COLLECTION, REDUCTION, AND DISPOSAL OF SOLID WASTE IN HIGH-RISE MULTIFAMILY DWELLINGS

National Research Council
Washington, D. C.

1971

BUILDING
RESEARCH
ADVISORY
BOARD

INTERIM REPORT ‹
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An interim report prepared by the
Special Advisory Committee on Solid Waste

NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL
Washington, D. C.
1970

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A research program is being conducted on three alternative methods of handling solid waste in high-rise multifamily housing: incineration, compaction, and wet pulverization. This interim report presents, in narrative form, the results of the first study period of the three-study-period program. Conclusions and recommendations are yet to be formulated. The report covers: (1) the objectives and scope of the project, (2) the work to be accomplished during each of the study periods, (3) the method of conducting the project, and (4) the test structures used. In addition, the existing conditions at the test structures are assessed, including the quantity and composition of the refuse, the number and age of the tenants, the contribution to air pollution by incinerators, the degree of vermin and insect infestation, the personnel and power requirements, the cost, the effectiveness and limitations, and the acceptance by owners, tenants, and custodians. The tentative data-collection program and refuse-handling equipment to be installed for the second study period are discussed.

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FOREWORD

Directly related to increasing urban expansion is the problem of refuse disposal. Considerable time and effort have been devoted to the problem as a municipal or regional concern, but comparatively little attention has been paid to what can be done at the point of origin, particularly in high-rise multifamily housing. Recent efforts to abate air pollution by limiting the incineration of refuse in apartment buildings accentuate the point-of-origin aspect of refuse disposal. Although recycling of waste into useful products is recognized as the most desirable goal, until this goal can be realized, onsite problems of waste handling are a potentially remunerative target in the attack on the general refuse problem. Moreover, even if recycling can be achieved, waste handling at the point of origin would still merit consideration, for it is at the site that separation and storage can most easily be effected.

This interim report presents the results of the first study period in a three-study-period research program concerning alternative methods of handling refuse in high-rise multifamily dwellings. It is essentially a narrative; conclusions and recommendations are yet to be formulated.

The research program was undertaken by the Building Research Advisory Board, with support provided by the U. S. Public Health Service, and involves the use of public housing authority high-rise buildings in New Haven, Connecticut, as a field laboratory. The operational character of the research program distinguishes it from the usual, strictly advisory function of the Board. With the diversity of parties and organizations necessarily involved in the program and the requirement for broad interdisciplinary competence, it was believed that an organization such as the Board was needed to provide guidance and direction.

The research program is being planned and coordinated by the Special Advisory Committee on Solid Waste, whose membership was appointed by the Building Research Advisory Board with the approval of the Chairman of the Division of Engineering and the President of the National Academy of Sciences. However, the actual physical work of collecting data for the committee is performed by subcontractors employed for that purpose, as required.

Numerous details are included in this interim report in the belief that they will be helpful to others--for example, city administrations--who, it is hoped, will initiate similar research programs. Comments on the value of these details will be appreciated.

Many persons have contributed to this effort. Particularly noteworthy are the contributions of members of the staff of the Housing Authority of the City of New Haven--Mr. Robert Wolfe, former Executive Director, Mr. Edward White, present Executive Director, Mr. Albert Libbey, and

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This interim report was prepared for the
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Mrs. Geraldine Daniels. Mr. Edward DeLouise, Director of the New Haven Bureau of Environmental Health, and Messrs. Dennis Rezendez and Everett Shaw of the City Administration did much to make the program a reality. Without the tolerance and cooperation of the tenants of the Housing Authority, the program could not be conducted. The tenants serving as liaison--Mrs. May Belle Green and Messrs. Thomas Bones, Frank Graham, and Martin Texeira--have given valuable assistance.

The Board gratefully acknowledges the work to date of the Special Advisory Committee on Solid Waste.

JOHN P. GNAEDINGER, Chairman
Building Research Advisory Board

ABSTRACT

The Building Research Advisory Board of the National Academy of Sciences is conducting a research program on alternative methods of handling refuse in high-rise multifamily housing: incineration, compaction, and wet pulverization. The program is funded under Contract No. PH 86-67-167 between the U. S. Public Health Service and the National Academy of Sciences.

This interim report presents the results of the first study period of the three-study-period program.

