46	0	2	0.1020	0.8980	89.80
34	44	0	2	0.1429	0.8571	85.71
35	42	0	1	0.1633	0.8367	83.67
38	41	0	1	0.1837	0.8163	81.63
42	40	0	1	0.2041	0.7959	79.59
45	39	0	2	0.2449	0.7551	75.51
46	37	0	1	0.2653	0.7347	73.47
48	36	0	1	0.2857	0.7143	71.43
49	35	0	1	0.3061	0.6939	69.39
50	34	0	1	0.3265	0.6735	67.35
52	33	0	1	0.3469	0.6531	65.31
54	32	0	1	0.3673	0.6327	63.27
58	31	0	1	0.3878	0.6122	61.22
59	30	0	1	0.4082	0.5918	59.18
62	29	0	1	0.4286	0.5714	57.14
64	28	0	1	0.4490	0.5510	55.10
65	27	0	2	0.4898	0.5102	51.02
69	25	0	1	0.5102	0.4898	48.98
72	24	0	4	0.5918	0.4082	40.82
73	20	0	1	0.6122	0.3878	38.78
75	19	0	1	0.6327	0.3673	36.73
79	18	0	3	0.6939	0.3061	30.61
80	15	0	4	0.7755	0.2245	22.45
81	11	0	2	0.8163	0.1837	18.37
83	9	0	1	0.8367	0.1633	16.33
84	8	0	3	0.8980	0.1020	10.20
86	5	0	1	0.9184	0.0816	8.16
90	4	0	1	0.9388	0.0612	6.12
92	3	3	0	0.9388	0.0612	0.00

MINUSIL + FERRIC OXIDE CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 16

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
18	50	0	1	0.0200	0.9800	98.00
22	49	0	1	0.0400	0.9600	96.00
38	48	0	1	0.0600	0.9400	94.00
39	47	1	2	0.1000	0.9000	88.00
40	44	0	1	0.1200	0.8800	86.00
41	43	0	2	0.1600	0.8400	82.00
42	41	0	1	0.1800	0.8200	80.00
43	40	0	1	0.2000	0.8000	78.00
44	39	0	1	0.2200	0.7800	76.00
46	38	0	1	0.2400	0.7600	74.00
48	37	0	1	0.2600	0.7400	72.00
50	36	0	1	0.2800	0.7200	70.00
52	35	0	1	0.3000	0.7000	68.00
55	34	0	1	0.3200	0.6800	66.00
58	33	0	1	0.3400	0.6600	64.00
59	32	0	1	0.3600	0.6400	62.00
60	31	0	1	0.3800	0.6200	60.00
61	30	0	3	0.4400	0.5600	54.00
63	27	0	3	0.5000	0.5000	48.00
64	24	0	1	0.5200	0.4800	46.00
68	23	0	3	0.5800	0.4200	40.00
69	20	0	1	0.6000	0.4000	38.00
74	19	0	3	0.6600	0.3400	32.00
75	16	0	2	0.7000	0.3000	28.00
76	14	0	1	0.7200	0.2800	26.00
77	13	0	1	0.7400	0.2600	24.00
78	12	0	1	0.7600	0.2400	22.00
80	11	0	1	0.7800	0.2200	20.00
81	10	0	3	0.8400	0.1600	14.00
82	7	0	1	0.8600	0.1400	12.00
83	6	0	1	0.8800	0.1200	10.00
85	5	0	2	0.9200	0.0800	6.00
86	3	0	1	0.9400	0.0600	4.00
87	2	0	1	0.9600	0.0400	2.00
92	1	1	0	0.9600	0.0400	0.00

MINUSIL + FERRIC OXIDE + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 17

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
12	50	0	1	0.0200	0.9800	98.00
34	49	0	2	0.0600	0.9400	94.00
37	47	0	1	0.0800	0.9200	92.00
41	46	0	1	0.1000	0.9000	90.00
42	45	0	1	0.1200	0.8800	88.00
50	44	0	1	0.1400	0.8600	86.00
55	43	0	1	0.1600	0.8400	84.00
65	42	0	1	0.1800	0.8200	82.00
66	41	0	1	0.2000	0.8000	80.00
70	40	0	1	0.2200	0.7800	78.00
72	39	0	1	0.2400	0.7600	76.00
73	38	0	1	0.2600	0.7400	74.00
74	37	0	1	0.2800	0.7200	72.00
75	36	0	1	0.3000	0.7000	70.00
76	35	0	2	0.3400	0.6600	66.00
80	33	0	2	0.3800	0.6200	62.00
82	31	0	1	0.4000	0.6000	60.00
83	30	0	1	0.4200	0.5800	58.00
84	29	0	1	0.4400	0.5600	56.00
87	28	0	1	0.4600	0.5400	54.00
88	27	0	1	0.4800	0.5200	52.00
90	26	0	1	0.5000	0.5000	50.00
91	25	0	1	0.5200	0.4800	48.00
92	24	24	0	0.5200	0.4800	0.00

OLIVINE (Nc) CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 18

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
14	50	0	1	0.0200	0.9800	98.00
20	49	0	1	0.0400	0.9600	96.00
23	48	0	1	0.0600	0.9400	94.00
26	47	0	1	0.0800	0.9200	92.00
32	46	0	2	0.1200	0.8800	88.00
35	44	0	1	0.1400	0.8600	86.00
38	43	0	2	0.1800	0.8200	82.00
40	41	0	2	0.2200	0.7800	78.00
43	39	0	1	0.2400	0.7600	76.00
44	38	0	1	0.2600	0.7400	74.00
50	37	0	1	0.2800	0.7200	72.00
51	36	0	1	0.3000	0.7000	70.00
53	35	0	1	0.3200	0.6800	68.00
54	34	0	1	0.3400	0.6600	66.00
55	33	0	2	0.3800	0.6200	62.00
56	31	0	1	0.4000	0.6000	60.00
57	30	0	1	0.4200	0.5800	58.00
58	29	0	1	0.4400	0.5600	56.00
60	28	0	3	0.5000	0.5000	50.00
62	25	0	1	0.5200	0.4800	48.00
63	24	0	1	0.5400	0.4600	46.00
64	23	0	2	0.5800	0.4200	42.00
67	21	0	1	0.6000	0.4000	40.00
69	20	0	2	0.6400	0.3600	36.00
70	18	0	1	0.6600	0.3400	34.00
71	17	0	1	0.6800	0.3200	32.00
73	16	0	1	0.7000	0.3000	30.00
75	15	0	3	0.7600	0.2400	24.00
76	12	0	1	0.7800	0.2200	22.00
79	11	0	1	0.8000	0.2000	20.00
80	10	0	2	0.8400	0.1600	16.00
85	8	0	2	0.8800	0.1200	12.00
86	6	0	1	0.9000	0.1000	10.00
87	5	0	2	0.9400	0.0600	6.00
92	3	3	0	0.9400	0.0600	0.00

OLIVINE (Nc) + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 19

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
7	50	0	1	0.0200	0.9800	98.00
9	49	0	1	0.0400	0.9600	96.00
18	48	0	1	0.0600	0.9400	94.00
19	47	0	1	0.0800	0.9200	92.00
28	46	0	1	0.1000	0.9000	90.00
32	45	0	1	0.1200	0.8800	88.00
33	44	0	2	0.1600	0.8400	84.00
34	42	0	1	0.1800	0.8200	82.00
38	41	0	2	0.2200	0.7800	78.00
40	39	0	1	0.2400	0.7600	76.00
41	38	0	1	0.2600	0.7400	74.00
45	37	0	1	0.2800	0.7200	72.00
47	36	0	1	0.3000	0.7000	70.00
49	35	0	1	0.3200	0.6800	68.00
50	34	0	1	0.3400	0.6600	66.00
55	33	0	1	0.3600	0.6400	64.00
57	32	0	1	0.3800	0.6200	62.00
58	31	0	1	0.4000	0.6000	60.00
62	30	0	1	0.4200	0.5800	58.00
63	29	0	1	0.4400	0.5600	56.00
67	28	0	1	0.4600	0.5400	54.00
68	27	0	2	0.5000	0.5000	50.00
72	25	0	1	0.5200	0.4800	48.00
78	24	0	1	0.5400	0.4600	46.00
81	23	0	1	0.5600	0.4400	44.00
85	22	0	2	0.6000	0.4000	40.00
88	20	0	1	0.6200	0.3800	38.00
89	19	0	1	0.6400	0.3600	36.00
90	18	0	4	0.7200	0.2800	28.00
91	14	0	3	0.7800	0.2200	22.00
92	11	11	0	0.7800	0.2200	0.00

OLIVINE (Wa) CONTROL

TABLE 1 (CONTINUED)

PROBABILITY OF SURVIVAL

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

GROUP 20

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
12	50	0	1	0.0200	0.9800	98.00
16	49	0	1	0.0400	0.9600	96.00
21	48	0	1	0.0600	0.9400	94.00
22	47	0	1	0.0800	0.9200	92.00
28	46	0	3	0.1400	0.8600	86.00
31	43	0	1	0.1600	0.8400	84.00
32	42	0	1	0.1800	0.8200	82.00
34	41	0	1	0.2000	0.8000	80.00
35	40	0	3	0.2600	0.7400	74.00
37	37	0	1	0.2800	0.7200	72.00
39	36	0	2	0.3200	0.6800	68.00
41	34	0	3	0.3800	0.6200	62.00
45	31	0	2	0.4200	0.5800	58.00
46	29	0	1	0.4400	0.5600	56.00
47	28	0	1	0.4600	0.5400	54.00
49	27	0	2	0.5000	0.5000	50.00
52	25	0	2	0.5400	0.4600	46.00
53	23	0	1	0.5600	0.4400	44.00
58	22	0	1	0.5800	0.4200	42.00
60	21	0	1	0.6000	0.4000	40.00
61	20	0	1	0.6200	0.3800	38.00
62	19	0	1	0.6400	0.3600	36.00
63	18	0	1	0.6600	0.3400	34.00
64	17	0	1	0.6800	0.3200	32.00
68	16	0	1	0.7000	0.3000	30.00
72	15	0	1	0.7200	0.2800	28.00
77	14	0	1	0.7400	0.2600	26.00
78	13	0	1	0.7600	0.2400	24.00
79	12	0	2	0.8000	0.2000	20.00
83	10	0	1	0.8200	0.1800	18.00
84	9	0	1	0.8400	0.1600	16.00
89	8	0	2	0.8800	0.1200	12.00
90	6	0	2	0.9200	0.0800	8.00
91	4	0	2	0.9600	0.0400	4.00
92	2	2	0	0.9600	0.0400	0.00

OLIVINE (Wa) + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 21

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
5	50	0	1	0.0200	0.9800	98.00
20	49	0	1	0.0400	0.9600	96.00
21	48	0	1	0.0600	0.9400	94.00
25	47	0	1	0.0800	0.9200	92.00
29	46	0	1	0.1000	0.9000	90.00
39	45	0	1	0.1200	0.8800	88.00
40	44	0	1	0.1400	0.8600	86.00
43	43	0	1	0.1600	0.8400	84.00
50	42	0	1	0.1800	0.8200	82.00
51	41	0	1	0.2000	0.8000	80.00
59	40	0	1	0.2200	0.7800	78.00
66	39	0	1	0.2400	0.7600	76.00
68	38	0	1	0.2600	0.7400	74.00
69	37	0	1	0.2800	0.7200	72.00
72	36	0	1	0.3000	0.7000	70.00
74	35	0	2	0.3400	0.6600	66.00
76	33	0	1	0.3600	0.6400	64.00
77	32	0	1	0.3800	0.6200	62.00
80	31	0	1	0.4000	0.6000	60.00
81	30	0	1	0.4200	0.5800	58.00
84	29	0	1	0.4400	0.5600	56.00
86	28	0	2	0.4800	0.5200	52.00
88	26	0	2	0.5200	0.4800	48.00
91	24	0	1	0.5400	0.4600	46.00
92	23	22	1	0.5600	0.4400	0.00

ALUMINUM (48) CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 22

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
17	50	0	1	0.0200	0.9800	98.00
18	49	0	1	0.0400	0.9600	96.00
21	48	0	1	0.0600	0.9400	94.00
24	47	0	1	0.0800	0.9200	92.00
31	46	0	1	0.1000	0.9000	90.00
32	45	0	1	0.1200	0.8800	88.00
35	44	0	1	0.1400	0.8600	86.00
36	43	0	1	0.1600	0.8400	84.00
39	42	0	2	0.2000	0.8000	80.00
46	40	0	1	0.2200	0.7800	78.00
51	39	0	2	0.2600	0.7400	74.00
52	37	0	1	0.2800	0.7200	72.00
53	36	0	1	0.3000	0.7000	70.00
55	35	0	1	0.3200	0.6800	68.00
56	34	0	1	0.3400	0.6600	66.00
57	33	0	1	0.3600	0.6400	64.00
59	32	0	3	0.4200	0.5800	58.00
60	29	0	1	0.4400	0.5600	56.00
63	28	0	2	0.4800	0.5200	52.00
64	26	0	2	0.5200	0.4800	48.00
66	24	0	1	0.5400	0.4600	46.00
67	23	0	2	0.5800	0.4200	42.00
68	21	0	1	0.6000	0.4000	40.00
70	20	0	1	0.6200	0.3800	38.00
72	19	0	1	0.6400	0.3600	36.00
73	18	0	2	0.6800	0.3200	32.00
74	16	0	1	0.7000	0.3000	30.00
76	15	0	2	0.7400	0.2600	26.00
77	13	0	2	0.7800	0.2200	22.00
81	11	0	1	0.8000	0.2000	20.00
82	10	0	2	0.8400	0.1600	16.00
83	8	0	1	0.8600	0.1400	14.00
89	7	0	1	0.8800	0.1200	12.00
90	6	0	1	0.9000	0.1000	10.00
91	5	0	1	0.9200	0.0800	8.00
92	4	4	0	0.9200	0.0800	0.00

ALUMINUM (48) + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 23

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	49	0	0	0.0000	1.0000	100.00
15	49	0	1	0.0204	0.9796	97.96
22	48	0	1	0.0408	0.9592	95.92
28	47	0	1	0.0612	0.9388	93.88
29	46	0	2	0.1020	0.8980	89.80
31	44	0	1	0.1224	0.8776	87.76
32	43	0	1	0.1429	0.8571	85.71
33	42	0	1	0.1633	0.8367	83.67
36	41	0	1	0.1837	0.8163	81.63
43	40	0	1	0.2041	0.7959	79.59
44	39	0	1	0.2245	0.7755	77.55
46	38	0	1	0.2449	0.7551	75.51
47	37	0	1	0.2653	0.7347	73.47
54	36	0	2	0.3061	0.6939	69.39
61	34	0	1	0.3265	0.6735	67.35
62	33	0	1	0.3469	0.6531	65.31
67	32	0	2	0.3878	0.6122	61.22
69	30	0	1	0.4082	0.5918	59.18
73	29	0	2	0.4490	0.5510	55.10
74	27	0	1	0.4694	0.5306	53.06
78	26	0	1	0.4898	0.5102	51.02
79	25	0	1	0.5102	0.4898	48.98
80	24	0	1	0.5306	0.4694	46.94
81	23	0	1	0.5510	0.4490	44.90
82	22	0	1	0.5714	0.4286	42.86
83	21	0	1	0.5918	0.4082	40.82
85	20	0	2	0.6327	0.3673	36.73
86	18	0	1	0.6531	0.3469	34.69
89	17	0	1	0.6735	0.3265	32.65
90	16	0	2	0.7143	0.2857	28.57
92	14	14	0	0.7143	0.2857	0.00

ALUMINUM (60) CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 24

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
12	50	0	1	0.0200	0.9800	98.00
14	49	0	1	0.0400	0.9600	96.00
17	48	0	1	0.0600	0.9400	94.00
25	47	0	1	0.0800	0.9200	92.00
28	46	0	1	0.1000	0.9000	90.00
31	45	0	1	0.1200	0.8800	88.00
32	44	0	2	0.1600	0.8400	84.00
33	42	0	1	0.1800	0.8200	82.00
35	41	0	1	0.2000	0.8000	80.00
37	40	0	1	0.2200	0.7800	78.00
38	39	0	1	0.2400	0.7600	76.00
41	38	0	1	0.2600	0.7400	74.00
46	37	0	1	0.2800	0.7200	72.00
49	36	0	1	0.3000	0.7000	70.00
50	35	0	1	0.3200	0.6800	68.00
54	34	0	1	0.3400	0.6600	66.00
56	33	0	1	0.3600	0.6400	64.00
59	32	0	1	0.3800	0.6200	62.00
60	31	0	2	0.4200	0.5800	58.00
61	29	0	1	0.4400	0.5600	56.00
62	28	0	2	0.4800	0.5200	52.00
65	26	0	1	0.5000	0.5000	50.00
66	25	0	1	0.5200	0.4800	48.00
70	24	0	1	0.5400	0.4600	46.00
72	23	0	3	0.6000	0.4000	40.00
76	20	0	1	0.6200	0.3800	38.00
79	19	0	1	0.6400	0.3600	36.00
80	18	0	2	0.6800	0.3200	32.00
81	16	0	4	0.7600	0.2400	24.00
83	12	0	1	0.7800	0.2200	22.00
86	11	0	1	0.8000	0.2000	20.00
87	10	0	1	0.8200	0.1800	18.00
88	9	0	1	0.8400	0.1600	16.00
89	8	0	1	0.8600	0.1400	14.00
90	7	0	2	0.9000	0.1000	10.00
91	5	0	2	0.9400	0.0600	6.00
92	3	3	0	0.9400	0.0600	0.00

ALUMINUM (60) + B(a)P

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 25

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
14	50	0	1	0.0200	0.9800	98.00
29	49	0	1	0.0400	0.9600	96.00
32	48	0	2	0.0800	0.9200	92.00
33	46	0	1	0.1000	0.9000	90.00
34	45	0	1	0.1200	0.8800	88.00
37	44	0	1	0.1400	0.8600	86.00
38	43	0	1	0.1600	0.8400	84.00
41	42	0	1	0.1800	0.8200	82.00
42	41	0	1	0.2000	0.8000	80.00
45	40	0	1	0.2200	0.7800	78.00
53	39	0	1	0.2400	0.7600	76.00
54	38	0	1	0.2600	0.7400	74.00
57	37	0	1	0.2800	0.7200	72.00
59	36	0	2	0.3200	0.6800	68.00
62	34	0	1	0.3400	0.6600	66.00
67	33	0	1	0.3600	0.6400	64.00
69	32	0	1	0.3800	0.6200	62.00
70	31	0	1	0.4000	0.6000	60.00
71	30	0	2	0.4400	0.5600	56.00
72	28	0	1	0.4600	0.5400	54.00
73	27	0	2	0.5000	0.5000	50.00
74	25	0	1	0.5200	0.4800	48.00
77	24	0	1	0.5400	0.4600	46.00
78	23	0	1	0.5600	0.4400	44.00
79	22	0	1	0.5800	0.4200	42.00
81	21	0	2	0.6200	0.3800	38.00
83	19	0	1	0.6400	0.3600	36.00
86	18	0	1	0.6600	0.3400	34.00
88	17	0	1	0.6800	0.3200	32.00
89	16	0	3	0.7400	0.2600	26.00
92	13	11	2	0.7800	0.2200	0.00

ALUMINUM (70) CONTROL

TABLE 1 (CONTINUED)
PROBABILITY OF SURVIVAL
COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES
GROUP 26

WEEK	NUMBER ALIVE AT BEGINNING OF PERIOD	NUMBER WITHDRAWN AT END OF PERIOD	NUMBER DYING DURING PERIOD	PROBABILITY OF DYING BY END OF PERIOD	PROBABILITY OF SURVIVING THROUGH END OF PERIOD	CUMULATIVE % SURVIVAL
0	50	0	0	0.0000	1.0000	100.00
4	50	0	1	0.0200	0.9800	98.00
6	49	0	1	0.0400	0.9600	96.00
7	48	0	1	0.0600	0.9400	94.00
12	47	0	1	0.0800	0.9200	92.00
22	46	0	1	0.1000	0.9000	90.00
29	45	0	1	0.1200	0.8800	88.00
30	44	0	1	0.1400	0.8600	86.00
31	43	0	2	0.1800	0.8200	82.00
43	41	0	1	0.2000	0.8000	80.00
45	40	0	3	0.2600	0.7400	74.00
46	37	0	1	0.2800	0.7200	72.00
50	36	0	1	0.3000	0.7000	70.00
53	35	0	1	0.3200	0.6800	68.00
56	34	0	1	0.3400	0.6600	66.00
57	33	0	2	0.3800	0.6200	62.00
60	31	0	1	0.4000	0.6000	60.00
61	30	0	1	0.4200	0.5800	58.00
62	29	0	1	0.4400	0.5600	56.00
66	28	0	1	0.4600	0.5400	54.00
67	27	0	1	0.4800	0.5200	52.00
69	26	0	1	0.5000	0.5000	50.00
70	25	0	2	0.5400	0.4600	46.00
71	23	0	1	0.5600	0.4400	44.00
73	22	0	2	0.6000	0.4000	40.00
75	20	0	1	0.6200	0.3800	38.00
76	19	0	1	0.6400	0.3600	36.00
77	18	0	1	0.6600	0.3400	34.00
78	17	0	2	0.7000	0.3000	30.00
80	15	0	1	0.7200	0.2800	28.00
81	14	0	3	0.7800	0.2200	22.00
82	11	0	2	0.8200	0.1800	18.00
83	9	0	1	0.8400	0.1600	16.00
84	8	0	1	0.8600	0.1400	14.00
89	7	0	1	0.8800	0.1200	12.00
91	6	0	1	0.9000	0.1000	10.00
92	5	5	0	0.9000	0.1000	0.00

ALUMINUM (70) + B(a)P

TABLE:2

CHI SQUARE ANALYSES: RATE OF SURVIVAL

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUSTITUTES

TREATMENT	GROUP NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
SALINE CONTROL	1	.	0	0	.	+1	.	0	.	0	.	0	.	0	.	+1	.	0	.	0	.	0	.	0	.	0	.
SALINE + B(a)P	2	.	.	.	0	.	0	.	0	.	0	.	0	.	+5	.	+1	.	0	.	+5	.	0	.	0	.	0
FERRIC OXIDE	3	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FERRIC OXIDE + B(a)P	4	.	.	.	.	.	0	.	0	.	0	.	0	.	0	.	0	.	0	.	0	.	0	.	0	.	0
SILICA SAND	5	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SILICA SAND + B(a)P	6	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MINUSIL	7	.	.	0	.	+1	.	.	+1	0	.	0	.	0	.	+1	.	0	.	0	.	0	.	0	.	0	.
MINUSIL + B(a)P	8	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ZIRCONIUM (Au)	9	.	.	.	.	.	.	.	.	.	+1	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ZIRCONIUM (Au) + B(a)P	10	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ZIRCONIUM (F1)	11	.	.	.	.	.	.	.	.	.	.	.	+5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ZIRCONIUM (F1) + B(a)P	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CHROMITE SAND	13	.	.	.	.	.	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.
CHROMITE SAND + B(a)P	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MINUSIL + FERRIC OXIDE	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.
MINUSIL+FERRIC OXIDE+B(a)P	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
OLIVINE (Nc)	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+1	0	.	.	.	.	.	.	.
OLIVINE (Nc) + B(a)P	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.
OLIVINE (Wa)	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.
OLIVINE (Wa) + B(a)P	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ALUMINUM (48)	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	.	0	.
ALUMINUM (48) + B(a)P	22	.	.	.	.	.	0	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	0
ALUMINUM (60)	23	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+5	0	.
ALUMINUM (60) + B(a)P	24	.	.	.	.	.	0	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
ALUMINUM (70)	25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
ALUMINUM (70) + B(a)P	26	.	.	.	.	.	0	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

. No comparison made

0 No Statistically significant difference

1 Group on Y axis with statistically significantly higher (+) survival rate than group on X axis at $p<0.01$

5 Group on Y axis with statistically significantly higher (+) survival rate than group on X axis at $p<0.05$

TABLE 3

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

GROUP		STUDY WEEK 1	2	3	4	5	6	7	8	9	10	11	12	13
1	MEAN	86	91	95	98	102	107	109	111	113	115	119	120	121
	S.D.	9	9	9	10	10	11	11	12	12	12	11	11	12
	N	50	50	50	50	50	50	50	50	50	49	49	49	49
2	MEAN	85	89	92	96	101	104	106	108	110	112	114	115	118
	S.D.	9	10	10	10	10	11	11	11	9	11	11	11	12
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
3	MEAN	85	86	92	96	100	104	106	109	111	113	117	117	119
	S.D.	9	11	10	11	11	12	12	13	13	13	14	14	14
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
4	MEAN	85	89	91	94	98	100	101	103	104	105	106	105	104
	S.D.	11	10	10	10	11	11	11	12	12	12	14	14	16
	N	49	49	49	49	49	49	49	49	49	49	49	49	47
5	MEAN	86	91	94	98	103	107	108	110	114	116	119	120	121
	S.D.	11	10	10	11	11	12	13	15	13	13	13	14	15
	N	50	50	50	50	50	50	50	49	49	49	49	49	49
6	MEAN	84	89	94	96	100	102	107	107	105	109	111	112	113
	S.D.	17	13	13	15	15	16	16	16	15	14	15	15	15
	N	50	50	50	50	50	50	49	49	49	49	49	49	49
7	MEAN	87	90	94	98	101	104	109	108	110	111	113	114	115
	S.D.	8	10	10	8	9	10	10	11	11	11	14	13	14
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
8	MEAN	85	87	92	94	97	99	102	103	102	104	106	106	106
	S.D.	10	10	17	10	9	10	11	11	10	11	10	11	13
	N	50	50	49	49	49	49	49	49	49	49	49	49	49

TABLE 3 (Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK												
GROUP		1	2	3	4	5	6	7	8	9	10	11	12	13
9	MEAN	87	91	96	100	104	107	112	111	113	117	118	118	119
	S.D.	12	12	12	11	12	13	13	14	15	15	15	14	16
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
10	MEAN	88	91	95	96	99	102	105	105	105	108	109	109	104
	S.D.	11	11	12	12	12	12	12	12	12	12	14	14	16
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
11	MEAN	89	93	97	98	100	103	107	108	111	115	116	118	119
	S.D.	11	12	12	11	13	14	15	15	15	15	16	15	16
	N	50	50	50	50	50	50	50	50	50	50	50	50	49
12	MEAN	84	88	91	93	97	99	102	102	101	103	106	107	107
	S.D.	12	14	12	17	12	12	11	12	12	12	13	12	12
	N	50	50	50	50	50	50	50	50	50	50	50	49	49
13	MEAN	88	93	97	99	103	106	109	110	112	115	117	118	122
	S.D.	13	11	13	14	13	13	14	15	16	19	18	19	17
	N	50	50	50	50	50	50	50	49	49	48	48	46	45
14	MEAN	85	87	91	94	96	98	102	102	103	104	105	106	107
	S.D.	10	11	11	11	11	11	11	11	12	13	12	13	12
	N	49	49	49	49	49	49	49	49	49	49	49	49	49
15	MEAN	85	89	94	96	101	103	107	108	111	112	115	116	116
	S.D.	10	13	12	11	12	13	13	14	14	13	13	12	14
	N	49	49	49	49	49	49	49	49	49	49	49	49	49
16	MEAN	88	90	94	97	99	99	101	102	103	103	104	100	101
	S.D.	9	8	9	9	10	12	12	11	12	12	13	15	15
	N	50	50	50	50	50	50	50	50	50	50	50	50	50

TABLE 3 (Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK												
GROUP		1	2	3	4	5	6	7	8	9	10	11	12	13
17	MEAN	88	90	96	100	103	106	112	111	115	118	120	119	122
	S.D.	9	13	10	11	10	11	11	17	11	10	11	13	12
	N	50	50	50	50	50	50	50	50	50	50	50	49	49
18	MEAN	88	89	93	94	99	100	103	104	104	104	107	106	103
	S.D.	9	11	10	10	10	11	10	12	12	13	12	12	14
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
19	MEAN	88	88	94	99	102	103	107	110	112	112	117	118	118
	S.D.	10	14	11	18	12	15	13	14	14	16	14	14	15
	N	50	50	50	50	50	50	49	49	48	48	48	48	48
20	MEAN	88	90	95	97	101	102	107	105	107	109	112	113	113
	S.D.	12	14	12	12	14	14	13	14	13	13	14	13	14
	N	50	50	50	50	50	50	50	50	50	50	50	49	49
21	MEAN	85	90	94	98	102	105	107	107	110	113	115	116	118
	S.D.	12	11	11	11	12	13	13	14	14	13	13	12	11
	N	50	50	50	50	49	49	49	49	49	49	49	49	49
22	MEAN	88	90	94	96	99	103	104	105	104	109	110	111	112
	S.D.	11	12	11	10	12	12	12	12	13	12	12	12	13
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
23	MEAN	86	91	94	97	101	104	107	109	111	113	116	117	118
	S.D.	11	11	11	13	14	14	14	13	13	13	14	13	14
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
24	MEAN	87	90	94	96	101	102	104	106	107	108	108	109	111
	S.D.	11	11	11	11	12	13	12	12	12	13	14	14	13
	N	50	50	50	50	50	50	50	50	50	50	50	49	49
25	MEAN	88	93	97	100	103	107	109	110	114	115	118	117	118
	S.D.	9	9	10	10	11	12	12	12	12	12	12	13	14
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
26	MEAN	82	80	92	95	99	100	102	104	105	106	106	109	110
	S.D.	11	11	11	15	14	15	15	15	15	16	16	15	16
	N	50	50	50	49	49	47	47	47	47	47	47	46	46

TABLE 3(Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK												
GROUP		14	15	17	19	21	23	25	27	29	31	33	35	37
1	MEAN	122	123	125	127	129	129	127	128	127	127	123	122	119
	S.D.	12	13	14	14	14	15	15	14	14	14	16	13	13
	N	49	48	48	48	47	47	47	46	46	46	46	44	43
2	MEAN	118	118	121	123	124	125	125	124	125	125	123	121	118
	S.D.	11	11	11	11	13	12	12	13	12	12	15	12	13
	N	50	50	50	50	50	50	50	50	50	50	50	50	50
3	MEAN	121	122	123	124	125	126	126	126	125	126	124	123	118
	S.D.	14	15	15	15	15	15	15	13	13	13	14	14	16
	N	50	50	50	50	50	49	47	47	47	44	43	41	41
4	MEAN	107	108	113	117	119	121	121	122	121	121	119	117	115
	S.D.	14	14	13	12	13	12	12	13	14	12	11	11	12
	N	47	47	47	47	47	47	47	47	47	47	47	47	46
5	MEAN	123	123	125	126	127	125	125	126	123	123	120	121	117
	S.D.	15	16	16	14	14	16	18	16	17	15	18	16	16
	N	49	48	48	48	48	47	46	46	44	44	43	43	42
6	MEAN	115	116	119	120	122	123	122	122	123	122	119	118	117
	S.D.	15	15	16	17	18	17	18	16	12	16	18	16	18
	N	49	49	49	49	48	48	48	47	47	47	46	45	44
7	MEAN	119	117	120	119	120	122	121	121	122	120	119	118	115
	S.D.	13	14	13	17	14	14	12	12	12	13	13	12	12
	N	50	50	50	50	50	50	50	48	48	48	46	45	45
8	MEAN	107	108	110	111	116	117	117	116	118	117	115	114	110
	S.D.	14	14	14	20	13	12	12	12	11	12	12	10	13
	N	49	49	49	49	49	47	47	47	46	46	46	46	46

TABLE 3 (Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK												
GROUP		14	15	17	19	21	23	25	27	29	31	33	35	37
9	MEAN	123	123	125	125	126	127	127	126	122	123	123	122	120
	S.D.	14	14	14	16	15	14	14	17	14	14	15	15	15
	N	50	50	50	50	50	50	49	49	49	48	48	46	46
10	MEAN	105	106	111	116	118	119	119	119	119	118	116	116	114
	S.D.	17	16	15	14	14	14	14	14	14	15	17	15	15
	N	50	50	50	50	50	50	50	50	50	50	47	45	44
11	MEAN	122	122	122	123	122	124	120	125	123	123	122	120	118
	S.D.	14	14	14	15	15	14	14	14	15	16	15	13	14
	N	49	49	49	49	49	47	47	46	45	45	45	44	44
12	MEAN	105	104	110	114	114	114	118	118	115	115	116	113	112
	S.D.	13	14	13	12	12	12	12	12	13	13	14	14	14
	N	49	48	48	48	48	48	48	48	47	47	47	47	47
13	MEAN	123	123	125	125	127	129	129	129	125	125	129	120	118
	S.D.	19	19	18	23	16	16	16	16	15	15	14	15	16
	N	45	45	44	43	43	43	42	41	40	40	40	39	36
14	MEAN	109	108	113	115	117	117	118	118	118	118	118	112	115
	S.D.	12	14	12	12	12	12	13	13	15	15	14	16	15
	N	49	48	48	48	48	48	48	47	46	46	45	43	43
15	MEAN	118	117	119	120	119	121	122	122	120	120	117	116	114
	S.D.	13	15	13	14	12	13	12	12	13	13	13	11	11
	N	49	49	48	47	47	47	47	47	47	46	44	41	41
16	MEAN	105	106	111	113	116	117	118	118	116	115	112	112	110
	S.D.	13	13	13	15	12	12	12	12	14	12	15	13	14
	N	50	50	50	49	49	48	48	48	48	48	48	48	48

