RELATIVE TOXICITY TESTING OF SPACECRAFT MATERIALS

I. SPACECRAFT MATERIALS

ANNUAL REPORT TO
NASA JOHNSON SPACE CENTER
HOUSTON, TEXAS 77028

Contract Number	NAS 9-15670
Period Covered by Contract	November 10, 1978 to November 9, 1980
Date of Report	November 6, 1980
Report Prepared by	W.H. Lawrence, Ph.D. Associate Director and Head, Animal Toxicology Section
Report Submitted by	John Autian, Ph.D., Director Materials Science Toxicology Labs. University of Tennessee Center for the Health Sciences Memphis, Tennessee 38163
Investigators:	John Autian, Ph.D. W.H. Lawrence, Ph.D. L.J. Nunez, Ph.D. J.E. Turner, D.D.S. Sam Foster Eula Baldwin Michael Malik Walter Koch

RELATIVE TOXICITY TESTING OF SPACECRAFT MATERIALS

I. SPACECRAFT MATERIALS

ANNUAL REPORT TO

NASA JOHNSON SPACE CENTER

HOUSTON, TEXAS 77028

Contract Number	NAS 9-15670
Period Covered by Contract	November 10, 1978 to November 9, 1980
Date of Report	November 6, 1980
Report Prepared by	W.H. Lawrence, Ph.D., Associate Director and Head, Animal Toxicology Section
Report Submitted by	John Autian, Ph.D., Director Materials Science Toxicology Labs. University of Tennessee Center for the Health Sciences Memphis, Tennessee 38163
Investigators:	John Autian, Ph.D. W.H. Lawrence, Ph.D. L.J. Nunez, Ph.D. J.E. Turner, D.D.S. Sam Foster Eula Baldwin Michael Malik Walter Koch

TABLE OF CONTENTS

Page

Report Information 1

Table of Contents 2

Introduction 5

Materials and Methodology 7

Results and Discussion 11

Summary and Conclusions 16

Tables:

Table 1. Identification of Samples 19

Table 2. Analysis of TGA Data, Y-7387: KAU Foam 20

Table 3. Analysis of TGA Data, Y-7388: UNI (or UM) Foam, S82H 21

Table 4. Analysis of TGA Data, Y-7389: Adhesive Backed Metallic Tape 22

Table 5. Analysis of TGA Data, Y-7390: RTV Silicone rubber adhesive sealant 23

Table 6. Analysis of TGA Data, Y-7391: Minicell L-200 Coated with Fluorel . . 24

Table 7. LD_{50} and (95% Confidence Interval) Based Upon Initial Weight of Sample Pyrolyzed 25

Table 8. Acute Toxicity of Pyrolysis/Combustion Products, Y-7387: KAU Foam 26

Table 9. Acute Toxicity of Pyrolysis/Combustion Products, Y-7388: UNI (or UM) Foam . . 27

Table 10. Acute Toxicity of Pyrolysis/Combustion Products, Y-7389: Adhesive Backed Metallic Tape 28

Table 11. Acute Toxicity of Pyrolysis/Combustion Products, Y-7390: RTV Silicone rubber adhesive sealant, without filter . . . 29

TABLE OF CONTENTS (cont'd)

		Page
Table 11-a	Acute Toxicity of Pyrolysis/Combustion Products, Y-7390: RTV Silicone rubber adhesive sealant, with filter	30
Table 12.	Acute Toxicity of Pyrolysis/Combustion Products, Y-7391: Minicell L-200 coated with Fluorel	31
Table 13.	Lethality Toxicity Data and Percent Thermodegradation of Samples	32
Table 14.	Ranking of Samples By Lethality From Exposure to Pyrolysis/Combustion Products	33
Table 15.	Summary of Histopathologic Evaluation, Y-7387: KAU Foam	34
Table 16.	Summary of Histopathologic Evaluation, Y-7388: UNI Foam, S82H	35
Table 17.	Summary of Histopathologic Evaluation, Y-7389: Adhesive backed metallic tape . .	36
Table 18.	Summary of Histopathologic Evaluation, Y-7390: RTV Silicone rubber adhesive sealant	37
Table 19.	Summary of Histopathologic Evaluation, Y-7391: Minicell (L-200 Coated with Fluorel)	38
Figures:		
Figure 1.	TGA Curve of KAU Foam (Y-7387) Air, 200 ml/min, 10°C/min	39
Figure 2.	TGA Curve of KAU Foam (Y-7387) Air, 20 ml/min, 20°C/min	40
Figure 3.	TGA Curve of KAU Foam (Y-7387) Nitrogen 20 ml/min, 20°C/min	41
Figure 4.	TGA Curve of UNI Foam (Y-7388) Air, 200 ml/min, 10°C/min	42
Figure 5.	TGA Curve of UNI Foam (Y-7388) Air, 20 ml/min, 20°C/min	43

TABLE OF CONTENTS (cont'd)

		Page
Figure 6.	TGA Curve of UNI Foam (Y-7388) Nitrogen, 20 ml/min; 20°C/min	44
Figure 7.	TGA Curve of Adhesive backed metallic tape (Y-7389) Air, 200 ml/min; 10°C/min .	45
Figure 8.	TGA Curve of Adhesive backed metallic tape (Y-7389) Air, 20 ml/min; 20°C/min .	46
Figure 9.	TGA Curve of Adhesive backed metallic tape (Y-7389) Nitrogen, 20 ml/min; 20°C/min	47
Figure 10.	TGA Curve of RTV Silicone Rubber adhesive sealant (Y-7390) Air, 200 ml/min; 10°C/min	48
Figure 11.	TGA Curve of RTV Silicone Rubber adhesive sealant (Y-7390) Air, 20 ml/min; 20°C/min	49
Figure 12.	TGA Curve of RTV Silicone Rubber adhesive sealant (Y-7390) Nitrogen, 20 ml/min; 20°C/min	50
Figure 13.	TGA Curve of Minicell (L-200 coated with fluorel) (Y-7391) Air, 200 ml/min; 10°C/min	51
Figure 14.	TGA Curve of Minicell (L-200 coated with fluorel) (Y-7391) Air, 20 ml/min; 20°C/min	52
Figure 15.	TGA Curve of Minicell (L-200 coated with fluorel) (Y-7391) Nitrogen, 20 ml/min; 20°C/min	53
Exhibit A		54

Introduction

This work is, in essence, a continuation of previous studies to assess the relative toxicity (lethality) to rats of pyrolysis/combustion products of spacecraft materials. While the experimental design still emphasizes the role of carbon monoxide in the overall pyrolysate toxicity (by analysis of exposure chamber atmosphere for carbon monoxide concentration and determination of percent carboxyhemoglobin in rats dying in the chamber), the changes in conditions for pyrolysis/combustion (to an in-chamber thermodegradation) of test samples prevents direct comparison of these toxicity data with most of the data contained in previous reports.

The pyrolysis/combustion process can apparently exert a significant influence upon the absolute toxicity, and maybe relative toxicity, of the pyrolysis/combustion products produced. Much of the previous toxicity data obtained from spacecraft materials utilized a controlled heating rate for thermodegradation outside the exposure chamber, and continuous air-flow through the chamber during pyrolysis and post-pyrolysis exposure (the MSTL procedure). The theoretical rationale usually stated in support of <u>in-chamber</u> pyrolysis/combustion is based upon the concern that some toxicity is lost due to condensation/precipitation of some thermodegradation products from external pyrolysis/combustion prior to entering the exposure chamber. If this were true, then there would be a reduction in the observed toxicity from such externally produced

pyrolysis/combustion products when compared to in-chamber pyrolysis.

An earlier report (1) presented toxicity data from a limited number of samples that were evaluated both by in-chamber pyrolysis procedure and by the MSTL procedure (as mentioned above). Although it was apparent that condensates did occur prior to entrance of pyrolysates into the exposure chamber, lethality data did not support the concept that these "high boiling" condensates significantly contributed to the lethality of the pyrolysis/combustion products. The data, in fact, indicated the pyrolysis/combustion products produced by the MSTL (outside of chamber) procedure were more toxic than those produced by the in-chamber method in every instance where there was comparable data. This phenomenon might be due to the formation of different gaseous products by the slower rate of thermodegradation (by the MSTL method) and/or a longer exposure period.

The in-chamber thermodegradation procedure used in the current study does not permit the slow rate of degradation, as used in the MSTL procedure, because of (a) the need to prevent excessive temperatures (i.e., greater than 35°C) within the animal exposure chamber, and (b) the fixed volume of air (i.e., static environment during pyrolysis and subsequent exposure) contained in the animal exposure chamber may produce

---

[1] W.H. Lawrence and John Autian, "Toxicity of the Pyrolysis Products of Spacecraft Materials", Annual Report to NASA Johnson Space Center, July 25, 1978, p. 45.

hypoxia in the experimental animals (independent of pyrolysate toxicity) as a result of longer sojourns of animals in chamber, coupled with depletion of oxygen by pyrolysis/combustion of the test samples.

The preceeding discussion should be kept in mind in evaluating the subsequent data. These comments may also help to understanding why it was sometimes necessary to conduct the experiment or test in a particular manner.

Purpose of Work. The primary objective of this work was to obtain information about the relative toxicity of thermodegradation (pyrolysis/combustion) products of spacecraft materials supplied by the Technical Monitor. The biological activities of the pyrolysis/combustion products were evaluated based upon the acute lethality to rats from inhalation of these pyrolysates. Post-exposure observation of the rats, coupled with histological evaluation of selected organs, serve to screen the materials for significant delayed toxic reactions resulting from inhalation of their pyrolysis/combustion products. Also, determination of carbon monoxide concentrations in the chamber atmosphere during exposure, and percent carboxyhemoglobin in animals expiring in the chamber, provide some basis for assessing the importance of carbon monoxide as a toxicant in the pyrolysis/combustion mixture.

Materials and Methodology

Materials. The code designations and description of the test samples, as supplied by the Technical Monitor, included

in this study are presented in Table 1.

Method of Sample Pyrolysis/Combustion. All samples were pyrolyzed/combusted directly in the rat exposure chamber using an electric furnace, and all products mixed thoroughly with the chamber atmosphere by an electric fan located inside the exposure chamber. An experimental constraint which influenced pyrolysis/combustion of samples was that of chamber temperature, i.e., the chamber temperature was not to exceed 35°C (95°F). To accomplish this, the sample was pyrolyzed rapidly (~ 10 minutes) and the furnace removed from the chamber to reduce added heating of the chamber atmosphere from the furnace as it was cooling (i.e., after thermodegradation).

The first part of this study was performed using a conical ceramic furnace with a platinum wire heating element to provide rapid, intense heat for thermodegradation of the test sample. Initially this system worked quite well, but after awhile the furnace began to fail, often breaking down in the middle of an experiment. It was found that the exposed platinum wire was apparently reacting with the pyrolysis products, which resulted in its failure as a heating element. This procedure permitted rapid attainment of a high temperature (well in excess of 1,000°C) to produce rapid thermodegradation (pyrolysis) of the test sample, and thereby minimizing heating of the exposure chamber atmosphere. Problems associated with this procedure were that the platinum heating element

degenerated with use, and it was also difficult to quantitatively recover sample residues thereby providing, at best, only estimates of percent degradation.

A new furnace was built which was used in the rest of the study. It contained heating elements embedded in a high temperature ceramic type material which were located in the bottom and four sides of a rectangular chamber 3" x 3" x 5". These heating elements had a maximum temperature rating of 1,200°C., thus exceeding the 1,000°C capability which we desired. A removable stainless steel rectangular cup, with internal dimensions of 2.5" x 2.5" x 4.5", was constructed to fit closely inside the space formed by the heating elements. Since this furnace requires much longer to pyrolyze a sample, starting at room temperature, than the platinum-wire one, pyrolysis was accomplished by pre-heating the furnace (outside of the chamber) to about 800-900°C, then placing the stainless steel cup (containing the test sample) in the furnace opening, and immediately placing the furnace and sample in position to pyrolyze the sample directly into the rat exposure chamber. When pyrolysis was completed this furnace, like the other one, was removed from the exposure chamber to prevent additional heating of the chamber atmosphere by radiation from the furnace. The time required for thermodegradation, and the increase in chamber temperature, varied depending upon sample and quantity of sample. In most cases, however, this could be accomplished and still maintain the chamber temperature less than 35°C (95°F). One advantage to this system was

that it provided a more accurate and easier determination of sample residue.

Thermogravimetric Analyses (TGA). The thermodegradation characteristics of each sample were determined in air and nitrogen. This provided general information about the temperature required to initiate degradation, to complete degradation, expected percent degradation, and some indication of the importance of oxidative processes for degradation.

LD_{50} Determinations. The lethality of each sample was determined by pyrolyzing specific weights of sample and exposing a group of 4 male Sprague Dawley rats to the pyrolysates for 30 minutes after completion of pyrolysis of each sample weight. LD_{50}s were calculated for the samples based upon chamber deaths, deaths occurring within 48 hours, and those occurring within the 14-day post-exposure observation period. The chamber atmosphere was analyzed for selected gases by use of gas detector tubes or gas chromatography, or both. Carboxyhemoglobin (COHb) levels were determined in rats which died in the chamber. Animals were autopsied, when they died or were sacrificed after 14-days, and tissues from most of these preserved in buffered formalin and subjected to histopathologic evaluation. The actual LD_{50}, expressed as initial weight of sample, which when pyrolyzed by this method would kill 50% of exposed rats, was calculated by Cornfield and Mantel's modification of Karber's method (2).

---

[2] J. Cornfield and N. Mantel, "Some New Aspects of the Application of Maximum Likelihood to the Calculation of the Dosage Response Curve", American Statistical Association Journal, 45:181-210 (1950).

Results and Discussion

Thermogravimetric Analyses (TGA). A computer plot of the thermodegradation of each test material is presented in Figures 1 through 15. Each material was tested in air and nitrogen to obtain an indication of the importance of oxidative degradation vs. a non-oxidative atmosphere.

During the TGA runs, it was noted that the platinum weighing pans tended to fail (develop a hole, etc.) after repeated use. This would suggest the possibility of reaction between the pyrolysis products and the platinum, an observation also noted with the platinum wire furnace. Therefore, the TGA data must be considered as approximations where the patterns of decomposition of samples are probably real, but too much significance should not be attached to exact sample residue weights or percentages.

Significant information from the TGA experiments is summarized, grouped by sample, and presented in Tables 2 through 6.

Comparative Toxicity of Samples. The LD_{50} values for each sample material, for chamber deaths, cumulative deaths through 48 hours, and cumulative deaths through 14 days post-exposure are presented in Table 7. Summary data from individual pyrolysis/combustion experiments used in determining the LD_{50} values for the samples are presented in Tables 8 through 12. These show sample weights, percent pyrolyzed, mortality, mean COHb, oxygen, carbon dioxide, carbon monoxide, hydrogen cyanide, and water vapor values.

Based upon lethality from initial sample weights, the KAU foam (Y-7387) was the most toxic of these samples, with the UNI form (Y-7388) as a close second; the LD_{50} values for these two samples were very close and their 95% confidence intervals were overlapping. The Minicell sample (Y-7391) had a higher LD_{50}, but also a larger range for its 95% confidence interval, thus its 95% confidence interval also overlapped those of the KAU and UNI foams. The other two samples required significantly larger quantities to obtain an LD_{50}, with the Adhesive backed Metallic Tape (Y-7389) requiring the most sample. This information is contained in Table 7.

Table 13 incorporates the theoretical percent decomposition of samples (from TGA data) with the sample weights required to kill 50% of the exposed rats. The KAU and UNI foams were essentially completely degraded by the heat, but the other samples left a residue of about 20 to 80% of the initial sample weight, as indicated from Table 13. Table 14 presents a ranking of these samples, from least toxic to most toxic, based upon (I) the initial sample weight, and (II) from the theoretical quantity of the sample pyrolyzed/combusted.

Autopsy. Gross observations, for the most part, were rather nonspecific with non-consistent changes in coloration and/or texture of internal organs. Suggestions of pulmonary hemorrhage, of varying degrees, was observed fairly frequently, but not always, in animals dying in the chamber and those sacrificed two weeks later. A dark colored debris, presumably

particulate matter from pyrolysis, was noted in the pulmonary system of chamber deaths from Y-7390 (RTV Silicone Rubber Adhesive Sealant).