The report covers: (1) the objectives and scope of the project, (2) the work to be accomplished during each of the study periods, (3) the method of conducting the project, and (4) the test structures being used. In addition, methods are described for assessing the existing conditions at the test structures, including the quantity and composition of the refuse, the contribution to air pollution by incinerators, the degree of vermin and insect infestation, and others; results of the assessment are presented. The tentative data-collection program and refuse-handling equipment to be installed for the second study period are discussed.

A separate supplement gives the results of a preliminary investigation of the feasibility of installing and evaluating an experimental pneumatic transport system for the central collection of refuse from the complex of high-rise structures serving as a field laboratory in the research program.

SUMMARY

The Building Research Advisory Board of the National Academy of Sciences is conducting a research program on alternative methods of handling refuse in high-rise multifamily housing: incineration, compaction, and wet pulverization. The program is funded under Contract No. PH 86-67-167 between the U. S. Public Health Service and the National Academy of Sciences. The program involves the use of high-rise buildings belonging to the Public Housing Authority of the City of New Haven, Connecticut, as a field laboratory. The objective of the program is to develop recommendations concerning alternative methods of handling solid waste from high-rise dwellings, taking into consideration user needs and acceptance, public health concerns, and performance and cost.

This interim report presents, in narrative form, the results of the first study period of the three-study-period program. Conclusions and recommendations are yet to be formulated.

This interim report covers: (1) the objectives and scope of the project, (2) the work to be accomplished during each of the study periods, (3) the method of conducting the project, and (4) the test structures used. In addition, methods are described for assessing the existing conditions at the test structures. The tentative data-collection program and refuse-handling equipment to be installed for the second study period are discussed.

Considered in the assessment of existing conditions were: the quantity and composition of the refuse generated, the number and age of the tenants, the contribution of the buildings' incinerators to air pollution, and, specifically with respect to the equipment now in use, the degree of vermin and insect infestation, the personnel and power requirements, the cost, the effectiveness and limitations, and the acceptance by owners, tenants, and custodians.

Chute-generated waste, miscellaneous bulky items of refuse, and incinerator residue were surveyed for 7 consecutive days. Disregarding the bulky refuse items, a total of 10,947 lb. of chute refuse, with a volume of 1,961 cu. ft., was generated during the 7-day period, resulting in an overall density of 5.6 lb. per cu. ft. Per capita generation of chute refuse was 1.48 lb. per day per person (adults and children). For adults only, the amount was 4.33 lb. per day per person. Table I gives the percentage by weight and volume of each category of chute refuse. Peak refuse generation, by weight, occurred on Saturday, with Sunday a close second.

TABLE I
REFUSE COMPOSITION

Category of Refuse	% by Wt.	% by Vol.
Paper and Paper Products	32.98	62.61
Wood and Wood Products	0.38	0.15
Plastic, Leather, and Rubber Products	6.84	9.06
Rags and Textile Products	6.36	5.10
Glass	16.06	5.31
Metallics	10.74	9.12
Stones, Sands, and other inerts	0.26	0.07
Garbage (organics)	26.38	8.58

To assess air pollution from incineration, 51 refuse samples were burned under varying conditions. For the most part, particulate emissions were determined by ASME-PTC stack monitoring techniques. But, during the burning of six samples, particulate emissions were determined simultaneously by the methods developed by NAPCA and ASME. From 23 samples of similar composition burned in one incinerator, an average incinerator particulate emission rate was determined to be 0.18 lb. per hr. per 40 lb. of refuse burned using the ASME stack monitoring techniques; sample composition for these tests was based on the findings of the refuse survey previously conducted, and the incinerator was charged at design capacity (40 lb. per hr.). For three 40-lb. samples burned, during which simultaneous stack monitoring was performed, the average particulate emission rate using the ASME procedures was 0.38 lb. per hr. per 40 lb. of refuse, while with the NAPCA procedures an average of 0.69 was obtained. During these simultaneous tests, the weight of particulates picked up by both impinger and thimble was used in determining particulate emission rates when the ASME procedures were used. For other simultaneous tests, only the weight of particulates picked up by the thimble was used in the determination of particulate emission rates with the ASME procedures, and the variance from results obtained with the NAPCA procedures was considerably greater.