TABLE 3 (Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

GROUP		STUDY WEEK 14	15	17	19	21	23	25	27	29	31	33	35	37
17	MEAN	125	125	126	126	128	129	128	127	125	125	122	121	116
	S.D.	12	13	12	18	13	13	13	12	13	12	14	12	11
	N	49	49	49	49	49	49	49	49	49	49	49	47	47
18	MEAN	103	105	110	113	117	118	118	120	118	115	115	113	111
	S.D.	14	13	12	15	12	15	14	14	14	16	14	18	16
	N	49	49	49	49	48	47	47	46	46	46	44	43	43
19	MEAN	120	120	121	120	123	125	123	123	121	121	120	118	112
	S.D.	15	15	15	18	15	15	15	15	15	14	14	16	16
	N	48	48	48	46	46	46	46	46	45	45	43	41	41
20	MEAN	115	116	114	118	120	123	122	122	123	118	119	118	118
	S.D.	13	15	18	16	17	15	16	17	15	17	18	17	14
	N	49	49	48	48	47	46	46	46	43	43	41	39	37
21	MEAN	118	120	121	122	123	125	123	123	122	123	122	119	114
	S.D.	12	13	13	15	16	13	13	13	15	13	14	15	14
	N	49	49	49	49	48	47	46	46	45	45	45	45	45
22	MEAN	114	116	118	120	121	121	122	120	119	117	117	113	115
	S.D.	13	13	13	16	12	13	12	12	12	13	12	15	13
	N	50	50	49	48	47	47	46	46	46	46	44	44	42
23	MEAN	119	120	120	121	123	124	123	122	122	123	120	118	109
	S.D.	14	14	14	14	14	15	14	15	14	14	15	14	17
	N	50	49	49	49	49	48	48	48	46	44	43	42	41
24	MEAN	112	115	116	118	121	120	120	120	115	117	118	115	113
	S.D.	14	13	12	15	14	15	15	16	17	16	15	16	19
	N	48	48	47	47	47	47	46	46	45	44	42	41	40
25	MEAN	119	120	121	121	123	127	125	124	122	122	121	121	117
	S.D.	13	13	14	13	15	13	14	14	13	15	14	14	17
	N	49	49	49	49	49	49	49	49	49	48	46	44	44
26	MEAN	111	113	114	118	119	122	121	122	120	119	121	120	118
	S.D.	16	15	16	14	15	14	15	14	17	18	14	15	15
	N	46	46	46	46	46	45	45	45	45	43	41	41	41

TABLE 3 (Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK												
GROUP		39	41	43	45	47	49	51	53	55	57	59	61	63
1	MEAN	121	120	118	120	121	122	124	126	129	131	130	132	133
	S.D.	13	13	14	14	14	15	15	16	13	13	13	12	12
	N	41	40	39	39	38	38	38	38	38	38	37	35	35
2	MEAN	117	116	117	119	120	122	123	122	125	125	125	128	128
	S.D.	13	12	13	12	12	12	12	11	11	9	12	11	12
	N	49	48	46	35	45	45	45	41	40	38	37	34	34
3	MEAN	116	114	115	116	115	120	121	124	124	124	125	128	128
	S.D.	16	15	14	13	15	13	13	12	13	12	12	12	12
	N	41	41	40	39	39	39	38	37	37	35	35	35	32
4	MEAN	112	111	111	113	114	117	117	120	122	123	123	125	124
	S.D.	13	12	13	14	14	15	15	13	12	17	12	10	11
	N	46	45	45	45	45	43	39	37	36	36	33	30	29
5	MEAN	116	118	114	117	116	119	121	124	125	126	128	128	128
	S.D.	17	15	17	16	16	16	15	15	15	17	15	20	15
	N	42	41	39	38	37	37	36	36	35	35	34	33	32
6	MEAN	113	111	113	112	115	117	119	121	121	120	122	125	125
	S.D.	19	19	17	17	17	17	18	17	17	20	22	17	18
	N	44	42	38	38	35	35	33	33	33	32	26	25	25
7	MEAN	113	112	112	115	114	117	118	119	120	120	122	124	122
	S.D.	13	14	13	15	14	14	14	14	14	15	14	14	15
	N	44	42	42	40	38	38	38	38	38	37	37	37	37
8	MEAN	109	107	108	108	108	107	110	112	113	115	116	118	117
	S.D.	13	13	13	14	14	15	15	15	14	15	16	15	15
	N	46	46	44	44	43	41	39	37	36	36	34	33	32

TABLE 3(Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK												
GROUP		39	41	43	45	47	49	51	53	55	57	59	61	63
9	MEAN	115	115	113	115	119	121	122	123	126	122	125	127	128
	S.D.	17	14	16	17	16	15	16	15	13	13	12	11	16
	N	46	46	44	43	39	39	37	36	35	34	33	33	32
10	MEAN	111	109	111	112	111	114	115	115	115	117	120	125	123
	S.D.	15	18	16	17	17	16	17	17	17	19	19	15	15
	N	44	43	43	42	40	37	36	31	31	28	25	24	23
11	MEAN	116	116	115	115	118	119	121	122	123	125	122	125	127
	S.D.	14	14	16	18	16	15	14	13	13	14	12	14	14
	N	41	40	39	39	39	39	38	37	36	36	36	36	35
12	MEAN	110	110	109	108	109	112	112	113	116	118	120	121	119
	S.D.	14	16	13	15	16	14	16	14	13	14	13	13	14
	N	47	45	42	41	39	37	37	36	34	31	31	30	29
13	MEAN	118	118	116	118	117	120	121	125	127	123	128	131	129
	S.D.	16	14	16	18	16	17	17	17	17	18	16	15	19
	N	36	35	35	34	34	34	34	34	33	33	32	32	32
14	MEAN	114	120	111	111	113	114	114	113	116	119	120	117	118
	S.D.	14	16	14	15	12	15	17	15	16	13	13	16	15
	N	42	41	39	37	35	34	32	32	29	24	21	20	19
15	MEAN	112	112	113	117	116	117	122	123	125	123	124	127	127
	S.D.	10	11	12	17	11	15	12	12	12	12	12	12	15
	N	41	40	39	39	36	35	33	32	31	31	30	29	28
16	MEAN	107	109	107	107	109	112	112	114	113	111	115	113	113
	S.D.	17	17	16	18	15	15	17	14	15	14	18	19	18
	N	47	44	41	39	38	37	36	35	35	34	33	30	28

TABLE 3(Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK												
GROUP		39	41	43	45	47	49	51	53	55	57	59	61	63
17	MEAN	116	115	114	115	117	119	119	122	122	122	124	125	124
	S.D.	12	13	15	14	14	14	14	12	12	13	14	13	14
	N	46	46	44	44	44	44	43	43	43	42	42	42	42
18	MEAN	109	110	107	109	110	111	114	115	115	118	117	121	119
	S.D.	17	15	12	15	16	18	17	18	17	15	19	16	19
	N	41	39	39	37	37	37	36	35	33	30	28	25	24
19	MEAN	112	113	108	114	116	116	120	120	120	121	124	124	123
	S.D.	16	15	18	15	14	14	12	13	14	14	14	16	15
	N	39	38	37	37	36	34	33	33	32	32	30	30	39
20	MEAN	113	114	114	115	115	115	117	119	123	124	124	121	122
	S.D.	16	17	16	18	19	20	18	20	15	16	17	21	20
	N	36	33	31	30	28	26	25	23	22	22	21	19	18
21	MEAN	114	111	111	114	115	119	121	121	121	119	121	123	121
	S.D.	14	12	13	12	12	13	14	11	11	13	13	13	14
	N	45	44	44	43	43	43	42	41	41	41	41	40	40
22	MEAN	112	109	108	110	110	112	112	114	115	114	114	117	118
	S.D.	14	12	11	10	11	12	16	13	13	16	17	14	13
	N	42	40	40	40	39	39	39	36	35	32	32	28	28
23	MEAN	113	112	112	115	117	117	120	119	121	122	123	127	124
	S.D.	15	15	16	14	15	16	14	17	15	14	15	20	14
	N	41	41	41	39	38	37	37	37	35	35	35	35	33
24	MEAN	115	114	111	112	112	112	117	119	118	118	117	118	122
	S.D.	14	14	14	14	15	18	16	16	17	16	21	20	17
	N	38	38	37	37	36	36	34	34	33	32	32	29	26
25	MEAN	115	114	115	118	116	120	120	122	122	123	126	126	127
	S.D.	14	14	13	14	16	15	13	2	13	12	15	12	11
	N	42	41	40	40	39	39	39	39	37	37	36	34	33
26	MEAN	116	115	114	114	115	117	120	120	121	119	123	122	125
	S.D.	15	15	14	14	15	14	15	15	15	16	16	17	13
	N	41	41	41	39	36	36	35	35	34	32	31	30	28

TABLE 3 (Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK													
GROUP		65	67	69	71	73	75	77	79	81	83	85	87	89	91
1	MEAN	125	135	135	134	135	131	132	131	117	123	121	117	115	109
	S.D.	13	12	12	16	12	12	13	10	18	12	15	14	15	17
	N	35	35	35	35	33	31	30	30	28	24	23	21	19	17
2	MEAN	126	129	130	127	126	126	126	123	126	122	122	119	118	109
	S.D.	15	14	13	14	14	15	15	16	14	15	16	16	13	15
	N	34	31	31	30	28	27	25	23	22	19	19	19	16	13
3	MEAN	128	128	131	130	130	125	128	126	113	119	118	119	116	114
	S.D.	13	14	14	13	13	15	12	11	19	13	16	11	12	12
	N	32	32	32	30	30	30	29	26	26	20	20	17	17	14
4	MEAN	124	123	124	120	126	125	123	122	117	115	114	112	107	105
	S.D.	12	10	10	18	13	12	10	12	16	15	12	14	15	13
	N	28	25	24	22	21	20	19	19	17	12	11	9	8	8
5	MEAN	129	129	132	133	128	131	129	126	117	118	118	114	121	112
	S.D.	15	15	15	20	18	14	14	17	14	13	15	14	23	10
	N	32	31	28	26	24	22	20	16	14	8	8	7	6	4
6	MEAN	124	*	123	122	123	120	120	113	115	115	118	123	117	111
	S.D.	15	*	14	16	19	22	19	20	18	21	14	13	10	5
	N	24	*	21	20	19	17	17	14	12	8	6	4	4	3
7	MEAN	124	*	125	125	125	125	124	123	119	117	112	111	108	101
	S.D.	14	*	15	16	15	14	16	18	17	14	18	15	14	26
	N	36	*	34	34	34	32	30	30	28	25	24	23	23	23
8	MEAN	115	*	115	115	119	118	118	111	120	114	109	109	109	96
	S.D.	19	*	17	18	16	19	16	17	13	13	21	15	19	32
	N	31	*	26	22	19	17	15	14	9	8	5	5	5	3

* Data not avilable.

TABLE 3 (Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK													
GROUP		65	67	69	71	73	75	77	79	81	83	85	87	89	91
9	MEAN	128	*	129	128	131	129	127	124	119	122	117	116	112	110
	S.D.	12	*	12	12	12	11	14	12	15	14	15	14	15	18
	N	31	*	31	29	29	28	27	27	26	24	23	23	23	17
10	MEAN	120	*	121	119	122	120	129	114	120	111	114	116	106	102
	S.D.	18	*	19	15	17	19	15	13	12	14	16	12	10	20
	N	22	*	19	18	17	16	13	12	11	10	9	8	6	2
11	MEAN	127	*	128	129	130	130	127	126	120	121	118	118	116	109
	S.D.	14	*	16	15	14	19	15	17	14	14	15	17	16	18
	N	35	*	35	35	33	33	31	29	26	24	22	18	18	17
12	MEAN	118	*	119	123	124	123	119	117	118	113	122	113	105	103
	S.D.	19	*	12	13	14	13	17	15	17	20	21	17	17	11
	N	28	*	22	19	18	18	18	16	19	12	10	8	8	6
13	MEAN	130	*	131	131	131	130	130	127	122	124	123	121	118	112
	S.D.	18	*	19	20	24	20	19	20	19	17	15	13	15	19
	N	32	*	32	31	30	29	29	29	25	24	21	21	21	18
14	MEAN	122	*	119	118	121	117	114	108	106	108	103	98	99	111
	S.D.	13	*	15	20	16	17	16	17	19	16	16	10	5	0
	N	18	*	18	17	13	13	12	10	6	5	5	4	4	2
15	MEAN	129	*	124	121	126	129	125	126	108	113	115	119	114	112
	S.D.	15	*	16	20	12	17	15	20	19	16	19	14	10	9
	N	27	*	24	24	19	19	18	18	11	9	5	4	4	3
16	MEAN	117	*	116	114	113	112	113	112	112	115	108	110	109	78
	S.D.	17	*	16	15	16	15	17	12	19	21	16	8	6	13
	N	24	*	21	20	20	17	14	13	11	7	6	2	2	2

* Data not avilable.

TABLE 3 (Continued)

MEAN BODY WEIGHTS (g)

COCARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

		STUDY WEEK													
GROUP		65	67	69	71	73	75	77	79	81	83	85	87	89	91
17	MEAN	125	*	126	126	127	127	126	122	115	121	120	117	113	103
	S.D.	14	*	13	14	16	17	14	13	18	12	12	13	13	23
	N	42	*	40	39	37	36	33	33	31	30	28	28	26	22
18	MEAN	121	*	122	124	125	122	127	122	120	120	116	114	121	116
	S.D.	17	*	19	18	15	24	18	24	11	12	13	16	14	6
	N	21	*	20	17	16	14	11	11	8	8	8	5	3	3
19	MEAN	123	*	125	127	128	124	123	120	108	120	118	116	112	109
	S.D.	15	*	11	15	15	14	16	17	20	15	16	16	18	16
	N	28	*	25	25	24	24	24	23	23	22	21	20	18	10
20	MEAN	124	*	123	122	123	118	120	115	120	120	115	112	104	90
	S.D.	15	*	15	15	14	15	15	19	15	13	13	12	10	16
	N	16	*	15	15	14	14	14	12	10	9	8	8	8	2
21	MEAN	121	*	125	125	127	122	125	123	121	120	119	117	115	111
	S.D.	14	*	14	14	18	12	11	11	13	14	12	13	11	11
	N	40	*	38	37	36	34	33	32	31	30	29	27	25	21
22	MEAN	118	*	110	117	118	118	118	121	116	116	113	108	106	108
	S.D.	13	*	15	14	19	16	15	9	14	8	10	13	14	14
	N	24	*	20	19	18	15	13	11	11	8	7	7	7	4
23	MEAN	124	*	127	127	127	126	126	126	120	121	122	117	113	111
	S.D.	14	*	14	14	18	14	15	13	15	14	19	13	13	11
	N	33	*	31	30	29	27	26	25	23	20	19	17	17	14
24	MEAN	122	*	124	136	126	122	122	119	116	114	115	114	106	108
	S.D.	17	*	16	16	14	17	17	18	20	18	14	20	12	10
	N	26	*	24	23	20	20	19	19	15	12	11	10	8	3
25	MEAN	127	*	130	129	122	124	127	125	124	125	125	121	113	107
	S.D.	11	*	11	12	16	14	15	13	12	15	8	10	13	15
	N	33	*	31	30	26	24	22	21	21	19	18	17	17	11
26	MEAN	125	*	126	126	129	131	128	126	118	121	122	112	111	105
	S.D.	13	*	15	16	16	12	13	13	20	19	13	12	16	14
	N	28	*	25	23	22	20	18	15	14	9	7	7	7	5

* Data not avilable.

TABLE 4

TWO-TAILED STUDENT'S T-TEST: BODY WEIGHT ANALYSIS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA SAND AND SILICA SAND SUBSTITUTES

GROUPS COMPARED	TREATMENT	RESULTS OF THE T-TEST
1 vs 2	SALINE CONTROL vs SALINE + B(a)P	11, 12, 15, 57, 73, 79
3 vs 4	FERRIC OXIDE vs FERRIC OXIDE + B(a)P	7, 8, 9, 10, 11, 12, 13, 14, 17, 19, 21, 35, 69, 71
5 vs 6	SILICA SAND vs SILICA SAND + B(a)P	9, 10, 11, 12, 13, 14, 15, 69
7 vs 8	MINUSIL vs MINUSIL + B(a)P	4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 27, 45, 49, 51, 53, 55, 65, 69, 71, 79
9 vs 10	ZIRCONIUM (Au) vs ZIRCONIUM (Au) + B(a)P	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 21, 23, 25, 27, 33, 47, 53, 55, 71, 73, 79, 83
11 vs 12	ZIRCONIUM (Fl) vs ZIRCONIUM (Fl) + B(a)P	1, 3, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 21, 23, 27, 29, 31, 35, 37, 39, 47, 49, 51, 53, 55, 57, 63, 65, 69
13 vs 14	CHROMITE SAND vs CHROMITE SAND + B(a)P	2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 53, 55, 63, 69, 71, 75, 77, 79, 85, 87, 89
15 vs 16	MINUSIL + FERRIC OXIDE vs MINUSIL + FERRIC OXIDE + B(a)P	7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 45, 47, 51, 53, 55, 57, 59, 61, 63, 65, 73, 75, 77, 79, 91
17 vs 18	OLIVINE (Nc) vs OLIVINE (Nc) + B(a)P	4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 39, 43, 47, 49, 53, 55
19 vs 20	OLIVINE (Wa) vs OLIVINE (Wa) + B(a)P	17
21 vs 22	ALUMINUM (48) vs ALUMINUM (48) + B(a)P	9, 11, 12, 13, 31, 49, 51, 53, 55, 69, 71
23 vs 24	ALUMINUM (60) vs ALUMINUM (60) + B(a)P	11, 12, 13, 14, 29
25 vs 26	ALUMINUM (70) vs ALUMINUM (70) + B(a)P	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17

[a]Study week intervel were particulate + B(a)P group was statistically lower than the Particular Control Group at $p<0.05$.

TABLE 5
RESULTS OF THE TWO TAILED STUDENT'S T-TEST: MEAN LUNG WEIGHT ANALYSIS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	N	MEAN	S.D.	STATISTICAL SIGNIFICANCE AT $p<0.05$
1	SALINE CONTROL	47	1.18	0.51	None
2	SALINE + B(a)P	47	1.59	1.03	A & C
3	FERRIC OXIDE	50	1.33	0.51	None
4	FERRIC OXIDE + B(a)P	48	2.07	1.28	B & C
5	SILICA SAND	47	1.84	0.62	A
6	SILICA SAND + B(a)P	48	2.06	0.86	B
7	MINUSIL	50	1.71	0.85	A
8	MINUSIL + B(a)P	48	2.64	1.33	B & C
9	ZIRCONIUM (Au)	50	1.09	0.53	None
10	ZIRCONIUM (Au) + B(a)P	49	2.36	1.53	B & C
11	ZIRCONIUM (Fl)	49	1.34	1.13	None
12	ZIRCONIUM (Fl) + B(a)P	49	1.88	1.29	C
13	CHROMITE SAND	50	1.15	0.59	None
14	CHROMITE SAND + B(a)P	49	2.08	1.21	B & C
15	MINUSIL + FERRIC OXIDE	49	2.04	0.53	A
16	MINUSIL + FERRIC OXIDE + B(a)P	48	2.92	1.07	B & C
17	OLIVINE (Nc)	50	1.19	0.47	None
18	OLIVINE (Nc)	49	1.80	0.95	C
19	OLIVINE (Wa)	47	1.35	0.72	None
20	OLIVINE (Wa) + B(a)P	47	2.04	1.30	C
21	ALUMINUM (48)	48	1.33	0.47	None
22	ALUMINUM (48) + B(a)P	50	2.02	1.29	C
23	ALUMINUM (60)	48	1.17	0.43	None
24	ALUMINUM (60) + B(a)P	49	2.00	1.70	C
25	ALUMINUM (70)	48	1.34	0.60	None
26	ALUMINUM (70) + B(a)P	50	1.71	0.97	C

Statistical significance - A = Statistically higher mean lung weight was observed in the Particulate groups as compared with the Saline Control.
B = Statistically higher mean lung weight was observed in the Particulate + B(a)P groups as compared with the Saline + B(a)P group.
C = Statistically higher mean lung weight was observed in the Particulate + B(a)P groups as compared with their respective control.

TABLE 6

LIFE TABLE ANALYSES ON RESPIRATORY TRACT TUMOR BEARING ANIMALS

TABLE 6

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 1

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	48	48.000	0.000	1.000
10	1	0	47	48.000	0.000	1.000
15	1	0	46	47.000	0.000	1.000
20	1	0	45	46.000	0.000	1.000
26	1	0	44	45.000	0.000	1.000
34	1	0	43	44.000	0.000	1.000
35	1	0	42	43.000	0.000	1.000
37	1	0	41	42.000	0.000	1.000
38	1	0	40	41.000	0.000	1.000
39	2	0	38	40.000	0.000	1.000
43	1	0	37	38.000	0.000	1.000
45	1	0	36	37.000	0.000	1.000
58	1	0	35	36.000	0.000	1.000
59	1	0	34	35.000	0.000	1.000
61	1	0	33	34.000	0.000	1.000
71	1	0	32	33.000	0.000	1.000
73	1	0	31	32.000	0.000	1.000
74	1	0	30	31.000	0.000	1.000
76	1	0	29	30.000	0.000	1.000
80	2	0	27	29.000	0.000	1.000
81	3	0	24	27.000	0.000	1.000
82	1	0	23	24.000	0.000	1.000
85	2	0	21	23.000	0.000	1.000
88	1	0	20	21.000	0.000	1.000
89	2	0	18	20.000	0.000	1.000
90	1	0	17	18.000	0.000	1.000
92	17	0	0	17.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 48 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

SALINE CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 2

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	47	47.000	0.000	1.000
37	0	1	46	47.000	0.021	0.979
38	1	0	45	46.000	0.021	0.979
39	1	0	44	45.000	0.021	0.979
42	1	1	42	43.500	0.043	0.957
44	1	0	41	42.000	0.043	0.957
51	1	1	39	40.500	0.064	0.936
53	0	2	37	39.000	0.106	0.894
55	0	1	36	37.000	0.128	0.872
57	1	0	35	36.000	0.128	0.872
58	0	1	34	35.000	0.149	0.851
60	2	1	31	33.000	0.170	0.830
65	0	1	30	31.000	0.191	0.809
66	0	1	29	30.000	0.213	0.787
67	1	0	28	29.000	0.213	0.787
69	1	0	27	28.000	0.213	0.787
72	1	0	26	27.000	0.213	0.787
74	1	0	25	26.000	0.213	0.787
75	1	0	24	25.000	0.213	0.787
76	1	0	23	24.000	0.213	0.787
77	0	1	22	23.000	0.234	0.766
79	1	0	21	22.000	0.234	0.766
80	0	1	20	21.000	0.255	0.745
81	0	1	19	20.000	0.277	0.723
82	2	0	17	19.000	0.277	0.723
87	1	1	15	16.500	0.298	0.702
88	0	1	14	15.000	0.319	0.681
90	1	0	13	14.000	0.319	0.681
91	1	0	12	13.000	0.319	0.681
92	5	7	0	9.500	0.468	0.532

TOTAL WITHDRAWN (NTBA) = 25 TOTAL TBA'S = 22

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

SALINE + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 3

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
23	1	0	49	50.000	0.000	1.000
24	1	0	48	49.000	0.000	1.000
25	1	0	47	48.000	0.000	1.000
29	1	0	46	47.000	0.000	1.000
30	2	0	44	46.000	0.000	1.000
32	1	0	43	44.000	0.000	1.000
33	1	0	42	43.000	0.000	1.000
34	1	0	41	42.000	0.000	1.000
43	1	0	40	41.000	0.000	1.000
44	1	0	39	40.000	0.000	1.000
49	1	0	38	39.000	0.000	1.000
52	1	0	37	38.000	0.000	1.000
55	1	0	36	37.000	0.000	1.000
56	1	0	35	36.000	0.000	1.000
61	1	0	34	35.000	0.000	1.000
62	1	1	32	33.500	0.020	0.980
69	1	0	31	32.000	0.020	0.980
70	1	0	30	31.000	0.020	0.980
76	1	0	29	30.000	0.020	0.980
78	3	0	26	29.000	0.020	0.980
81	5	0	21	26.000	0.020	0.980
83	1	0	20	21.000	0.020	0.980
85	1	0	19	20.000	0.020	0.980
86	1	0	18	19.000	0.020	0.980
87	1	0	17	18.000	0.020	0.980
90	2	0	15	17.000	0.020	0.980
91	1	0	14	15.000	0.020	0.980
92	14	0	0	14.000	0.020	0.980

TOTAL WITHDRAWN (NTBA) = 49 TOTAL TBA'S = 1

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

FERRIC OXIDE CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 4

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	48	48.000	0.000	1.000
13	2	0	46	48.000	0.000	1.000
36	0	1	45	46.000	0.021	0.979
40	1	0	44	45.000	0.021	0.979
47	1	0	43	44.000	0.021	0.979
48	1	0	42	43.000	0.021	0.979
49	0	1	41	42.000	0.042	0.958
50	2	1	38	40.000	0.063	0.938
51	0	1	37	38.000	0.083	0.917
52	0	1	36	37.000	0.104	0.896
54	0	1	35	36.000	0.125	0.875
57	0	1	34	35.000	0.146	0.854
58	0	2	32	34.000	0.188	0.813
59	0	1	31	32.000	0.208	0.792
60	0	1	30	31.000	0.229	0.771
61	0	1	29	30.000	0.250	0.750
62	0	1	28	29.000	0.271	0.729
63	0	1	27	28.000	0.292	0.708
65	1	0	26	27.000	0.292	0.708
66	0	2	24	26.000	0.333	0.667
67	0	1	23	24.000	0.354	0.646
69	0	1	22	23.000	0.375	0.625
70	0	1	21	22.000	0.396	0.604
71	0	1	20	21.000	0.417	0.583
74	1	0	19	20.000	0.417	0.583
76	0	1	18	19.000	0.438	0.563
79	0	2	16	18.000	0.479	0.521
81	0	2	14	16.000	0.521	0.479
82	0	2	12	14.000	0.563	0.438
83	0	1	11	12.000	0.583	0.417
86	0	1	10	11.000	0.604	0.396
87	0	1	9	10.000	0.625	0.375
90	1	0	8	9.000	0.625	0.375
92	3	5	0	6.500	0.729	0.271

TOTAL WITHDRAWN (NTBA) = 13 TOTAL TBA'S = 35

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

FERRIC OXIDE + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 5

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
8	1	0	49	50.000	0.000	1.000
15	1	0	48	49.000	0.000	1.000
22	1	0	47	48.000	0.000	1.000
24	1	0	46	47.000	0.000	1.000
28	2	0	44	46.000	0.000	1.000
32	1	0	43	44.000	0.000	1.000
36	1	0	42	43.000	0.000	1.000
40	1	0	41	42.000	0.000	1.000
42	2	0	39	41.000	0.000	1.000
43	1	0	38	39.000	0.000	1.000
46	1	0	37	38.000	0.000	1.000
49	1	0	36	37.000	0.000	1.000
54	1	0	35	36.000	0.000	1.000
58	1	0	34	35.000	0.000	1.000
60	1	0	33	34.000	0.000	1.000
61	1	0	32	33.000	0.000	1.000
65	1	0	31	32.000	0.000	1.000
68	4	0	27	31.000	0.000	1.000
71	3	0	24	27.000	0.000	1.000
74	2	0	22	24.000	0.000	1.000
75	1	0	21	22.000	0.000	1.000
77	2	0	19	21.000	0.000	1.000
78	2	0	17	19.000	0.000	1.000
79	1	0	16	17.000	0.000	1.000
80	2	0	14	16.000	0.000	1.000
81	2	0	12	14.000	0.000	1.000
82	4	0	8	12.000	0.000	1.000
86	1	0	7	8.000	0.000	1.000
88	1	0	6	7.000	0.000	1.000
89	2	0	4	6.000	0.000	1.000
92	4	0	0	4.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 50 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

SILICA SAND CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 6

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
7	1	0	49	50.000	0.000	1.000
21	1	0	48	49.000	0.000	1.000
28	1	0	47	48.000	0.000	1.000
31	0	1	46	47.000	0.020	0.980
35	1	0	45	46.000	0.020	0.980
36	0	1	44	45.000	0.040	0.960
39	1	0	43	44.000	0.040	0.960
40	1	0	42	43.000	0.040	0.960
41	0	3	39	42.000	0.100	0.900
42	0	1	38	39.000	0.120	0.880
46	0	1	37	38.000	0.140	0.860
47	1	1	35	36.500	0.160	0.840
50	0	1	34	35.000	0.180	0.820
51	1	0	33	34.000	0.180	0.820
56	1	0	32	33.000	0.180	0.820
57	1	1	30	31.500	0.200	0.800
58	1	3	26	29.500	0.260	0.740
59	0	1	25	26.000	0.280	0.720
63	1	0	24	25.000	0.280	0.720
65	0	1	23	24.000	0.300	0.700
66	0	1	22	23.000	0.320	0.680
68	0	1	21	22.000	0.340	0.660
70	0	1	20	21.000	0.360	0.640
71	0	1	19	20.000	0.380	0.620
73	0	1	18	19.000	0.400	0.600
74	0	1	17	18.000	0.420	0.580
77	0	1	16	17.000	0.440	0.560
78	0	2	14	16.000	0.480	0.520
79	0	1	13	14.000	0.500	0.500
80	0	1	12	13.000	0.520	0.480
81	0	1	11	12.000	0.540	0.460
82	0	2	9	11.000	0.580	0.420
83	0	2	7	9.000	0.620	0.380
84	0	1	6	7.000	0.640	0.360
86	0	2	4	6.000	0.680	0.320
90	0	1	3	4.000	0.700	0.300
92	2	1	0	2.000	0.720	0.280

TOTAL WITHDRAWN (NTBA) = 14 TOTAL TBA'S = 36

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

SILICA SAND + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 7

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
26	2	0	48	50.000	0.000	1.000
32	2	0	46	48.000	0.000	1.000
34	1	0	45	46.000	0.000	1.000
38	1	0	44	45.000	0.000	1.000
39	1	0	43	44.000	0.000	1.000
40	1	0	42	43.000	0.000	1.000
43	1	0	41	42.000	0.000	1.000
45	2	0	39	41.000	0.000	1.000
47	1	0	38	39.000	0.000	1.000
57	1	0	37	38.000	0.000	1.000
63	1	0	36	37.000	0.000	1.000
67	1	0	35	36.000	0.000	1.000
68	0	1	34	35.000	0.020	0.980
73	1	0	33	34.000	0.020	0.980
74	1	0	32	33.000	0.020	0.980
75	1	0	31	32.000	0.020	0.980
76	1	0	30	31.000	0.020	0.980
80	2	0	28	30.000	0.020	0.980
81	1	0	27	28.000	0.020	0.980
82	1	0	26	27.000	0.020	0.980
83	2	0	24	26.000	0.020	0.980
86	1	0	23	24.000	0.020	0.980
92	23	0	0	23.000	0.020	0.980

TOTAL WITHDRAWN (NTBA) = 49 TOTAL TBA'S = 1

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

MINUSIL CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 8

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
3	1	0	49	50.000	0.000	1.000
23	0	1	48	49.000	0.020	0.980
24	1	0	47	48.000	0.020	0.980
29	0	1	46	47.000	0.040	0.960
41	0	1	45	46.000	0.060	0.940
42	1	0	44	45.000	0.060	0.940
47	0	1	43	44.000	0.080	0.920
48	0	1	42	43.000	0.100	0.900
49	1	2	39	41.500	0.140	0.860
51	0	1	38	39.000	0.160	0.840
52	0	1	37	38.000	0.180	0.820
55	0	1	36	37.000	0.200	0.800
58	1	1	34	35.500	0.220	0.780
60	0	1	33	34.000	0.240	0.760
61	0	1	32	33.000	0.260	0.740
64	1	0	31	32.000	0.260	0.740
65	0	1	30	31.000	0.280	0.720
66	0	1	29	30.000	0.300	0.700
67	0	1	28	29.000	0.320	0.680
68	0	2	26	28.000	0.360	0.640
70	0	3	23	26.000	0.420	0.580
71	0	3	20	23.000	0.480	0.520
72	0	1	19	20.000	0.500	0.500
73	0	1	18	19.000	0.520	0.480
74	0	1	17	18.000	0.540	0.460
75	0	1	16	17.000	0.560	0.440
77	0	1	15	16.000	0.580	0.420
78	0	1	14	15.000	0.600	0.400
79	0	3	11	14.000	0.660	0.340
80	0	2	9	11.000	0.700	0.300
82	0	1	8	9.000	0.720	0.280
83	0	1	7	8.000	0.740	0.260
84	0	2	5	7.000	0.780	0.220
90	0	1	4	5.000	0.800	0.200
91	0	1	3	4.000	0.820	0.180
92	0	3	0	3.000	0.880	0.120

TOTAL WITHDRAWN (NTBA) = 6 TOTAL TBA'S = 44

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

MINUSIL + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 9

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
25	1	0	49	50.000	0.000	1.000
30	1	0	48	49.000	0.000	1.000
33	2	0	46	48.000	0.000	1.000
41	1	0	45	46.000	0.000	1.000
42	1	0	44	45.000	0.000	1.000
43	1	0	43	44.000	0.000	1.000
45	2	0	41	43.000	0.000	1.000
46	1	0	40	41.000	0.000	1.000
47	1	0	39	40.000	0.000	1.000
50	1	0	38	39.000	0.000	1.000
51	1	0	37	38.000	0.000	1.000
52	1	0	36	37.000	0.000	1.000
53	1	0	35	36.000	0.000	1.000
55	1	0	34	35.000	0.000	1.000
59	1	0	33	34.000	0.000	1.000
61	1	0	32	33.000	0.000	1.000
63	1	0	31	32.000	0.000	1.000
69	2	0	29	31.000	0.000	1.000
70	1	0	28	29.000	0.000	1.000
74	1	0	27	28.000	0.000	1.000
76	1	0	26	27.000	0.000	1.000
80	1	0	25	26.000	0.000	1.000
81	2	0	23	25.000	0.000	1.000
90	2	0	21	23.000	0.000	1.000
91	4	0	17	21.000	0.000	1.000
92	17	0	0	17.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 50 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ZIRCONIUM (Au) CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 10