Histological examination revealed acute pulmonary congestion and edema in many of the animals, which were generally diffuse and ranged from mild to severe. Pneumonitis was seen in some acute exposure animals (chamber deaths), which did not seem to be related to pyrolysate exposure but may, at times, have been a contributory factor to death of the animal. There is the impression, however, that pyrolysate exposure tended to intensify or to create pulmonary and tracheal disorders/disturbances in many of the animals sacrificed 14 days post-exposure. Foreign debris were seen in the trachea and/or lungs of a few animals exposed to pyrolysates from Y-7391 (Minicell), but generally not as common or severe as with Y-7390. Pyrolysate exposure to sample Y-7390 (RTV Silicone) produced massive accumulation of debris in the respiratory system of exposed rats. From the amount of accumulation it would appear that the rats dying in the chamber was the result of suffocation from respiratory blockage. A summary of the histopathological evaluation for each sample is presented in Tables 15 through 19. An example of histological data accumulation and summarization is presented in Exhibit A, at the end of this report.

Comments about Y-7390. This sample, RTV Silicone Rubber Adhesive Sealant, was received as a paste in a tube. It was extruded onto glass and allowed to cure at room temperature

for at least 24 hours prior to testing. During heating for pyrolysis. the sample tended to intermittently burst into flames and gave off a copious greyish-brownish soot. Relatively large quantities of this sample had to be pyrolyzed to kill the exposed rats. The smallest sample weight (i.e., sample weight after "curing" and air-drying) to produce a mortality was 23.87 gm. Once this critical sample size was reached, however, the mortality curve was quite steep; a sample weight of 26.68 killed all of the exposed rats. On the other hand, consistency of the mortalities was not good, since an intermediate quantity (25.24 gm) did not kill any of the exposed rats. Blood levels of COHb, from rats dying in the chamber, were low (27% to 41%); below levels which we have found in the past were necessary to kill rats. Concurrently, the detected levels of HCN, NO, NO_2 or HCl were also very low in the chamber atmosphere, thus rat mortality could not be attributed to either of these compounds.

Therefore, the evidence (including histopathology) would suggest the lethal effect of the RTV Silicone (Y-7390) was due to physical obstruction of respiration by particulate matter formed during pyrolysis/combustion. This prompted us to attempt to determine the lethality of this sample in the absence of the particulates. There was no practical way of doing this without significant changes in the method of pyrolysis and/or exposure, so we decided to compromise and look at the mortality when the quantity of particulate matter is reduced, but not totally eliminated. This was done by attaching a small vacuum

cleaner bag over the outlet of the squirrel cage blower (used to mix and circulate the atmosphere within the exposure chamber), thus as the air is drawn through the fan, the larger particles would be retained in the bag rather than recirculated throughout the chamber. The problem with this, however, is that the air-vapor-particulate mixture does not necessarily pass through the fan before reaching the rats, and, further, the minimum particle size retained by the bag may not be as small as would be desirable.

This "filtration" process provided limited success. In the original experiment (without any filtration), 26.68 gm of the sample produced 100% chamber mortalities; in experiments with the crude filter, sample weights of 26.68 gm and 33.35 gm did not produce any deaths (either chamber or during the 14-day post-exposure period) and about 2 gm of particulate matter was trapped in each test. It was desired to obtain an LD_{50} for the sample without the particulates, but (a) the filtration procedure used reduced, but did not eliminate particulate matter, and (b) only 34.4 gm of the sample remained. A third experiment was conducted with the remainder of the sample using the vacuum cleaner bag filter, as described above, and the 34.4 gm was pyrolyzed/combusted. This time there was 100% chamber mortality. Although about 2 1/2 gm of material was collected in the bag (filter), a pronounced layer of brownish soot was deposited throughout the interior of the exposure chamber, attesting to the inefficiency of the filtration procedure. Autopsy of the rats (both gross observations and

histological examination) revealed their respiratory tracts were filled with brownish to black debris.

In conclusion, the LD_{50} for the RTV Silicone sample (Y-7390) when pyrolyzed/combusted in the exposure chamber was 25.6 gm (95% confidence interval of 24.9 and 26.3 gm), however accumulated data indicate this was not due to toxic gases, but rather from physical obstruction of the respiratory tract by particulates generated in the pyrolysis/combustion process.

Summary and Conclusions

Toxicity of pyrolysis/combustion products from these spacecraft materials, based upon lethality to exposed rats, was summarized in Tables 7 and 13, and a ranking of samples according to lethality of their pyrolysis products in Table 14. Data such as these, if available for all candidate materials, can be quite useful in selecting those materials for use in spacecraft which pose tne least toxic hazard to the occupants if localized overheating should occur. It is important, however, that all data used in the relative toxicity assessment be generated under the same experimental conditions, since the LD_{50} values obtained for materials may vary considerable when obtained under varying conditions of pyrolysis/combustion and animal exposure as discussed in the "Introduction".

Other considerations in selection of the best of the candidate materials include factors such as (normal) working maximum temperature in desired application, temperature at which

thermodegradation is initiated, density of material*, total quantity of material for the particular application, the tendency for the material to support combustion, etc., in addition to the inherent toxicity of the pyrolysis products produced by the material.

The TGA indicate that four of these five materials (all except the RTV Silicone) begin to degrade at relatively low temperatures (approximately 200°C or less) although it required an excess of 700°C to complete degradation. Thus the use of any of these four materials might be suspect for any application in which the maximum temperature, which might be expected during operation, would reach 150° to 200°C or more.

Pyrolysis/combustion of Y-7390 (RTV Silicone) tends to occur with intermittent bursts (presumably of spontaneous combustion) and the formation of rather dense particulates or grey to black soot (described by one technician as "volcanic eruptions"). Mortalities of rats exposed to the pyrolysis/combustion products of this material appeared to result from mechanical suffocation due to accumulation of this "soot" in the respiratory tract. The dense particulates also tend to markedly restrict vision, and might cause failure of mechanical equipment as they settled out.

Temperature control inside the exposure chamber was also

---

*Consider, as an illustration, two foams used as a seat cushion: foam "A" may produce more toxic pyrolysis products than foam "B" on a weight basis, but foam "A" is also more resilient and is lighter (less weight per unit volume) than foam "B". Thus it is possible that when considered as a *functional unit*, the seat cushion made of foam "A" may be less toxic than the seat cushion made of foam "B".

a problem with pyrolysis of some of the materials, particularly Y-7389 and Y-7390, because of the difficulty in obtaining maximum thermodegradation of the samples. As presented in Tables 10, 11 and 11-a, the exposure chamber maximum temperatures frequently exceeded the desired maximum of 35°C (95°F). These excess temperatures were not, in themselves, lethal to the rats as shown by all rats surviving exposure to some of the higher temperatures. This may be due to the relatively short time the rats are exposed to these higher (>35°C) temperatures. However the possibility cannot be excluded that the elevated chamber temperature might have potentiated the toxicity of the pyrolysate generated. While ambient temperatures in the exposure chamber might have been kept to lower levels by insertion of a cooling coil into the chamber or by cooling top and sides of the chamber, these were avoided because of the concern that they would lead to increased condensation or deposition of substances in the pyrolysate, thereby negating the theoretical advance of in-chamber pyrolysis over outside-of-chamber pyrolysis.

Table 1

IDENTIFICATION OF SAMPLES

(Spacecraft Materials)

Y-7387	KAU Foam (gray foam)
Y-7388	UNI Foam, S82H (gray foam)
Y-7389	Adhesive Backed Metallic Tape, Scotch Brand (3M)
Y-7390	RTV Silicone Rubber Adhesive Sealant, General Electric, RTV 159, Red
Y-7391	Minicell L-200 coated with Fluorel (blue foam with light gray, almost white, coating on outside. This coating can be peeled off of foam block.)

Table 2

ANALYSIS OF TGA DATA

Identification	Y-7387 KAU Foam (gray)		
TGA Run No.	370	356	359
Atmosphere	Air	Air	Nitrogen
Flow Rate	200 ml/min	20 ml/min	20 ml/min
Heating Rate	10°C/min	20°C/min	20°C/min
Sample Weight	3.75 mg	3.0 mg	3.18 mg
Approximate Initiation of Decomposition, °C*	145	165	170
Approximate Completion of Decomposition, °C*	615	790	795
Maximum TGA Temp.	1000°C	1032°C	977°C
Final Residue Weight	0 mg	0 mg	0 mg
Percent Final Residue	0%	0%	0%
Approximate Temperature for 50% Degradation, °C*	285°C	345°C	350
Percent Residue at 600°C	0%	5.7%	1.6%

* Value to nearest 5°C.

Table 3

ANALYSIS OF TGA DATA

Identification	Y-7388 UNI (or UM) Foam S82H (gray)		
TGA Run No.	371	357	358
Atmosphere	Air	Air	Nitrogen
Flow Rate	200 ml/min	20 ml/min	20 ml/min
Heating Rate	10°C/min	20°C/min	20°C/min
Sample Weight	4.7 mg	3.0 mg	3.3 mg
Approximate Initiation of Decomposition, °C*	135	160	180
Approximate Completion of Decomposition, °C*	800	775	790
Maximum TGA Temp.	1072°C	993°C	1025°C
Final Residue Weight	0 mg	0 mg	0 mg
Percent Final Residue	0%	0%	0%
Approximate Temperature for 50% Degradation, °C*	320	340	360
Percent Residue at 600°C	3.6%	1.3%	5.2%

* Value to nearest 5°C.

Table 4

ANALYSIS OF TGA DATA

Identification	Y-7389 Adhesive backed metallic tape (Scotch)		
TGA Run No.	375	353	365
Atmosphere	Air	Air	Nitrogen
Flow Rate	200 ml/min	20 ml/min	20 ml/min
Heating Rate	10°C/min	20°C/min	20°C/min
Sample Weight	10.5 mg	5.72 mg	7.91 mg
Approximate Initiation of Decomposition, °C*	240	170	310
Approximate Completion of Decomposition, °C*	435	510	450
Maximum TGA Temp.	961°C	892°C	689°C
Final Residue Weight	8.5 mg	4.72 mg	6.54 mg
Percent Final Residue	81%	83%	83%
Approximate Temperature for 50% Degradation, °C*	----	----	----
Percent Residue at 600°C	82%	83%	83%

* Value to nearest 5°C.

Table 5

ANALYSIS OF TGA DATA

Identification	Y-7390 RTV Silicone rubber adhesive sealant (G.E.)		
TGA Run No.	378	374	366
Atmosphere	Air	Air	Nitrogen
Flow Rate	200 ml/min	20 ml/min	20 ml/min
Heating Rate	10°C/min	20°C/min	20°C/min
Sample Weight	4.16 mg	3.83 mg	4.39 mg
Approximate Initiation of Decomposition, °C*	360	350	405
Approximate Completion of Decomposition, °C*	500	785	645
Maximum TGA Temp.	747°C	890°C	1012°C
Final Residue Weight	1.41 mg	1.13 mg	0.84 mg
Percent Final Residue	34%	30%	19%
Approximate Temperature for 50% Degradation, °C*	475	485	560
Percent Residue at 600°C	36%	37%	26%

* Value to nearest 5°C.

Table 6

ANALYSIS OF TGA DATA

Identification	Y-7391 Minicell L-200 coated with Fluorel		
TGA Run No.	377	355	360
Atmosphere	Air	Air	Nitrogen
Flow Rate	200 ml/min	20 ml/min	20 ml/min
Heating Rate	10°C/min	20°C/min	20°C/min
Sample Weight	4.91 mg	6.81 mg	8.7 mg
Approximate Initiation of Decomposition, °C*	190	205	235
Approximate Completion of Decomposition, °C*	435	810	----
Maximum TGA Temp.	806°C	906°C	1010°C
Final Residue Weight	1.0 mg	1.5 mg	1.5 mg
Percent Final Residue	20%	22%	17%
Approximate Temperature for 50% Degradation, °C*	370°C	430°C	445°C
Percent Residue at 600°C	22%	27%	23%

* Value to nearest 5°C.

44% White coating
56% Blue foam
All runs

Table 7

LD_{50} AND (95% CONFIDENCE INTERVAL) BASED UPON INITIAL WEIGHT OF SAMPLE PYROLYZED

Sample	Chamber	48 Hours	14 Days
Y-7387 KAU Foam	6.29 gm (5.82-6.79)	6.29 gm (5.82-6.79)	6.13 gm (5.78-6.50)
Y-7388 UNI Foam	6.43 gm (6.08-6.80)	6.43 gm (6.08-6.80)	6.43 gm (6.08-6.80)
Y-7389 Metallic Tape	62.51 gm (57.77-67.62)	62.51 gm (57.77-67.62)	57.50 gm (54.39-60.80)
Y-7390 RTV Silicone	25.59 gm (24.89-26.31)	25.59 gm (24.89-26.31)	25.59 gm (24.89-26.31)
Y-7391 Minicell	7.68 gm (6.31-9.34)	7.68 gm (6.31-9.34)	7.47 gm (6.44-8.66)

Table 8

ACUTE TOXICITY OF PYROLYSIS/COMBUSTION PRODUCTS

Sample Y-7387: KAU Foam

Initial Weight	Percent Pyrolyzed	Mortality		Maximum Chamber Temp.	COHb (mean)	---Chamber Atmosphere Analysis*--				
		Chamber	Delayed			O_2	CO_2	CO	HCN (ppm)	H_2O (mg/L)
5.00 gm	100%	0%	0%	32°C	N/A	(23%)	(0.49%) 0.8%	(0.18%) 0.2%		8
5.53 gm	100%	0%	0%	32°C	N/A	(19%)	(0.76%) 0.9%	(0.11%) 0.3%		18
6.12 gm	100%	75%	25%	35°C	46%	(19%)	(1.07%) 2.2%	(0.28%) 0.3%		>18
6.77 gm	100%	50%	0%	31°C	48%	(19%)	(0.71%) 1.0%	(0.10%) 0.3%		9
7.50 gm	100%	100%	0%	34°C	57%	(21%)	(1.26%) 1.8%	(0.12%) 0.5%		

*Gas chromatographic analyses were conducted immediately after pyrolysis of sample (0 time), and after 15 and 30 minutes. These are reported as the mean of the three determinations enclosed in parentheses. Other values were obtained from gas detector tube readings.

Table 9

ACUTE TOXICITY OF PYROLYSIS/COMBUSTION PRODUCTS

Sample Y-7388: UNI Foam, S82H

Initial Weight	Percent Pyrolyzed	Mortality		Maximum Chamber Temp.	COHb (mean)	---Chamber Atmosphere Analysis*--				
		Chamber	Delayed			O_2	CO_2	CO	HCN (ppm)	H_2O (mg/L)
6.99 gm	89%	0%	0%	32°C	N/A	(19%)	(0.52%) 0.6%	(0.08%) 0.18%	100	18
7.39 gm	95%	100%	0%	32°C	66%	(22%)	(1.43%) 1.0%	(0.20%) 0.3%	150	18
7.81 gm	95%	75%	0%	32°C	69%	(20%)	(0.49%) 1.0%	(0.19%) 0.21%	>150	18
8.26 gm	94%	100%	0%	34°C	67%	(19%)	(0.89%) 1.0%	(0.25%) 0.3%	150	16
8.73 gm	92%	100%	0%	34°C	72%	(21%)	(0.57%) 1%	(0.17%) 0.28%	>150	17

*Gas chromatographic analyses were conducted immediately after pyrolysis of sample (0 time), and after 15 and 30 minutes. These are reported as the mean of the three determinations enclosed in parentheses. Other values were obtained from gas detector tube readings.

Table 10

ACUTE TOXICITY OF PYROLYSIS/COMBUSTION PRODUCTS

Sample Y-7389: Adhesive Backed Metallic Tape, Scotch Brand (3M)

Initial Weight	Percent Pyrolyzed	Mortality		Maximum Chamber Temp.	COHb (mean)	---Chamber Atmosphere Analysis*---				
		Chamber	Delayed			O_2	CO_2	CO	HCN (ppm)	H_2O (mg/L)
50.00 gm	17%	0%	0%	45°C	N/A	(18%)	(4.45%) 5%	(0.11%) 0.2%	5	16
55.90 gm	15%	25%	0%	39°C	67%	(17%)	(5.57%) 3.2%	(0.10%) 0.4%		8
62.50 gm	16%	25%	75%	40°C	66%	(20%)	(1.00%) 1.0%	(0.23%) 0.2%	2	18
69.88 gm	18%	100%	0%	39°C	56%	(17%)	(3.50%) 3.3%	(0.17%) 0.6%		16
78.13 gm	17%	100%	0%	35°C	74%	(18%)	(0.43%) 0.8%	(0.32%) 0.5%		4

* Gas chromatographic analyses were conducted immediately after pyrolysis of sample (0 time), and after 15 and 30 minutes. These are reported as the mean of the three determinations enclosed in parentheses. Other values were obtained from gas detector tube readings.