All findings and data obtained through implementation of the program to assess the existing conditions at the test structures are given in the interim report.

In preparation for the second study period, specific refuse reduction equipment to be installed--an incineration system in one structure, a compaction system in a second structure, and a wet-pulverization system in a third structure--was selected and is described in this report; preliminary plans for the installation of this equipment are also discussed. Since results obtained on the specific equipment installed in the New Haven test structures might be generic either to a particular concept for handling refuse or only to equipment of the specific manufacturer involved, a national field survey is to be conducted concurrently with the New Haven program to collect data on the operation, performance, and cost of refuse-handling equipment of other manufacturers. The field survey questionnaire developed for this purpose is presented in the interim report.

Additional preparations made for the second study period include establishment of the tentative data-collection program to be implemented once the new refuse-handling equipment is installed. Areas identified and discussed include: refuse quantity and composition before and after processing by the newly installed refuse-handling equipment; inhabitants; initial and operational cost of new equipment; environmental conditions maintained by the new equipment; and equipment effectiveness, requirements and limitations. Since the third study period will involve the installation of garbage grinders within individual apartments in the test structures, in order to assess the effect of their use on the building sewer and on environmental conditions maintained by the newly installed refuse-handling equipment, the program to be implemented during the second study period for determining the quantity and composition of waste presently flowing through the building sewer line of one test structure is discussed.

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I
INTRODUCTION

Disposal of the 4.6 lb. of garbage and trash generated each day by the average U. S. citizen is a major problem for every city. The problem is aggravated by the increasing rate of per capita generation, by the increasing mass of the refuse, and by the rising cost of collection, now ranging from $15 to $30 per ton.

One way to reduce the problem is to decrease the weight or volume of the refuse at its source, and, in the past, the onsite incineration of refuse from high-rise multifamily dwellings has contributed significantly to this end. Recent legislation aimed at reducing air pollution within most of the Nation's largest cities by limiting the onsite incineration of refuse, either through prohibition or by performance criteria, plus the attention being given to the solid-waste problem in general, has accelerated the development of alternative methods for the onsite handling of waste and hastened advancements in the state of the art of incineration and attendant air pollution control equipment.

This turn of events led to repeated inquiries to both the U. S. Public Health Service and the Building Research Advisory Board of the National Academy of Sciences concerning the alternatives and improvements--their reliability and efficiency, their capability to maintain aesthetically pleasing and healthful environmental conditions at the site, and the impact of their use on ultimate waste disposal plans of municipalities or regions. Basically, the questions were: What is known about the alternative methods and techniques now coming to the forefront? How do these compare with current methods of onsite solid waste disposal? These questions can be extended to include concepts that have not yet been applied but are on the drawing boards.

Because of the lack of data upon which to base answers to such inquiries, the U. S. Public Health Service requested the National Academy of Sciences, through its Building Research Advisory Board, to collect and evaluate information on the alternatives and improvements to provide a basis for a response to the technical inquiries. The intent of the endeavor would be to study currently available as well as new concepts for the onsite handling of solid wastes and thus provide basic information that would be useful to building designers and owners, municipal and public health authorities, and city planners, and which would stimulate the development of equipment and systems by the private sector of the economy.

A three-phase effort was envisioned, in which the combined resources of science, government, and industry would be applied. Each phase would cover a period of about 3 years. Insofar as the first two phases were concerned, each would be so organized that, if the study were terminated at the end of either phase, results would have been obtained that would be of value. The overall study was phased as follows:

Phase I

Study currently available equipment and techniques for handling refuse and other solid waste within individual high-rise multifamily structures--due consideration being given to user needs and acceptance, public health concerns, performance, and costs--with only secondary concern for the interface between the onsite and offsite collection systems.

Phase II

Study currently available equipment and techniques (specifically techniques employing pneumatic, hydraulic, rail-haul, and conveyor concepts) of onsite handling of refuse and other solid waste within a complex of multifamily buildings under single ownership (or management)--due consideration being given to user needs and acceptance, public health concerns, performance, and costs--with only secondary concern for the interface between the onsite and offsite systems.

Phase III

In conjunction with a planned community, install and study the systems found to be desirable in Phases I and II--using individual structures, complexes, and groups of complexes of multifamily structures--to determine the true economies and cost effectiveness of such disposal practices and the policy requirements at the municipal level.