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
32	1	0	49	50.000	0.000	1.000
33	0	2	47	49.000	0.040	0.960
35	0	2	45	47.000	0.080	0.920
36	0	1	44	45.000	0.100	0.900
40	0	1	43	44.000	0.120	0.880
43	1	0	42	43.000	0.120	0.880
45	1	1	40	41.500	0.140	0.860
47	0	2	38	40.000	0.180	0.820
48	0	1	37	38.000	0.200	0.800
50	0	1	36	37.000	0.220	0.780
51	0	1	35	36.000	0.240	0.760
52	0	4	31	35.000	0.320	0.680
55	0	1	30	31.000	0.340	0.660
56	0	2	28	30.000	0.380	0.620
57	0	1	27	28.000	0.400	0.600
58	0	2	25	27.000	0.440	0.560
59	0	1	24	25.000	0.460	0.540
61	1	0	23	24.000	0.460	0.540
63	0	1	22	23.000	0.480	0.520
65	0	3	19	22.000	0.540	0.460
70	1	0	18	19.000	0.540	0.460
72	0	1	17	18.000	0.560	0.440
75	1	2	14	16.500	0.600	0.400
76	0	1	13	14.000	0.620	0.380
78	0	1	12	13.000	0.640	0.360
80	0	1	11	12.000	0.660	0.340
81	0	1	10	11.000	0.680	0.320
83	0	1	9	10.000	0.700	0.300
86	0	1	8	9.000	0.720	0.280
87	0	1	7	8.000	0.740	0.260
88	0	1	6	7.000	0.760	0.240
89	0	1	5	6.000	0.780	0.220
90	0	1	4	5.000	0.800	0.200
91	0	1	3	4.000	0.820	0.180
92	1	2	0	2.500	0.860	0.140

TOTAL WITHDRAWN (NTBA) = 7 TOTAL TBA'S = 43

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ZIRCONIUM (Au) + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 11

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
14	1	0	49	50.000	0.000	1.000
23	1	0	48	49.000	0.000	1.000
24	1	0	47	48.000	0.000	1.000
29	1	0	46	47.000	0.000	1.000
34	1	0	45	46.000	0.000	1.000
37	2	0	43	45.000	0.000	1.000
38	1	0	42	43.000	0.000	1.000
40	1	0	41	42.000	0.000	1.000
42	1	0	40	41.000	0.000	1.000
49	1	0	39	40.000	0.000	1.000
52	1	0	38	39.000	0.000	1.000
54	1	0	37	38.000	0.000	1.000
62	1	0	36	37.000	0.000	1.000
72	2	0	34	36.000	0.000	1.000
76	1	0	33	34.000	0.000	1.000
77	3	0	30	33.000	0.000	1.000
78	1	0	29	30.000	0.000	1.000
79	2	0	27	29.000	0.000	1.000
80	1	0	26	27.000	0.000	1.000
81	2	0	24	26.000	0.000	1.000
83	1	0	23	24.000	0.000	1.000
84	1	0	22	23.000	0.000	1.000
85	1	0	21	22.000	0.000	1.000
86	2	1	18	20.000	0.020	0.980
91	1	0	17	18.000	0.020	0.980
92	16	1	0	9.000	0.040	0.960

TOTAL WITHDRAWN (NTBA) = 48 TOTAL TBA'S = 2

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ZIRCONIUM (F½) CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 12

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
12	1	0	49	50.000	0.000	1.000
15	1	0	48	49.000	0.000	1.000
27	1	0	47	48.000	0.000	1.000
40	2	1	44	46.000	0.020	0.980
41	0	2	42	44.000	0.060	0.940
43	1	0	41	42.000	0.060	0.940
45	0	1	40	41.000	0.080	0.920
46	1	0	39	40.000	0.080	0.920
47	0	1	38	39.000	0.100	0.900
48	0	1	37	38.000	0.120	0.880
52	0	1	36	37.000	0.140	0.860
54	1	1	34	35.500	0.160	0.840
55	0	1	33	34.000	0.180	0.820
56	0	2	31	33.000	0.220	0.780
59	0	1	30	31.000	0.240	0.760
61	0	1	29	30.000	0.260	0.740
64	0	1	28	29.000	0.280	0.720
65	0	3	25	28.000	0.340	0.660
66	0	1	24	25.000	0.360	0.640
67	1	1	22	23.500	0.380	0.620
69	1	0	21	22.000	0.380	0.620
70	0	2	19	21.000	0.420	0.580
71	0	1	18	19.000	0.440	0.560
77	0	1	17	18.000	0.460	0.540
78	0	1	16	17.000	0.480	0.520
79	0	1	15	16.000	0.500	0.500
80	0	1	14	15.000	0.520	0.480
81	1	0	13	14.000	0.520	0.480
83	0	1	12	13.000	0.540	0.460
84	0	2	10	12.000	0.580	0.420
85	1	0	9	10.000	0.580	0.420
86	0	1	8	9.000	0.600	0.400
89	0	1	7	8.000	0.620	0.380
91	0	1	6	7.000	0.640	0.360
92	2	4	0	5.000	0.720	0.280

TOTAL WITHDRAWN (NTBA) = 14 TOTAL TBA'S = 36

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ZIRCONIUM (F1) + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 13

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
9	1	0	49	50.000	0.000	1.000
10	1	0	48	49.000	0.000	1.000
12	1	0	47	48.000	0.000	1.000
13	2	0	45	47.000	0.000	1.000
16	1	0	44	45.000	0.000	1.000
18	1	0	43	44.000	0.000	1.000
24	1	0	42	43.000	0.000	1.000
25	1	0	41	42.000	0.000	1.000
28	1	0	40	41.000	0.000	1.000
35	1	0	39	40.000	0.000	1.000
36	3	0	36	39.000	0.000	1.000
40	1	0	35	36.000	0.000	1.000
43	1	0	34	35.000	0.000	1.000
54	1	0	33	34.000	0.000	1.000
58	1	0	32	33.000	0.000	1.000
69	1	0	31	32.000	0.000	1.000
72	1	0	30	31.000	0.000	1.000
74	1	0	29	30.000	0.000	1.000
79	1	0	28	29.000	0.000	1.000
80	3	0	25	28.000	0.000	1.000
82	1	0	24	25.000	0.000	1.000
84	3	0	21	24.000	0.000	1.000
90	1	0	20	21.000	0.000	1.000
91	2	0	18	20.000	0.000	1.000
92	18	0	0	18.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 50 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

CHROMITE SAND CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 14

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	48	48.000	0.000	1.000
14	1	0	47	48.000	0.000	1.000
26	1	0	46	47.000	0.000	1.000
29	0	1	45	46.000	0.021	0.979
31	1	0	44	45.000	0.021	0.979
35	1	1	42	43.500	0.042	0.958
37	0	1	41	42.000	0.063	0.938
39	1	0	40	41.000	0.063	0.938
41	0	2	38	40.000	0.104	0.896
43	0	1	37	38.000	0.125	0.875
44	0	1	36	37.000	0.146	0.854
45	1	0	35	36.000	0.146	0.854
46	0	1	34	35.000	0.167	0.833
48	0	1	33	34.000	0.188	0.813
49	1	1	31	32.500	0.208	0.792
53	1	0	30	31.000	0.208	0.792
54	0	2	28	30.000	0.250	0.750
55	0	1	27	28.000	0.271	0.729
56	2	2	23	26.000	0.313	0.688
58	0	3	20	23.000	0.375	0.625
59	0	1	19	20.000	0.396	0.604
62	0	1	18	19.000	0.417	0.583
63	0	1	17	18.000	0.438	0.563
69	0	1	16	17.000	0.458	0.542
71	0	2	14	16.000	0.500	0.500
72	0	2	12	14.000	0.542	0.458
76	0	1	11	12.000	0.563	0.438
77	0	2	9	11.000	0.604	0.396
79	0	2	7	9.000	0.646	0.354
80	0	2	5	7.000	0.688	0.313
81	1	0	4	5.000	0.688	0.313
85	0	1	3	4.000	0.708	0.292
90	0	2	1	3.000	0.750	0.250
92	0	1	0	1.000	0.771	0.229

TOTAL WITHDRAWN (NTBA) = 11 TOTAL TBA'S = 37

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

CHROMITE SAND + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 15

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	49	49.000	0.000	1.000
16	1	0	48	49.000	0.000	1.000
17	1	0	47	48.000	0.000	1.000
30	1	0	46	47.000	0.000	1.000
33	2	0	44	46.000	0.000	1.000
34	2	0	42	44.000	0.000	1.000
35	1	0	41	42.000	0.000	1.000
38	1	0	40	41.000	0.000	1.000
42	1	0	39	40.000	0.000	1.000
45	2	0	37	39.000	0.000	1.000
46	1	0	36	37.000	0.000	1.000
48	1	0	35	36.000	0.000	1.000
49	1	0	34	35.000	0.000	1.000
50	1	0	33	34.000	0.000	1.000
52	1	0	32	33.000	0.000	1.000
54	1	0	31	32.000	0.000	1.000
58	1	0	30	31.000	0.000	1.000
59	1	0	29	30.000	0.000	1.000
62	1	0	28	29.000	0.000	1.000
64	1	0	27	28.000	0.000	1.000
65	2	0	25	27.000	0.000	1.000
69	1	0	24	25.000	0.000	1.000
72	4	0	20	24.000	0.000	1.000
73	1	0	19	20.000	0.000	1.000
75	1	0	18	19.000	0.000	1.000
79	3	0	15	18.000	0.000	1.000
80	4	0	11	15.000	0.000	1.000
81	2	0	9	11.000	0.000	1.000
83	1	0	8	9.000	0.000	1.000
84	3	0	5	8.000	0.000	1.000
86	1	0	4	5.000	0.000	1.000
90	1	0	3	4.000	0.000	1.000
92	3	0	0	3.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 49 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

MINUSIL + FERRIC OXIDE CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 16

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
18	1	0	49	50.000	0.000	1.000
22	1	0	48	49.000	0.000	1.000
38	1	0	47	48.000	0.000	1.000
39	1	2	44	46.500	0.040	0.960
40	0	1	43	44.000	0.060	0.940
41	2	0	41	43.000	0.060	0.940
42	1	0	40	41.000	0.060	0.940
43	0	1	39	40.000	0.080	0.920
44	0	1	38	39.000	0.100	0.900
46	0	1	37	38.000	0.120	0.880
48	0	1	36	37.000	0.140	0.860
50	0	1	35	36.000	0.160	0.840
52	0	1	34	35.000	0.180	0.820
55	0	1	33	34.000	0.200	0.800
58	0	1	32	33.000	0.220	0.780
59	0	1	31	32.000	0.240	0.760
60	0	1	30	31.000	0.260	0.740
61	2	1	27	29.000	0.280	0.720
63	1	2	24	26.500	0.320	0.680
64	0	1	23	24.000	0.340	0.660
68	1	2	20	22.500	0.380	0.620
69	0	1	19	20.000	0.400	0.600
74	0	3	16	19.000	0.460	0.540
75	0	2	14	16.000	0.500	0.500
76	0	1	13	14.000	0.520	0.480
77	0	1	12	13.000	0.540	0.460
78	0	1	11	12.000	0.560	0.440
80	0	1	10	11.000	0.580	0.420
81	1	2	7	9.500	0.620	0.380
82	0	1	6	7.000	0.640	0.360
83	0	1	5	6.000	0.660	0.340
85	0	2	3	5.000	0.700	0.300
86	0	1	2	3.000	0.720	0.280
87	0	1	1	2.000	0.740	0.260
92	0	1	0	1.000	0.760	0.240

TOTAL WITHDRAWN (NTBA) = 12 TOTAL TBA'S = 38

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

MINUSIL + FERRIC OXIDE + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 17

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
12	1	0	49	50.000	0.000	1.000
34	2	0	47	49.000	0.000	1.000
37	1	0	46	47.000	0.000	1.000
41	1	0	45	46.000	0.000	1.000
42	1	0	44	45.000	0.000	1.000
50	1	0	43	44.000	0.000	1.000
55	1	0	42	43.000	0.000	1.000
65	1	0	41	42.000	0.000	1.000
66	1	0	40	41.000	0.000	1.000
70	1	0	39	40.000	0.000	1.000
72	1	0	38	39.000	0.000	1.000
73	1	0	37	38.000	0.000	1.000
74	1	0	36	37.000	0.000	1.000
75	1	0	35	36.000	0.000	1.000
76	2	0	33	35.000	0.000	1.000
80	2	0	31	33.000	0.000	1.000
82	1	0	30	31.000	0.000	1.000
83	1	0	29	30.000	0.000	1.000
84	1	0	28	29.000	0.000	1.000
87	1	0	27	28.000	0.000	1.000
88	1	0	26	27.000	0.000	1.000
90	1	0	25	26.000	0.000	1.000
91	1	0	24	25.000	0.000	1.000
92	24	0	0	24.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 50 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

OLIVINE (Nc) CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 18

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
14	1	0	49	50.000	0.000	1.000
20	1	0	48	49.000	0.000	1.000
23	1	0	47	48.000	0.000	1.000
26	0	1	46	47.000	0.020	0.980
32	1	1	44	45.500	0.040	0.960
35	0	1	43	44.000	0.060	0.940
38	1	1	41	42.500	0.080	0.920
40	0	2	39	41.000	0.120	0.880
43	0	1	38	39.000	0.140	0.860
44	1	0	37	38.000	0.140	0.860
50	0	1	36	37.000	0.160	0.840
51	1	0	35	36.000	0.160	0.840
53	1	0	34	35.000	0.160	0.840
54	1	0	33	34.000	0.160	0.840
55	1	1	31	32.500	0.180	0.820
56	0	1	30	31.000	0.200	0.800
57	0	1	29	30.000	0.220	0.780
58	0	1	28	29.000	0.240	0.760
60	0	3	25	28.000	0.300	0.700
62	0	1	24	25.000	0.320	0.680
63	0	1	23	24.000	0.340	0.660
64	0	2	21	23.000	0.380	0.620
67	0	1	20	21.000	0.400	0.600
69	0	2	18	20.000	0.440	0.560
70	0	1	17	18.000	0.460	0.540
71	0	1	16	17.000	0.480	0.520
73	0	1	15	16.000	0.500	0.500
75	0	3	12	15.000	0.560	0.440
76	0	1	11	12.000	0.580	0.420
79	0	1	10	11.000	0.600	0.400
80	0	2	8	10.000	0.640	0.360
85	0	2	6	8.000	0.680	0.320
86	0	1	5	6.000	0.700	0.300
87	0	2	3	5.000	0.740	0.260
92	0	3	0	3.000	0.800	0.200

TOTAL WITHDRAWN (NTBA) = 10 TOTAL TBA'S = 40

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

OLIVINE (Nc) + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 19

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
7	1	0	49	50.000	0.000	1.000
9	1	0	48	49.000	0.000	1.000
18	1	0	47	48.000	0.000	1.000
19	1	0	46	47.000	0.000	1.000
28	1	0	45	46.000	0.000	1.000
32	1	0	44	45.000	0.000	1.000
33	2	0	42	44.000	0.000	1.000
34	1	0	41	42.000	0.000	1.000
38	2	0	39	41.000	0.000	1.000
40	1	0	38	39.000	0.000	1.000
41	1	0	37	38.000	0.000	1.000
45	1	0	36	37.000	0.000	1.000
47	1	0	35	36.000	0.000	1.000
49	1	0	34	35.000	0.000	1.000
50	1	0	33	34.000	0.000	1.000
55	1	0	32	33.000	0.000	1.000
57	1	0	31	32.000	0.000	1.000
58	1	0	30	31.000	0.000	1.000
62	1	0	29	30.000	0.000	1.000
63	1	0	28	29.000	0.000	1.000
67	1	0	27	28.000	0.000	1.000
68	2	0	25	27.000	0.000	1.000
72	1	0	24	25.000	0.000	1.000
78	1	0	23	24.000	0.000	1.000
81	1	0	22	23.000	0.000	1.000
85	2	0	20	22.000	0.000	1.000
88	1	0	19	20.000	0.000	1.000
89	1	0	18	19.000	0.000	1.000
90	4	0	14	18.000	0.000	1.000
91	3	0	11	14.000	0.000	1.000
92	11	0	0	11.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 50 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

OLIVINE (Wa) CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 20

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
12	1	0	49	50.000	0.000	1.000
16	1	0	48	49.000	0.000	1.000
21	1	0	47	48.000	0.000	1.000
22	1	0	46	47.000	0.000	1.000
28	1	2	43	45.500	0.040	0.960
31	0	1	42	43.000	0.060	0.940
32	0	1	41	42.000	0.080	0.920
34	0	1	40	41.000	0.100	0.900
35	2	1	37	39.000	0.120	0.880
37	0	1	36	37.000	0.140	0.860
39	0	2	34	36.000	0.180	0.820
41	0	3	31	34.000	0.240	0.760
45	1	1	29	30.500	0.260	0.740
46	0	1	28	29.000	0.280	0.720
47	0	1	27	28.000	0.300	0.700
49	0	2	25	27.000	0.340	0.660
52	1	1	23	24.500	0.360	0.640
53	0	1	22	23.000	0.380	0.620
58	0	1	21	22.000	0.400	0.600
60	0	1	20	21.000	0.420	0.580
61	1	0	19	20.000	0.420	0.580
62	0	1	18	19.000	0.440	0.560
63	0	1	17	18.000	0.460	0.540
64	0	1	16	17.000	0.480	0.520
68	0	1	15	16.000	0.500	0.500
72	0	1	14	15.000	0.520	0.480
77	0	1	13	14.000	0.540	0.460
78	1	0	12	13.000	0.540	0.460
79	0	2	10	12.000	0.580	0.420
83	0	1	9	10.000	0.600	0.400
84	0	1	8	9.000	0.620	0.380
89	0	2	6	8.000	0.660	0.340
90	0	2	4	6.000	0.700	0.300
91	0	2	2	4.000	0.740	0.260
92	0	2	0	2.000	0.780	0.220

TOTAL WITHDRAWN (NTBA) = 11 TOTAL TBA'S = 39

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

OLIVINE (Wa) + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 21

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTRA DURING WEEK
0	0	0	50	50.000	0.000	1.000
5	1	0	49	50.000	0.000	1.000
20	1	0	48	49.000	0.000	1.000
21	1	0	47	48.000	0.000	1.000
25	1	0	46	47.000	0.000	1.000
29	1	0	45	46.000	0.000	1.000
39	1	0	44	45.000	0.000	1.000
40	1	0	43	44.000	0.000	1.000
43	1	0	42	43.000	0.000	1.000
50	1	0	41	42.000	0.000	1.000
51	1	0	40	41.000	0.000	1.000
59	1	0	39	40.000	0.000	1.000
66	1	0	38	39.000	0.000	1.000
68	1	0	37	38.000	0.000	1.000
69	1	0	36	37.000	0.000	1.000
72	1	0	35	36.000	0.000	1.000
74	2	0	33	35.000	0.000	1.000
76	1	0	32	33.000	0.000	1.000
77	1	0	31	32.000	0.000	1.000
80	1	0	30	31.000	0.000	1.000
81	1	0	29	30.000	0.000	1.000
84	1	0	28	29.000	0.000	1.000
86	2	0	26	28.000	0.000	1.000
88	2	0	24	26.000	0.000	1.000
91	1	0	23	24.000	0.000	1.000
92	23	0	0	23.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 50 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ALUMINUM (48) CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 22

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
17	0	1	49	50.000	0.020	0.980
18	1	0	48	49.000	0.020	0.980
21	1	0	47	48.000	0.020	0.980
24	1	0	46	47.000	0.020	0.980
31	1	0	45	46.000	0.020	0.980
32	1	0	44	45.000	0.020	0.980
35	1	0	43	44.000	0.020	0.980
36	1	0	42	43.000	0.020	0.980
39	1	1	40	41.500	0.040	0.960
46	1	0	39	40.000	0.040	0.960
51	0	2	37	39.000	0.080	0.920
52	0	1	36	37.000	0.100	0.900
53	0	1	35	36.000	0.120	0.880
55	0	1	34	35.000	0.140	0.860
56	0	1	33	34.000	0.160	0.840
57	0	1	32	33.000	0.180	0.820
59	0	3	29	32.000	0.240	0.760
60	0	1	28	29.000	0.260	0.740
63	1	1	26	27.500	0.280	0.720
64	0	2	24	26.000	0.320	0.680
66	0	1	23	24.000	0.340	0.660
67	0	2	21	23.000	0.380	0.620
68	0	1	20	21.000	0.400	0.600
70	0	1	19	20.000	0.420	0.580
72	0	1	18	19.000	0.440	0.560
73	0	2	16	18.000	0.480	0.520
74	0	1	15	16.000	0.500	0.500
76	0	2	13	15.000	0.540	0.460
77	0	2	11	13.000	0.580	0.420
81	0	1	10	11.000	0.600	0.400
82	0	2	8	10.000	0.640	0.360
83	0	1	7	8.000	0.660	0.340
89	1	0	6	7.000	0.660	0.340
90	0	1	5	6.000	0.680	0.320
91	0	1	4	5.000	0.700	0.300
92	1	3	0	3.500	0.760	0.240

TOTAL WITHDRAWN (NTBA) = 12 TOTAL TBA'S = 38

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ALUMINUM (48) + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 23

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	49	49.000	0.000	1.000
15	1	0	48	49.000	0.000	1.000
22	1	0	47	48.000	0.000	1.000
28	1	0	46	47.000	0.000	1.000
29	2	0	44	46.000	0.000	1.000
31	1	0	43	44.000	0.000	1.000
32	1	0	42	43.000	0.000	1.000
33	1	0	41	42.000	0.000	1.000
36	1	0	40	41.000	0.000	1.000
43	1	0	39	40.000	0.000	1.000
44	1	0	38	39.000	0.000	1.000
46	1	0	37	38.000	0.000	1.000
47	1	0	36	37.000	0.000	1.000
54	2	0	34	36.000	0.000	1.000
61	1	0	33	34.000	0.000	1.000
62	1	0	32	33.000	0.000	1.000
67	2	0	30	32.000	0.000	1.000
69	1	0	29	30.000	0.000	1.000
73	2	0	27	29.000	0.000	1.000
74	1	0	26	27.000	0.000	1.000
78	1	0	25	26.000	0.000	1.000
79	1	0	24	25.000	0.000	1.000
80	1	0	23	24.000	0.000	1.000
81	1	0	22	23.000	0.000	1.000
82	1	0	21	22.000	0.000	1.000
83	1	0	20	21.000	0.000	1.000
85	2	0	18	20.000	0.000	1.000
86	1	0	17	18.000	0.000	1.000
89	1	0	16	17.000	0.000	1.000
90	2	0	14	16.000	0.000	1.000
92	14	0	0	14.000	0.000	1.000

TOTAL WITHDRAWN (NTBA) = 49 TOTAL TBA'S = 0

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ALUMINUM (60) CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 24

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
12	1	0	49	50.000	0.000	1.000
14	0	1	48	49.000	0.020	0.980
17	1	0	47	48.000	0.020	0.980
25	1	0	46	47.000	0.020	0.980
28	1	0	45	46.000	0.020	0.980
31	1	0	44	45.000	0.020	0.980
32	1	1	42	43.500	0.040	0.960
33	1	0	41	42.000	0.040	0.960
35	1	0	40	41.000	0.040	0.960
37	0	1	39	40.000	0.060	0.940
38	1	0	38	39.000	0.060	0.940
41	1	0	37	38.000	0.060	0.940
46	0	1	36	37.000	0.080	0.920
49	1	0	35	36.000	0.080	0.920
50	1	0	34	35.000	0.080	0.920
54	0	1	33	34.000	0.100	0.900
56	0	1	32	33.000	0.120	0.880
59	0	1	31	32.000	0.140	0.860
60	1	1	29	30.500	0.160	0.840
61	0	1	28	29.000	0.180	0.820
62	0	2	26	28.000	0.220	0.780
65	0	1	25	26.000	0.240	0.760
66	0	1	24	25.000	0.260	0.740
70	0	1	23	24.000	0.280	0.720
72	0	3	20	23.000	0.340	0.660
76	0	1	19	20.000	0.360	0.640
79	1	0	18	19.000	0.360	0.640
80	1	1	16	17.500	0.380	0.620
81	1	3	12	15.500	0.440	0.560
83	0	1	11	12.000	0.460	0.540
86	0	1	10	11.000	0.480	0.520
87	0	1	9	10.000	0.500	0.500
88	0	1	8	9.000	0.520	0.480
89	1	0	7	8.000	0.520	0.480
90	0	2	5	7.000	0.560	0.440
91	1	1	3	4.500	0.580	0.420
92	1	2	0	2.500	0.620	0.380

TOTAL WITHDRAWN (NTBA) = 19 TOTAL TBA'S = 31

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ALUMINUM (60) + B(a)P

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 25

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
14	1	0	49	50.000	0.000	1.000
29	1	0	48	49.000	0.000	1.000
32	2	0	46	48.000	0.000	1.000
33	1	0	45	46.000	0.000	1.000
34	1	0	44	45.000	0.000	1.000
37	1	0	43	44.000	0.000	1.000
38	1	0	42	43.000	0.000	1.000
41	1	0	41	42.000	0.000	1.000
42	1	0	40	41.000	0.000	1.000
45	1	0	39	40.000	0.000	1.000
53	1	0	38	39.000	0.000	1.000
54	1	0	37	38.000	0.000	1.000
57	1	0	36	37.000	0.000	1.000
59	2	0	34	36.000	0.000	1.000
62	1	0	33	34.000	0.000	1.000
67	1	0	32	33.000	0.000	1.000
69	1	0	31	32.000	0.000	1.000
70	1	0	30	31.000	0.000	1.000
71	2	0	28	30.000	0.000	1.000
72	1	0	27	28.000	0.000	1.000
73	2	0	25	27.000	0.000	1.000
74	1	0	24	25.000	0.000	1.000
77	1	0	23	24.000	0.000	1.000
78	1	0	22	23.000	0.000	1.000
79	1	0	21	22.000	0.000	1.000
81	2	0	19	21.000	0.000	1.000
83	1	0	18	19.000	0.000	1.000
86	1	0	17	18.000	0.000	1.000
88	1	0	16	17.000	0.000	1.000
89	3	0	13	16.000	0.000	1.000
92	12	1	0	7.000	0.020	0.980

TOTAL WITHDRAWN (NTBA) = 49 TOTAL TBA'S = 1

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

ALUMINUM (70) CONTROL

TABLE 6 (CONTINUED)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES
SILICA AND SILICA SAND SUBSTITUTES

TOTAL RESPIRATORY TRACT TUMORS

GROUP 26

WEEK	NTBA WITHDRAWN DURING WEEK	TBA DURING WEEK	ALIVE AT START OF WEEK	ADJUSTED ALIVE	PROBABILITY OF TBA DURING WEEK	PROBABILITY OF NTBA DURING WEEK
0	0	0	50	50.000	0.000	1.000
4	1	0	49	50.000	0.000	1.000
6	1	0	48	49.000	0.000	1.000
7	1	0	47	48.000	0.000	1.000
12	1	0	46	47.000	0.000	1.000
22	1	0	45	46.000	0.000	1.000
29	0	1	44	45.000	0.020	0.980
30	0	1	43	44.000	0.040	0.960
31	0	2	41	43.000	0.080	0.920
43	0	1	40	41.000	0.100	0.900
45	1	2	37	39.500	0.140	0.860
46	0	1	36	37.000	0.160	0.840
50	1	0	35	36.000	0.160	0.840
53	0	1	34	35.000	0.180	0.820
56	1	0	33	34.000	0.180	0.820
57	1	1	31	32.500	0.200	0.800
60	0	1	30	31.000	0.220	0.780
61	0	1	29	30.000	0.240	0.760
62	0	1	28	29.000	0.260	0.740
66	0	1	27	28.000	0.280	0.720
67	0	1	26	27.000	0.300	0.700
69	0	1	25	26.000	0.320	0.680
70	0	2	23	25.000	0.360	0.640
71	0	1	22	23.000	0.380	0.620
73	0	2	20	22.000	0.420	0.580
75	0	1	19	20.000	0.440	0.560
76	0	1	18	19.000	0.460	0.540
77	0	1	17	18.000	0.480	0.520
78	1	1	15	16.500	0.500	0.500
80	0	1	14	15.000	0.520	0.480
81	0	3	11	14.000	0.580	0.420
82	0	2	9	11.000	0.620	0.380
83	0	1	8	9.000	0.640	0.360
84	0	1	7	8.000	0.660	0.340
89	0	1	6	7.000	0.680	0.320
91	0	1	5	6.000	0.700	0.300
92	3	2	0	3.500	0.740	0.260

TOTAL WITHDRAWN (NTBA) = 13 TOTAL TBA'S = 37

TBA (TUMOR-BEARING ANIMAL) NTBA (NON-TUMOR-BEARING ANIMAL)

TABLE 7
TOTAL RESPIRATORY TRACT AND NON-RESPIRATORY TRACT TUMOR BEARING ANIMALS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	EFFECTIVE NO. OF ANIMALS [a]	TOTAL NO. OF RESP. TBA [b]	TOTAL NO. OF NON-RESP.TBA [c]	TOTAL NO. OF TBA [d]
1	SALINE CONTROL	48	0	10	10
2	SALINE + B(a)P	47	22	6	28
3	FERRIC OXIDE	50	1	4	5
4	FERRIC OXIDE + B(a)P	48	35	1	36
5	SILICA SAND	50	0	6	6
6	SILICA SAND + B(a)P	50	36	1	37
7	MINUSIL	50	1	5	6
8	MINUSIL + B(a)P	50	44	1	45
9	ZIRCONIUM (Au)	50	0	5	5
10	ZIRCONIUM (Au) + B(a)P	50	43	1	44
11	ZIRCONIUM (F1)	50	2	9	11
12	ZIRCONIUM (F1) + B(a)P	50	36	2	38
13	CHROMITE SAND	50	0	9	9
14	CHROMITE SAND + B(a)P	48	37	0	37
15	MINUSIL + FERRIC OXIDE	49	0	2	2
16	MINUSIL + FERRIC OXIDE + B(a)P	50	38	5	43
17	OLIVINE (Nc)	50	0	5	5
18	OLIVINE (Nc) + B(a)P	50	40	0	40
19	OLIVINE (Wa)	50	0	6	6
20	OLIVINE (Wa) + B(a)P	50	39	0	39
21	ALUMINUM (48)	50	0	3	3
22	ALUMINUM (48) + B(a)P	50	38	4	42
23	ALUMINUM (60)	49	0	8	8
24	ALUMINUM (60) + B(a)P	50	31	2	33
25	ALUMINUM (70)	50	1	5	6
26	ALUMINUM (70) + B(a)P	50	37	2	39

[a] = Effective No: Number of animals histopathologically confirmed.

[b] = RESP. TBA: Respiratory Tract Tumor Bearing Animals.

[c] = NON-RESP. TBA: Non-respiratory Tract Tumor Bearing animals.

[d] = Tumor Bearing Animals.

TABLE 8
INCIDENCES OF RESPIRATORY TRACT TUMORS IN HAMSTERS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	EFFECTIVE NO. OF ANIMALS [a]	NO. AT RISK	TOTAL NO. OF RESP. TBA [b]	% OF RESP. TBA [c]	TOTAL NO. OF RESP. TUMORS PER SITE LARYNX	TRACHEA	BRONCHI & LUNG	TOTAL TUMORS	APPEARANCE OF FIRST TUMOR (WEEKS)	MEAN LATENCY ± S.D. (WEEKS)
1	SALINE CONTROL	48	0	0	0	0	0	0	0	0	0.0±0.0
2	SALINE + B(a)P	47	47	22	47	5	3	32	40	37	72.6±18.8
3	FERRIC OXIDE	50	34	1	3	1	0	0	1	62	62.0±00.0
4	FERRIC OXIDE + B(a)P	48	46	35	76	5	6	69	80	36	70.2±15.0
5	SILICA SAND	50	0	0	0	0	0	0	0	0	0.0±0.0
6	SILICA SAND + B(a)P	50	47	36	77	13	13	72	98	31	66.5±17.3
7	MINUSIL	50	35	1	3	0	0	1	1	68	68.0±0.0
8	MINUSIL + B(a)P	50	49	44	90	10	2	111	123	23	68.5±16.3
9	ZIRCONIUM (Au)	50	0	0	0	0	0	0	0	0	0.0±0.0
10	ZIRCONIUM (Au) + B(a)P	50	49	43	88	8	8	110	126	33	62.8±18.3
11	ZIRCONIUM (F1)	50	21	2	10	0	0	4	4	86	89.0±4.2
12	ZIRCONIUM (F1) + B(a)P	50	47	36	77	9	9	77	95	40	68.3±16.5
13	CHROMITE SAND	50	0	0	0	0	0	0	0	0	0.0±0.0
14	CHROMITE SAND + B(a)P	48	46	37	80	12	13	62	87	29	62.3±16.8
15	MINUSIL + FERRIC OXIDE	49	0	0	0	0	0	0	0	0	0.0±0.0
16	MINUSIL + FERRIC OXIDE + B(a)P	50	47	38	81	10	4	81	95	39	66.7±15.4
17	OLIVINE (Nc)	50	0	0	0	0	0	0	0	0	0.0±0.0
18	OLIVINE (Nc) + B(a)P	50	47	40	85	14	7	86	107	26	65.7±17.7
19	OLIVINE (Wa)	50	0	0	0	0	0	0	0	0	0.0±0.0
20	OLIVINE (Wa) + B(a)P	50	46	39	85	8	11	64	83	28	60.5±21.8
21	ALUMINUM (48)	50	0	0	0	0	0	0	0	0	0.0±0.0
22	ALUMINUM (48) + B(a)P	50	50	38	76	12	12	84	108	17	67.8±15.7
23	ALUMINUM (60)	49	0	0	0	0	0	0	0	0	0.0±0.0
24	ALUMINUM (60) + B(a)P	50	49	31	63	13	7	51	71	14	69.6±19.1
25	ALUMINUM (70)	50	13	1	8	0	0	3	3	92	92.0±0.0
26	ALUMINUM (70) + B(a)P	50	45	37	82	11	8	61	80	29	66.9±18.5

[a] = Effective No: Number of animals histopathologically confirmed.