Table 11

ACUTE TOXICITY OF PYROLYSIS/COMBUSTION PRODUCTS

Sample Y-7390 RTV Silicone Rubber Adhesive Sealant (WITHOUT FILTER, see text)

Initial Weight	Percent Pyrolyzed	Mortality		Maximum Chamber Temp.	%COHb (mean)	O_2	CO_2	CO	HCN (ppm)	H_2O (mg/L)
		Chamber	Delayed							
9.76 gm	67%	0%	0%	34°C	N/A	(21%)	(1.63%) 1.9%	(0.05%) 0.08%	<5	18
17.05 gm	67%	0%	0%	42°C	N/A	(17%)	(2.62%) 3.0%	(0.10%) 0.12%	<5	>18
21.35 gm	75%	0%	0%	39°C	N/A	(18%)	(4.59%) 2.4%	(0.06%) 0.1%	<0.25	12
22.57 gm	85%	0%	0%	39°C	N/A	(20%)	(2.4%) **	(no peak) 0.04%		15
23.87 gm	72%	25%	0%	38°C	41%	(16%)	(3.24%) **	(0.07%) 0.12%	<0.25	11
25.24 gm	75%	0%	0%	39°C	N/A	(17%)	(3.59%) **	(0.03%) 0.1	<0.15	16
26.68 gm	74%	100%	0%	40°C	34%	(16%)	(4.21%) **	(0.15%) 0.3	1	18

*Gas chromatographic analyses were conducted immediately after pyrolysis of sample (0 time), and after 15 and 30 minutes. These are reported as the mean of the three determinations enclosed in parentheses. Other values are obtained from gas detector tubes.

**Out of appropriate detector tubes.

Table 11-a

ACUTE TOXICITY OF PYROLYSIS/COMBUSTION PRODUCTS

Sample Y-7390 RTV Silicone Rubber Adhesive Sealant (WITH FILTER, see text)

Initial Weight	Percent Pyrolyzed	Mortality		Maximum Chamber Temp.	COHb (mean)	---Chamber Atmosphere Analysis*--				
		Chamber	Delayed			O_2	CO_2	CO	HCN (ppm)	H_2O (mg/L)
26.68 gm	75%	0%	0%	39°C	N/A	(18%)	(3.45%) **	(no peak) 0.1%	<1	12
33.35 gm	76%	0%	0%	39°C	N/A	(16%)	(2.63%) **	(0.02%) 0.1	<1	12
34.40 gm	74%	100%	0%	40°C	49%	(14%)	(5.21%) **	(0.13%) 0.3	1	14

* Gas chromatographic analyses were conducted immediately after pyrolysis of sample (0 time), and after 15 and 30 minutes. These are reported as the mean of the three determinations enclosed in parentheses. Other values were obtained from gas detector tube readings.

** Out of appropriate detector tubes.

Table 12

ACUTE TOXICITY OF PYROLYSIS/COMBUSTION PRODUCTS

Sample Y-7391: Minicell L-200 coated with Fluorel.

Initial Weight	Percent Pyrolyzed	Mortality		Maximum Chamber Temp.	COHb (mean)	---Chamber Atmosphere Analysis*--				
		Chamber	Delayed			O_2	CO_2	CO	HCN (ppm)	H_2O (mg/L)
6.87 gm	80%	0%	0%	30°C	N/A	(19%)	(1.26%) 1.75%	(0.10%) 0.26%	7	14
7.68 gm	74%	75%	0%	32°C	71%	(18%)	(2.03%) 2.0%	(0.20%) 0.3%	12	18
8.59 gm	80%	75%	25%	33°C	82%	(17%)	(2.46%) 3.0%	(0.26%) 0.3%	25	18
9.60 gm	79%	100%	0%	34°C	77%	(18%)	(3.04%) 3.5%	(0.25%) 0.31%	15	18
12.0 gm	79%	100%	0%	30°C	67%	(17%)	(4.18%) >3%	(0.25%) 0.32%	15	>18

* Gas chromatographic analyses were conducted immediately after pyrolysis of sample (0 time), and after 15 and 30 minutes. These are reported as the mean of the three determinations enclosed in parentheses. Other values were obtained from gas detector tube readings.

Table 13

LETHALITY TOXICITY DATA AND PERCENT THERMODEGRADATION OF SAMPLES

Sample	14-Day LD_{50}[a]	Percent Decomposition of Sample: Theoretical est @ 700°C	(from TGA)[b] Final[c]	Expt'l Value[d]	Weight of Sample Decomposed at LD_{50}: Theoretical @ 700°C	(TGA) Final	Experimental Value
Y-7387	6.13 gm	~94%	94%	100%	~5.8 gm	5.8 gm	6.1 gm
Y-7388	6.43 gm	~99%	100%	93%	~6.4 gm	6.4 gm	6.0 gm
Y-7389	57.50 gm	~20%	20%	17%	~11.5 gm	11.5 gm	9.8 gm
Y-7390	25.59 gm	~70%	70%	74%	~17.9 gm	17.9 gm	18.9 gm[e]
Y-7391	7.47 gm	~77%	78%	78%	~ 5.8 gm	5.8 gm	5.8 gm

a) Chamber volume is approximately 200 liters.
b) TGA determined in air, with an airflow rate of 20 ml/min, and heating rate of 20°C/min.
c) Final temperatures ranged from 890°C to 1032°C, mean of 949°C.
d) Mean values from various experimental runs for determination of the LD_{50}s.
e) An undetermined quantity (weight) was deposited inside the exposure chamber after being dispersed during pyrolysis/combustion of the sample.

Table 14

RANKING OF SAMPLES BY LETHALITY FROM EXPOSURE TO PYROLYSIS/COMBUSTION PRODUCTS

I. Based Upon Initial Weight of Sample

Least Toxic	Y-7389 Adhesive Backed Metallic Tape
↓	Y-7390 RTV Silicone Rubber Adhesive Sealant
↓	Y-7391 Minicell L-200 Coated with Fluorel
↓	Y-7388 UNI Foam, S82H
Most Toxic	Y-7387 KAU Foam

II. Based Upon Quantity of Sample Pyrolyzed/Combusted (Experimental Value)

Least Toxic	Y-7390 RTV Silicone Rubber Adhesive Sealant
↓	Y-7389 Adhesive Backed Metallic Tape
↓	Y-7387 KAU Foam
↓	Y-7388 UNI Foam, S82H
Most Toxic	Y-7391 Minicell L-200 Coated with Fluorel

Table 15

SUMMARY OF HISTOPATHOLOGIC EVALUATION

Sample: Y- 7387 KAU Foam

Histopathologic features observed in organs/tissue of rats exposed to pyrolysis/combustion products of this material suggest inhalation of these products produced the following:

Two out of four animals showed evidence of congestion and edema acute, diffuse, moderate and atelectasis, diffuse, moderate to severe.
The other 2 of four animals showed evidence of chronic pulmonary disease such as bronchopneumonia, chronic, focal, moderate to severe which was not related to inhalation exposure but contributed to the death of the animals.

Histopathologic features observed in organs/tissues from rats exposed to pyrolysis/combustion products of this material suggest the following are delayed reactions (pathologies) which resulted from such exposure:

Twelve out of 21 animals showed hemorrhage, acute, mild to massive. Nine of these 12 (9/12) also showed bronchopheumonia, chronic, focal, mild to moderate; and/or atelectasis, focal to diffuse mild to severe; and/or emphysema, focal to diffuse, mild to severe. Of the remaining 9 of 21 animals, 3 of 21 showed bronchopneumonia, chronic focal, mild to moderate and one of these 2 also showed pneumonitis, chronic, focal mild, one of 21 showed multiple lung abcesses, three of 21 showed atelectasis, focal, moderate, 2 of 21 showed pneumonitis, focal, chronic, mild.

(Note! This summary should exclude any abnormality which does not appear to be related to inhalation exposure of the rats to the pyrolysates.)

Table 16

SUMMARY OF HISTOPATHOLOGIC EVALUATION

Sample: Y- 7388 UNI Foam, S82H

Histopathologic features observed in organs/tissue of rats exposed to pyrolysis/combustion products of this material suggest inhalation of these products produced the following:

Six out of six showed pulmonary congestion and edema, acute, diffuse mild to moderate; 1 of the six showed atelectasis focal mild.

Histopathologic features observed in organs/tissues from rats exposed to pyrolysis/combustion products of this material suggest the following are delayed reactions (pathologies) which resulted from such exposure:

Two out of 5 showed bronchopneumonia, chronic, focal, mild to moderate.

(Note! This summary should exclude any abnormality which does not appear to be related to inhalation exposure of the rats to the pyrolysates.)

Table 17

SUMMARY OF HISTOPATHOLOGIC EVALUATION

Sample: Y- 7389 Adhesive Backed Metallic Tape, Scotch Brand (3M)

Histopathologic features observed in organs/tissue of rats exposed to pyrolysis/combustion products of this material suggest inhalation of these products produced the following:

Five out of 6 animals showed pulmonary congestion and edema diffuse acute, mild to moderate, 2 out of 5 also showed atelectasis, focal, mild to moderate. One out of 6 showed massive acute hemorrhage.

Histopathologic features observed in organs/tissues from rats exposed to pyrolysis/combustion products of this material suggest the following are delayed reactions (pathologies) which resulted from such exposure:

Three out of 7 showed pneumonitis chronic focal, mild.
Two out of 7 showed bronchopheumonia, focal, chronic, mild to severe and one out of 7 also showed vasculitis, chronic, diffuse moderate.
One out of 7 showed no pathologic changes.

(Note! This summary should exclude any abnormality which does not appear to be related to inhalation exposure of the rats to the pyrolysates

Table 18

SUMMARY OF HISTOPATHOLOGIC EVALUATION

Sample: Y- 7390 RTV Silicone Rubber Adhesive Sealant

Histopathologic features observed in organs/tissue of rats exposed to pyrolysis/combustion products of this material suggest inhalation of these products produced the following:

Three out of three animals exposed to non-filtered pyrolysis/combustion products of Y-7390 showed massive debris within the pulmonary tree sufficient to suffocate the animal.

One out of two animals exposed to filtered pyrolysis/combustion products of Y-7390 showed a severe mucus-hemorrhagic exudate of the pulmonary tree which was sufficiently severe to be a contributory factor in the animal's death; the other animal showed evidence of previous pulmonary disease which was sufficient to contribute to the animal's death.

Histopathologic features observed in organs/tissues from rats exposed to pyrolysis/combustion products of this material suggest the following are delayed reactions (pathologies) which resulted from such exposure:

In the low dose groups (9.76 - 21.35 gm), 3/5 animals showed pneumonitis, acute and/or chronic, focal, mild to moderate. At higher doses (22.57 - 33.35 gm), 5/8 showed a variety of pulmonary lesions, such as pneumonitis, chronic, focal, mild to moderate; vasculitis, chronic, focal to diffuse, mild to severe; bronchopneumonia, chronic, mild; tracheitis, chronic, focal to diffuse, mild to moderate.

There appears to be no significant difference in pulmonary lesions between those animal exposed to the "filtered" vs. "non-filtered" pyrolysis/combustion products.

(Note! This summary should exclude any abnormality which does not appear to be related to inhalation exposure of the rats to the pyrolysate

Table 19

SUMMARY OF HISTOPATHOLOGIC EVALUATION

Sample: Y- 7391 Minicell (L-200 Coated with Fluorel)

Histopathologic features observed in organs/tissue of rats exposed to pyrolysis/combustion products of this material suggest inhalation of these products produced the following:

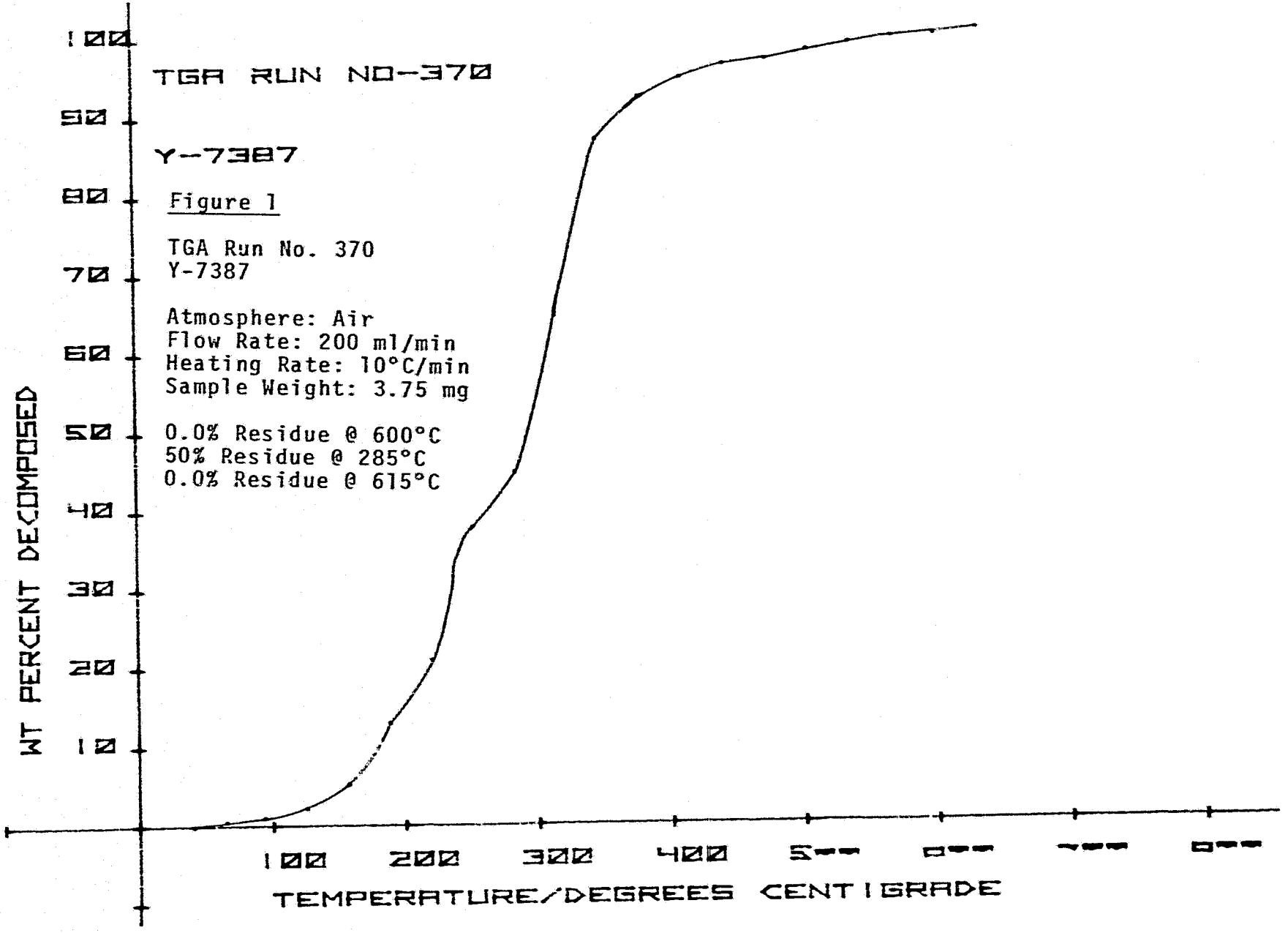
Five out of 7 showed congestion and edema, acute, diffuse mild to severe. One of 7 showed hemorrhage acute, moderate. One of 7 showed changes not related to inhalation exposure such as pneumonitis acute and chronic, diffuse moderate.

Histopathologic features observed in organs/tissues from rats exposed to pyrolysis/combustion products of this material suggest the following are delayed reactions (pathologies) which resulted from such exposure:

Seven out of 8 showed pneumonitis, acute and chronic, focal to diffuse, mild to severe. Of the 7, 3 of these (3/7) also showed bronchopneumonia, chronic, focal mild to severe. Two out of 7 showed atelectasis focal, mild, one of 7 showed vasculitis focal chronic mild, and congestion and edema acute diffuse mild.

One out of 7 showed congestion, acute, diffuse pulmonary and black debris in the trachea. The remaining one of the seven animals showed pneumonitis acute and chronic moderate to severe which may or may not be related to inhalation pyrolysates.

(Note! This summary should exclude any abnormality which does not appear to be related to inhalation exposure of the rats to the pyrolysates


TGA RUN NO-370
Y-7387
Figure 1
TGA Run No. 370
Y-7387
Atmosphere: Air
Flow Rate: 200 ml/min
Heating Rate: 10°C/min
Sample Weight: 3.75 mg
0.0% Residue @ 600°C
50% Residue @ 285°C
0.0% Residue @ 615°C
WT PERCENT DECOMPOSED
100
90
80
70
60
50
40
30
20
10
100
200
300
400
TEMPERATURE/DEGREES CENTIGRADE

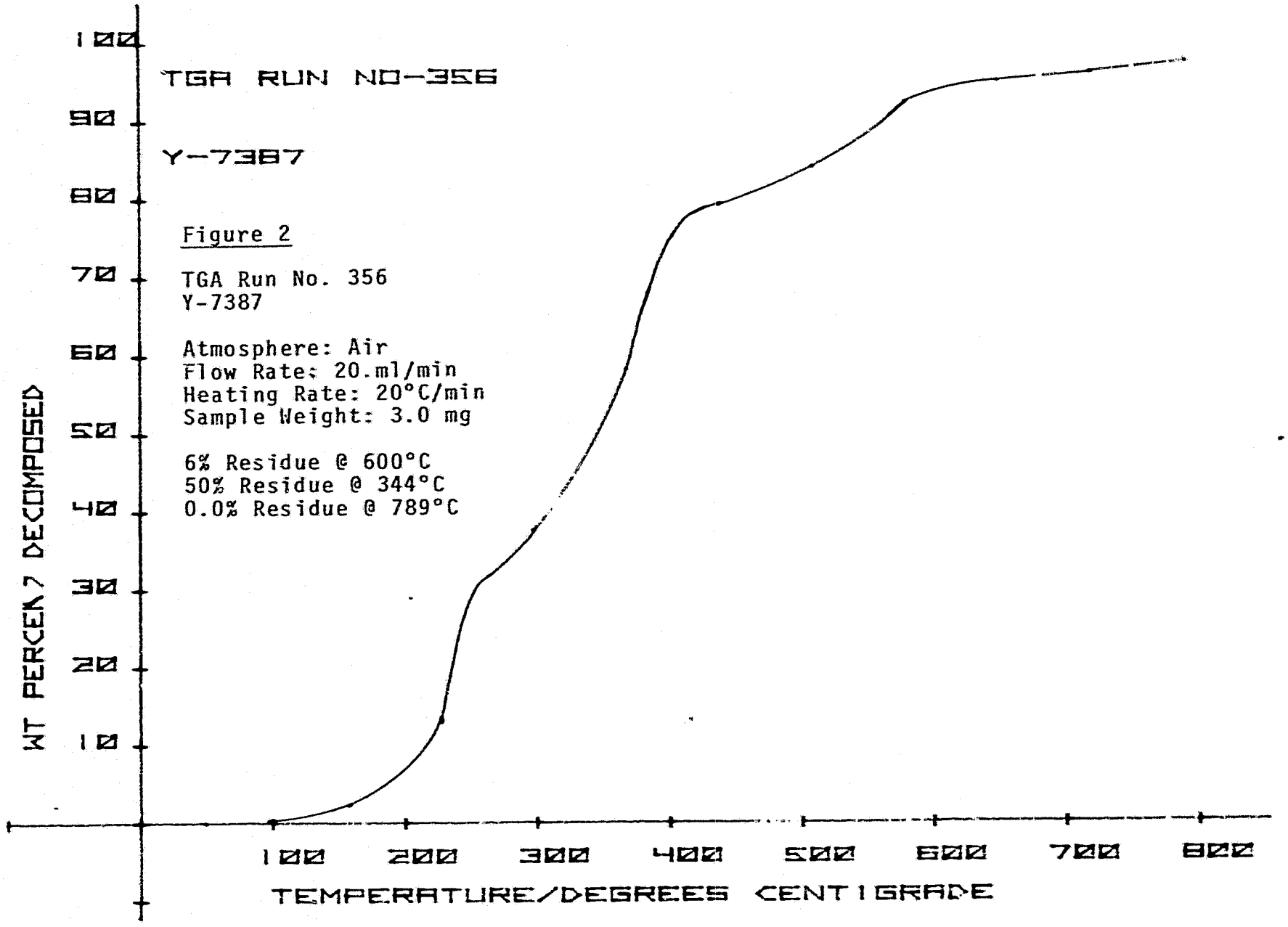
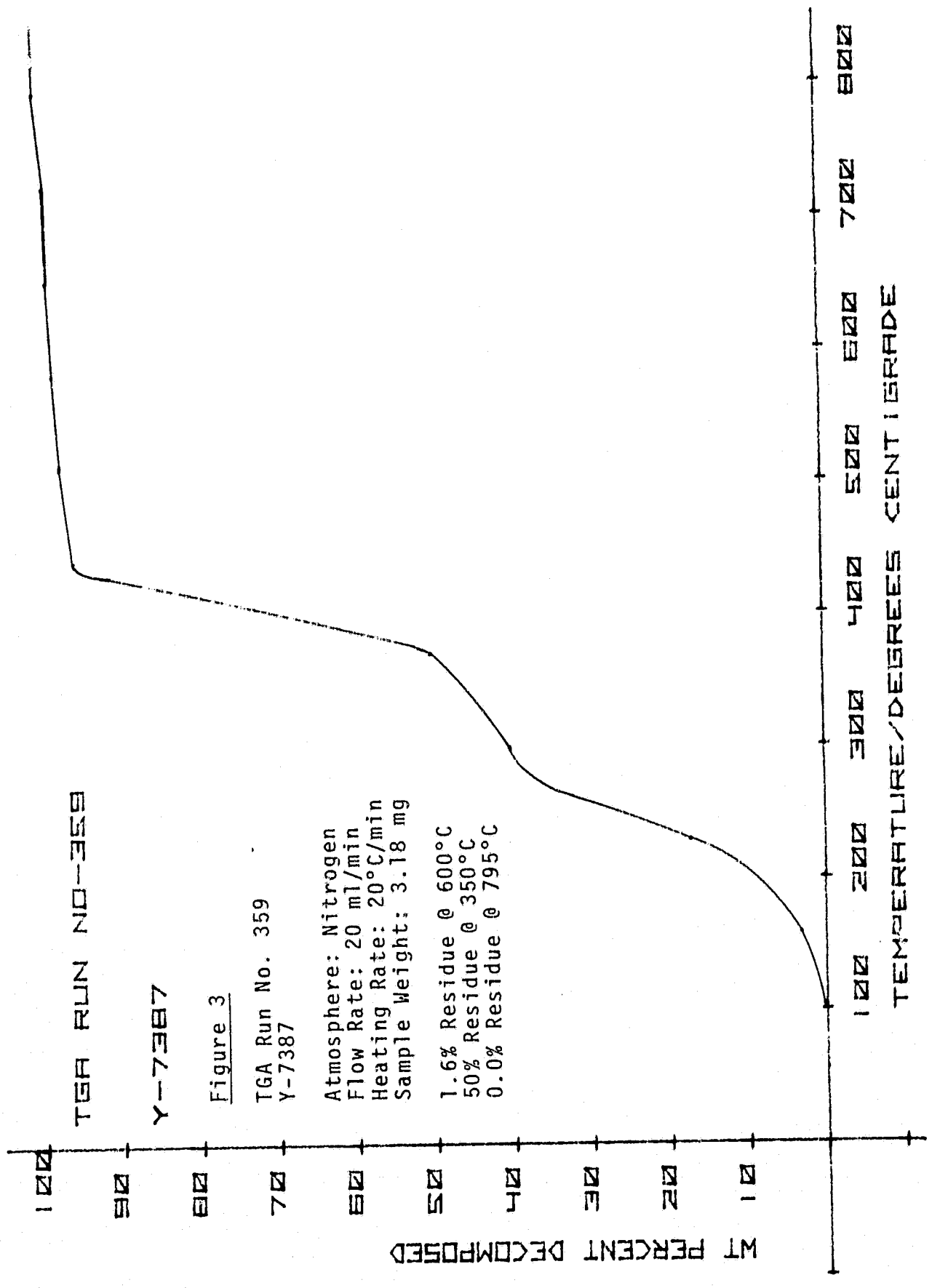