[b] = RESP. TBA: Respiratory Tract Tumor Bearing Animals.

[c] = % of RESP. TBA: Based on the number of animals at risk at the time of appearence of the first tumor.

TABLE 9

DISTRIBUTION OF RESPIRATORY TRACT TUMOR BEARING ANIMALS
BY SITE AND CORRECTED % OF TBA

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	PERCENTAGE OF ANIMALS[a] WITH TUMORS OF THE: LARYNX + TRACHEA	BRONCHI & LUNG	OVERLAP OF LARYNX, TRACHEA BRONCHI & LUNG	CORRECTED % OF RESP. TBA [b]
1	SALINE CONTROL	0	0	0	0
2	SALINE + B(a)P	13	30	4	47
3	FERRIC OXIDE	3	0	0	3
4	FERRIC OXIDE + B(a)P	7	52	17	76
5	SILICA SAND	0	0	0	0
6	SILICA SAND + B(a)P	13	28	36	77
7	MINUSIL	0	3	0	3
8	MINUSIL + B(a)P	2	67	20	90
9	ZIRCONIUM (Au)	0	0	0	0
10	ZIRCONIUM (Au) + B(a)P	4	61	22	88
11	ZIRCONIUM (F1)	0	10	0	10
12	ZIRCONIUM (F1) + B(a)P	4	45	28	77
13	CHROMITE SAND	0	0	0	0
14	CHROMITE SAND + B(a)P	9	33	39	80
15	MINUSIL + FERRIC OXIDE	0	0	0	0
16	MINUSIL + FERRIC OXIDE + B(a)P	4	55	21	81
17	OLIVINE (Nc)	0	0	0	0
18	OLIVINE (Nc) + B(a)P	4	47	34	85
19	OLIVINE (Wa)	0	0	0	0
20	OLIVINE (Wa) + B(a)P	13	46	26	85
21	ALUMINUM (48)	0	0	0	0
22	ALUMINUM (48) + B(a)P	6	34	36	76
23	ALUMINUM (60)	0	0	0	0
24	ALUMINUM (60) + B(a)P	10	27	27	63
25	ALUMINUM (70)	0	8	0	8
26	ALUMINUM (70) + B(a)P	4	42	36	82

[a]=Percentage = $\frac{\text{No. of TBA}}{\text{No. at Risk}}$

[b]=Resp. TBA = Respiratory Tract Tumor Bearing Animals.

TABLE 10

DISTRIBUTION OF RESPIRATORY TRACT TUMOR TYPES AND CORRECTED % OF TBA

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	TUMORS TYPES			TOTAL TUMORS	CORRECTED % OF RESP. TBA[c]
		POLYPS	BENIGN TUMORS [a]	MALIGNANT TUMORS [b]		
1	SALINE CONTROL	0	0	0	0	0
2	SALINE + B(a)P	11	1	28	40	47
3	FERRIC OXIDE	0	1	0	1	3
4	FERRIC OXIDE + B(a)P	10	5	65	80	76
5	SILICA SAND	0	0	0	0	0
6	SILICA SAND + B(a)P	17	24	57	98	77
7	MINUSIL	0	0	1	1	3
8	MINUSIL + B(a)P	9	23	91	123	90
9	ZIRCONIUM (Au)	0	0	0	0	0
10	ZIRCONIUM (Au) + B(a)P	13	5	108	126	88
11	ZIRCONIUM (Fl)	0	2	2	4	10
12	ZIRCONIUM (Fl) + B(a)P	12	4	79	95	77
13	CHROMITE SAND	0	0	0	0	0
14	CHROMITE SAND + B(a)P	16	7	64	87	80
15	MINUSIL + FERRIC OXIDE	0	0	0	0	0
16	MINUSIL + FERRIC OXIDE + B(a)P	9	13	73	95	81
17	OLIVINE (Nc)	0	0	0	0	0
18	OLIVINE (Nc) + B(a)P	17	4	86	107	85
19	OLIVINE (Wa)	0	0	0	0	0
20	OLIVINE (Wa) + B(a)P	12	1	70	83	85
21	ALUMINUM (48)	0	0	0	0	0
22	ALUMINUM (48) + B(a)P	16	6	86	108	76
23	ALUMINUM (60)	0	0	0	0	0
24	ALUMINUM (60) + B(a)P	16	5	50	71	63
25	ALUMINUM (70)	0	0	3	3	8
26	ALUMINUM (70) + B(a)P	15	10	55	80	82

a=Papillomas and Adenomas

b=Carcinomas, Adenocarcinomas, Sarcomas, and others.

c=RESP. TBA = Respiratory Tract Tumor Bearing Animal.

TABLE 11

RESPIRATORY TRACT TUMOR INCIDENCES IN THE PARTICULATE CONTROL GROUPS
CO-CARCINOGENCITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	ANIMAL NO.	TIME OF TUMOR APPEARANCE (WEEKS)	LOCATION OF TUMOR	TYPE OF TUMOR	TOTAL NO. OF TBA	NO. AT RISK
3	FERRIC OXIDE	17,353	62	LARYNX	NEOPLASM	1	34
7	MINUSIL	17,563	68	BRONCHI & LUNG: LEFT LOBE	ADENOSQUAMOUS CARCINOMA	1	35
11	ZIRCONIUM (F1)	17,758	86	BRONCHI & LUNG:		2	21
				AZYGOUS LOBE	NEOPLASM		
				DIAPH. LOBE	ADENO CARCINOMA		
				CARDIAC LOBE	NEOPLASM		
		17,784	92	BRONCHI & LUNG: LEFT LOBE	SARCOMA		
25	ALUMINUM (70)	18,450	92	BRONCHI & LUNG:			
				LEFT LOBE	ADENOSQUAMOUS CARCINOMA	1	13
				AZYGOUS LOBE	ADENOSQUAMOUS CARCINOMA		
				CARDIAC LOBE	ADENOSQUAMOUS CARCINOMA		

TABLE 12
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	2	4	6	8	10	12	14
Site and Tumor Type	Saline + B(a)P	Ferric Oxide + B(a)P	Silica Sand + B(a)P	Minusil + B(a)P	Zirconium (Au) + B(a)P	Zirconium (Fl) + B(a)P	Chromite Sand + B(a)P
LARYNX							
Polyp	5	3	7	8	6	6	5
Papilloma	0	0	0	0	0	0	0
Carcinoma, squamous cell	0	2	2	2	1	1	5
Carcinoma	0	0	1	0	1	1	1
Adenocarcinoma	0	0	3	0	0	1	0
Sarcoma	0	0	0	0	0	0	1

Group No.:	16	18	20	22	24	26
Site and Tumor Type	Minusil + Ferric Oxide + B(a)P	Olivine (Nc) + B(a)P	Olivine (Wa) + B(a)P	Aluminum (48) + B(a)P	Aluminum (60) + B(a)P	Aluminum (70) + B(a)P
LARYNX						
Polyp	4	12	5	8	11	10
Papilloma	0	0	1	0	0	0
Carcinoma, squamous cell	5	2	2	3	2	1
Carcinoma	1	0	0	0	0	0
Adenocarcinoma	0	0	0	1	0	0
Sarcoma	0	0	0	0	0	0

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	2	4	6	8	10	12	14
Site and Tumor Type	Saline + B(a)P	Ferric Oxide + B(a)P	Silica Sand + B(a)P	Minusil + B(a)P	Zirconium (Au) + B(a)P	Zirconium (Fl) + B(a)P	Chromite Sand + B(a)P
TRACHEA							
Polyp	3	4	10	1	3	6	9
Carcinoma, squamous cell	0	0	2	0	1	3	3
Carcinoma, adenosquamous	0	1	0	0	1	0	0
Carcinoma*	0	0	0	0	0	0	0
Carcinosarcoma	0	0	0	0	1	0	0
Adenocarcinoma	0	1	1	1	2	0	1
Sarcoma, undifferentiated	0	0	0	0	0	0	0
Neoplasms, NOS	0	0	0	0	0	0	0

Group No.:	16	18	20	22	24	26
Site and Tumor Type	Minusil + Ferric Oxide + B(a)P	Olivine (Nc) + B(a)P	Olivine (Wa) + B(a)P	Aluminum (48) + B(a)P	Aluminum (60) + B(a)P	Aluminum (70) + B(a)P
TRACHEA						
Polyp	3	4	5	6	3	5
Carcinoma, squamous cell	1	1	0	3	1	1
Carcinoma, adenosquamous	0	1	1	1	1	0
Carcinoma*	0	0	2	0	0	1
Carcinosarcoma	0	0	0	0	0	0
Adenocarcinoma	0	0	2	2	2	1
Sarcoma, undifferentiated	0	0	1	0	0	0
Neoplasms, NOS	0	1	0	0	0	0

*Carcinoma, polypoid (Group 26) is included under carcinoma.

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	2	4	6	8	10	12	14
Site and Tumor Type	Saline + B(a)P	Ferric Oxide + B(a)P	Silica Sand + B(a)P	Minusil + B(a)P	Zirconium (Au) + B(a)P	Zirconium (Fl) + B(a)P	Chromite Sand + B(a)P
LUNGS AND BRONCHI							
Polyp	3	3	0	0	4	0	2
Carcinoma, squamous cell	4	5	10	8	35	13	17
Carcinoma, adenosquamous	7	25	17	18	17	22	9
Carcinoma	0	0	0	1	2	0	0
Carcinoma, squamous cell metastatic	0	0	0	0	6	0	0
Carcinoma, adenosquamous, metastatic	1	0	0	0	0	0	0
Carcinoma, metastatic	0	0	0	0	0	1	0
Adenoma	1	5	24	23	5	3	7
Adenocarcinoma	9	29	22	61	33	37	22
Adenocarcinoma, metastatic	0	0	0	0	6	0	0
Sarcoma	0	2	0	0	1	0	5
Sarcoma, metastatic	0	0	0	0	1	0	0
Melanoma, metastatic	5	0	0	0	0	0	0
Neoplasms, NOS	2	0	0	0	0	1	0

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	16	18	20	22	24	26
Site and Tumor Type	Minusil + Ferric Oxide + B(a)P	Olivine (Nc) + B(a)P	Olivine (Wa) + B(a)P	Aluminum (48) + B(a)P	Aluminum (60) + B(a)P	Aluminum (70) + B(a)P
LUNGS AND BRONCHI						
Polyp	2	1	2	2	2	0
Carcinoma, squamous cell	16	30	15	10	7	6
Carcinoma, adenosquamous	12	25	12	23	18	17
Carcinoma	0	1	5	2	1	0
Carcinoma, squamous cell, metastatic	0	0	0	0	0	0
Carcinoma, adenosquamous, metastatic	0	0	0	0	1	0
Carcinoma, metastatic	0	0	0	0	2	0
Adenoma	12	3	0	6	5	9
Adenocarcinoma	33	22	29	36	15	25
Adenocarcinoma, metastatic	0	3	1	0	0	2
Sarcoma	5	1	0	0	0	1
Sarcoma, metastatic	0	0	0	5	0	0
Melanoma, metastatic	0	0	0	0	0	0
Neoplasms, NOS	1	0	0	0	0	1

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	2	4	6	8	10	12	14
Site and Tumor Type	Saline + B(a)P	Ferric Oxide + B(a)P	Silica Sand + B(a)P	Minusil + B(a)P	Zirconium (Au) + B(a)P	Zirconium (Fl) + B(a)P	Chromite Sand + B(a)P
LUNG - LEFT LOBE							
Polyp	2	2	0	0	2	0	0
Carcinoma, squamous cell	1	1	3	6	6	6	9
Carcinoma, adenosquamous	2	10	6	4	4	6	2
Carcinoma*	0	0	0	1	1	0	0
Carcinoma, squamous cell, metastatic	0	0	0	0	1	0	0
Carcinoma, metastatic	0	0	0	0	0	1	0
Adenoma	1	3	6	5	2	3	5
Adenocarcinoma	3	7	12	17	12	12	12
Adenocarcinoma, metastatic	0	0	0	0	2	0	0
Sarcoma	0	2	0	0	0	0	1
Sarcoma, metastatic	0	0	0	0	1	0	0
Melanoma, metastatic	1	0	0	0	0	0	0
Neoplasms, NOS	1	0	0	0	0	1	0

*Anaplastic carcinoma (Group 10), included under carcinoma.

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	16	18	20	22	24	26
Site and Tumor Type	Minusil + Ferric Oxide + B(a)P	Olivine (Nc) + B(a)P	Olivine (Wa) + B(a)P	Aluminum (48) + B(a)P	Aluminum (60) + B(a)P	Aluminum (70) + B(a)P
LUNG - LEFT LOBE						
Polyp	1	0	0	1	1	0
Carcinoma, squamous cell	6	8	8	5	1	3
Carcinoma, adenosquamous	6	13	5	11	9	5
Carcinoma	0	0	1	0	0	0
Carcinoma, squamous cell, metastatic	0	0	0	0	0	0
Carcinoma, metastatic	0	0	0	0	0	0
Adenoma	4	0	0	3	3	4
Adenocarcinoma	13	7	10	12	9	14
Adenocarcinoma, metastatic	0	1	0	0	0	1
Sarcoma	1	1	0	0	0	1
Sarcoma, metastatic	0	0	0	1	0	0
Melanoma, metastatic	0	0	0	0	0	0
Neoplasms, NOS	0	0	0	0	0	1

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	2	4	6	8	10	12	14
Site and Tumor Type	Saline + B(a)P	Ferric Oxide + B(a)P	Silica Sand + B(a)P	Minusil + B(a)P	Zirconium (Au) + B(a)P	Zirconium (Fl) + B(a)P	Chromite Sand + B(a)P
LUNG - DIAPHRAGMATIC LOBE							
Polyp	0	1	0	0	1	0	1
Carcinoma, squamous cell	0	2	3	1	11	6	4
Carcinoma, adenosquamous	3	8	6	5	3	7	2
Carcinoma	0	0	0	0	1	0	0
Carcinoma, squamous cell, metastatic	0	0	0	0	1	0	0
Carcinoma, adenosquamous, metastatic	1	0	0	0	0	0	0
Carcinoma, metastatic	0	0	0	0	0	0	0
Adenoma	0	2	6	7	1	0	2
Adenocarcinoma	3	10	4	17	8	13	7
Adenocarcinoma, metastatic	0	0	0	0	1	0	0
Sarcoma	0	0	0	0	1	0	1
Sarcoma, metastatic	0	0	0	0	0	0	0
Melanoma, metastatic	1	0	0	0	0	0	0
Neoplasms, NOS	1	0	0	0	0	0	0

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	16	18	20	22	24	26
Site and Tumor Type	Minusil + Ferric Oxide + B(a)P	Olivine (Nc) + B(a)P	Olivine (Wa) + B(a)P	Aluminum (48) + B(a)P	Aluminum (60) + B(a)P	Aluminum (70) + B(a)P
LUNG - DIAPHRAGMATIC LOBE						
Polyp	1	1	1	0	0	0
Carcinoma, squamous cell	3	8	2	1	3	1
Carcinoma, adenosquamous	4	4	2	6	5	6
Carcinoma*	0	1	1	1	0	0
Carcinoma, squamous cell, metastatic	0	0	0	0	0	0
Carcinoma, adenosquamous, metastatic	0	0	0	0	1	0
Carcinoma, metastatic	0	0	0	0	0	0
Adenoma	3	1	0	2	2	2
Adenocarcinoma	7	6	10	11	4	8
Adenocarcinoma, metastatic	0	0	1	0	0	1
Sarcoma	1	0	0	0	0	0
Sarcoma, metastatic	0	0	0	1	0	0
Melanoma, metastatic	0	0	0	0	0	0
Neoplasms, NOS	0	0	0	0	0	0

*The one anaplastic carcinoma (Group 22) is included under carcinoma.

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	2	4	6	8	10	12	14
Site and Tumor Type	Saline + B(a)P	Ferric Oxide + B(a)P	Silica Sand + B(a)P	Minusil + B(a)P	Zirconium (Au) + B(a)P	Zirconium (Fl) + B(a)P	Chromite Sand + B(a)P
LUNG - CARDIAC LOBE							
Polyp	0	0	0	0	1	0	1
Carcinoma, squamous cell	1	1	0	0	7	0	0
Carcinoma, adenosquamous	0	2	1	4	3	2	1
Carcinoma	0	0	0	0	0	0	0
Carcinoma, squamous cell, metastatic	0	0	0	0	2	0	0
Carcinoma, metastatic	0	0	0	0	0	0	0
Adenoma	0	0	2	2	0	0	0
Adenocarcinoma	1	1	1	9	5	3	0
Adenocarcinoma, metastatic	0	0	0	0	1	0	0
Sarcoma	0	0	0	0	0	0	1
Sarcoma, metastatic	0	0	0	0	0	0	0
Melanoma, metastatic	1	0	0	0	0	0	0

Group No.:	16	18	20	22	24	26
Site and Tumor Type	Minusil + Ferric Oxide + B(a)P	Olivine (Nc) + B(a)P	Olivine (Wa) + B(a)P	Aluminum (48) + B(a)P	Aluminum (60) + B(a)P	Aluminum (70) + B(a)P
LUNG - CARDIAC LOBE						
Polyp	0	0	0	0	0	0
Carcinoma, squamous cell	2	3	2	0	1	0
Carcinoma, adenosquamous	1	1	1	1	1	1
Carcinoma	0	0	0	0	0	0
Carcinoma, squamous cell, metastatic	0	0	0	0	0	0
Carcinoma, metastatic	0	0	0	0	1	0
Adenoma	0	0	0	0	0	1
Adenocarcinoma	4	4	2	2	0	0
Sarcoma	1	0	0	1	0	0
Sarcoma, metastatic	0	0	0	1	0	0
Melanoma, metastatic	0	0	0	0	0	0

TABLE 12 (Continued)
INCIDENCES OF RESPIRATORY TRACT TUMORS BY SITE AND MORPHOLOGY
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

Group No.:	2	4	6	8	10	12	14
Site and Tumor Type	Saline + B(a)P	Ferric Oxide + B(a)P	Silica Sand + B(a)P	Minusil + B(a)P	Zirconium (Au) + B(a)P	Zirconium (Fl) + B(a)P	Chromite Sand + B(a)P
LUNG - AZYGOUS LOBE							
Polyp	0	0	0	0	0	0	0
Carcinoma, squamous cell	0	0	2	1	6	1	4
Carcinoma, adenosquamous	1	3	3	4	4	2	4
Carcinoma	0	0	0	0	0	0	0
Carcinoma, squamous cell, metastatic	0	0	0	0	1	0	0
Carcinoma, metastatic	0	0	0	0	0	0	0
Adenoma	0	0	6	4	2	0	0
Adenocarcinoma	1	9	4	12	5	6	2
Adenocarcinoma, metastatic	0	0	0	0	1	0	0
Sarcoma	0	0	0	0	0	0	1
Sarcoma, metastatic	0	0	0	0	0	0	0
Melanoma, metastatic	1	0	0	0	0	0	0
Neoplasms, NOS	0	0	0	0	0	0	0

TABLE 13
NO. OF NON-RESPIRATORY TRACT TUMOR BEARING ANIMALS
WITH RESPIRATORY TRACT HYPERPLASIAS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	HYPERPLASIA FOUND IN			
		LARYNX	TRACHEA	LUNG	TOTAL RESP. SYSTEM
1	SALINE CONTROL	0	0	2	2
2	SALINE + B(a)P	0	0	5	5
3	FERRIC OXIDE	0	0	0	0
4	FERRIC OXIDE + B(a)P	2	2	4	4*
5	SILICA SAND	0	0	0	0
6	SILICA SAND + B(a)P	2	0	2	3
7	MINUSIL	1	0	1	2
8	MINUSIL + B(a)P	0	0	0	0
9	ZIRCONIUM (Au)	1	0	1	2
10	ZIRCONIUM (Au) + B(a)P	0	0	3	3
11	ZIRCONIUM (Fl)	0	0	0	0
12	ZIRCONIUM (Fl) + B(a)P	1	0	2	3
13	CHROMITE SAND	0	0	0	0
14	CHROMITE SAND + B(a)P	1	1	2	4
15	MINUSIL + FERRIC OXIDE	0	0	1	1
16	MINUSIL + FERRIC OXIDE + B(a)P	0	0	3	3
17	OLIVINE (Nc)	1	0	0	1
18	OLIVINE (Nc) +B(a)	2	0	1	3
19	OLIVINE (Wa)	0	0	1	1
20	OLIVINE (Wa) + B(a)P	2	1	3	5*
21	ALUMINUM (48)	0	0	1	1
22	ALUMINUM (48) + B(a)P	1	1	1	2*
23	ALUMINUM (60)	0	0	0	0
24	ALUMINUM (60) + B(a)P	0	0	7	7^{S+}
25	ALUMINUM (70)	0	0	4	4
26	ALUMINUM (70) + B(a)P	0	0	2	2

$^{S+}$=Statistically significantly higher than the Aluminum (60) control at p=<0.01207.

*=The total number is not the summation of the larynx, trachea and lung, because occasionally the same animal had the lesion in more than one tissue.

TABLE 14
NUMBER OF HAMSTERS WITH PULMONARY GRANULOMATOUS INFLAMMATION
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	EFFECTIVE NO. OF ANIMALS [a]	NO. WITH INFLAMMATION	% OF HAMSTERS WITH INFLAMMATION [b]
1	SALINE CONTROL	48	2	4.2
2	SALINE + B(a)P	47	3	6.4
3	FERRIC OXIDE	50	1	2.0
4	FERRIC OXIDE + B(a)P	48	5	10.4
5	SILICA SAND	50	44	88.0
6	SILICA SAND + B(a)P	50	36	72.0
7	MINUSIL	50	42	84.0
8	MINUSIL + B(a)P	50	30	60.0
9	ZIRCONIUM (Au)	50	1	2.0
10	ZIRCONIUM (Au) + B(a)P	50	7	14.0
11	ZIRCONIUM (F1)	50	2	4.0
12	ZIRCONIUM (F1) + B(a)P	50	2	4.0
13	CHROMITE SAND	50	4	8.0
14	CHROMITE SAND + B(a)P	48	3	6.3
15	MINUSIL + FERRIC OXIDE	49	32	65.3
16	MINUSIL + FERRIC OXIDE + B(a)P	50	26	52.0
17	OLIVINE (Nc)	50	2	4.0
18	OLIVINE (Nc) +B(a)P	50	4	8.0
19	OLIVINE (Wa)	50	7	14.0
20	OLIVINE (Wa) + B(a)P	50	8	16.0
21	ALUMINUM (48)	50	40	80.0
22	ALUMINUM (48) + B(a)P	50	33	66.0
23	ALUMINUM (60)	49	7	14.3
24	ALUMINUM (60) + B(a)P	50	7	14.0
25	ALUMINUM (70)	50	3	6.0
26	ALUMINUM (70) + B(a)P	50	1	2.0

a=Effective No: Number of animals histopathologically confirmed.

b=% based on effective no of animals.

TABLE 15
FISHER'S EXACT ANALYSES OF HAMSTERS WITH PULMONARY GRANULOMATOUS INFLAMMATION

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

SALINE CONTROL VS PARTICULATE TREATED

GROUPS COMPARED	TREATMENT	NO. AFFECTED	NO. AT RISK	TREATMENT	NO. AFFECTED	NO. AT RISK	PROBABILITY 1-TAIL	PROBABILITY 2-TAIL
1 vs 3	SALINE	2	27	FERRIC OXIDE	1	26	0.51444	0.88903
vs 5	SALINE	2	47	SILICA SAND	44	49	0.00000	0.00000[S]
vs 7	SALINE	2	44	MINUSIL	42	48	0.00000	0.00000[S]
vs 9	SALINE	2	33	ZIRCONIUM (Au)	1	29	0.54916	1.00007
vs 11	SALINE	2	27	ZIRCONIUM (FT)	2	26	0.68038	1.01025
vs 13	SALINE	2	46	CHROMITE SAND	4	45	0.32793	1.00189
vs 15	SALINE	2	46	MINUSIL + FERRIC OXIDE	32	49	0.00000	0.00000[S]
vs 17	SALINE	2	33	OLIVINE (Nc)	2	40	0.61654	1.00009
vs 19	SALINE	2	46	OLIVINE (Wa)	7	48	0.08955	0.15913
vs 21	SALINE	2	48	ALUMINUM (48)	40	50	0.00000	0.00000[S]
vs 23	SALINE	2	44	ALUMINUM (60)	7	46	0.08952	0.15823
vs 25	SALINE	2	33	ALUMINUM (70)	3	31	0.46977	1.00006

[S]=Statistically increased number of animals with inflammation in the particulate treated groups as compared to saline control, at $p<0.01$.

TABLE 16
NUMBER OF HAMSTERS WITH HYPERPLASIA AND TUMORS OF THE STOMACH
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

GROUP NO.	TREATMENT	HYPERLASIA	TUMORS	HYPERPLASIA[a] WITH TUMORS
1	SALINE CONTROL	3	0	3
2	SALINE + B(a)P	3	1	4
3	FERRIC OXIDE	1	1	2
4	FERRIC OXIDE + B(a)P	3	4	6
5	SILICA SAND	2	1	3
6	SILICA SAND + B(a)P	5	1	6
7	MINUSIL	0	0	0
8	MINUSIL + B(a)P	5	2	6
9	ZIRCONIUM (Au)	3	0	3
10	ZIRCONIUM (Au) + B(a)P	1	3	4
11	ZIRCONIUM (Fl)	0	1	1
12	ZIRCONIUM (Fl) + B(a)P	11	3	13
13	CHROMITE SAND	1	0	1
14	CHROMITE SAND + B(a)P	4	4	8
15	MINUSIL + FERRIC OXIDE	3	0	3
16	MINUSIL + FERRIC OXIDE + B(a)P	5	4	9
17	OLIVINE (Nc)	0	0	0
18	OLIVINE (Nc) + B(a)P	5	1	6
19	OLIVINE (Wa)	1	0	1
20	OLIVINE (Wa) + B(a)P	6	2	8
21	ALUMINUM (48)	0	0	0
22	ALUMINUM (48) + B(a)P	3	3	6
23	ALUMINUM (60)	1	0	1
24	ALUMINUM (60) + B(a)P	6	3	9
25	ALUMINUM (70)	0	0	0
26	ALUMINUM (70) + B(a)P	7	4	11

[a]=The number in this column is not the Summation of numbers in the preceeding columns, as some animals had tumors in addition to hyperplasia.

TABLE 17
FISHER'S EXACT ANALYSES OF HAMSTERS WITH HYPERPLASIA AND/OR TUMORS OF THE STOMACH
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES
PARTICULATE CONTROL VS PARTICULATE + B(a)P

DESCRIPTION	GROUPS COMPARED	TREATMENT	NO. AFFECTED	NO. AT RISK	PROBABILITY 1-TAIL	PROBABILITY 2-TAIL
HYPERPLASIA ONLY	7	MINUSIL	0	36		
	vs					
	8	MINUSIL + B(a)P	5	32	0.01932	0.01932[S]
	11	ZIRCONIUM (F1)	0	36		
	vs					
	12	ZIRCONIUM (F1) + B(a)P	11	28	0.00003	0.00003[S]
	17	OLIVINE (Nc)	0	42		
	vs					
	18	OLVINE (Nc) + B(a)P	5	28	0.00812	0.00812[S]
	25	~~ALUM~~INUM (70)	0	33		
	vs					
	26	ALUMINUM (70) + B(a)P	7	28	0.00271	0.00271[S]
TUMORS ONLY	9	ZIRCONIUM (Au)	0	23		
	vs					
	10	ZIRCONIUM (Au) + B(a)P	3	8	0.01246	0.01246[S]
	13	CHROMITE SAND	0	31		
	vs					
	14	CHROMITE SAND + B(a)P	4	14	0.00672	0.00672[S]
HYPERPLASIA AND TUMORS	7	MINUSIL	0	36		
	vs					
	8	MINUSIL + B(a)P	6	32	0.00828	0.00828[S]
	11	ZIRCONIUM (F1)	1	40		
	vs					
	12	ZIRCONIUM (F1) + B(a)P	13	38	0.00022	0.00024[S]
	17	OLIVINE (Nc)	0	42		
	vs					
	18	OLIVINE (Nc) + B(a)P	6	28	0.00287	0.00287[S]
	19	OLIVINE (Wa)	1	35		
	vs					
	20	OLIVINE (Wa) + B(a)P	8	27	0.00406	0.00754[S]
	21	ALUMINUM (48)	0	39		
	vs					
	22	ALUMINUM (48) B(a)P	6	28	0.00378	0.00378[S]
	23	ALUMINUM (60)	1	32		
	vs					
	24	ALUMINUM (60) + B(a)P	9	25	0.00159	0.00308[S]
	25	ALUMINUM (70)	0	37		
	vs					
	26	ALUMINUM (70) + B(a)P	11	34	0.00011	0.00011[S]

[S]Statistically increased number of animals with lesions in the Particulate + B(a)P group as compared to Particulate Control group at $p<0.01$.