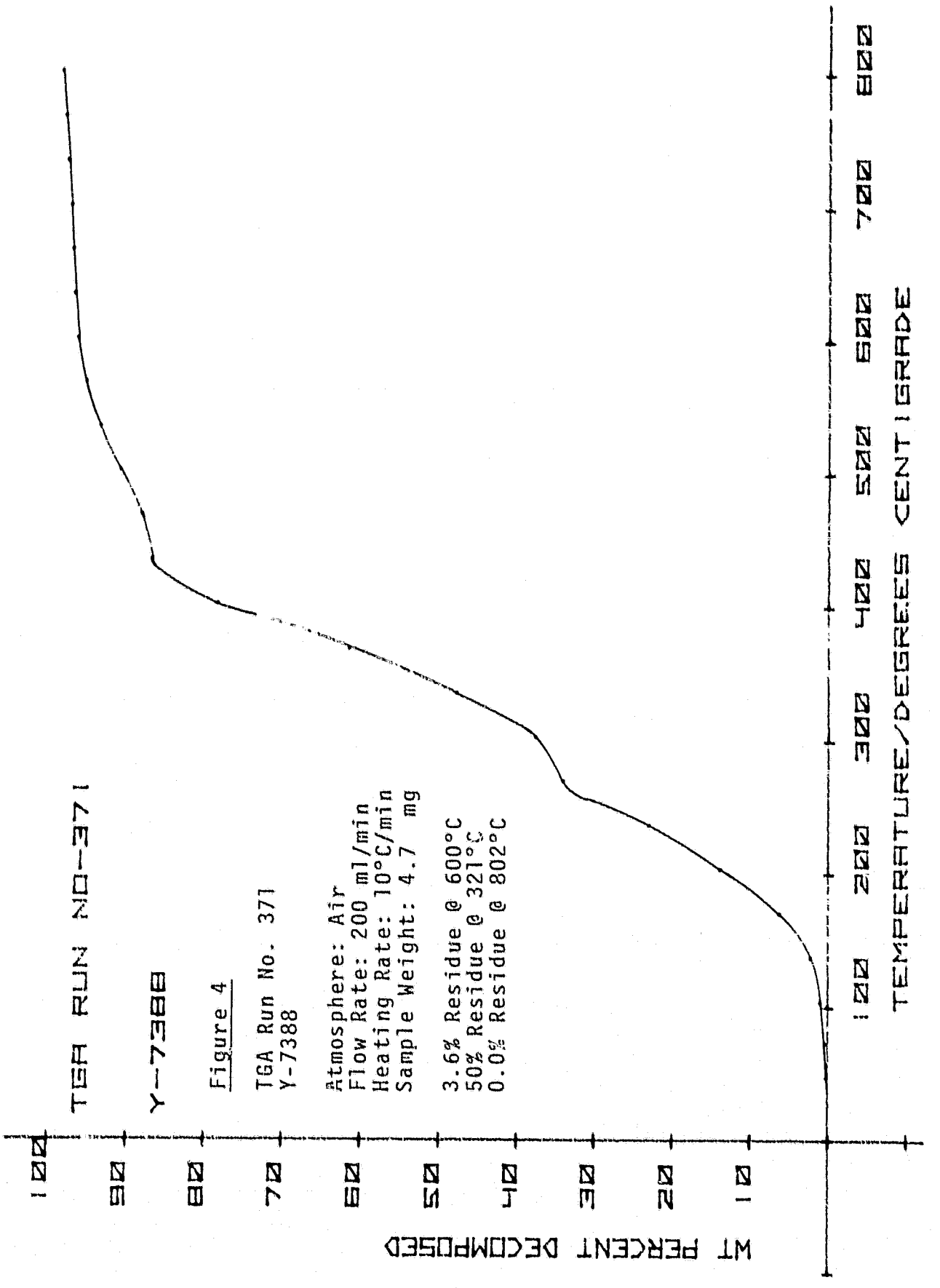
Figure 2

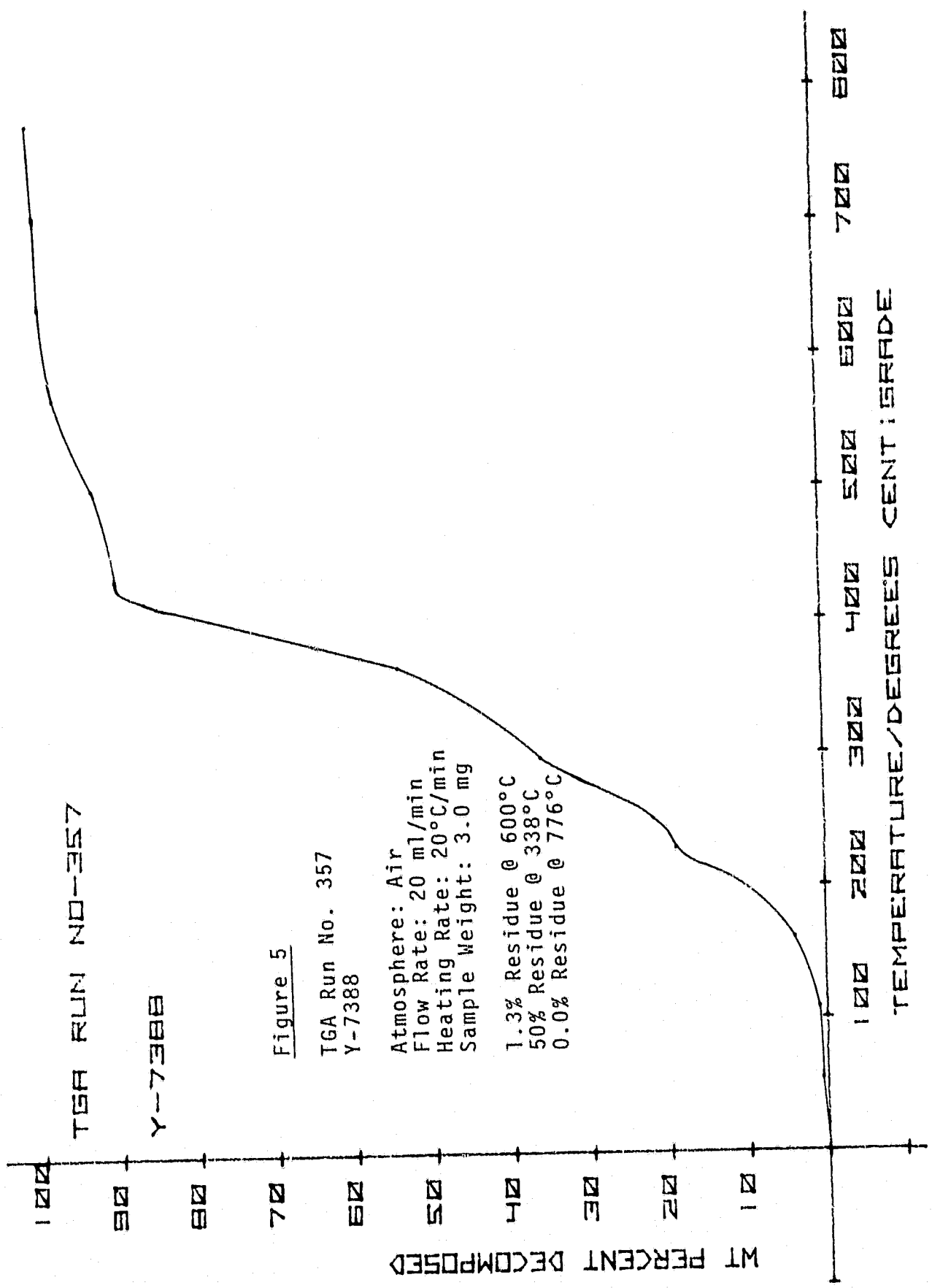
TGA Run No. 356
Y-7387

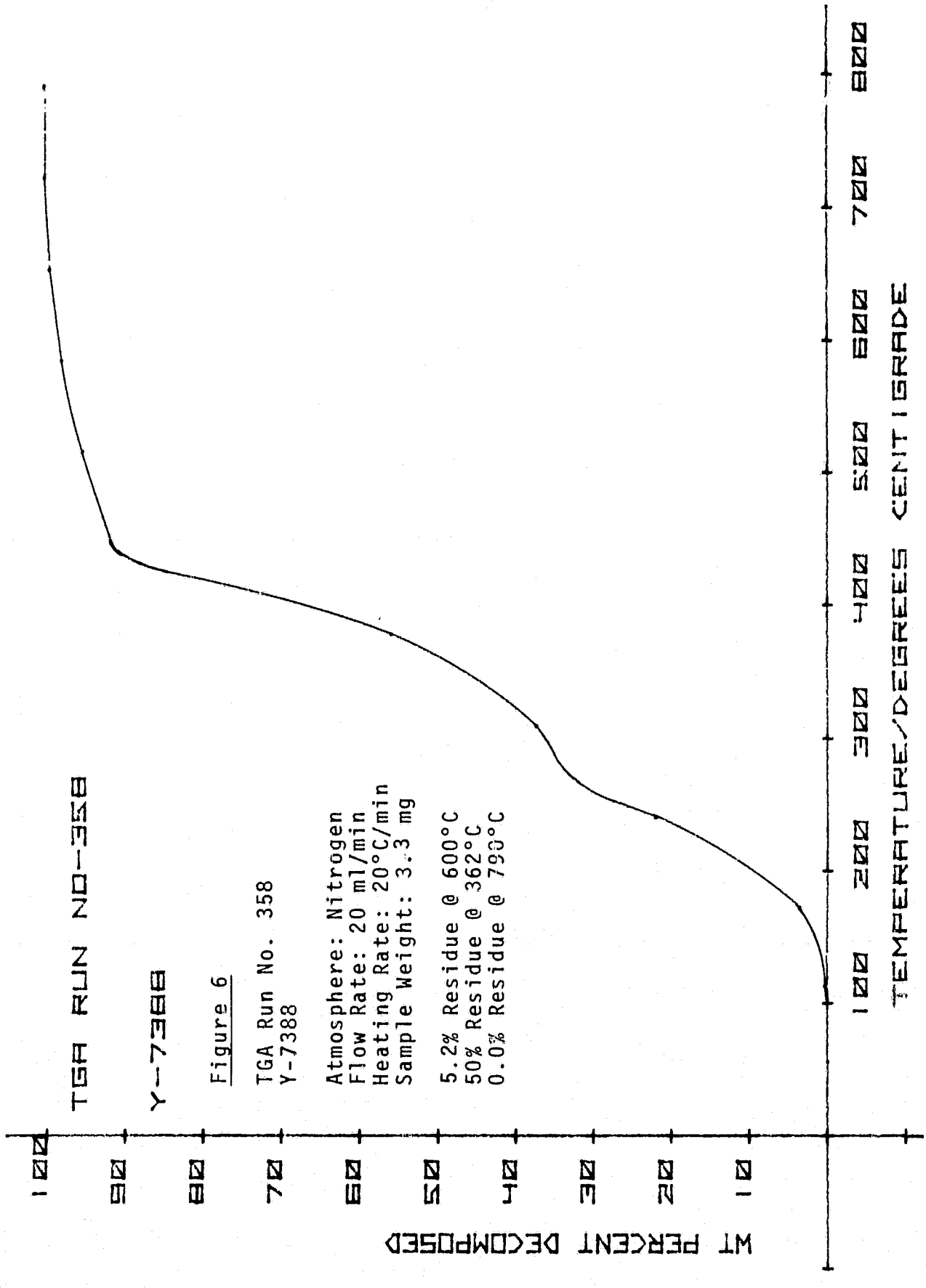
Atmosphere: Air
Flow Rate: 20.ml/min
Heating Rate: 20°C/min
Sample Weight: 3.0 mg

6% Residue @ 600°C
50% Residue @ 344°C
0.0% Residue @ 789°C


TGA RUN NO-359
Y-7387
Figure 3
TGA Run No. 359
Y-7387
Atmosphere: Nitrogen
Flow Rate: 20 ml/min
Heating Rate: 20°C/min
Sample Weight: 3.18 mg
1.6% Residue @ 600°C
50% Residue @ 350°C
0.0% Residue @ 795°C
WT PERCENT DECOMPOSED
100
90
80
70
60
50
40
30
20
10
100
200
300
400
500
600
700
800
TEMPERATURE/DEGREES CENTIGRADE


TGA RUN NO-371
Y-7388
Figure 4
TGA Run No. 371
Y-7388
Atmosphere: Air
Flow Rate: 200 ml/min
Heating Rate: 10°C/min
Sample Weight: 4.7 mg
3.6% Residue @ 600°C
50% Residue @ 321°C
0.0% Residue @ 802°C
WT PERCENT DECOMPOSED
100
90
80
70
60
50
40
30
20
10
100
200
300
400
500
600
700
800
TEMPERATURE/DEGREES CENTIGRADE


TGA RUN NO-357
Y-7388
Figure 5
TGA Run No. 357
Y-7388
Atmosphere: Air
Flow Rate: 20 ml/min
Heating Rate: 20°C/min
Sample Weight: 3.0 mg
1.3% Residue @ 600°C
50% Residue @ 338°C
0.0% Residue @ 776°C
WT PERCENT DECOMPOSED
100
90
80
70
60
50
40
30
20
10
100
200
300
400
500
600
700
800
TEMPERATURE/DEGREES CENTIGRADE


TGA RUN NO-358
Y-7388
Figure 6
TGA Run No. 358
Y-7388
Atmosphere: Nitrogen
Flow Rate: 20 ml/min
Heating Rate: 20°C/min
Sample Weight: 3.3 mg
5.2% Residue @ 600°C
50% Residue @ 362°C
0.0% Residue @ 790°C
WT PERCENT DECOMPOSED
100
90
80
70
60
50
40
30
20
10
100
200
300
400
500
600
700
800
TEMPERATURE/DEGREES CENTIGRADE

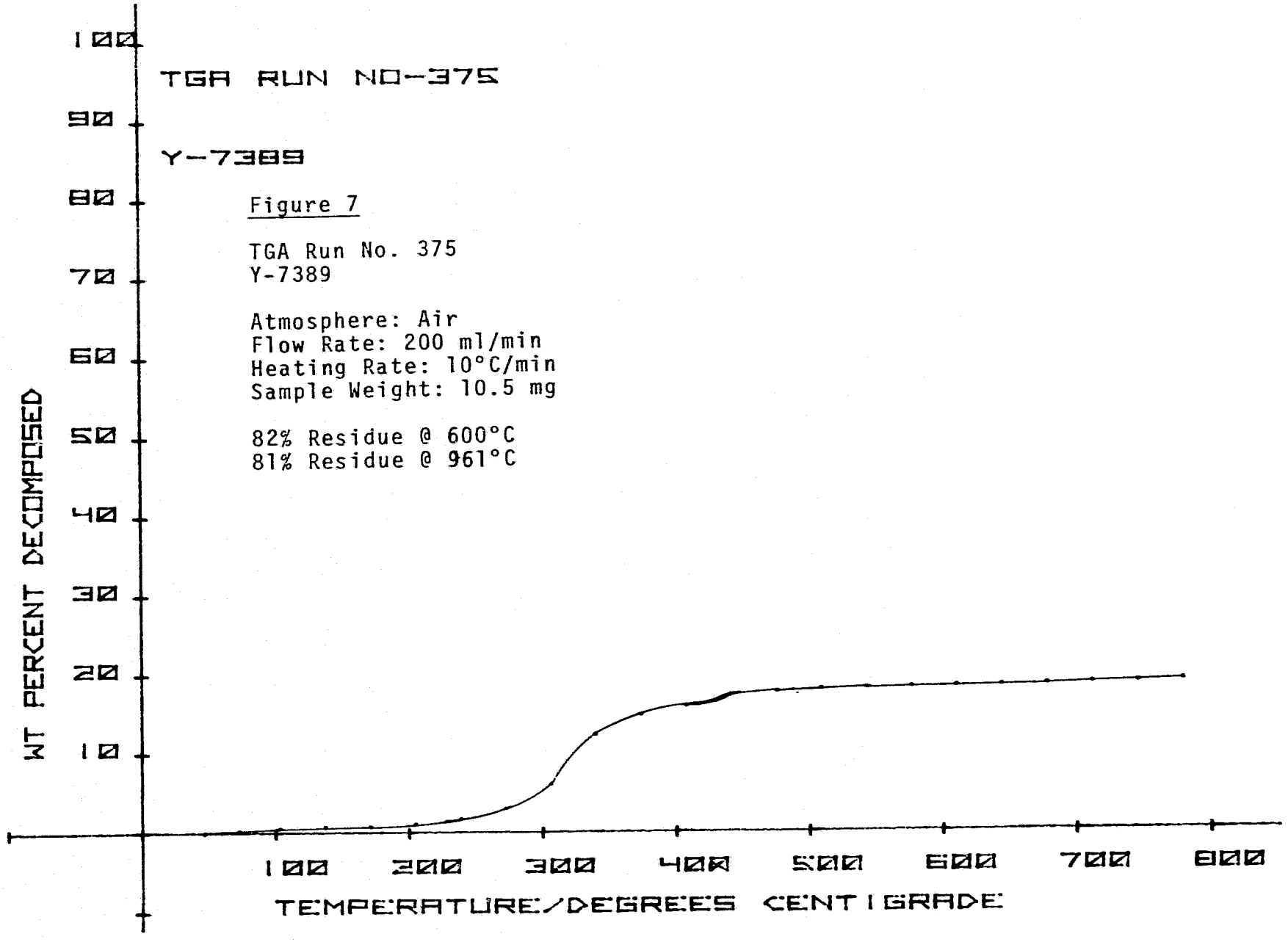


Figure 7

TGA Run No. 375
Y-7389

Atmosphere: Air
Flow Rate: 200 ml/min
Heating Rate: 10°C/min
Sample Weight: 10.5 mg

82% Residue @ 600°C
81% Residue @ 961°C

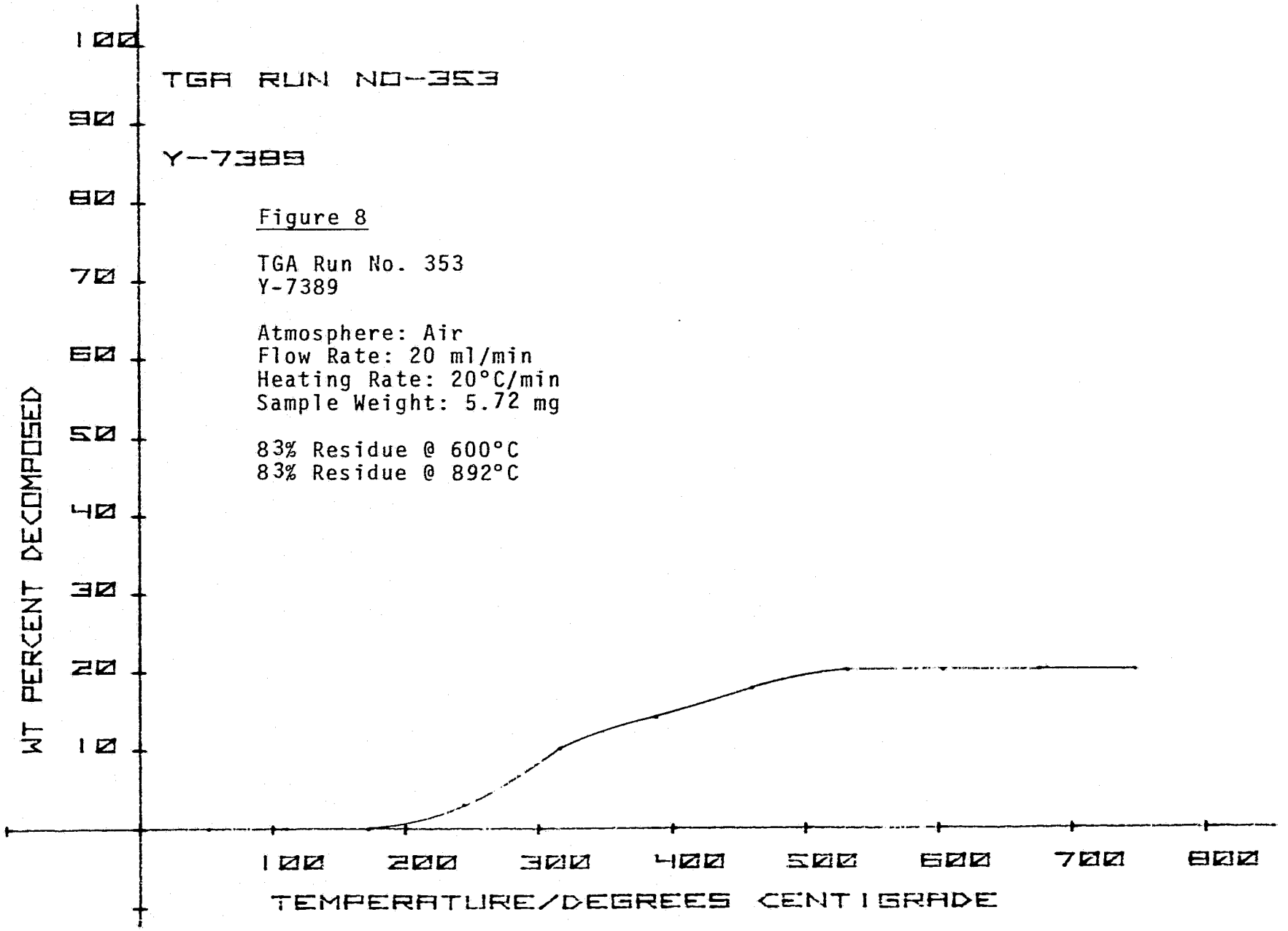


Figure 8

TGA Run No. 353
Y-7389

Atmosphere: Air
Flow Rate: 20 ml/min
Heating Rate: 20°C/min
Sample Weight: 5.72 mg

83% Residue @ 600°C
83% Residue @ 892°C

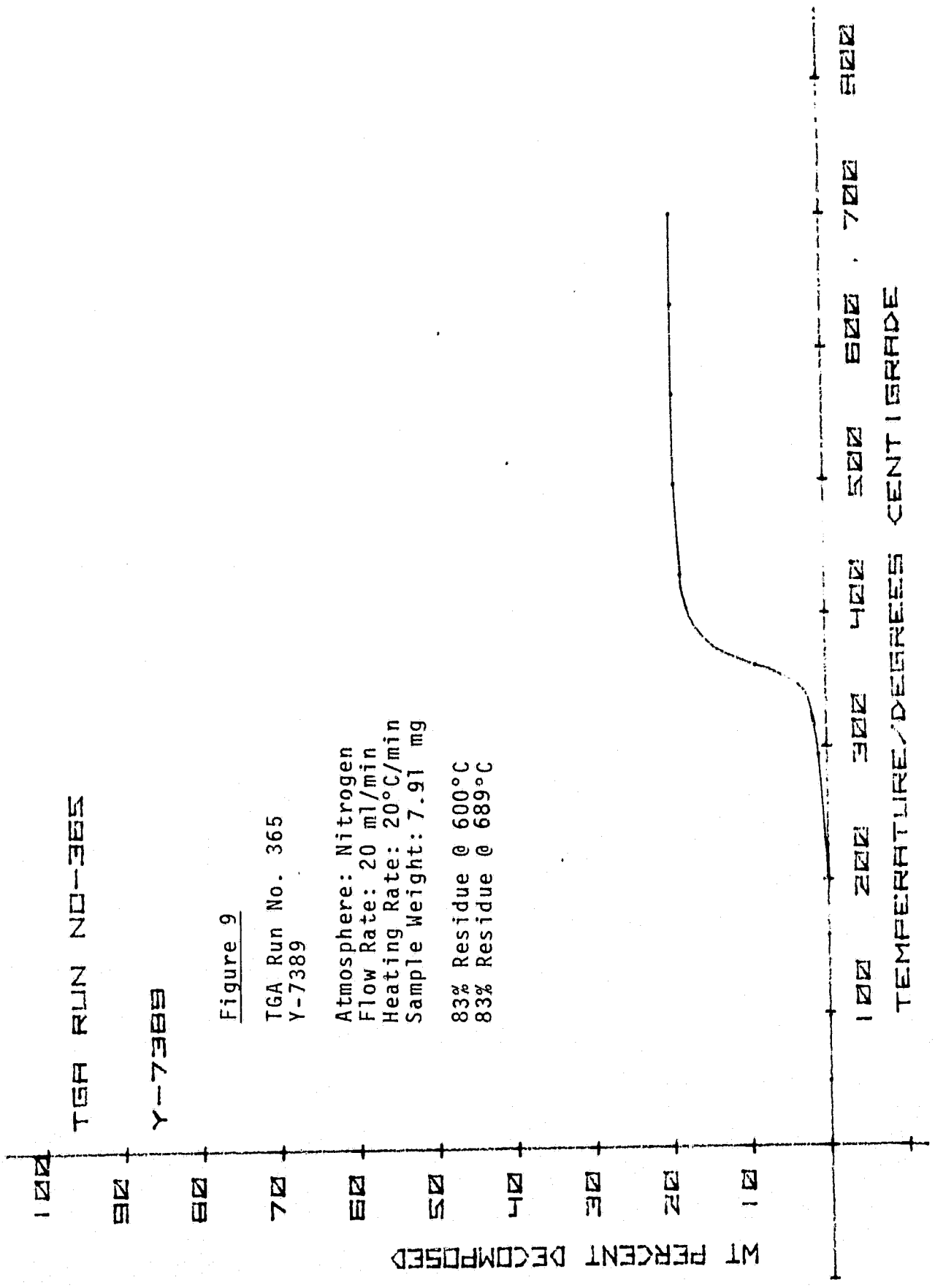


Figure 9

TGA Run No. 365
Y-7389

Atmosphere: Nitrogen
Flow Rate: 20 ml/min
Heating Rate: 20°C/min
Sample Weight: 7.91 mg

83% Residue @ 600°C
83% Residue @ 689°C

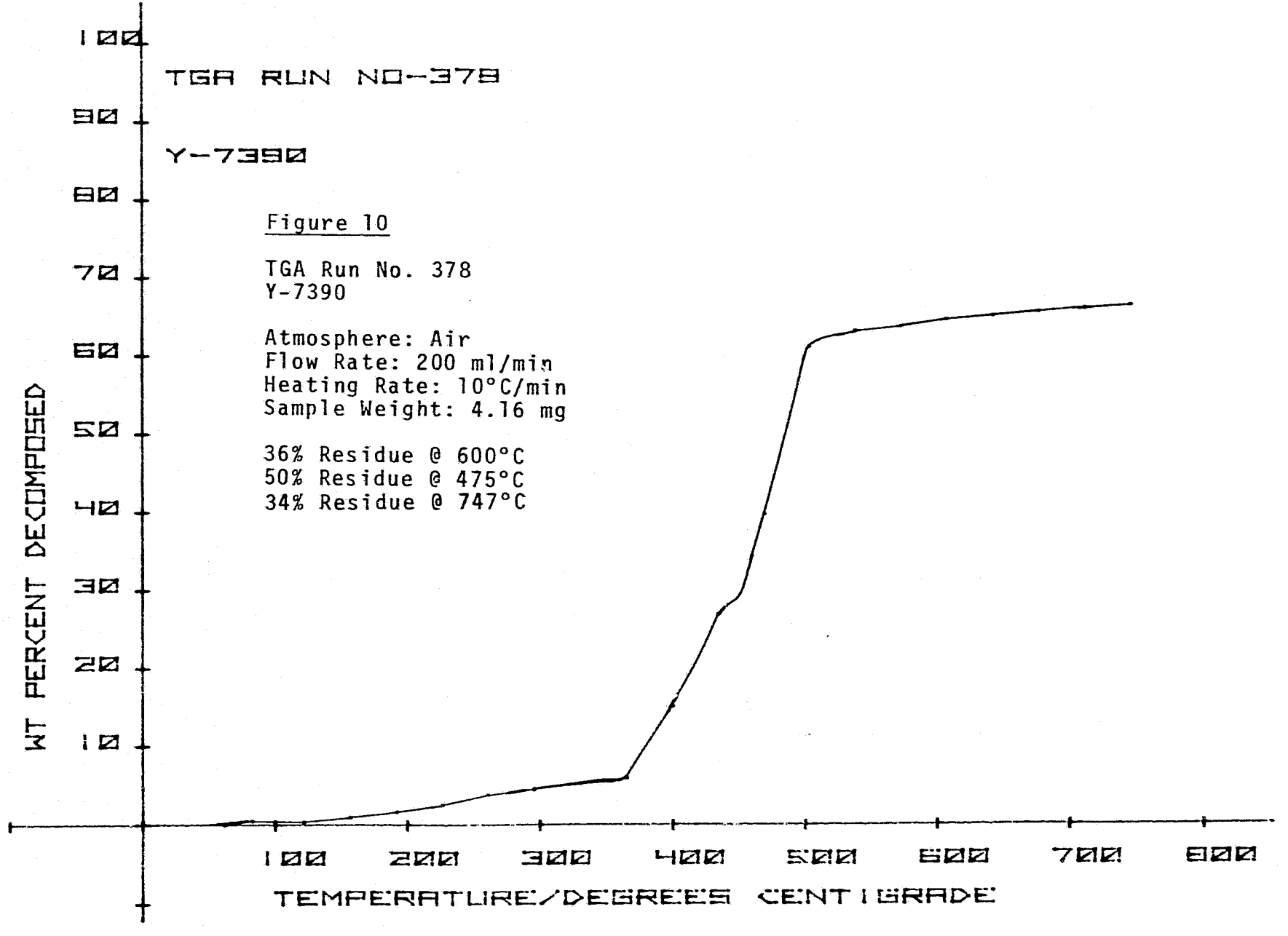


Figure 10

TGA Run No. 378
Y-7390

Atmosphere: Air
Flow Rate: 200 ml/min
Heating Rate: 10°C/min
Sample Weight: 4.16 mg

36% Residue @ 600°C
50% Residue @ 475°C
34% Residue @ 747°C

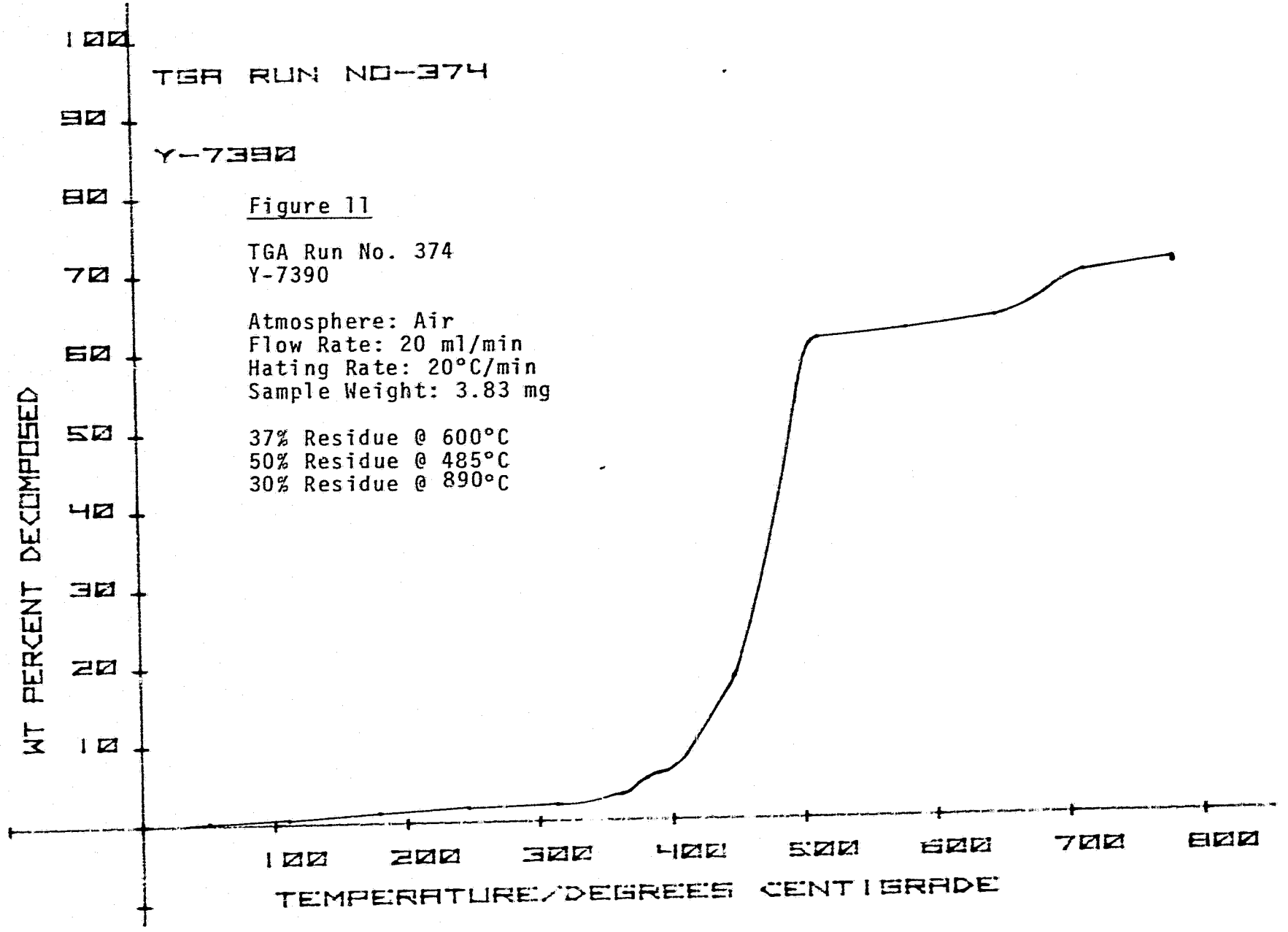


Figure 11

TGA Run No. 374
Y-7390

Atmosphere: Air
Flow Rate: 20 ml/min
Hating Rate: 20°C/min
Sample Weight: 3.83 mg

37% Residue @ 600°C
50% Residue @ 485°C
30% Residue @ 890°C

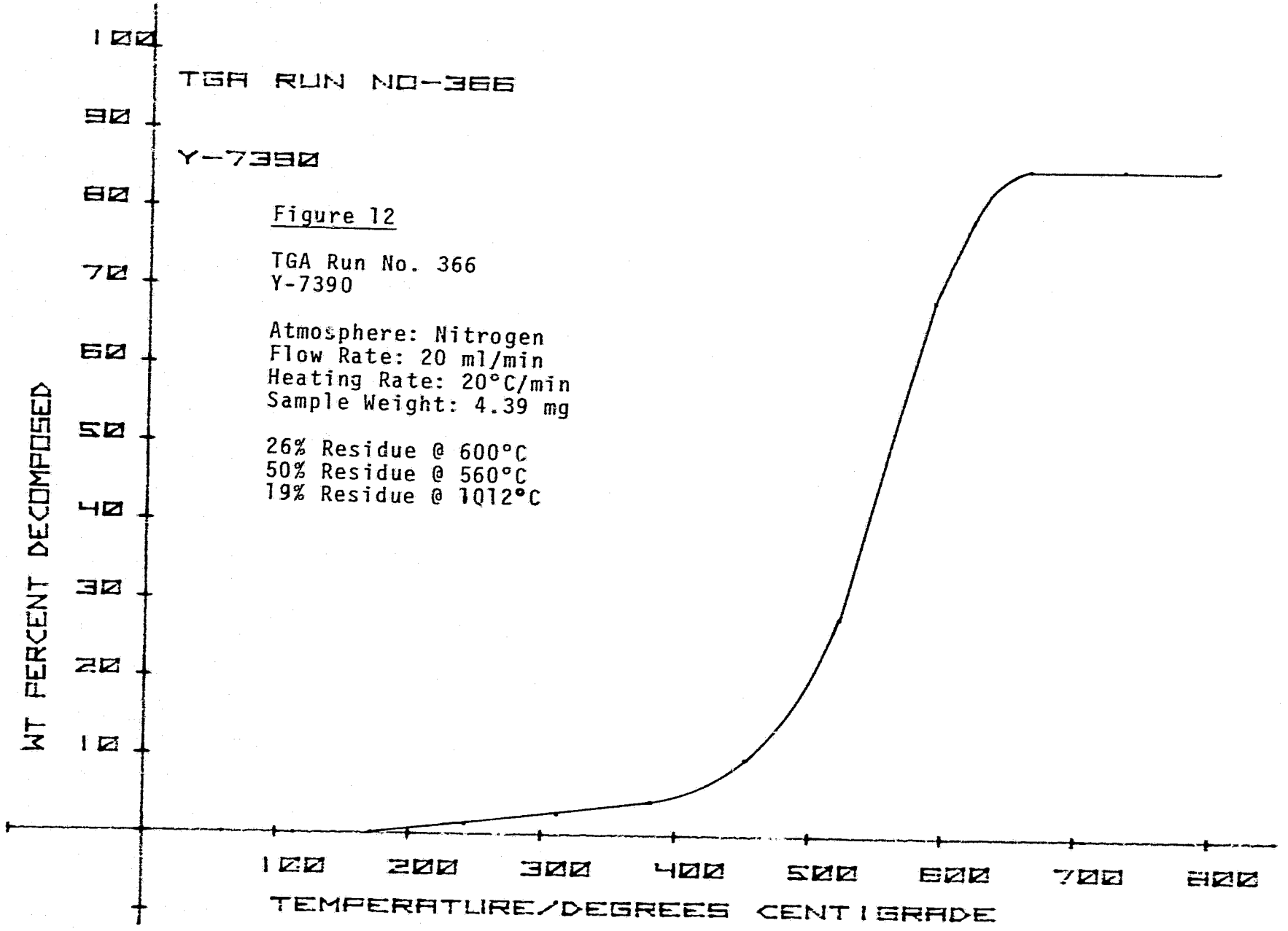


Figure 12

TGA Run No. 366
Y-7390

Atmosphere: Nitrogen
Flow Rate: 20 ml/min
Heating Rate: 20°C/min
Sample Weight: 4.39 mg

26% Residue @ 600°C
50% Residue @ 560°C
19% Residue @ 1012°C

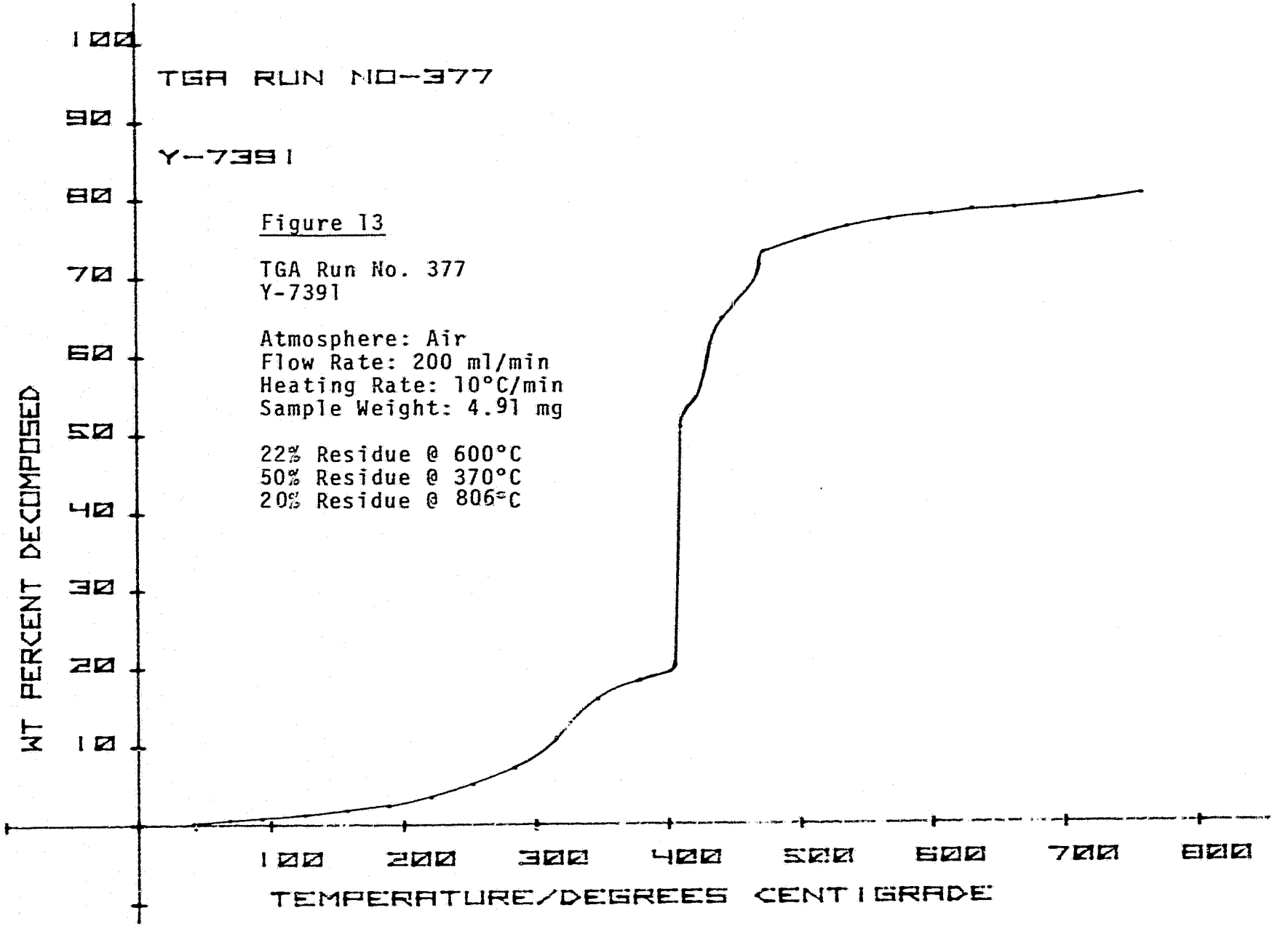


Figure 13

TGA Run No. 377
Y-7391

Atmosphere: Air
Flow Rate: 200 ml/min
Heating Rate: 10°C/min
Sample Weight: 4.91 mg