TABLE 18

INCIDENCES OF NON-RESPIRATORY TRACT LESIONS IN HAMSTERS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SUBSTITUTES

GROUP:	1	2	3	4	5	6	7	8	9	10	11	12	13
TREATMENT:	SALINE	SALINE + B(a)P	FERRIC OXIDE	FERRIC OXIDE + B(a)P	SILICA SAND	SILICA SAND + B(a)P	MINUSIL	MINUSIL + B(a)P	ZIRCONIUM (Au)	ZIRCONIUM (Au) + B(a)P	ZIRCONIUM (Fl)	ZIRCONIUM (Fl) + B(a)P	CHROMITE
EFFECTIVE NO. OF ANIMALS:	48	47	50	48	50	50	50	50	50	50	50	50	50
NO. LESIONS/TISSUE													
THYROID													
HYPERPLASIA	0	0	0	0	0	0	1	0	1	0	0	0	0
AMYLOIDOSIS	3	2	3	1	10	1	2	0	1	1	6	0	3
THYMUS													
ATROPHY	5	2	2	2	2	4	0	1	5	6	6	3	3
HEART													
THROMBOSIS	4	4	2	0	11	6	2	4	2	3	2	4	3
LIVER													
CYSTS	1	2	4	3	3	2	9	6	5	2	3	1	9
HYPERPLASIA	0	1	0	0	1	1	0	1	0	3	0	2	0
AMYLOIDOSIS	7	10	18	6	23	11	26	13	6	5	9	5	13
SPLEEN													
HYPERRPLASIA	0	0	0	1	0	2	0	1	0	8	0	7	0
AMYLOIDOSIS	5	1	5	1	17	5	5	3	5	5	4	1	6
ADRENEL													
HYPERPLASIA	9	3	7	4	1	1	5	8	4	5	6	5	2
AMLOIDOSIS	10	12	21	11	35	19	29	18	9	9	13	5	20
KIDNEY													
AMYLOIDOSIS	11	12	14	10	33	15	19	15	11	10	13	8	16
CHRONIC NEPHROPATHY	17	18	14	9	2	10	10	6	10	15	13	9	10
TESTES													
ATROPHY	25	20	19	15	26	31	19	19	15	19	21	15	18
STERNUM & RIB JUNCTION													
HYPERPLASIA	0	0	0	0	0	1	0	1	0	6	2	1	0
FEMUR/BONE MARROW													
HYPERPLASIA	0	0	0	1	0	2	0	0	0	5	2	0	0
SKIN													
SUBCUTANEOUS EDEMA	0	7	5	4	4	2	5	1	0	2	5	4	0
STOMACH													
HYPERPLASIA	3	3	1	3	2	5	0	5	3	1	0	11	1

TABLE 18 (Continued)

INCIDENCES OF NON-RESPIRATORY TRACT LESIONS IN HAMSTERS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SUBSTITUTES

GROUP NO:	14	15	16	17	18	19	20	21	22	23	24	25	26
TREATMENT:	CHROMITE + B(a)P	MINUSIL + FERRIC OXIDE	MINUSIL + FERRIC OXIDE + B(a)P	OLIVINE (Nc)	OLIVINE (Nc) + B(a)P	OLIVINE (Wa)	OLIVINE (Wa) + B(a)P	ALUMINUM (48)	ALUMINUM (48) + B(a)P	ALUMINUM (60)	ALUMINUM (60) + B(a)P	ALUMINUM (70)	ALUMINUM (70) + B(a)P
EFFECTIVE NO OF ANIMALS:	48	49	50	50	50	50	50	50	50	49	50	50	50
NO. LESIONS/TISSUES													
THYROID													
HYPERPLASIA	0	0	0	0	0	0	0	0	0	0	0	0	0
AMYLOIDOSIS	2	10	7	3	1	6	3	2	2	2	0	4	1
THYMUS													
ATROPHY	3	0	2	3	2	3	2	0	2	1	1	0	0
HEART													
THROMBOSIS	1	4	8	5	2	4	0	4	4	4	4	3	4
LIVER													
CYSTS	1	4	7	4	5	1	3	8	4	5	6	8	1
HYPERPLASIA	1	0	1	0	0	1	0	2	0	0	0	0	0
AMYLOIDOSIS	5	23	21	11	5	13	5	10	9	16	6	22	4
SPLEEN													
HYPERPLASIA	2	0	2	0	7	0	2	2	3	0	7	0	6
AMYLOIDOSIS	5	12	12	3	2	9	4	4	3	4	1	10	2
ADRENEL													
HYPERPLASIA	4	1	1	5	4	6	1	1	4	2	3	4	3
AMLOIDOSIS	10	27	29	12	10	15	9	23	14	21	12	27	10
KIDNEY													
AMYLOIDOSIS	11	27	28	15	8	14	9	19	12	22	10	26	10
CHRONIC NEPHROPATHY	8	8	3	8	9	7	8	4	9	7	10	7	10
TESTES													
ATROPHY	20	28	24	21	16	18	18	17	21	14	28	21	18
STERNUM & RIB JUNCTION													
HYPERPLASIA	0	0	0	1	2	0	0	0	0	0	1	0	0
FEMUR/BONE MARROW													
HYPERPLASIA	0	0	1	1	2	0	0	0	0	0	1	0	0
SKIN													
SUBCUTANEOUS EDEMA	1	6	6	2	4	2	0	1	1	2	4	3	2
STOMACH													
HYPERPLASIA	4	3	5	0	5	1	6	0	3	1	6	0	7

TABLE 19

INCIDENCES OF NON-RESPIRATORY TRACT TUMORS IN HAMSTERS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SUBSTITUTES

GROUP:	1	2	3	4	5	6.	7	8	9	10	11	12	13
TREATMENT:	SALINE	SALINE + B(a)P	FERRIC OXIDE	FERRIC OXIDE + B(a)P	SILICA SAND	SILICA SAND + B(a)P	MINUSIL	MINUSIL + B(a)P	ZIRCONIUM (Au)	ZIRCONIUM (Au) + B(a)P	ZIRCONIUM (Fl)	ZIRCONIUM (Fl) + B(a)P	CHROMITE SAND
EFFECTIVE NO. OF ANIMALS:[a]	48	47	50	48	50	50	50	50	50	50	50	50	50
TOTAL NO. OF TBA:[b]	10	28	5	36	6	37	6	45	5	44	11	38	9
NO. LESIONS/TISSUE													
SALIVARY GLAND	0	0	0	1	0	0	0	1	0	0	0	0	1
THYROID	2	0	0	0	0	1	0	0	0	1	0	1	1
PARATHYROID	0	0	0	0	0	0	0	0	0	0	0	0	0
THYMUS	0	1	0	1	0	1	0	1	0	1	2	1	0
HEART (NON METASTATIC)	0	0	0	2	0	0	0	1	0	2	0	1	1
LIVER (gall bladder)	1	3	0	5	0	2	0	0	1	1	2	0	1
PANCREAS	2	1	0	1	2	0	2	1	0	0	0	0	0
SPLEEN	2	3	0	3	0	4	0	2	0	0	0	1	1
STOMACH	0	1	1	4	1	1	0	2	0	3	1	3	0
G.I. TRACT	0	1	2	5	0	0	0	0	0	2	1	0	1
KIDNEY	0	0	0	2	0	0	0	1	0	2	0	1	0
ADRENAL	6	4	1	4	2	1	2	5	3	3	4	3	5
MANDIBULAR LYMPH NODE	0	0	0	1	0	0	0	0	1	1	2	0	0
MEDIASTINAL LYMPH NODE	0	1	0	0	0	0	0	0	0	1	0	0	1
BRONCHIAL LYMPH NODE	0	0	0	0	0	0	0	0	0	0	0	0	0
MESENTERIC LYMPH NODE	0	1	0	3	0	0	0	0	0	2	1	1	2
STERNUM & RIB	0	0	0	0	0	0	0	0	0	0	1	1	0
OTHER	0	0	0	2	0	0	0	6	0	0	4	0	0

[a]Effective No.: Histopathologically confirmed.
[b]TBA: Tumor bearing animals.

TABLE 19 (Continued)

INCIDENCES OF NON-RESPIRATORY TRACT TUMORS IN HAMSTERS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SUBSTITUTES

GROUP NO:	14	15	16	17	18	19	20	21	22	23	24	25	26
TREATMENT:	CHROMITE SAND + B(a)P	MINUSIL + FERRIC OXIDE	MINUSIL + FERRIC OXIDE + B(a)P	OLIVINE (Nc)	OLIVINE (Nc) + B(a)P	OLIVINE (Wa)	OLIVINE (Wa) + B(a)P	ALUMINUM (48)	ALUMINUM (48) + B(a)P	ALUMINUM (60)	ALUMINUM (60) + B(a)P	ALUMINUM (70)	ALUMINUM (70) + B(a)P
EFFECTIVE NO OF ANIMALS:[a]	48	49	50	50	50	50	50	50	50	49	50	50	50
TOTAL NO. OF TBA[b]	37	2	43	5	40	6	39	3	42	8	33	6	39
NO. LESIONS/TISSUES													
SALIVARY GLAND	0	0	0	0	0	0	0	0	0	0	0	0	0
THYROID	0	0	0	0	1	1	1	1	0	1	0	0	0
PARATHYROID	0	0	0	0	0	0	1	0	0	0	0	0	0
THYMUS	1	0	1	0	1	0	0	0	1	0	1	0	0
HEART (NON METASTATIC)	1	0	1	0	1	0	0	0	2	0	0	0	1
LIVER (gall bladder)	4	0	4	3	1	0	0	0	1	2	2	1	4
PANCREAS	0	0	0	0	0	0	0	0	0	0	1	0	3
SPLEEN	0	1	1	0	0	0	1	0	2	1	1	1	2
STOMACH	4	0	4	0	1	0	2	0	3	0	3	0	4
G.I. TRACT	1	0	1	1	0	0	0	0	0	0	0	0	3
KIDNEY	1	0	0	0	0	0	0	0	0	0	1	0	2
ADRENAL	2	1	2	2	2	4	2	2	3	4	5	4	4
MANDIBULAR LYMPH NODE	2	0	0	0	0	0	0	0	0	0	0	0	0
MEDIASTINAL LYMPH NODE	0	0	0	0	0	0	2	0	0	0	0	0	0
BRONCHIAL LYMPH NODE	0	0	1	0	0	0	0	0	0	0	0	0	1
MESENTERIC LYMPH NODE	1	0	1	0	0	0	0	0	0	0	1	0	2
STERNUM & RIB	1	0	2	0	0	1	0	0	1	0	0	0	0
OTHER	1	0	2	0	2	0	1	0	2	0	1	2	0

[a]Effective No.: Histopathologically confirmed.

[b]TBA: Tumor bearing animals.

TABLE 20

FISHER'S EXACT ANALYSES OF HAMSTERS WITH LARYNGEAL TUMOR

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

PARTICULATE CONTROL VS PARTICULATE + B(a)P

GROUPS COMPARED	PARTICULATE CONTROL			PARTICULATE + B(a)P			PROBABILITY	
	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	1-TAIL	2-TAIL
1 vs 2	SALINE	0	38	SALINE + B(a)P	5	44	0.03981	0.05821
3 vs 4	FERRIC OXIDE	1	35	FERRIC OXIDE + B(a)P	5	32	0.07971	0.09597
5 vs 6	SILICA SAND	0	41	SILICA SAND + B(a)P	13	42	0.00005	0.00008[S]
7 vs 8	MINUSIL	0	38	MINUSIL + B(a)P	10	42	0.00089	0.00118[S]
9 vs 10	ZIRCONIUM (Au)	0	40	ZIRCONIUM (Au) + B(a)P	8	40	0.00265	0.00265[S]
11 vs 12	ZIRCONIUM (F1)	0	41	ZIRCONIUM (F1) + B(a)P	9	44	0.00172	0.00257[S]
13 vs 14	CHROMITE SAND	0	35	CHROMITE SAND + B(a)P	12	38	0.00015	0.00019[S]
15 vs 16	MINUSIL + FERRIC OXIDE	0	39	MINUSIL + FER. OXIDE + B(a)P	10	40	0.00059	0.00103[S]
17 vs 18	OLIVINE (Nc)	0	46	OLIVINE (Nc) + B(a)P	14	43	0.00001	0.00001[S]
19 vs 20	OLIVINE (Wa)	0	42	OLIVINE (Wa) + B(a)P	8	41	0.00242	0.00269[S]
21 vs 22	ALUMINUM (48)	0	40	ALUMINUM (48) + B(a)P	12	35	0.00003	0.00003[S]
23 vs 24	ALUMINUM (60)	0	49	ALUMINUM (60) + B(a)P	13	49	0.00005	0.00005[S]
25 vs 26	ALUMINUM (70)	0	37	ALUMINUM (70) + B(a)P	11	33	0.00009	0.00009[S]

[S]Statistically increased number of animals with laryngeal tumors in the Particulate + B(a)P group as compared to the Particulate Control group at $p<0.01$.

TABLE 21

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TRACHEAL TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

PARTICULATE CONTROL VS PARTICULATE + B(a)P

GROUPS COMPARED	PARTICULATE CONTROL			PARTICULATE + B(a)P			PROBABILITY	
	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	1-TAIL	2-TAIL
1 vs 2	SALINE	0	42	SALINE + B(a)P	3	47	0.14281	0.24391
3 vs 4	FERRIC OXIDE	0	37	FERRIC OXIDE + B(a)P	6	36	0.01144	0.01308[S]
5 vs 6	SILICA SAND	0	41	SILICA SAND + B(a)P	13	42	0.00005	0.00008[S]
7 vs 8	MINUSIL	0	30	MINUSIL + B(a)P	2	14	0.09619	0.09619[S]
9 vs 10	ZIRCONIUM (Au)	0	34	ZIRCONIUM (Au) + B(a)P	7	27	0.00204	0.00204[S]
11 vs 12	ZIRCONIUM (F1)	0	40	ZIRCONIUM (F1) + B(a)P	9	41	0.00134	0.00239[S]
13 vs 14	CHROMITE SAND	0	34	CHROMITE SAND + B(a)P	13	35	0.00004	0.00006[S]
15 vs 16	MINUSIL + FERRIC OXIDE	0	40	MINUSIL + FER. OXIDE + B(a)P	4	47	0.08014	0.12120[S]
17 vs 18	OLIVINE (Nc)	0	46	OLIVINE (Nc) + B(a)P	7	43	0.00468	0.00468[S]
19 vs 20	OLIVINE (Wa)	0	46	OLIVINE (Wa) + B(a)P	11	46	0.00025	0.00025[S]
21 vs 22	ALUMINUM (48)	0	41	ALUMINUM (48) + B(a)P	12	39	0.00006	0.00006[S]
23 vs 24	ALUMINUM (60)	0	34	ALUMINUM (60) + B(a)P	7	29	0.00282	0.00282[S]
25 vs 26	ALUMINUM (70)	0	49	ALUMINUM (70) + B(a)P	8	45	0.00194	0.00194[S]

[S]Statistically increased number of animals with tracheal tumors in the Particulate + B(a)P group as compared to the Particulate Control group at $p<0.01$.

TABLE 22

FISHER'S EXACT ANALYSES OF HAMSTERS WITH LUNG TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

PARTICULATE CONTROL VS PARTICULATE + B(a)P

GROUPS COMPARED	PARTICULATE CONTROL			PARTICULATE + B(a)P			PROBABILITY	
	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	1-TAIL	2-TAIL
1 vs 2	SALINE	0	38	SALINE + B(a)P	16	44	0.00001	0.00001
3 vs 4	FERRIC OXIDE	0	41	FERRIG OXIDE + B(a)P	32	46	0.00000	0.00000[S]
5 vs 6	SILICA SAND	0	44	SILICA SAND + B(a)P	30	47	0.00000	0.00000[S]
7 vs 8	MINUSIL	1	50	MINUSIL + B(a)P	43	49	0.00000	0.00000[S]
9 vs 10	ZIRCONIUM (Au)	0	48	ZIRCONIUM (Au) + B(a)P	41	49	0.00000	0.00000[S]
11 vs 12	ZIRCONIUM (F1)	2	42	ZIRCONIUM (F1) + B(a)P	34	47	0.00000	0.00000[S]
13 vs 14	CHROMITE SAND	0	40	CHROMITE SAND + B(a)P	33	46	0.00000	0.00000[S]
15 vs 16	MINUSIL + FERRIC OXIDE	0	40	MINUSIL + FER. OXIDE + B(a)P	36	47	0.00000	0.00000[S]
17 vs 18	OLIVINE (Nc)	0	49	OLIVINE (Nc) + B(a)P	38	47	0.00000	0.00000[S]
19 vs 20	OLIVINE (Wa)	0	45	OLIVINE (Wa) + B(a)P	33	43	0.00000	0.00000[S]
21 vs 22	ALUMINUM (48)	0	49	ALUMINUM (48) + B(a)P	35	50	0.00000	0.00000[S]
23 vs 24	ALUMINUM (60)	0	43	ALUMINUM (60) + B(a)P	26	44	0.00000	0.00000[S]
25 vs 26	ALUMINUM (70)	1	49	ALUMINUM (70) + B(a)P	35	45	0.00000	0.00000[S]

[S]Statistically increased number of animals with lung tumors in the Particulate + B(a)P group as compared to the Particulate Control group at $p<0.01$.

TABLE 23

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TOTAL RESPIRTORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

PARTICULATE CONTROL VS PARTICULATE + B(a)P

GROUPS COMPARED	PARTICULATE CONTROL			PARTICULATE + B(a)P			PROBABILITY	
	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	1-TAIL	2-TAIL
1 vs 2	SALINE	0	42	SALINE + B(a)P	22	47	0.00000	0.00000[S]
3 vs 4	FERRIC OXIDE	1	41	FERRIC OXIDE + B(a)P	35	46	0.00000	0.00000[S]
5 vs 6	SILICA SAND	0	44	SILICA SAND + B(a)P	36	47	0.00000	0.00000[S]
7 vs 8	MINUSIL	1	50	MINUSIL + B(a)P	44	49	0.00000	0.00000[S]
9 vs 10	ZIRCONIUM (Au)	0	48	ZIRCONIUM (Au) + B(a)P	43	49	0.00000	0.00000[S]
11 vs 12	ZIRCONIUM (Fl)	2	42	ZIRCONIUM (Fl) + B(a)P	36	47	0.00000	0.00000[S]
13 vs 14	CHROMITE SAND	0	40	CHROMITE SAND + B(a)P	37	46	0.00000	0.00000[S]
15 vs 16	MINUSIL + FERRIC OXIDE	0	40	MINUSIL + FER. OXIDE + B(a)P	38	47	0.00000	0.00000[S]
17 vs 18	OLIVINE (Nc)	0	49	OLIVINE (Nc) + B(a)P	40	47	0.00000	0.00000[S]
19 vs 20	OLIVINE (Wa)	0	46	OLIVINE (Wa) + B(a)P	39	46	0.00000	0.00000[S]
21 vs 22	ALUMINUM (48)	0	49	ALUMINUM (48) + B(a)P	38	50	0.00000	0.00000[S]
23 vs 24	ALUMINUM (60)	0	49	ALUMINUM (60) + B(a)P	31	49	0.00000	0.00000[S]
25 vs 26	ALUMINUM (70)	1	49	ALUMINUM (70) + B(a)P	37	45	0.00000	0.00000[S]

[S]Statistically increased number of animals with total respiratory tract tumors in the Particulate + B(a)P group as compared to the Particulate Control group at $p<0.01$.

TABLE 24

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TOTAL RESPIRATORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

SALINE + B(a)P CONTROL VS PARTICULATE + B(a)P

GROUPS COMPARED	SALINE + B(a)P CONTROL			PARTICULATE + B(a)P			PROBABILITY	
	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	1-TAIL	2-TAIL
2 vs 4	SALINE + B(a)P	22	47	FERRIC OXIDE + B(a)P	35	46	0.00341	0.00546[S]
vs 6	SALINE + B(a)P	22	47	SILICA SAND + B(a)P	36	47	0.00273	0.00546[S]
vs 8	SALINE + B(a)P	22	47	MINUSIL + B(a)P	44	49	0.00000	0.00001[S]
vs 10	SALINE + B(a)P	22	47	ZIRCONIUM (Au) + B(a)P	43	49	0.00002	0.00002[S]
vs 12	SALINE + B(a)P	22	47	ZIRCONIUM (F1) + B(a)P	36	47	0.00273	0.00546[S]
vs 14	SALINE + B(a)P	22	47	CHROMITE SAND + B(a)P	37	46	0.00072	0.00112[S]
vs 16	SALINE + B(a)P	22	47	MINUSIL + FERRIC OXIDE B(a)P	38	48	0.00102	0.00140[S]
vs 18	SALINE + B(a)P	22	47	OLIVINE (Nc) + B(a)P	40	47	0.00008	0.00017[S]
vs 20	SALINE + B(a)P	22	47	OLIVINE (Wa) + B(a)P	39	46	0.00011	0.00017[S]
vs 22	SALINE + B(a)P	22	47	ALUMINUM (48) + B(a)P	38	50	0.00285	0.00621[S]
vs 24	SALINE + B(a)P	22	47	ALUMINUM (60) + B(a)P	31	49	0.07830	0.22568
vs 26	SALINE + B(a)P	22	47	ALUMINUM (70) + B(a)P	37	45	0.00037	0.00049[S]

[S]Statistically increased number of animals with total respiratory tract tumors in the Particulate + B(a)P group as compared to the Particulate Control group at $p<0.01$.

TABLE 25

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TOTAL RESPIRATORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

FERRIC OXIDE + B(a)P CONTROL VS PARTICULATE + B(a)P

GROUPS COMPARED	FERRIC OXIDE + B(a)P CONTROL			PARTICULATE + B(a)P			PROBABILITY	
	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	1-TAIL	2-TAIL
4 vs 6	FERRIC OXIDE + B(a)P	35	46	SILICA SAND + B(a)P	36	47	0.57359	1.00007
vs 8	FERRIC OXIDE + B(a)P	35	46	MINUSIL + B(a)P	44	49	0.06500	0.10091
vs 10	FERRIC OXIDE + B(a)P	35	46	ZIRCONIUM (Au)	43	49	0.11208	0.28924
vs 12	FERRIC OXIDE + B(a)P	35	46	ZIRCONIUM (F1)	36	47	0.57359	1.00007
vs 14	FERRIC OXIDE + B(a)P	35	46	CHROMITE SAND + B(a)P	37	46	0.40050	0.62495
vs 16	FERRIC OXIDE + B(a)P	35	46	MINUSIL + FERRIC OXIDE + B(a)P	38	48	0.45573	1.00012
vs 18	FERRIC OXIDE + B(a)P	35	46	OLIVINE (Nc) + B(a)P	40	47	0.20122	0.79398
vs 20	FERRIC OXIDE + B(a)P	35	46	OLIVINE (Wa) + B(a)P	39	46	0.21560	1.00012
vs 22	FERRIC OXIDE + B(a)P	35	46	ALUMINUM (48) + B(a)P	38	50	0.59121	1.00010
vs 24	FERRIC OXIDE + B(a)P	35	46	ALUMINUM (60) + B(a)P	31	49	0.12843	0.50416
vs 26	FERRIC OXIDE + B(a)P	35	46	ALUMINUM (70) + B(a)P	37	45	0.32264	1.00011

TABLE 26

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TOTAL RESPIRATORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

SILICA SAND, MINUSIL, ZIRCONIUM SILICATES AND OLIVINE SANDS COMPARISONS

GROUPS COMPARED	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	PROBABILITY 1-TAIL	PROBABILITY 2-TAIL
6 vs 8	SILICA SAND + B(a)P	36	48	MINUSIL + B(a)P	44	49	0.04870	0.10764
10 vs 12	ZIRCONIUM (Au) + B(a)P	43	49	ZIRCONIUM (Fl) + B(a)P	36	47	0.12202	0.28698
18 vs 20	OLIVINE (Nc) + B(a)P	40	47	OLIVINE (Wa) + B(a)P	39	46	0.59667	1.00016

TABLE 27

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TOTAL RESPIRATORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

ALUMINUM (48) + B(a)P VS PARTICULATE + B(a)P

GROUPS COMPARED	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	PROBABILITY 1-TAIL	PROBABILITY 2-TAIL
22 vs 6	ALUMINUM (48) + B(a)P	38	50	SILICA SAND + B(a)P	36	49	0.47666	1.00013
22 vs 8	ALUMINUM (48) + B(a)P	38	50	MINUSIL + B(a)P	44	49	0.05922	0.10838
22 vs 24	ALUMINUM (48) + B(a)P	38	50	ALUMINUM (60) + B(a)P	31	49	0.12301	0.38735
22 vs 26	ALUMINUM (48) + B(a)P	38	50	ALUMINUM (70) + B(a)P	37	46	0.39152	1.00009

TABLE 28

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TOTAL RESPIRATORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

ALUMINUM (60) + B(a)P vs PARTICULATE + B(a)P

GROUPS COMPARED	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	PROBABILITY 1-TAIL	PROBABILITY 2-TAIL
24 vs 6	ALUMINUM (60) + B(a)P	31	49	SILICA SAND + B(a)P	36	49	0.19258	1.00005
24 vs 8	ALUMINUM (60) + B(a)P	31	49	MINUSIL + B(a)P	44	49	0.00181	0.00212[S]
24 vs 26	ALUMINUM (60) + B(a)P	31	49	ALUMINUM (70) + B(a)P	37	46	0.05126	0.11044

[S]Statistically increased number of animals with total respiratory tract tumors were seen as compared to the Aluminum (6) + B(a)P group at $p<0.01$.

TABLE 29

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TOTAL RESPIRATORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

ALUMINUM (70) + B(a)P VS PARTICULATE + B(a)P

GROUPS COMPARED	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	PROBABILITY 1-TAIL	PROBABILITY 2-TAIL
26 vs 6	ALUMINUM (70) + B(a)P	37	45	SILICA SAND + B(a)P	36	47	0.34210	1.00005
26 vs 8	ALUMINUM (70) + B(a)P	37	45	MINUSIL + B(a)P	44	49	0.22280	0.76786
26 vs 22	ALUMINUM (70) + B(a)P	37	46	ALUMINUM (48) + B(a)P	38	50	0.39152	1.00009
26 vs 24	ALUMINUM (70) + B(a)P	37	46	ALUMINUM (60) + B(a)P	31	49	0.05126	0.11044

TABLE 30

FISHER'S EXACT ANALYSES OF HAMSTERS WITH TOTAL RESPIRATORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:
SILICA AND SILICA SAND SUBSTITUTES

MINUSIL, FERRIC OXIDE, AND MINUSIL + FERRIC OXIDE COMPARISONS

GROUPS COMPARED	TREATMENT	NO. OF TBA	NO. AT RISK	TREATMENT	NO. OF TBA	NO. AT RISK	PROBABILITY 1-TAIL	PROBABILITY 2-TAIL
16 vs 4	MINUSIL + FERRIC OXIDE + B(a)P	38	48	FERRIC OXIDE + B(a)P	35	46	0.45573	1.00012
16 vs 8	MINUSIL + FERRIC OXIDE + B(a)P	38	48	MINUSIL + B(a)P	44	49	0.12147	0.26150
4 vs 8	FERRIC OXIDE + B(a)P	35	46	MINUSIL + B(a)P	44	49	0.06500	0.10091

FIGURE 1

RATE OF SURVIVAL

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

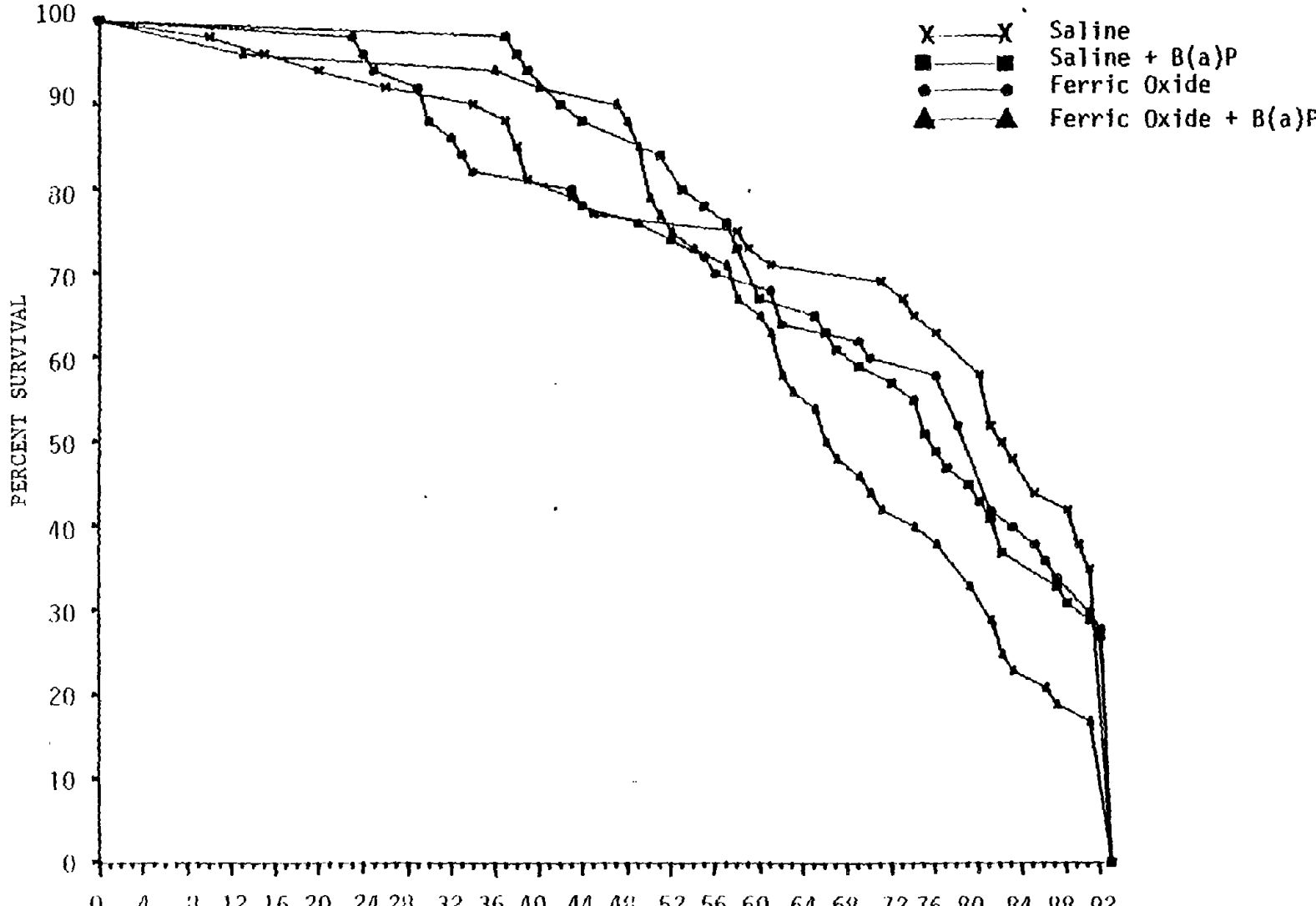

FIGURE 1 (CONTINUED)

RATE OF SURVIVAL

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

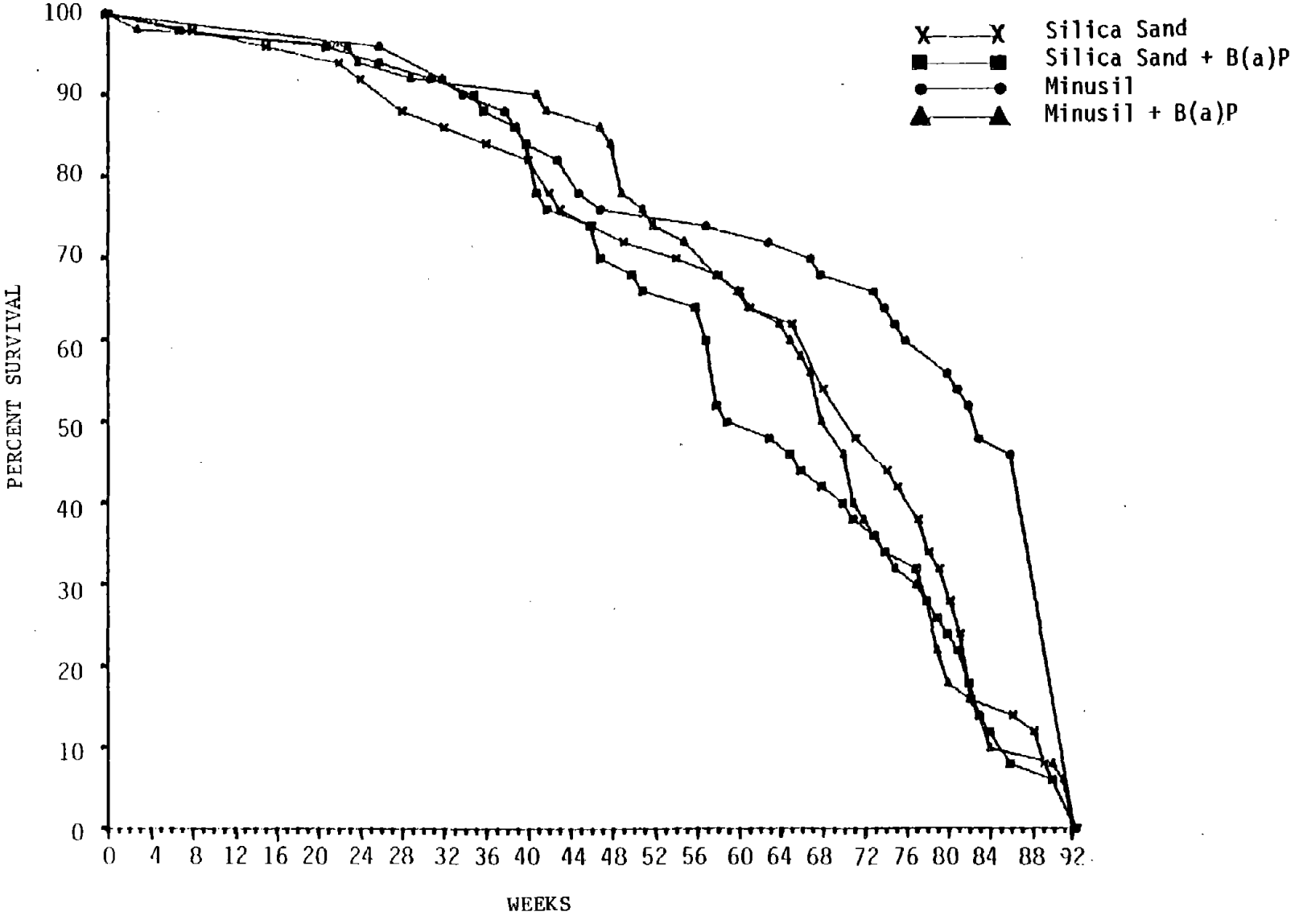

FIGURE 1 (CONTINUED)

RATE OF SURVIVAL

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

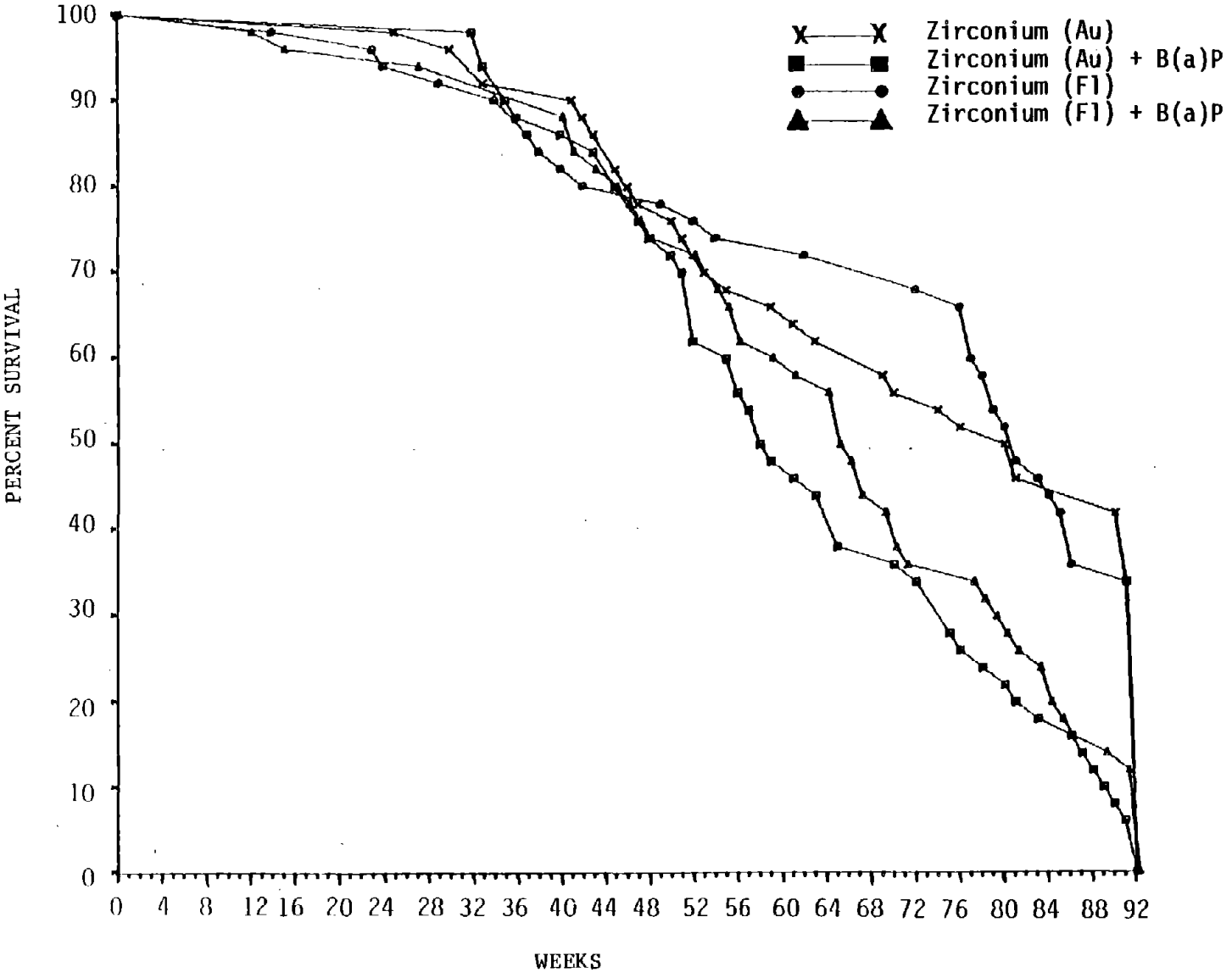

FIGURE 1 (CONTINUED)