22% Residue @ 600°C
50% Residue @ 370°C
20% Residue @ 806°C

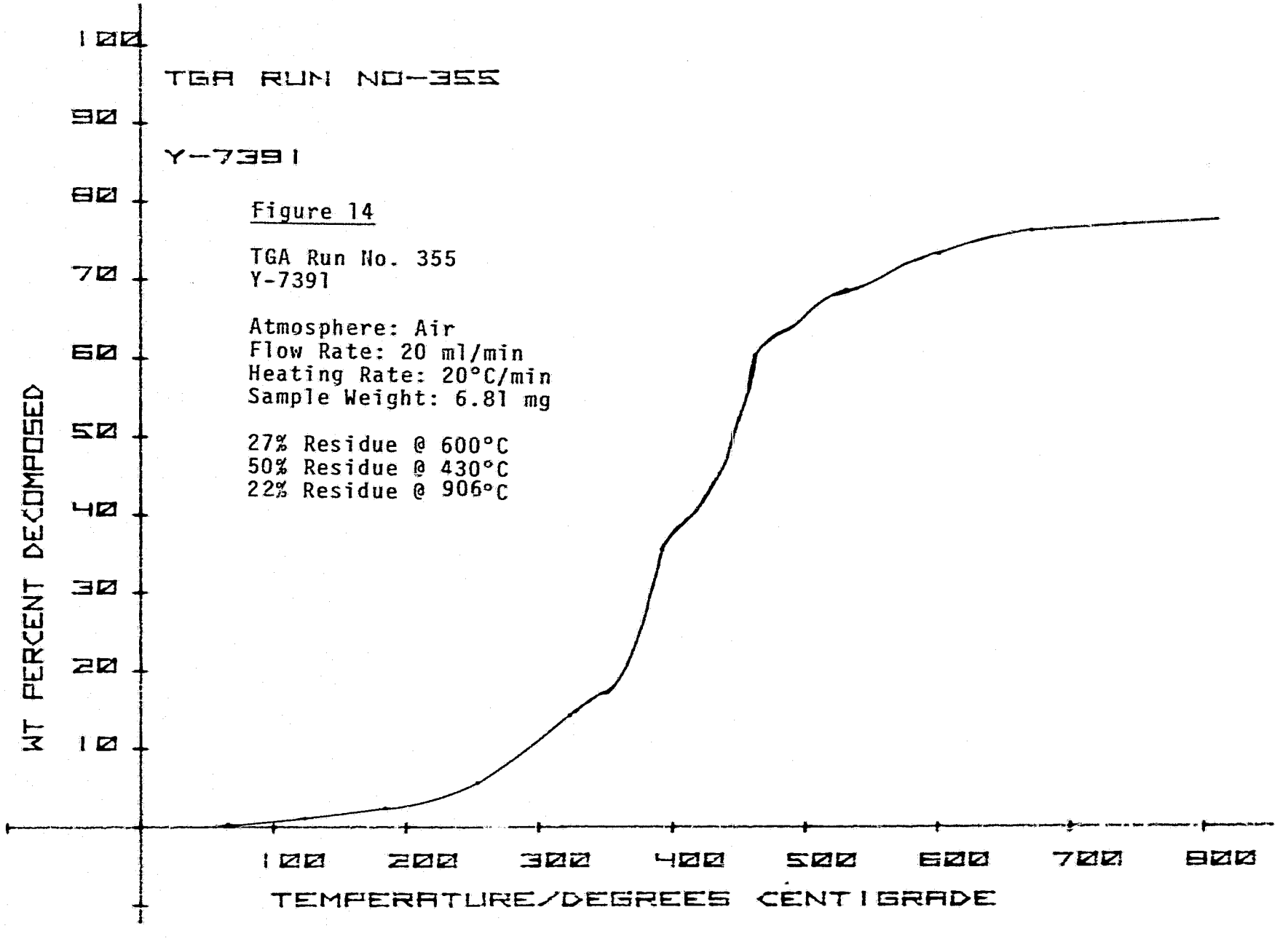


Figure 14

TGA Run No. 355
Y-7391

Atmosphere: Air
Flow Rate: 20 ml/min
Heating Rate: 20°C/min
Sample Weight: 6.81 mg

27% Residue @ 600°C
50% Residue @ 430°C
22% Residue @ 906°C

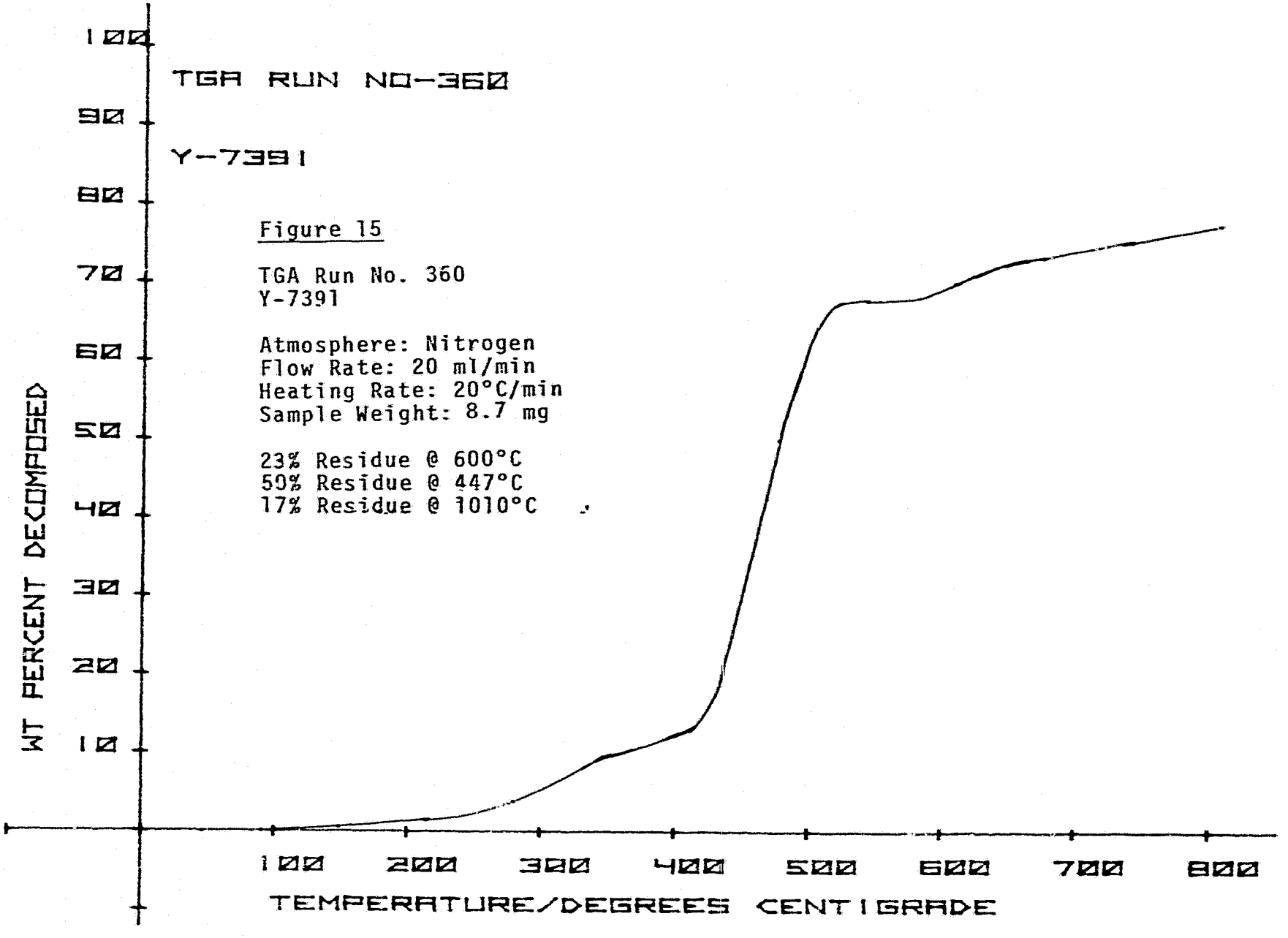


Figure 15

TGA Run No. 360
Y-7391

Atmosphere: Nitrogen
Flow Rate: 20 ml/min
Heating Rate: 20°C/min
Sample Weight: 8.7 mg

23% Residue @ 600°C
59% Residue @ 447°C
17% Residue @ 1010°C

Exhibit A

Example of histopathologic data accumulation and reduction to summary as presented in Tables 15 through 19. Summary of these data is presented in Table 18.

PT 0. 1736

Y- 7390

Sample Weight	Group Number	Deaths: Chamber	Deaths: 14-day Sacrifices	Deaths: Other (specify day)	MST Path. Number	Histopathology observed which is apparently due to pyrolysate exposure (acute and/or delayed)
9.76	44, #1	--	4*	---	11876	massive acute and chronic congestion of spleen
9.76	44, #2	--	4*	---	11877	pneumonitis, chronic, focal, moderate
17.05	46, #1	--	4*	---	11878	pneumonitis, chronic, focal, moderate
17.05	46, #2	--	4*	---	11879	pneumonitis, acute and chronic, focal, moderate
21.35	15, #1	--	4*	---	12023	congestion and edema acute,diffuse,severe
21.35	15, #2	--	4*	-- --	12024	congestion and edema, acute, diffuse, moderate
21.35	13, #1	--	4*	----	12021	no histology due to technical error
21.35	13, #2	--	4*	--	12022	massive, acute hemorrhage. Bronchopneumonia, chronic, focal, mild. Bronchitis, focal, chronic,mild
22.57	19, #1	--	4*	---	12069	pneumonitis, chronic, focal, mild, trachitis, chronic, diffuse, vasculitis, chronci, focal, moderate peribronchitis, chronic, focal, moderate to severe

Additional Comments:

* Indicates time of death, following exposure to pyrolysate, for this rat.

PT 0. 1736

Y- 7390

Sample Weight	Group Number	Deaths: Chamber	Deaths: 14-day Sacrifices	Deaths: Other (specify day)	MST Path. Number	Histopathology observed which is apparently due to pyrolysate exposure (acute and/or delayed)
						pneumonitis, chronic, focal, mild to moderate vasculitis, chronic, diffuse, mild to moderate trachitis, chronic, diffuse, severe
22.57	19, #2	--	4*	---	12070	
23.86	16, #1	1	3*	---	12045	Bronchitis, peribronchitis, diffuse, chronic, moderate to severe. Vasculitis, diffuse, chronic, moderate
23.86	16, #2	1	3*	---	12046	Hemorrhagic bronchitis, peribronchitis, chronic, diffuse, moderate to severe. Vasculitis, chronic, diffuse, moderate. Pneumanitis, ~~focal, chronic, mild~~
23.86	16, #3	1*	3	---	12018	massive foreign body debris in bronchial tree
25.24	18, #1	--	4*	---	12047	Massive acute hemorrhage. Bronchitis, peribronchitis, diffuse, chronic, moderate to severe. Vasculitis, diffuse, chronic, moderate. Bronchopneumonia, focal, chronic, moderate
25.24	18, #2	--	4*	--	12048	Hemorrhagic, peribronchitis, chronic, diffuse, mild. Vasculitis focal chronic mild. Congestion and edema.
26.65	45, #1	4*	--	--	11866	previous pulmonary disease
26.65	45, #2	4*	--	--	11867	bloody mucous in bronchial tree
26.66	17, #2	4*	--	--	12019	massive foreign body debris in bronchial tree

Additional Comments:

PT O. 1736

Y- 7390

Sample Weight	Group Number	Deaths: Chamber	Deaths: 14-day Sacrifices	Deaths: Other (specify day)	MST Path. Number	Histopathology observed which is apparently due to pyrolysate exposure (acute and/or delayed)
26.66	17, #3	4*	--	--	12020	massive foreign body debris in bronchial tree
++ 26.66	20, #1	--	4*	---	12071	bronchopneumonia, chronic, focal, mild to severe bronchitis, chronic, focal, mild vasculitis, chronic, focal, mild - trachitis, chronic, focal, mild
++26.66	20, #2	--	4*	--	12072	vasculitis, chronic, diffuse, moderate trachitis, chronic, focal, mild to moderate
++ 33.35	21, #1	--	4*	--	12073	vasculitis, chronic, focal, mocerate peribronchitis, chronic, diffuse, moderate to severe bronchopneumonia, chronic, focal, mild -- trachitis, chronic, focal, mild mild
++ 33.35	21, #2	--	4*	--	12074	vasculitis, chronic, focal, mild to moderate bronchopneumonia, chronic, focal, mild' trachitis, chronic, focal, mild
++ 34.4	22, #1	4*	--	--	12075	Mottled (Brown-Pink-White) Massive foreign body debris. Black debris fills lungs.
++ 34.4	22, #2	4*	--	--	12076	Mottled (Red-Brown-Pink-White) Black debris fills lungs. Massive foreign body debris.

Additional Comments:

++Some of the particulates were removed by filter bag at fan

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y-7310 7.7 Gy Data Ref.: MST# 11876

Specimen: ORGANS

Species ♂ S-D RAT ; Group 44 ; No. 1

Date (Treatment/Sacrifice): 2/13/80 / 2/27/80

Duration: 2 weeks ; Reason: sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

- BRAIN ✓ Congestion and edema acute diffuse mild
- HEART ✓ Congestion acute focal moderate
- AORTA
- LUNGS ✓ NS
- LIVER ✓ Congestion acute diffuse mild
- GALLBLADDER
- SPLEEN ✓ Marked acute and chronic congestion
- KIDNEY ✓ Congestion medullary
- ADRENAL ✓ WNL
- BLADDER ✓ WNL
- GONADS ✓ WNL
- PANCREAS ✓ WNL
- STOMACH
- SMALL INTESTINE ✓ WNL
- LARGE INTESTINE
- TONGUE ✓ WNL
- ESOPHAGUS ✓ WNL
- TRACHEA ✓ WNL

Investigator/Technician

28 Oct 80
Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT #. 1736 Y-7390 7.7656gm. Data Ref.: MST # 11877

Specimen: ORGANS

Species SD RAT ; Group 4C ; No. 2

Date (Treatment/Sacrifice): 2/13/80 / 2/27/80

Duration: 2 weeks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN ✓ Congested and edema acute diffuse mild

HEART ✓ wnl

AORTA

LUNGS ✓ Atelectasis diffuse mild. Pneumonitis focal chronic moderate. Congestion and edema acute diffuse mild

LIVER ✓ Congestion acute diffuse mild

GALLBLADDER

SPLEEN ✓ wnl

KIDNEY ✓ Congestion medullary

ADRENAL ✓ wnl

BLADDER ✓ wnl

GONADS ✓ wnl

PANCREAS wnl

STOMACH

SMALL INTESTINE ✓ wnl

LARGE INTESTINE

TONGUE ✓ wnl

ESOPHAGUS ✓ WNL

TRACHEA ✓ wnl

Investigator/Technician

28 Feb 80
Date

Discard 3-4-80

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y-7390 (17.0578gm) Data Ref.: MST 11878

Specimen: ORGANS

Species OLS-D RAT ; Group 46 ; No. 1

Date (Treatment/Sacrifice): 8/15/80 / 12/29/80

Duration: 2 wks ; Reason: sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

- BRAIN ✓ Congestion and edema acute, diffuse mild
- HEART ✓ Hemorrhage acute focal mild
- AORTA
- LUNGS ✓ Pneumonitis, focal chronic mild. Congestion and edema, acute, focal mild
- LIVER ✓ Congestion acute diffuse mild
- GALLBLADDER
- SPLEEN ✓ Congestion acute diffuse
- KIDNEY ✓ Congestion acute medullary.
- ADRENAL ✓ wnl
- BLADDER ✓ wnl
- GONADS ✓ wnl
- PANCREAS ✓ wnl
- STOMACH
- SMALL INTESTINE ✓ wnl
- LARGE INTESTINE
- TONGUE ✓ wnl
- ESOPHAGUS ✓ wnl
- TRACHEA ✓ wnl

J Turner
Investigator/Technician

28 Oct 80
Date

Dorr
cul. 3-4-80

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1236 Y-7310 C17 0513 Data Ref.: MSC H 11879

Specimen: ORGANS

Species SD RAT ; Group 46 ; No. 2

Date (Treatment/Sacrifice): 2/15/80 / 2/27/80

Duration: 7 wks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN ✓ Congestion and edema acute diffuse mild

HEART ✓ Congestion acute focal mild

AORTA

LUNGS ✓ Pneumonitis acute and chronic focal moderate Congestion and edema acute diffuse moderate & same

LIVER ✓

GALLBLADDER

SPLEEN ✓ Congestion acute diffuse moderate & same

KIDNEY ✓

ADRENAL ✓

BLADDER ✓ wnl

GONADS ✓ wnl

PANCREAS wnl

STOMACH

SMALL INTESTINE ✓ wnl

LARGE INTESTINE

TONGUE wnl

ESOPHAGUS ✓ NS

TRACHEA ✓ wnl

D Turner
Investigator/Technician

6-6/28,80
Date

ORIGINAL PAGE IS
OF POOR QUALITY

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 17360 Y-7390 (2135) Data Ref: MS# 12003

Specimen: Rat Organ Samples

Species Rattus albino ; Group 15 ; No. 1

Date (Treatment/Sacrifice); 10/23/80 / 11/6/80

Duration: 2 wks ; Reason: sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

X HEART WNL.

AORTA

X LUNGS Congestion and edema acute distress severe

X LIVER wnl

GALLBLADDER

X SPLEEN wnl

X KIDNEY Congestion acute medullary, moderate

X ADRENAL wnl

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

X TRACHEA lumen is patent c lytorf

J. Tucker Nov 13, 80
Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y-7390(21.35) Data Ref: MST# 12024

Specimen: Organ Samples

Species Rattus albino ; Group 15 ; No. 2

Date (Treatment/Sacrifice); 10/23/80 / 11/6/80

Duration: 2 wks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS Congestion and edema acute diffuse moderate

LIVER WNL

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA WNL

J. Winn 13 Nov 80
Investigator/Technician Date

NOTE: Those rats are not included in LD_{50} Calculation -64-

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0-1736 Y-7320(21354) Data Ref: MSL # 12021

Specimen: Rat organs

Species Rattus albino ; Group 13 ; No. 1

Date (Treatment/Sacrifice); 10/20/80 / 11/3/80

Duration: 2 wks ; Reason: Sacrifice

Process Completion Date NO HISTOLOGY / NONNEOPLASTIC

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART

AORTA

LUNGS

LIVER

GALLBLADDER

SPLEEN

KIDNEY

ADRENAL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA

Investigator/Technician Date

Note: This Group is not included in LD50 Calculation -65-

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y-7390(21354) Data Ref: MST# 12022

Specimen: Oxygen samples

Species Rattus albino ; Group 13 ; No. 2

Date (Treatment/Sacrifice); 10/20/80 / 11/3/80

Duration: 2 wks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART wnl

AORTA

LUNGS Massive Acute Hemorrhage. Bronchopneumonia Chronic Focal Mild. Bronchitis Focal, Chronic Mild.

LIVER Fatty Change Diffuse Chronic Mild

GALLBLADDER

SPLEEN wnl

KIDNEY wnl

ADRENAL wnl

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA wnl

Investigator/Technician 12/4/80 Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0-1736 Y-7390 Data Ref: MST #12069

Specimen: Organ Samples

Species Rattus albus ; Group ; No.

Date (Treatment/Sacrifice); 11/7/80 / 11/21/80

Duration: 2 weeks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS hemorrhage ... Hemorrhage ... Focal ... Bronchitis ... Focal Chronic ... Vasculitis, Focal Chronic Moderate; Bronchitis Focal Chronic Moderate to Severe.

LIVER WNL

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA Tracheitis Diffuse Chronic Severe

Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0· 1736 Y-7390(2257) Data Ref: MST# 12070

Specimen: Organ samples

Species Rattus albino ; Group 19 ; No. 2

Date (Treatment/Sacrifice); 11/7/80 / 11/21/80

Duration: 2 weeks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS [illegible] hemorrhage of lung Congestion and Edema [illegible] lung bronchitis chronic diffuse moderate to severe Pneumonitis diffuse chronic [illegible] moderate

LIVER Congestion acute diffuse mild

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA Tracheitis, diffuse chronic severe

[illegible] 11-25-80

Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y- 7390 (23.8Gy) Data Ref: MST # 1046

Specimen: Rat Organ Samples

Species Cotton Rat ; Group 4 ; No. 1

Date (Treatment/Sacrifice); 03/80 / 04/80

Duration: 2 weeks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS Hemorrhage, Edema, Polymorphs, Chronic Diffuse Moderate to Severe, Vasculitis, Pneumonitis, Pleurisy Moderate

LIVER Fatty Change, Diffuse, Mild.

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA WNL

12/4/80

Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y- 7390 (73864) Data Ref: MST# 10045

Specimen: Rat Organ Samples

Species Rattus albino ; Group 10 ; No. 2

Date (Treatment/Sacrifice); 01/31/80 / 04/14/80

Duration: 2 weeks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS Black spot on Right Lung (dorsal surface), Hemorrhage Bronchitis Pneumonitis Diffuse, Chronic, Moderate to Severe. Vasculitis, Diffuse Chronic Moderate.

LIVER

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA Tracheitis, Chronic Diffuse Moderate

Investigator/Technician 14/4/80
Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y- 7390 (2.3.86g) Data Ref: MSTL #12018

Specimen: Rat Organs

Species Rattus albino ; Group 10 ; No. 3

Date (Treatment/Sacrifice); 8/31/80 / 10/31/80

Duration: Died in Chamber; Reason: 1 DIC

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART wnl

AORTA

LUNGS Massive foreign body debris in lung

LIVER Congestion acute diffuse severe

GALLBLADDER

SPLEEN wnl

KIDNEY Congestion acute medullary severe

ADRENAL wnl

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

× TRACHEA wnl

× Thymus wnl

Investigator/Technician Date 11/8/80

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 11360 Y- 7330 (6534) Data Ref: MST #120.17

Specimen: Organ Samples

Species Rattus albino ; Group 1B ; No. 1

Date (Treatment/Sacrifice); 11/1/80 / 11/15/80

Duration: 2 weeks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART wnl

AORTA

LUNGS Hemorrhagic Massive acute pneumonitis, Bronchitis, Peribronchiolitis, Diffuse chronic moderate to severe vasculitis, Diffuse chronic moderate. Bronchopneumonia focal chronic moderate

LIVER Periportal hepatitis, Diffuse chronic, mild

GALLBLADDER

SPLEEN Abnormally large wnl

KIDNEY wnl

ADRENAL wnl

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA Tracheitis, Diffuse chronic, mild

Investigator/Technician Date 1 Dec 80

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT.O. 1736 Y-7390 (25.2%) Data Ref: MST #12048

Specimen: Organ Samples

Species Rattus albino ; Group 18 ; No. 2

Date (Treatment/Sacrifice); 1/2/80 / 1/8/80

Duration: 2 weeks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS Hemorrhagic Vasculitis focal chronic mild Peribronchitis, chronic, diffuse mild. Congestion and edema

LIVER Fatty change diffuse mild

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA Bronchitis Focal chronic mild

Investigator/Technician Date 4 Dec 80

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y-7390 (26 65 57) Data Ref.: MST 11 866

Specimen: ORGANS

Species SD RAT ; Group 45 ; No. 1

Date (Treatment/Sacrifice): 2/14/80 / 2/24/80

Duration: 30 min ; Reason: Death inside chamber

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN ✓ Cong Hem acute diffuse moderate

HEART ✓ Congestion acute diffuse mild

AORTA

LUNGS ✓ Pneumonitis focal Chronic mild. Congestion and edema acute diffuse moderate

LIVER ✓ Congestion acute diffuse mild to moderate

GALLBLADDER

SPLEEN ✓ wnl

KIDNEY ✓

ADRENAL wnl

BLADDER ✓ wnl

GONADS ✓ wnl

PANCREAS ✓ wnl

STOMACH wnl

SMALL INTESTINE ✓

LARGE INTESTINE

TONGUE ✓ wnl

ESOPHAGUS ✓ WNL

TRACHEA ✓ WNL

J Turner
Investigator/Technician

28 Oct 80
Date

Dioxin Cut # 21-82

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT #. Y-7370 26.6-57 Data Ref.: 11867

Specimen: ORGANS

Species SD RATS ; Group 45 ; No. 2

Date (Treatment/Sacrifice): 2/14/80 / 2/14/80

Duration: 30 Min. ; Reason: Death inside chamber

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN ✓ Congestion and edema acute diffuse mild

HEART ✓ Congestion acute focal moderate

AORTA

LUNG ✓ Tinged congestion bronchi congestion and edema acute diffuse mild

LIVER ✓ Congestion diffuse acute severe

GALLBLADDER

SPLEEN ✓ Congestion acute diffuse moderate

KIDNEY ✓ Congestion medullary acute severe

ADRENAL ✓ WNL

BLADDER ✓ WNL

GONADS ✓ WNL

PANCREAS WNL

STOMACH

SMALL INTESTINE ✓ WNL

LARGE INTESTINE

TONGUE ✓ WNL

ESOPHAGUS WNL

TRACHEA ✓ WNL

Investigator/Technician

2-80 CPB

Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0: 1136 Y- 1320 (26/dec) Data Ref: NSF # 12017

Specimen: Organ Samples

Species Rattus albus ; Group 7 ; No. 2

Date (Treatment/Sacrifice); 1/3/80 1/3/80

Duration: Died in Chamber ; Reason: 4 Dic

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART Wnl

AORTA

LUNGS Mucosa foreign body debris

LIVER Congestion acute hyperemia

GALLBLADDER

SPLEEN Wnl

KIDNEY Bright acute nephritis moderate

ADRENAL Wnl

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA foreign body debris in lumen

Investigator/Technician 11/5/80
Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0-1136 Y- 1370 Data Ref: [illegible]

Specimen: Oxygen Scrubber

Species Rat; Group ; No. 5

Date (Treatment/Sacrifice); 11/3/80 / 11/3/80

Duration: Dwell x Chamber; Reason: 4 Dic.

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART Congestion acute diffuse moderate

AORTA

LUNGS Massive foreign body debris

LIVER Congestion acute diffuse moderate

GALLBLADDER

SPLEEN unt

KIDNEY Congestion Medullary acute moderate

ADRENAL unt

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA Debris w/ Lung

Investigator/Technician 11/5/81
Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT.O. 1736 Y-7320 (26.664 after) Data Ref: MST 12071

Specimen: Organ Samples

Species Rattus albino ; Group 20 ; No. 1

Date (Treatment/Sacrifice); 11/11/80 / 11/25/80

Duration: 2 wks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART Congestion Focal Acute Mild

AORTA

LUNGS Brown Spots on Pleura Bronchopneumonia, Focal Chronic Mild to Severe. Bronchiitis, Focal, Chronic Mild

LIVER WNL Vasculitis, Chronic Focal, Mild

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA Tracheitis, Chronic Focal. diffuse Moderate 12/3/80

J Thrum 3 Dec 80
Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 17.36 Y- 7380 (CA669 / [illegible]) Data Ref: MST 120772

Specimen: Organ Samples

Species Rattus albinus; Group 20; No. 2

Date (Treatment/Sacrifice); 11/11/80 / 11/25/80

Duration: 2 wks.; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS [illegible] VASCULITIS CHRONIC, DIFFUSE MODERATE. CONGESTION AND HEMORRHAGE, FOCAL, ACUTE, MODERATE EDEMA, ACUTE [illegible] MODERATE

LIVER WNL

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA TRACHEITIS, FOCAL CHRONIC MILD TO MODERATE

[signature] 3 Dec 80

Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 12310 Y-7370(33359) Data Ref: MST #12073

Specimen: Organ Samples

Species Rat ; Group P1 ; No. 1

Date (Treatment/Sacrifice); 1/13/80 / 1/13/80

Duration: 2 weeks ; Reason: SACRIFICE

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS Moderate hemorrhaging Vasculitis Focal Chronic, Moderate PERIBRONCHITIS, DIFFUSE CHRONIC, MODERATE TO SEVERE BRONCHOPNEUMONIA FOCAL CHRONIC MILD

LIVER WNL

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA TRACHEITIS FOCAL CHRONIC MILD

J Turner 3 Dec 80
Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 17360 Y- 7370 (3339) Data Ref: MST # 1074

Specimen: Organ Samples

Species Cottus albus ; Group 2 1 ; No. 2

Date (Treatment/Sacrifice); 11/5/80 12/5/80

Duration: 2 weeks ; Reason: Sacrifice

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

HEART WNL

AORTA

LUNGS Hemorrhage & Brown mats BRONCHOPNEUMONIA, CHRONIC Focal MILD Vasculitis, Focal, CHRONIC, MILD TO MODERATE

LIVER WNL Congestion, Hemorrhage Vacuolization, Acute Diffuse, Moderate to Severe

GALLBLADDER

SPLEEN WNL

KIDNEY WNL

ADRENAL WNL

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

TRACHEA Tracheitis Focal Chronic, Moderate

3 Dec 80

Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0. 1736 Y-7390 (34.4y) Data Ref: MSTH12075

Specimen: Organ Samples

Species Rattus Norvegicus; Group 22; No. 1

Date (Treatment/Sacrifice); 12/4/80 12/4/80

Duration: 20 mins. ; Reason: Died in Chamber

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

X HEART WNL

AORTA

X LUNGS BLACK DEBRIS FILLS ALVEOLI Mottled (Brown-Pale-White) Massive Foreign Body debris

X LIVER Blood Pool Autolysis

GALLBLADDER

X SPLEEN Autolysis

X KIDNEY Autolysis

X ADRENAL Autolysis

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

X TRACHEA

J. E. Turner 12/5/80
Investigator/Technician Date

Materials Science Toxicology Laboratories
University of Tennessee Center for the Health Sciences

PT 0.17360 Y-7390(34.4y) Data Ref: MST # 120760

Specimen: Organ Samples

Species Rattus albino ; Group 2 2 ; No. 2

Date (Treatment/Sacrifice); 12/4/80 / 12/4/80

Duration: 20 mins. ; Reason: Died in Chamber

Process Completion Date

AUTOPSY REPORT OR MICROSCOPIC SUMMARY:

BRAIN

✗HEART WNL

AORTA

✓LUNGS BLACK DEBRIS FILLS LUNGS. Massive Foreign Body Noted (Red Brown, Pink-White) Mottled

✗LIVER Red-to Brown - 2.5 x 2 cm clear spot on left median lobe (2 Pieces Submitted) AUTOLYSIS

GALLBLADDER

✗SPLEEN autolysis

✗KIDNEY autolysis

✗ADRENAL autolysis

BLADDER

GONADS

PANCREAS

STOMACH

SMALL INTESTINE

LARGE INTESTINE

TONGUE

ESOPHAGUS

✗TRACHEA

J.S. Turner 2/8/81
Investigator/Technician Date