RATE OF SURVIVAL

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

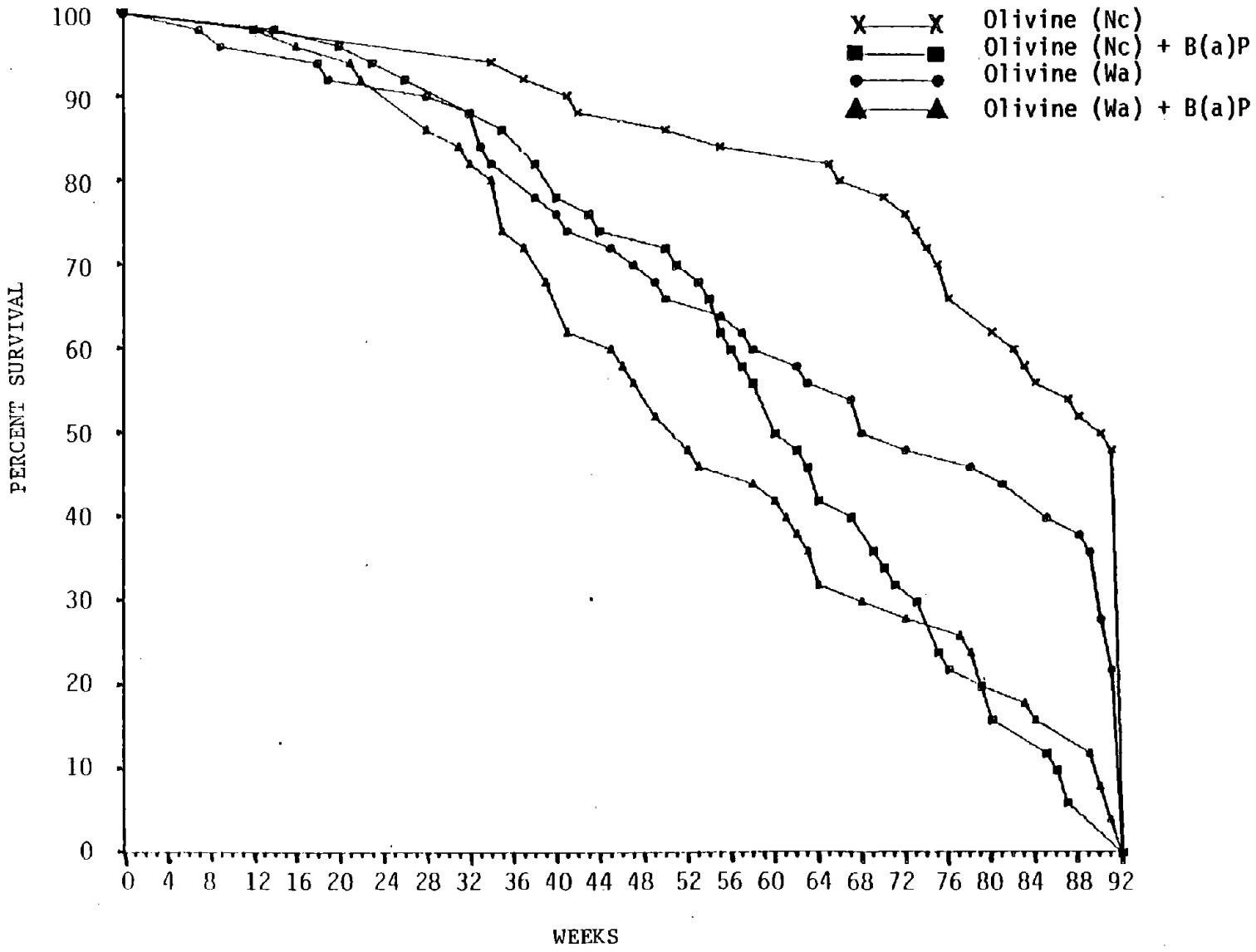

FIGURE 1 (CONTINUED)

RATE OF SURVIVAL

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

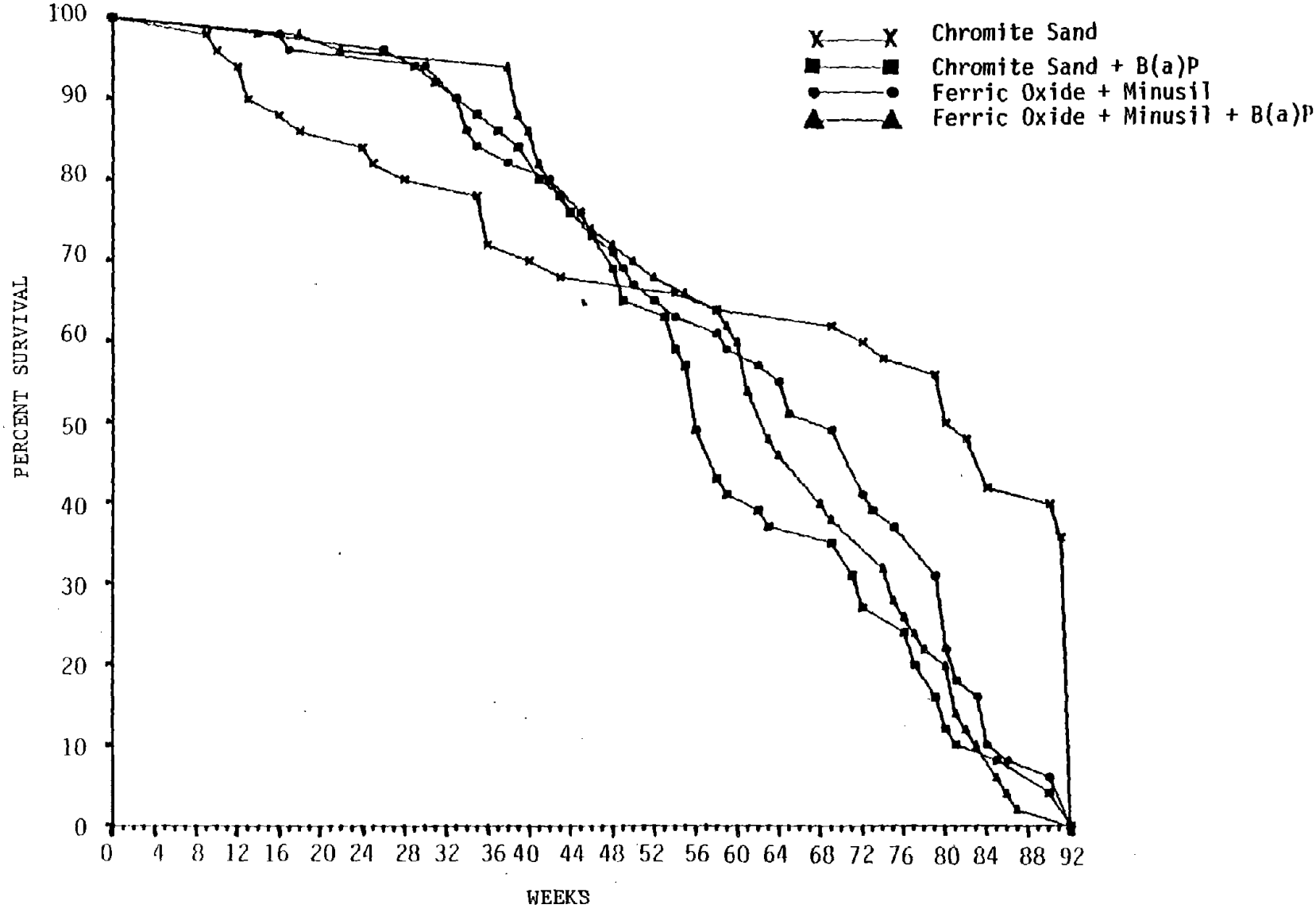

FIGURE 1 (CONTINUED)

RATE OF SURVIVAL

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

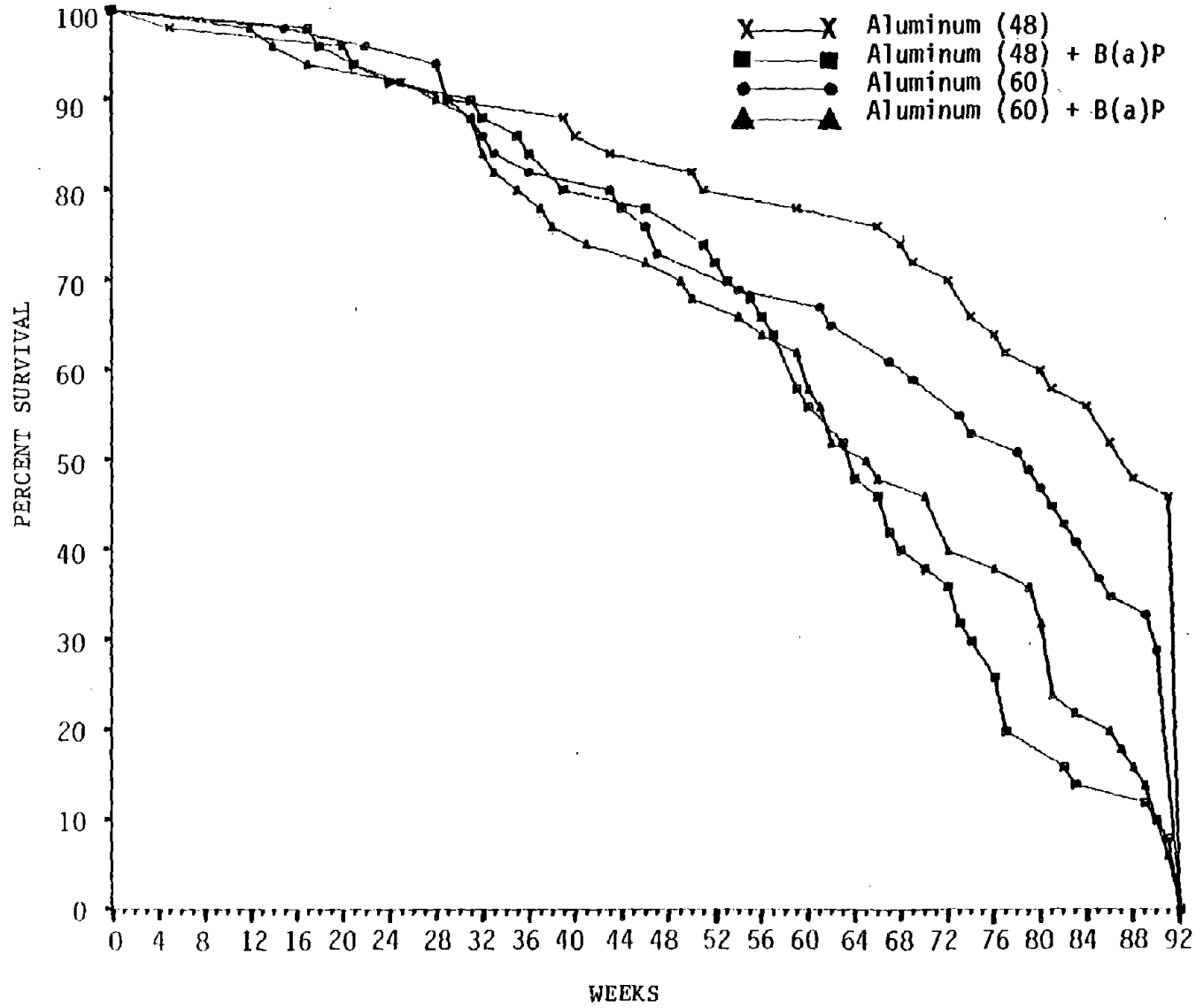

FIGURE 1 (CONTINUED)

RATE OF SURVIVAL

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

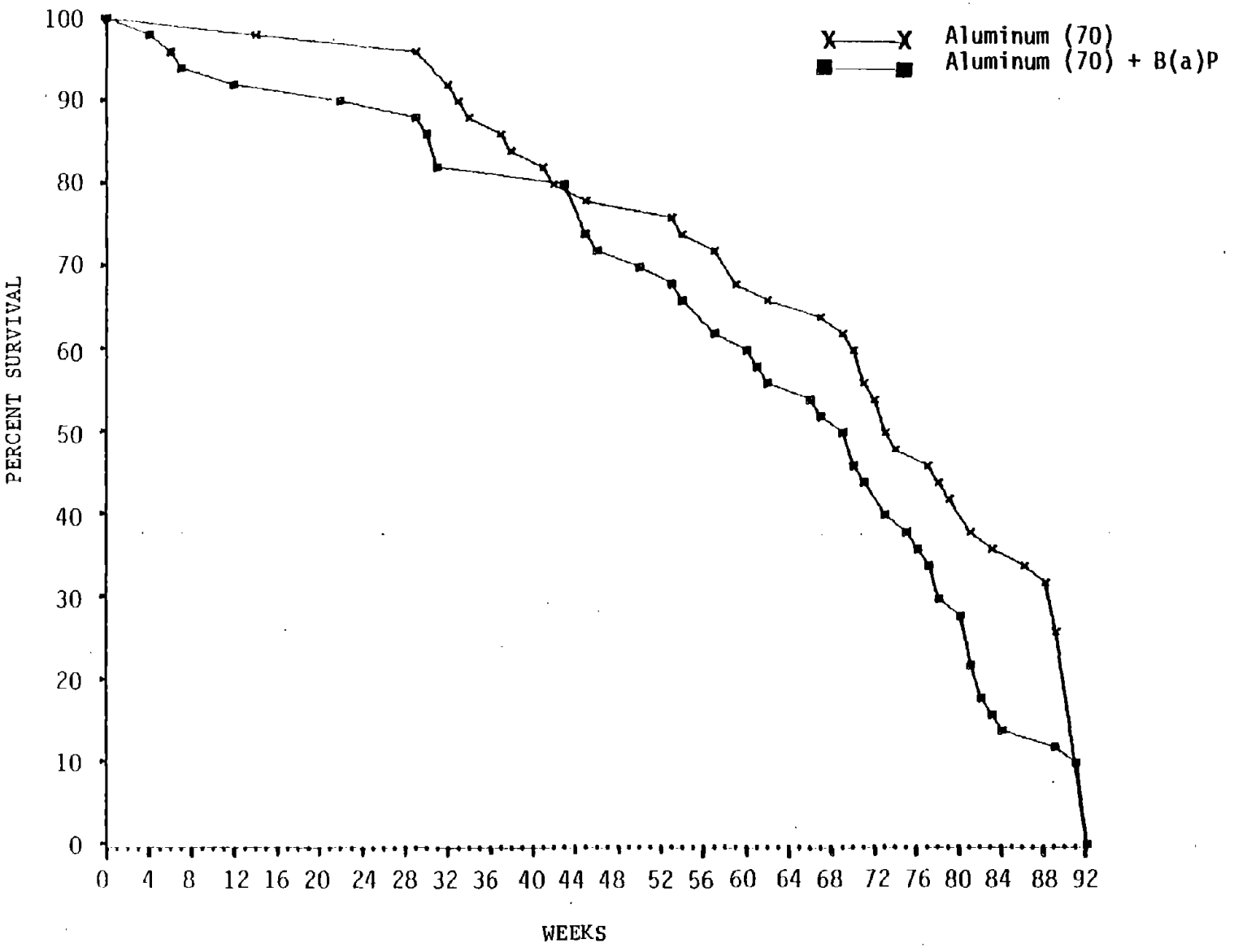

FIGURE 2

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

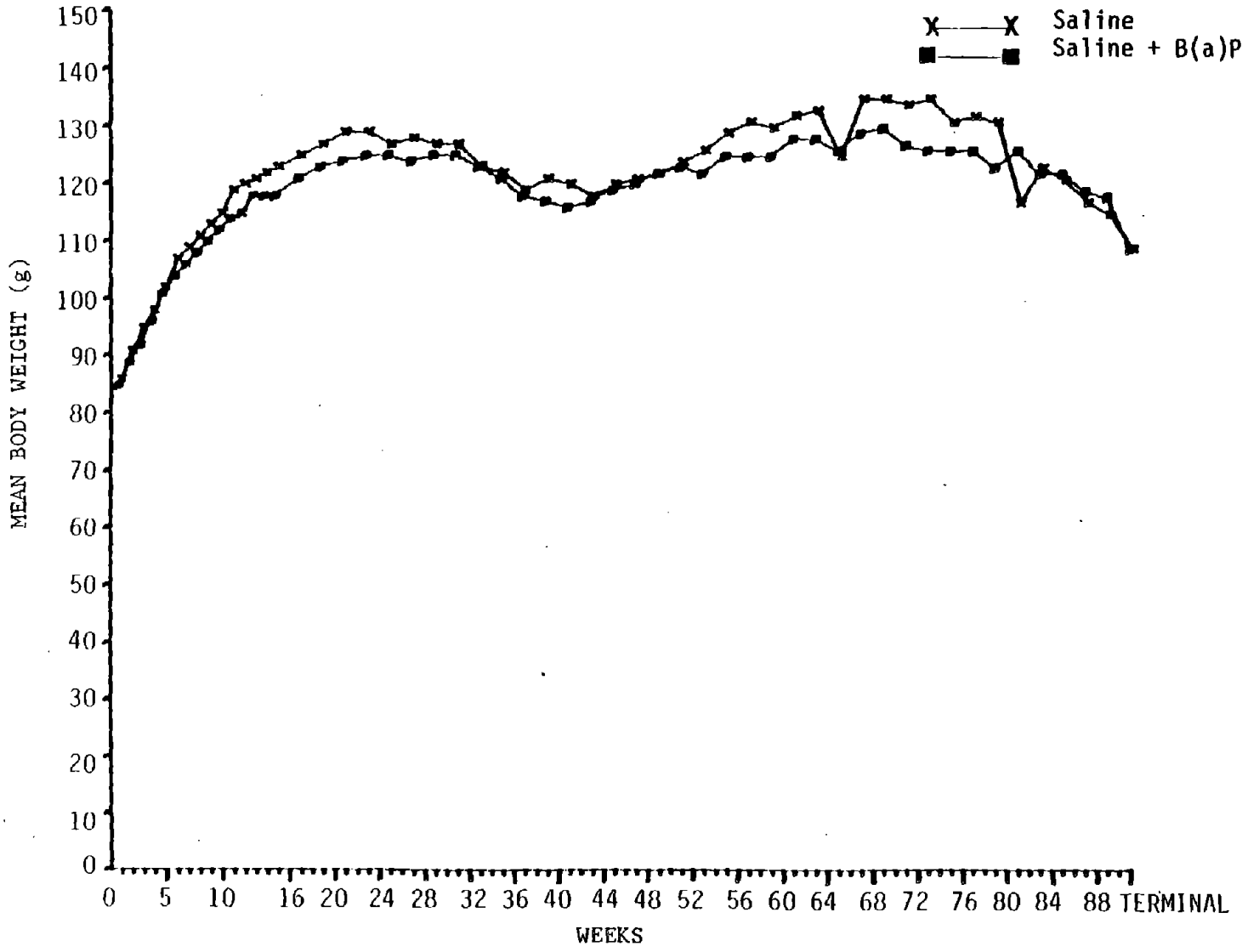

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

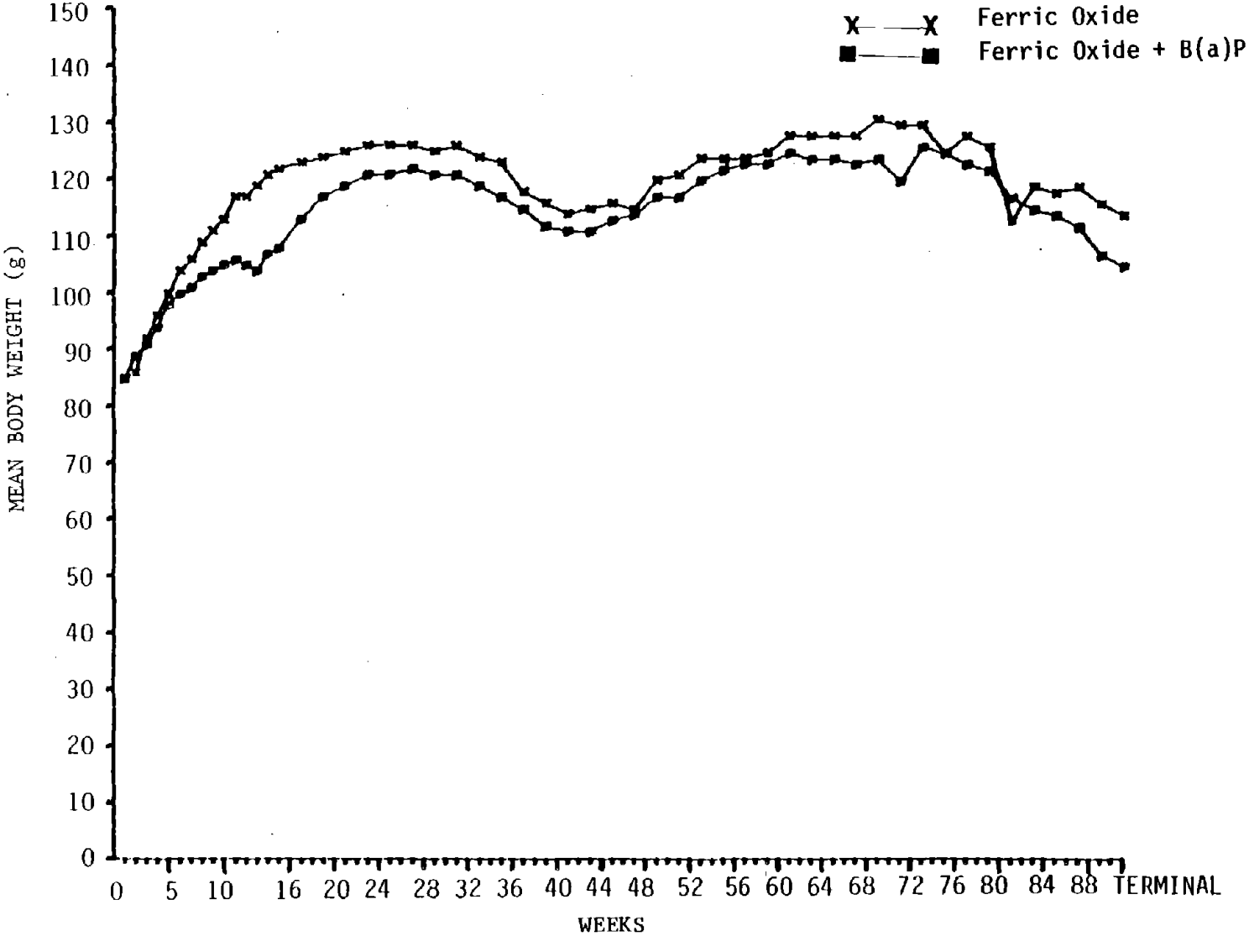

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

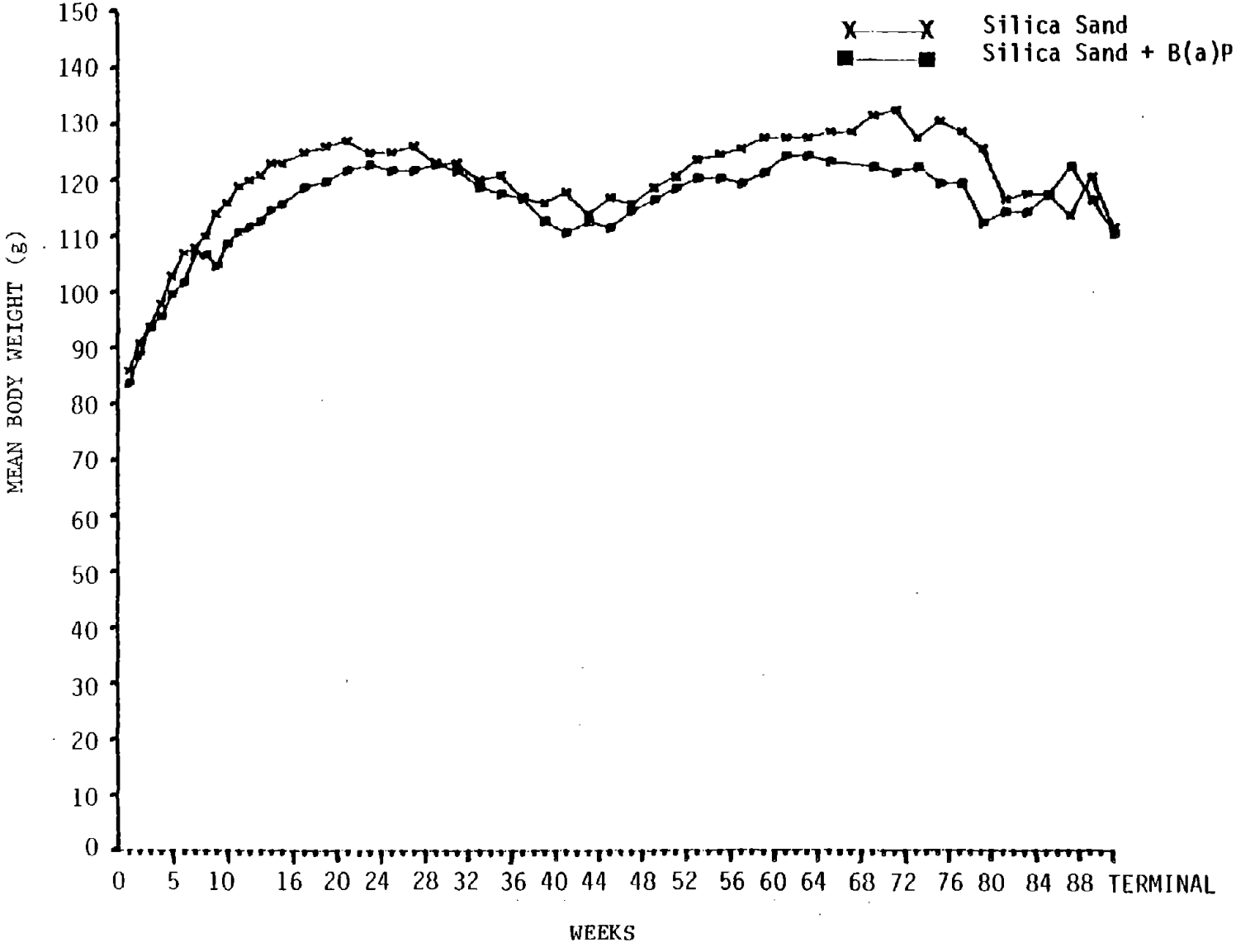

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

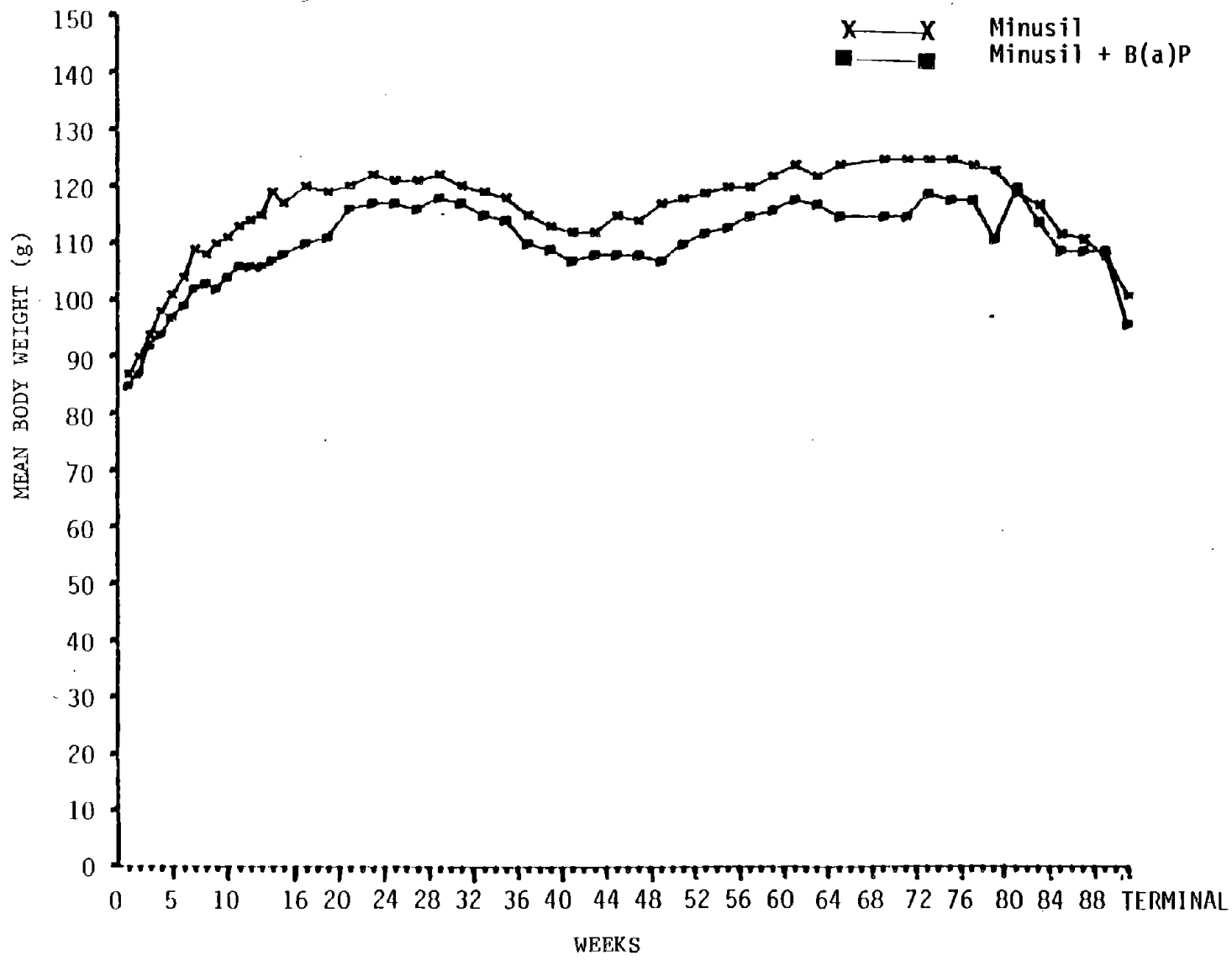

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

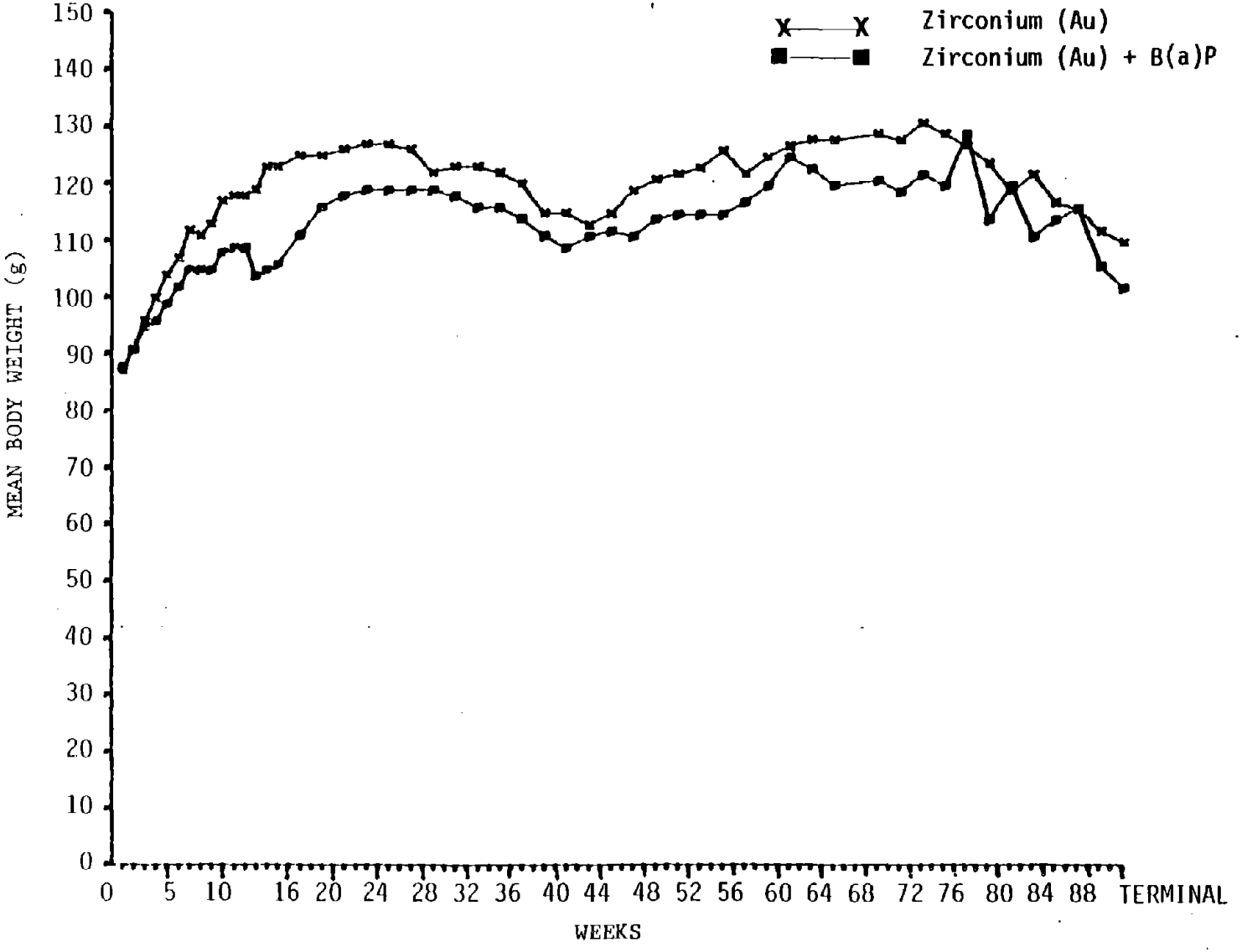

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

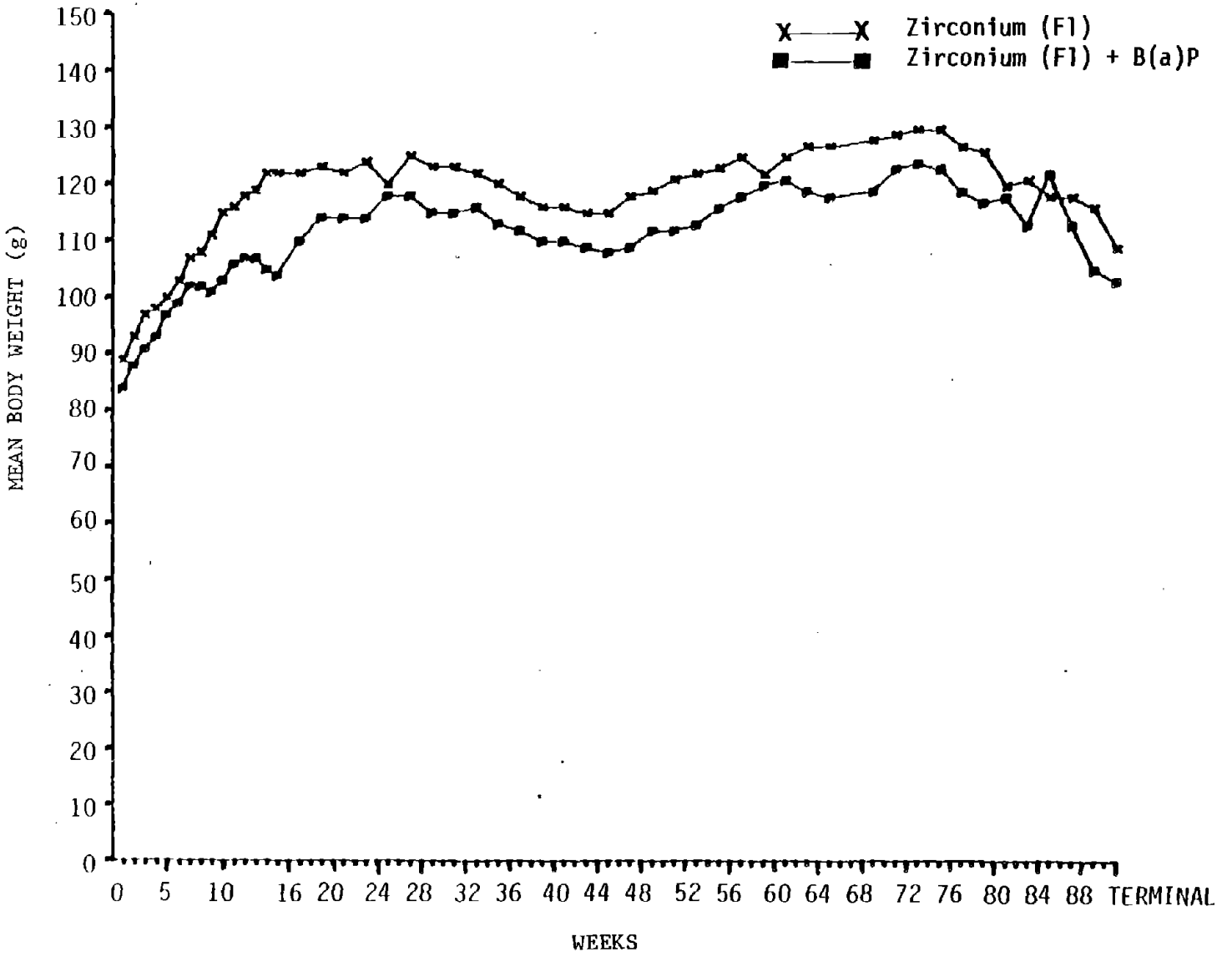

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g).

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

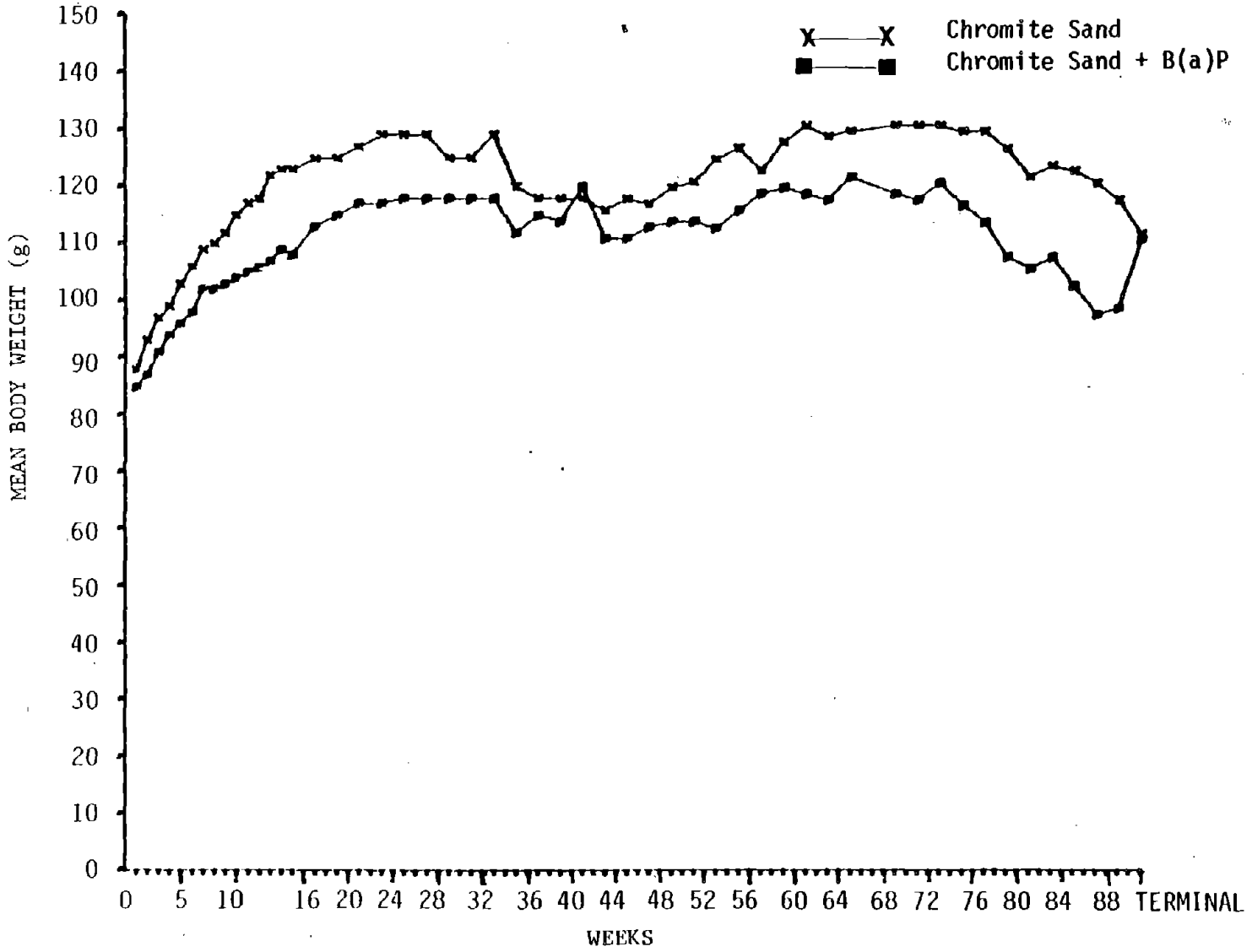

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

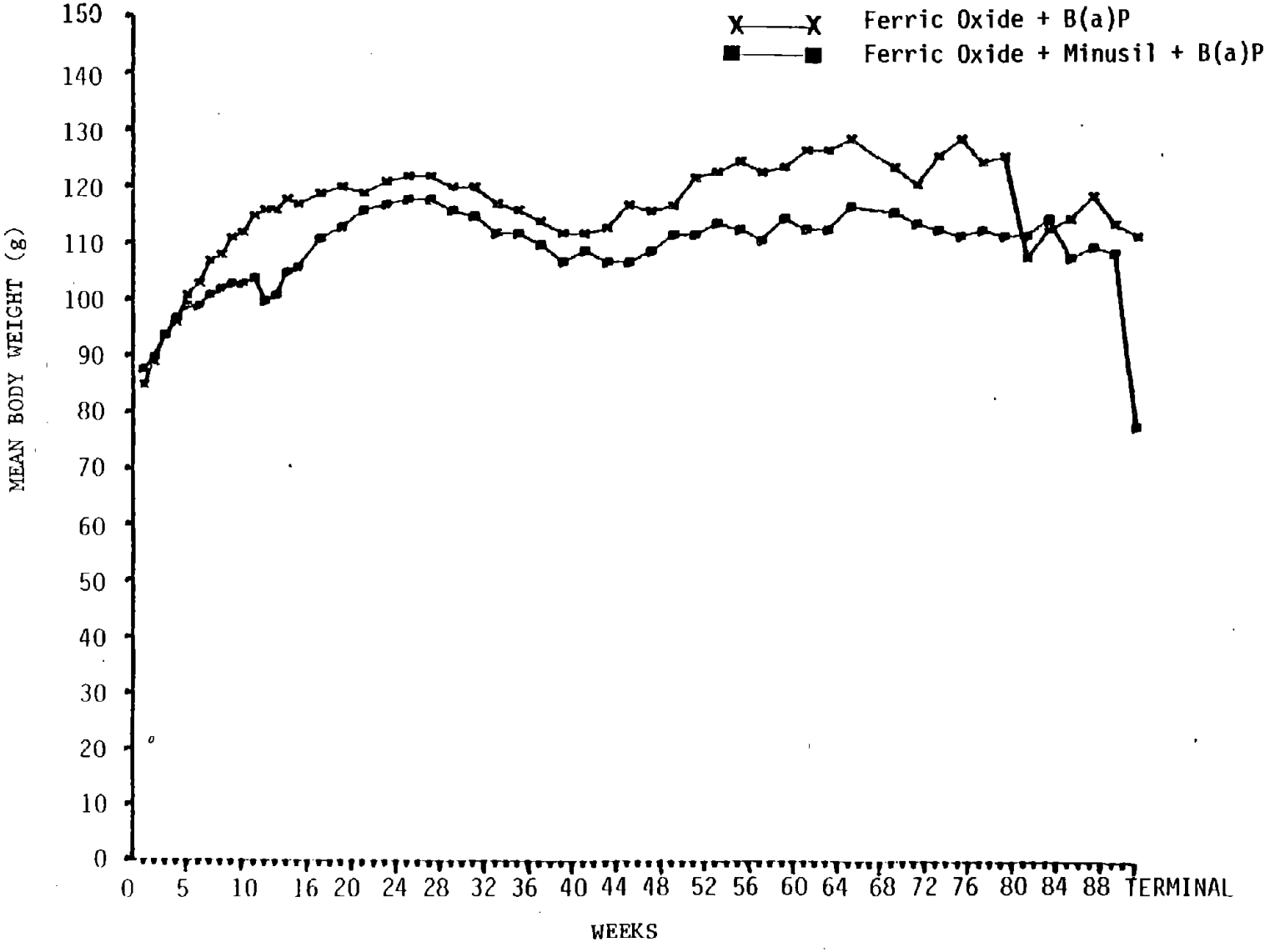

FIGURE 2 (CONTINUED

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

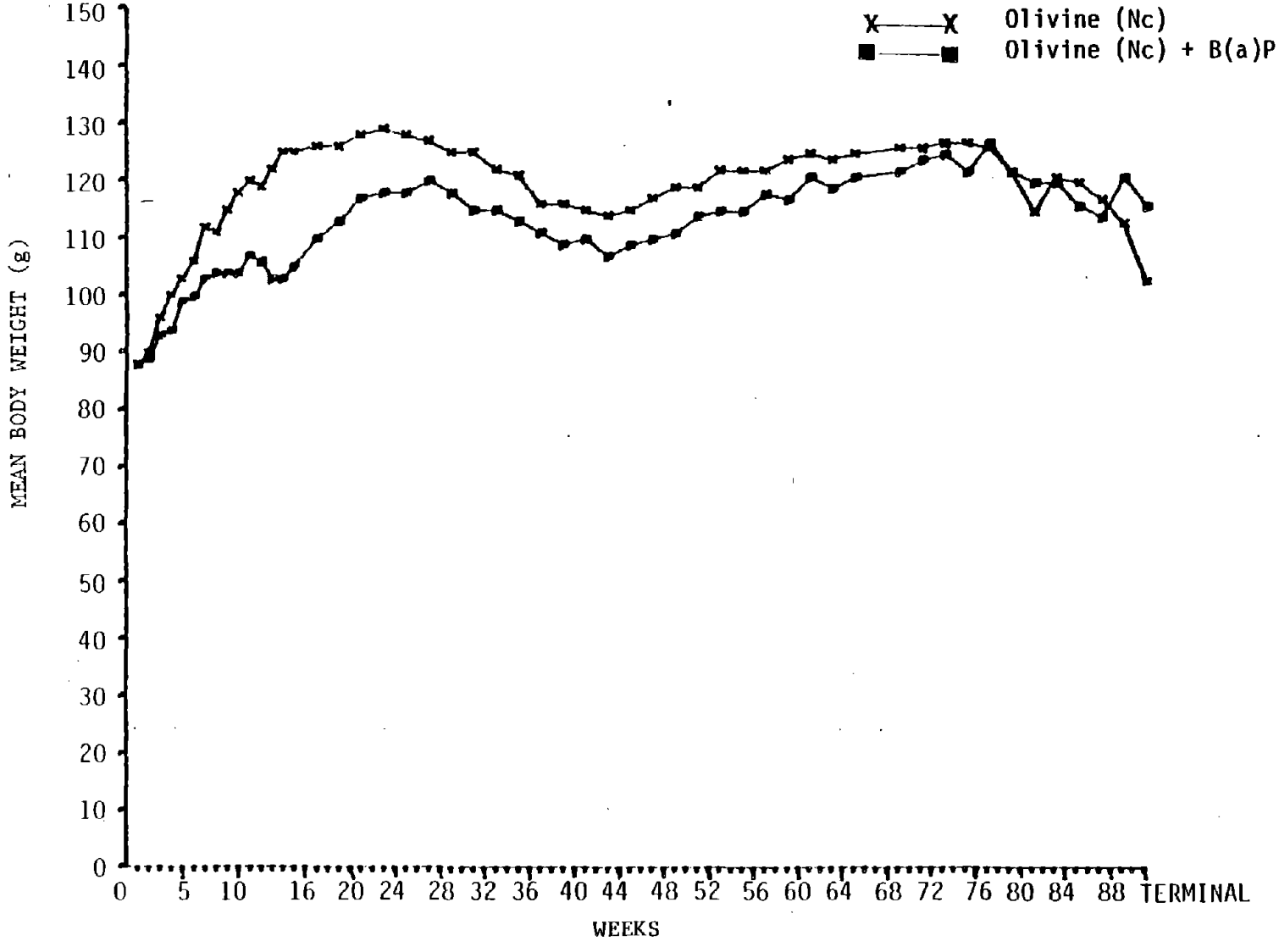

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

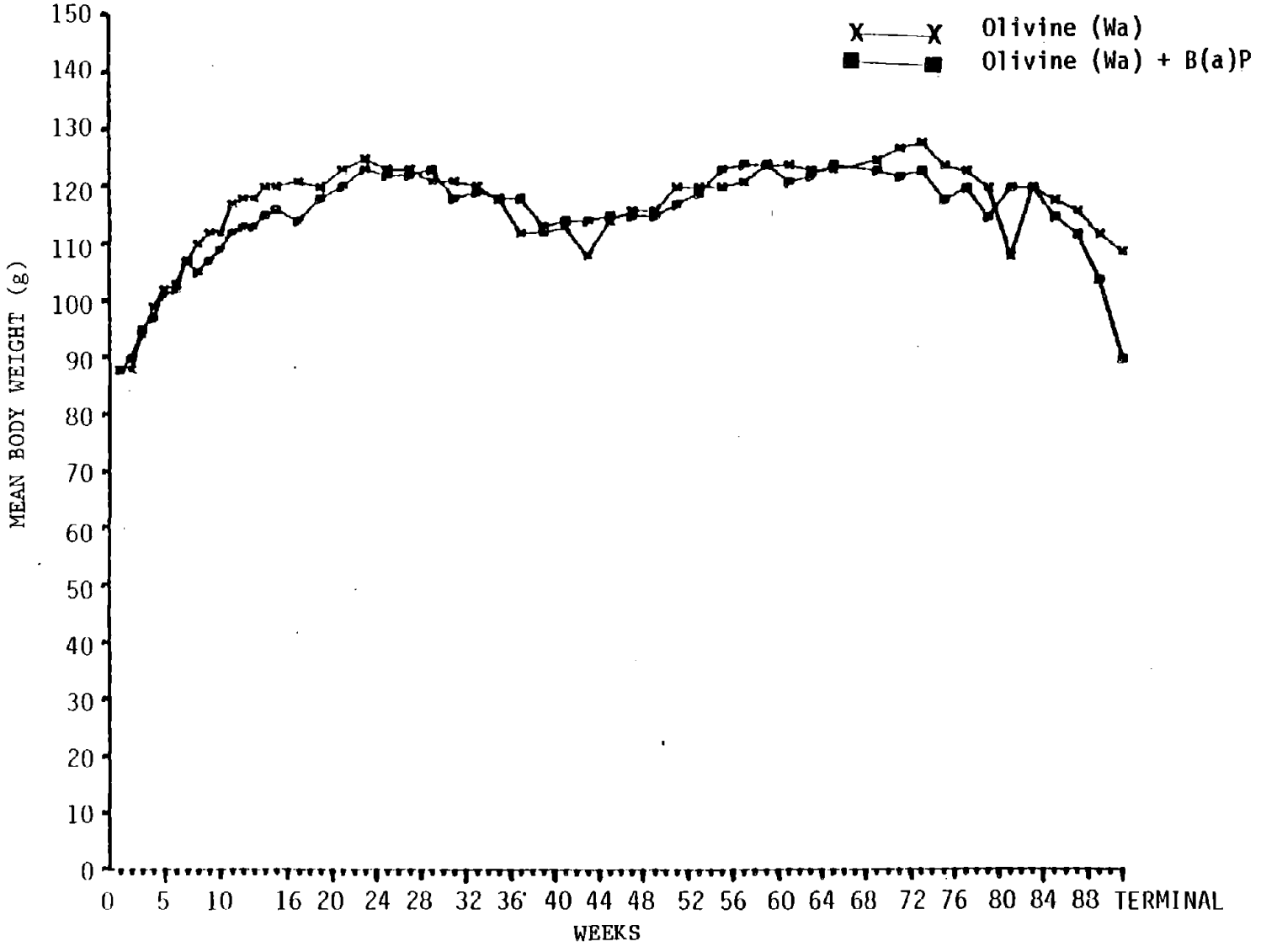

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

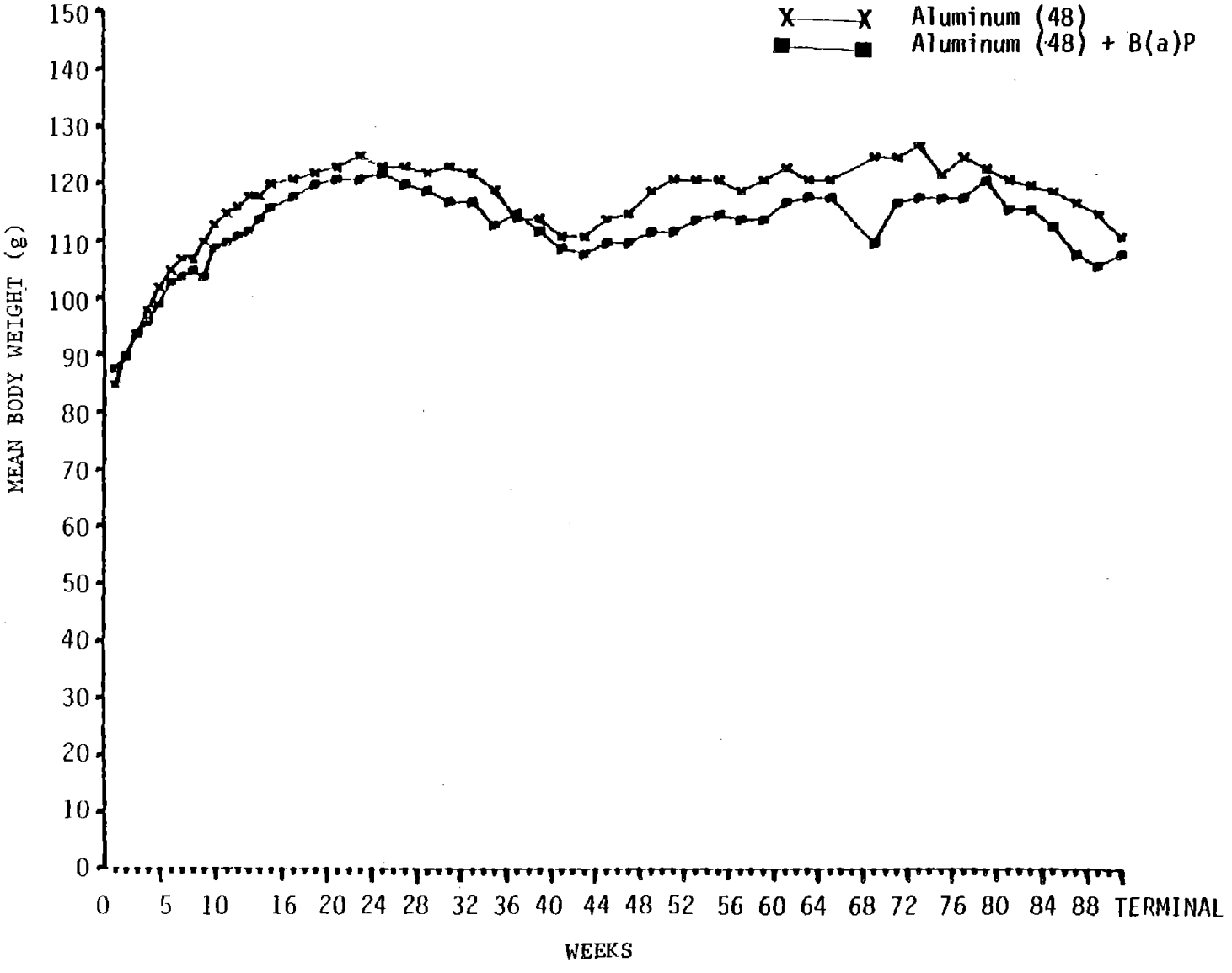

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

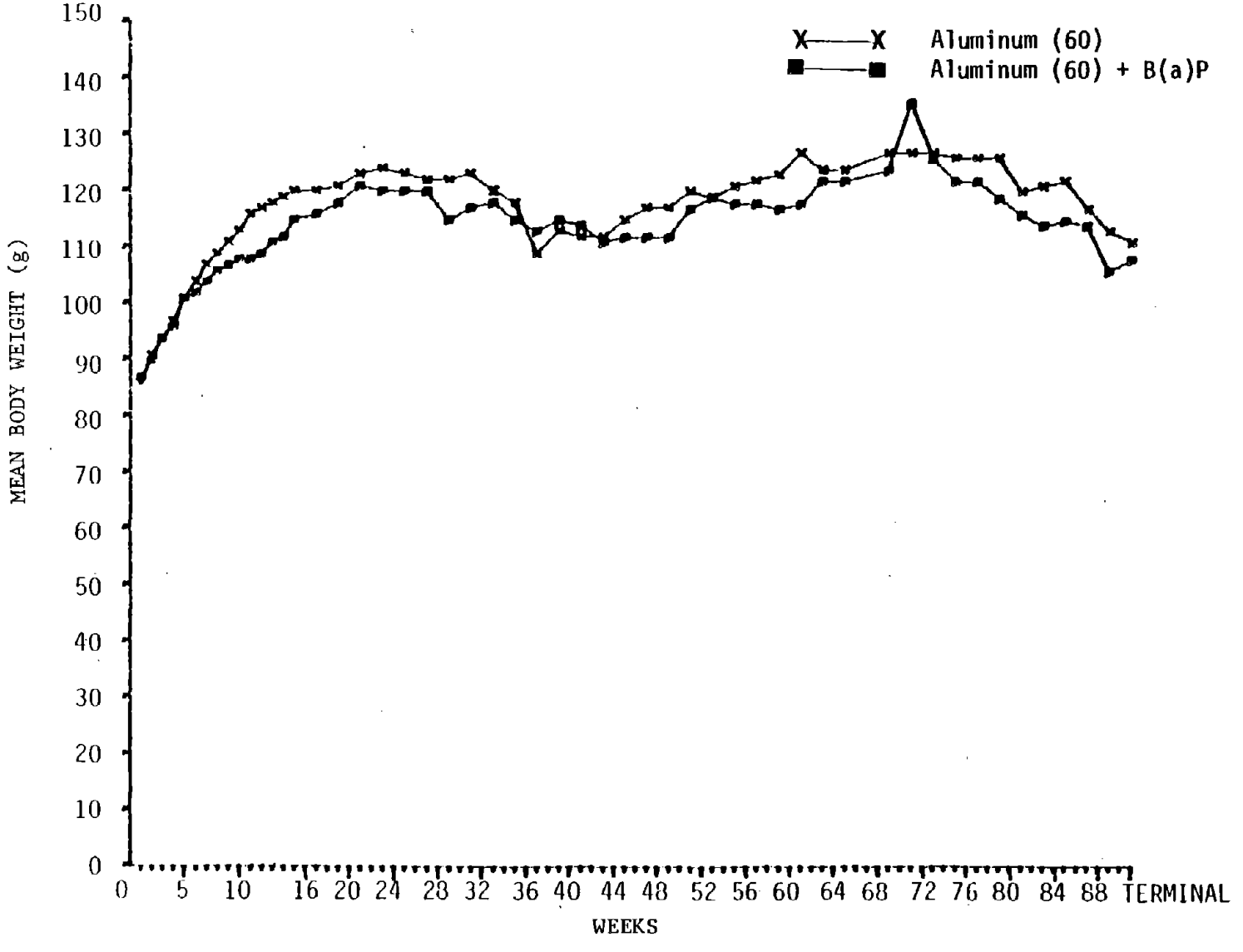

FIGURE 2 (CONTINUED)

MEAN BODY WEIGHT (g)

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES SILICA AND SILICA SAND SUBSTITUTES

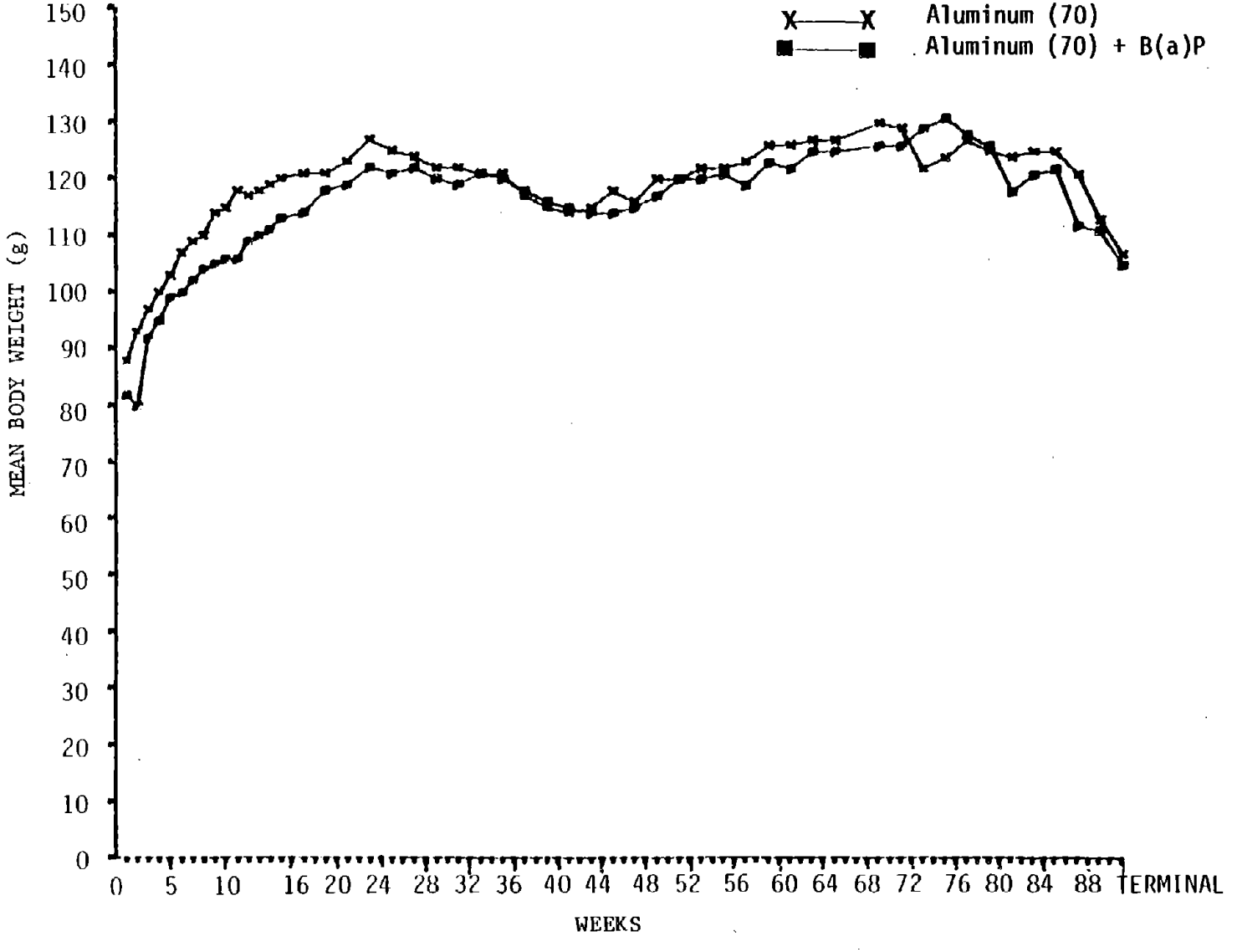

FIGURE 3 (CONTINUED)

CUMULATIVE INCIDENCE OF RESPIRATORY TRACT TUMORS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:SILICA AND SILICA SAND SUBSTITUTES

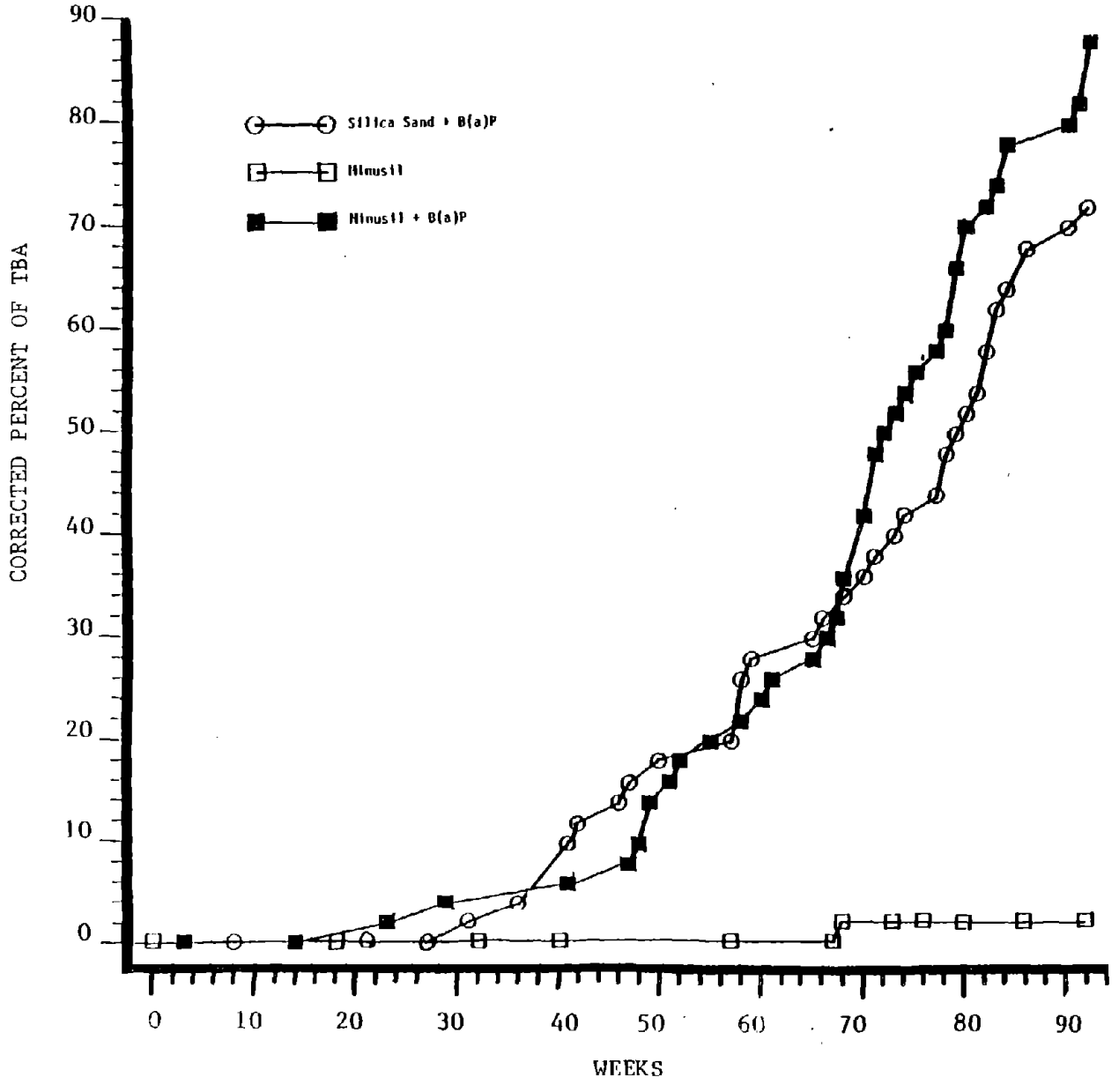

FIGURE 3 (CONTINUED)

CUMULATIVE INCIDENCE OF RESPIRATORY TRACT TUMORS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:SILICA AND SILICA SAND SUBSTITUTES

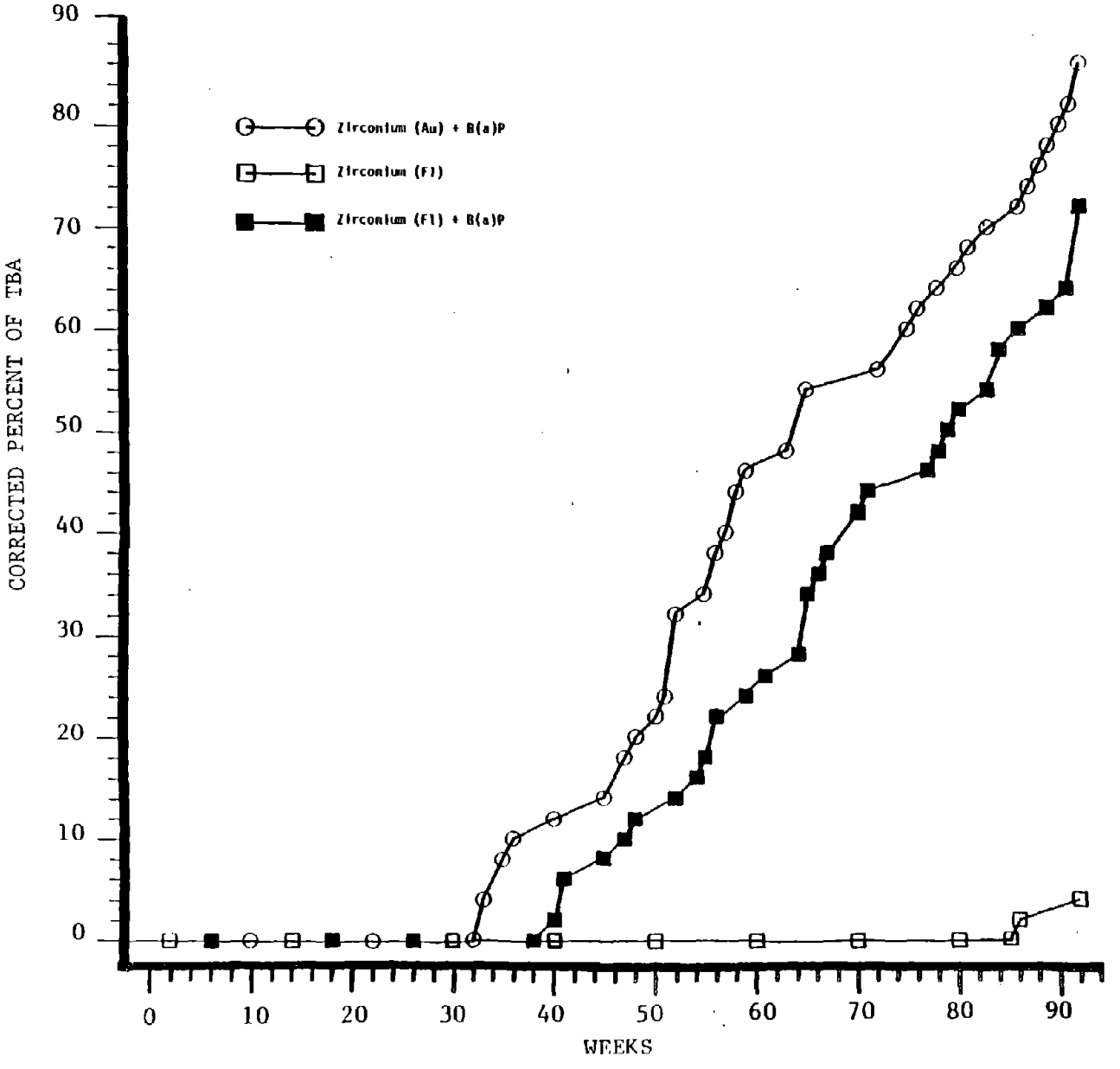

FIGURE 3 (CONTINUED)

CUMULATIVE INCIDENCE OF RESPIRATORY TRACT TUMORS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:SILICA AND SILICA SAND SUBSTITUTES

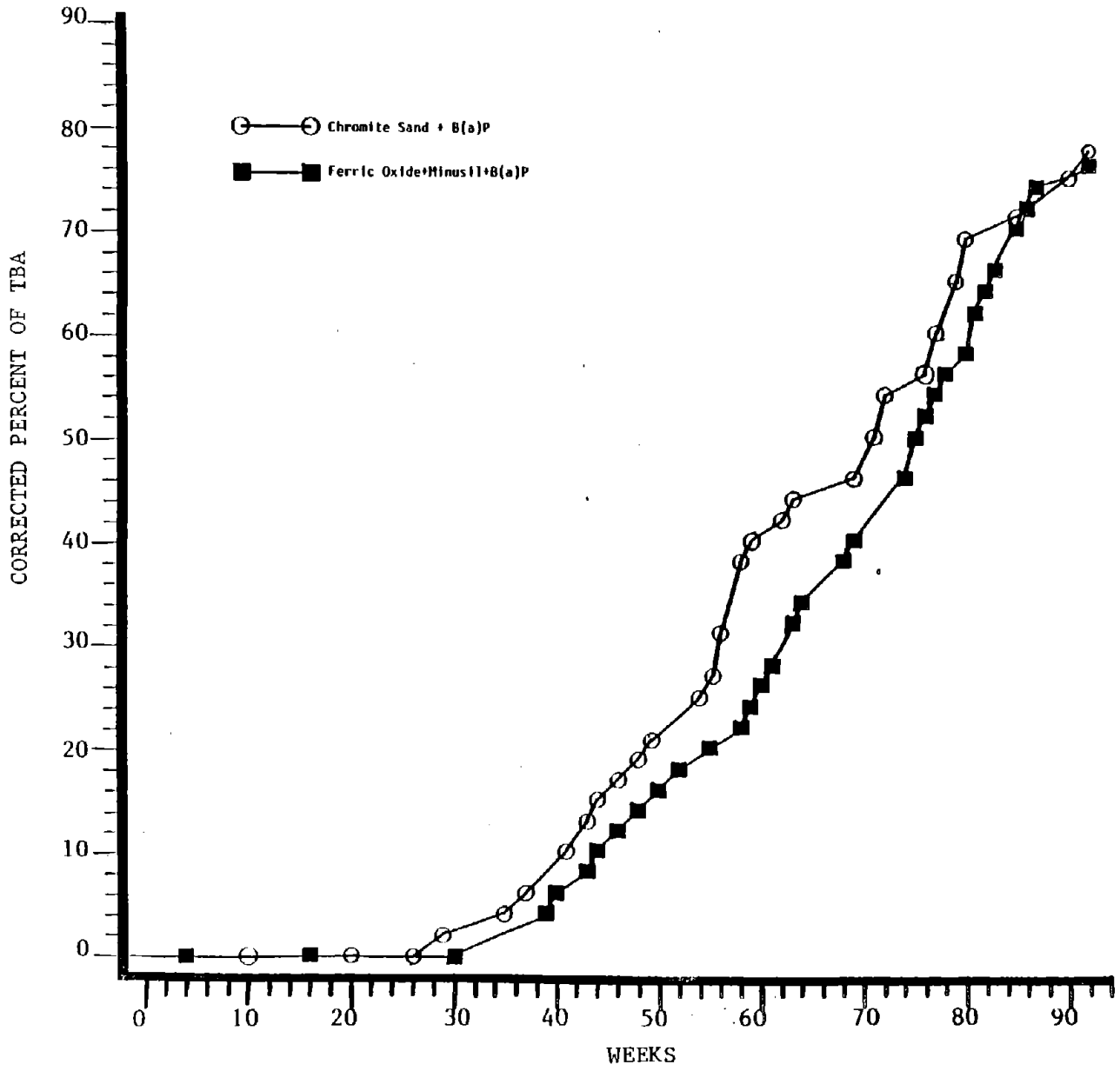

FIGURE 3 (CONTINUED)

CUMULATIVE INCIDENCE OF RESPIRATORY TRACT TUMORS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:SILICA AND SILICA SAND SUBSTITUTES

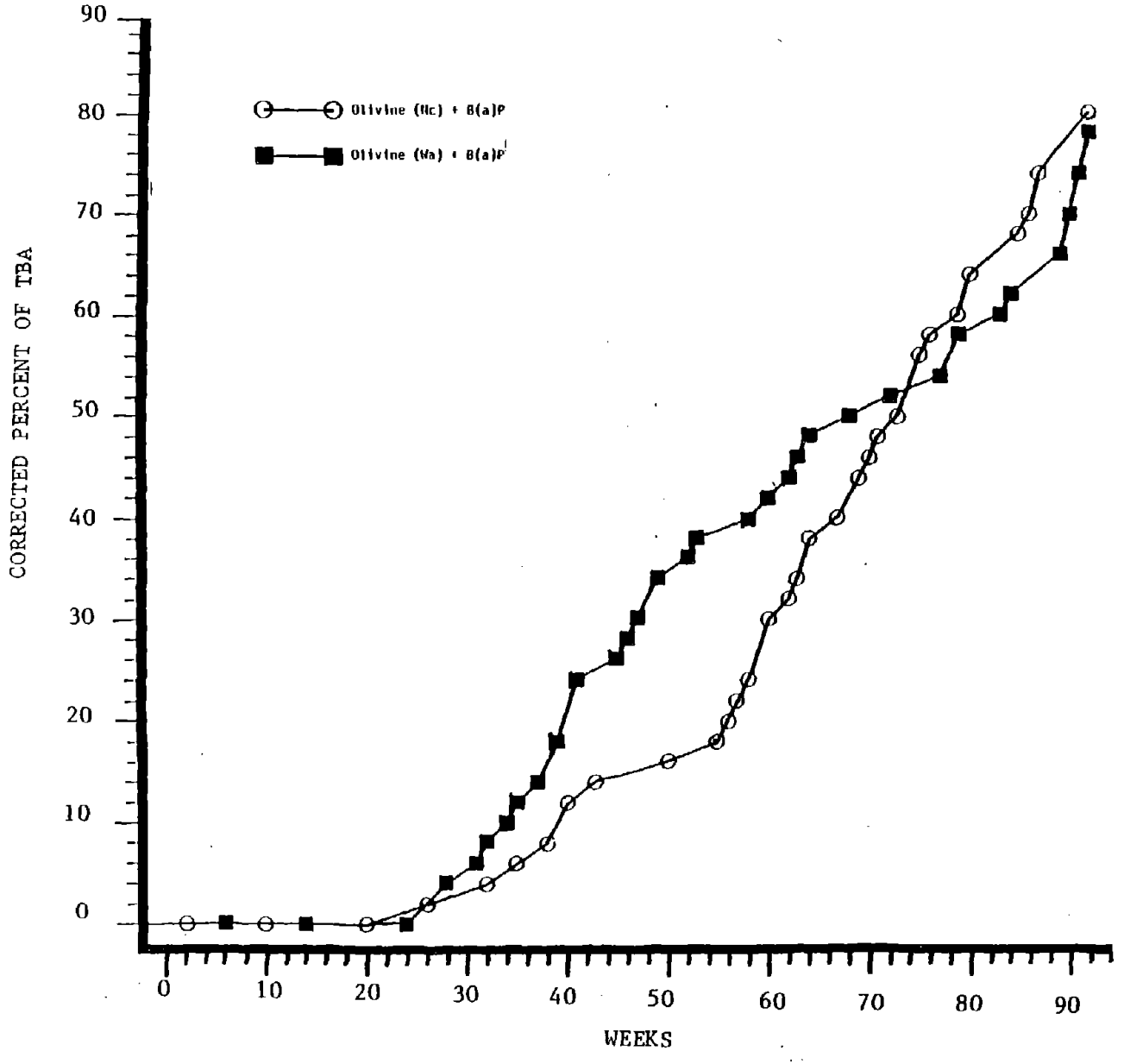

FIGURE 3 (CONTINUED)

CUMULATIVE INCIDENCE OF RESPIRATORY TRACT TUMORS
CO-CARCINOGENICITY OF FOUNDRY PARTICULATES:SILICA AND SILICA SAND SUBSTITUTES

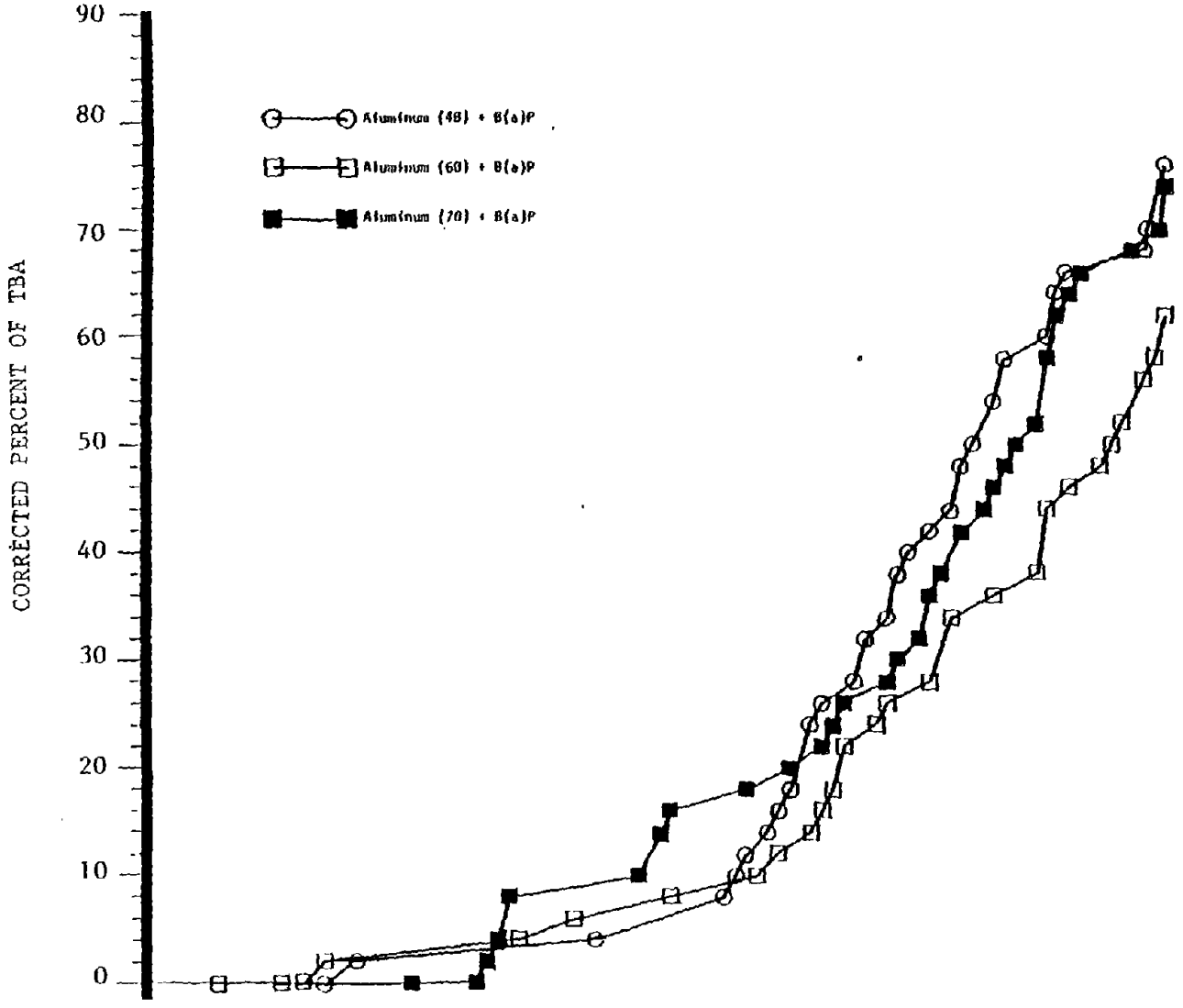

FIGURE 4

TUMOR INCIDENCES

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

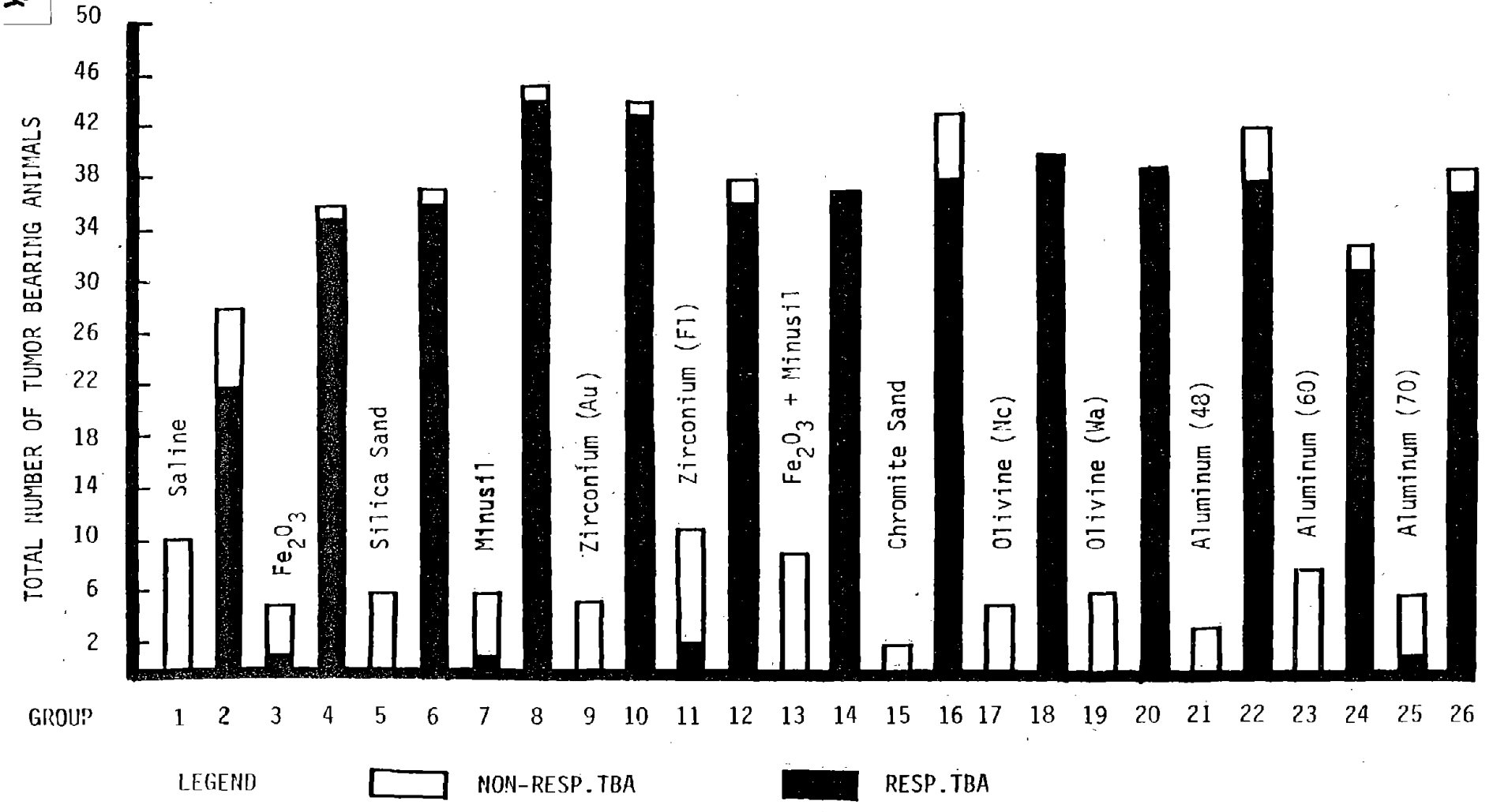

FIGURE 5

MEAN LATENCY PERIOD IN WEEKS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

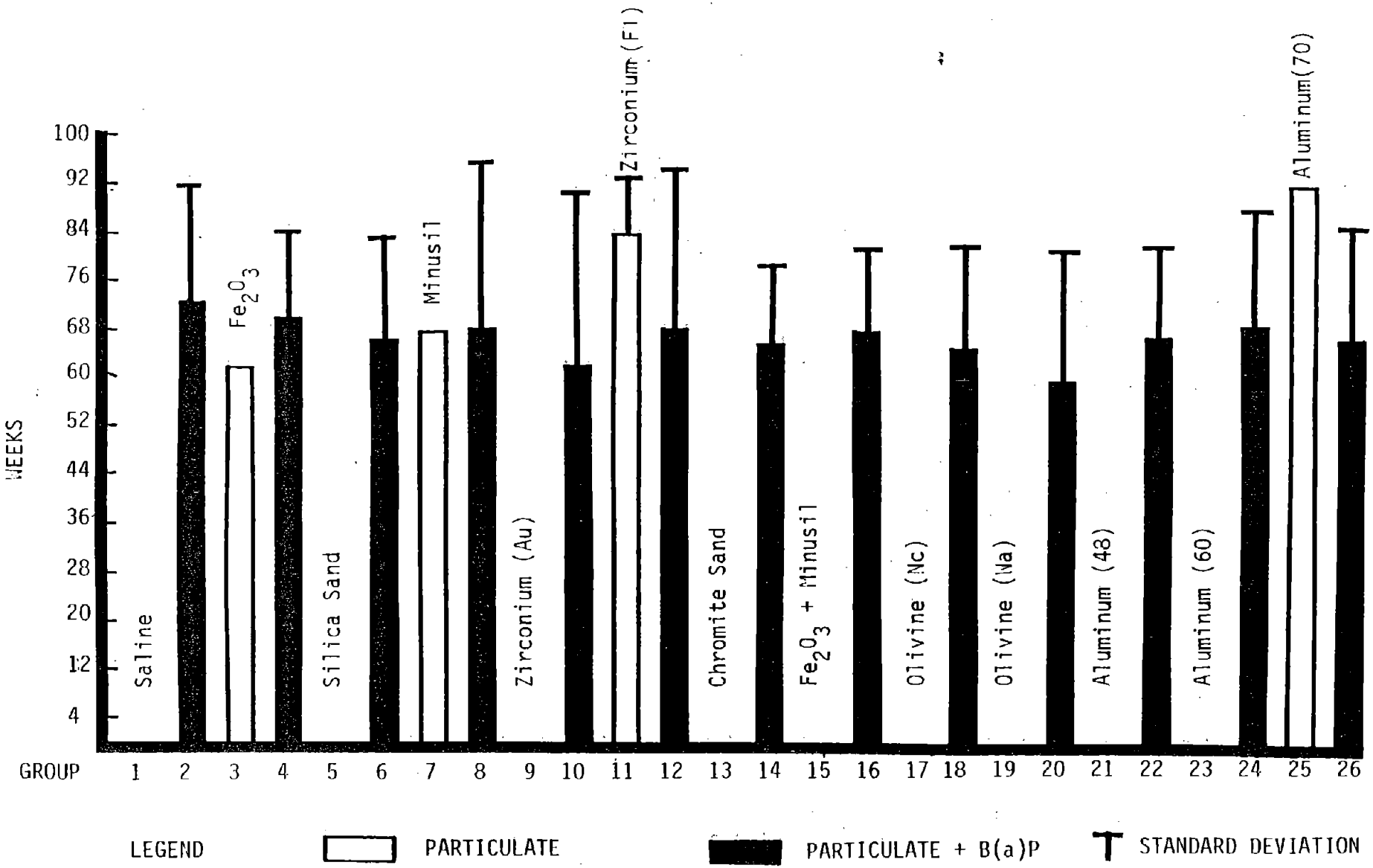

FIGURE 6

DISTRIBUTION OF RESPIRATORY TRACT TUMOR BEARING ANIMALS

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

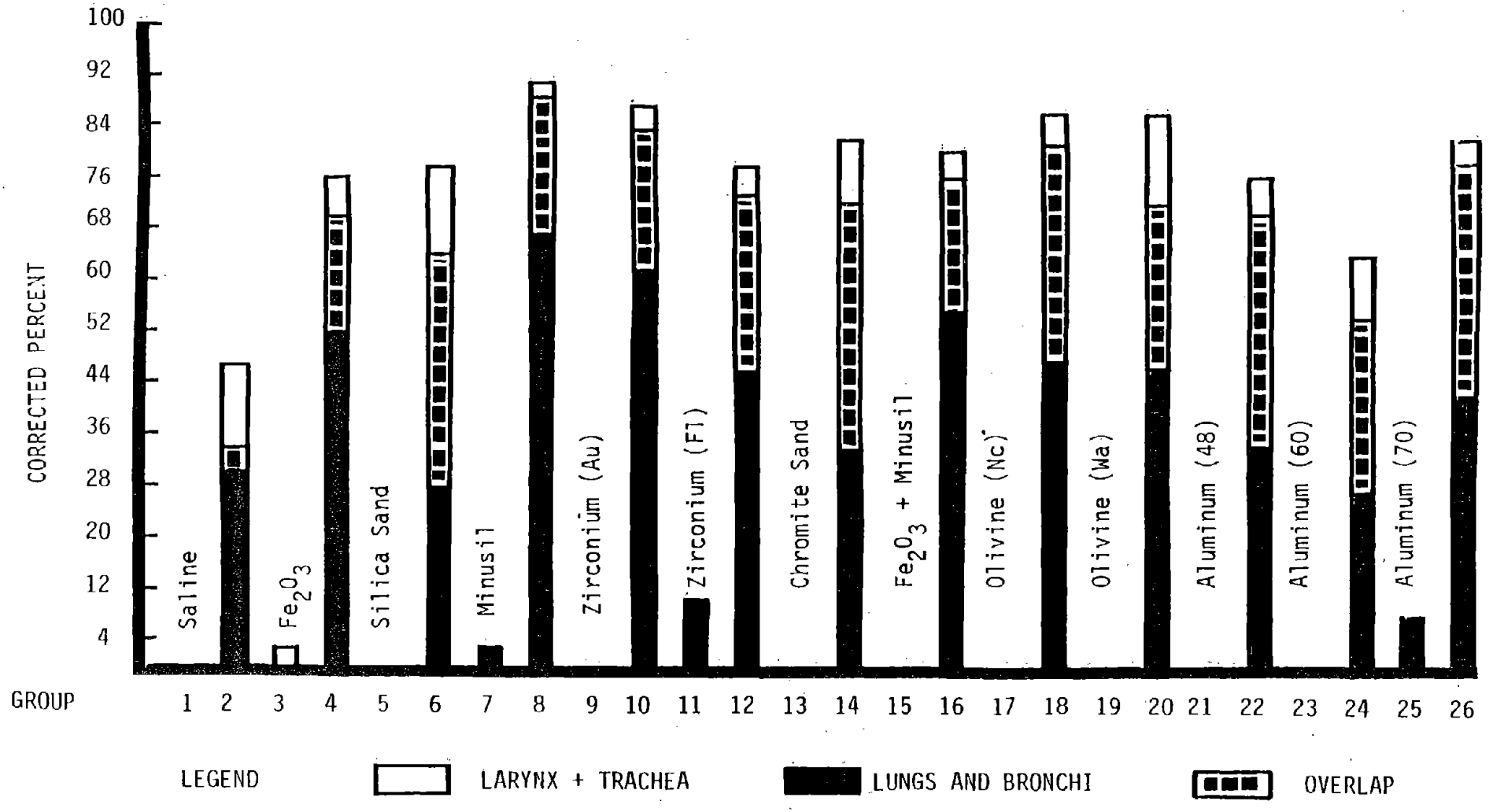

FIGURE 7

DISTRIBUTION OF RESPIRATORY TRACT TUMOR TYPES AND CORRECTED PERCENT CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES

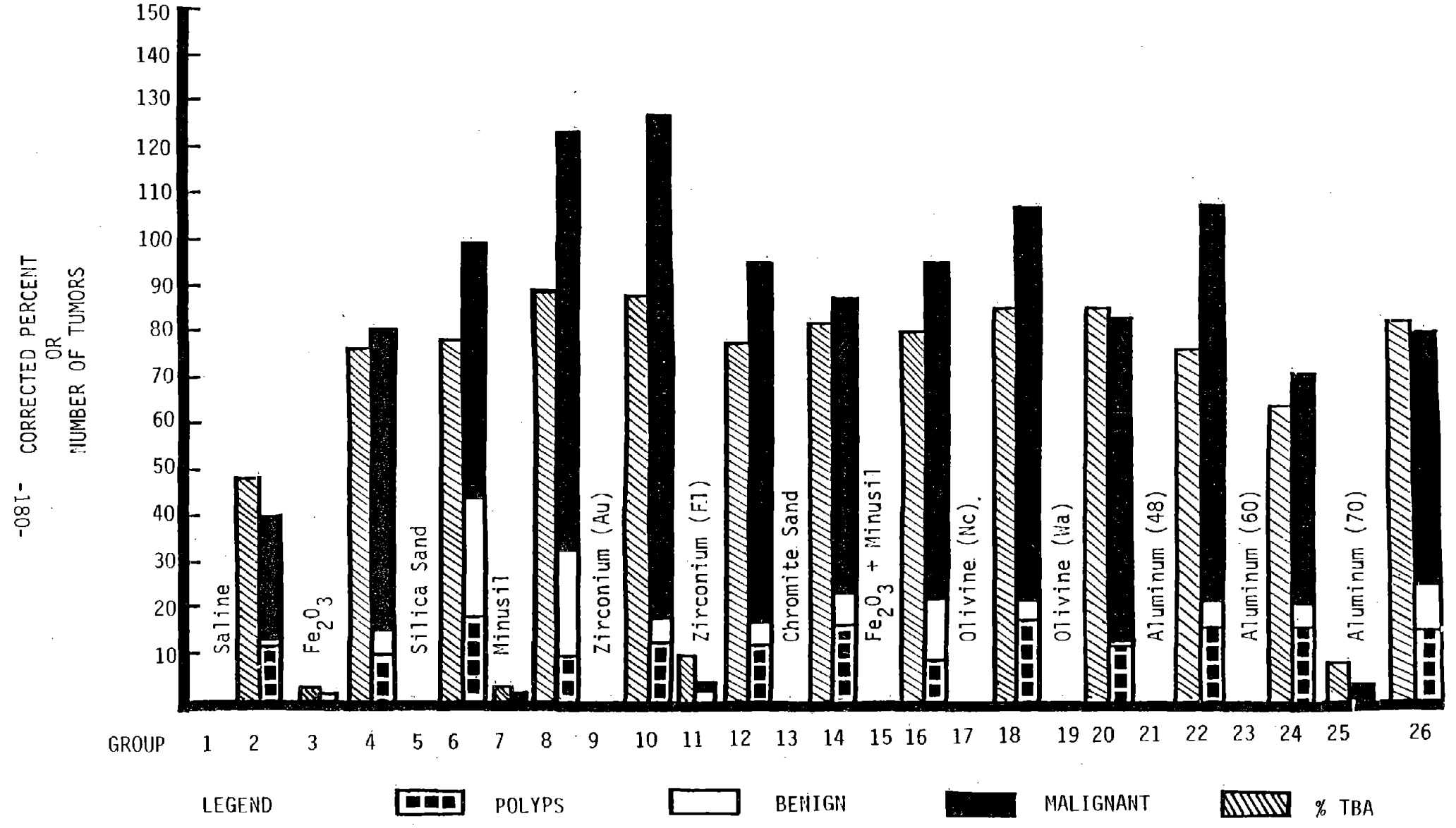

FIGURE 8

INCIDENCES OF HAMSTERS WITH PULMONARY GRANULOMATOUS INFLAMMATION

CO-CARCINOGENICITY OF FOUNDRY PARTICULATES: SILICA AND SILICA SAND SUBSTITUTES