The National Academy of Sciences agreed to undertake Phase I, with the understanding that it would play a quasi-operational role. Plans for initiating Phase I were then prepared by the Building Research Advisory Board, and a proposal was submitted to the Public Health Service. Subsequent review of the proposal by the Public Health Service resulted in formal action to proceed with the first of three study periods envisioned as constituting Phase I.

This interim report sets forth the detailed objectives and scope of the overall Phase I study, the work to be accomplished during each of the three study periods of Phase I, and describes the manner in which the study has been conducted to date.* In addition, the interim report relates all activity, work performed, and data collected during the first study period under the separate section headings The Test Structures, Assessment of Existing Conditions (at the test structures), and Preparation for Study Projection.

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*Shortly after Phase I was initiated, the Public Health Service requested that consideration be given to expanding the scope of the Phase I program to include the installation and subsequent evaluation of a pneumatic system for centrally collecting refuse from a group of high-rise multifamily structures. While this was previously intended to be part of Phase II of the overall study, the Public Health Service request served to emphasize that fundamental data on the operation of a refuse handling system employing this concept were needed as soon as possible. The request was incorporated, therefore, in the Phase I program, and the objectives and results are presented under separate cover as Supplement A, Pneumatic Transport System for Solid Waste, to this interim report.

II
OBJECTIVES AND SCOPE OF PHASE I

Phase I of the overall study is an investigation of three concepts of handling refuse: (1) incineration, (2) compaction, and (3) wet pulverization. Made in conjunction with central refuse-collection chutes, the investigation is being carried out, first, without the use of sink garbage grinders and then with garbage grinders. Existing high-rise multifamily structures serve as a field laboratory.

Specifically, the effort is directed toward obtaining adequate information to assess or establish:

1. Extent of contribution to air pollution of onsite incineration using presently accepted incineration practices and pollution control devices

2. Effectiveness and efficiency of onsite incineration, compaction, and wet pulverization

3. Weight, volume, and composition of solid waste before and after incineration, compaction, and wet pulverization

4. Environmental conditions maintained with onsite incineration, compaction, and wet pulverization

5. Power requirements, costs, and owner, tenant, and custodian acceptance of onsite incineration, compaction, and wet pulverization

6. Effects of separating putrescible wastes from rubbish with the use of garbage grinders on environmental conditions maintained by each of the different techniques for handling refuse

7. Extent of contribution to building sewer system associated with incineration, compaction, and pulverization and the use of garbage grinders

8. Acceptable refuse collection chute configurations, sizes, materials and methods of cleaning

9. Applicability and effectiveness of different methods of waste containerization (e.g., disposable paper and plastic sacks, metallic and plastic cans, and wheeled containers)

10. Onsite storage requirements for incineration, compaction, and wet pulverization, and the effect thereon of the different methods of waste containerization

11. Training requirements of janitorial and maintenance personnel for onsite incineration, compaction, and wet pulverization

12. Guidelines for architects, engineers, and builders in providing acceptable and convenient refuse collection, reduction, storage, and removal facilities

13. Techniques by which a building owner might select from the available alternatives for handling refuse on the site

Phase I was divided into three study periods, as follows:

First Study Period

1. Selection of the structures to serve as a field laboratory

2. Collection of data on existing conditions at the structures, including: number and age of tenants; extent of contribution to air pollution by existing equipment; weight, volume, and composition of generated refuse; personnel and power requirements, costs, and effectiveness and limitations of existing refuse-handling system; owner, tenant, and custodian-janitor acceptance of existing system; and degree of vermin and insect infestation associated with existing system

3. Selection of specific refuse reduction equipment intended for use in the project

4. Preparation of preliminary plans (architectural, mechanical, electrical, and plumbing), as required for the installation of the refuse-reduction equipment intended for investigation during subsequent periods of the study, and for modification of city refuse-collection trucks to accommodate containers having weights in excess of normal

5. Establishment of a data-collection program and methodology for subsequent use in conjunction with refuse-handling equipment to be investigated

6. Selection of a technique for sampling building sewer lines and establishment of a data-collection program for subsequent use in determining quantity and composition of waste flowing through the sewer line of one test structure

7. Partial installation of refuse-collection chutes, if required

Second Study Period

1. Removal of three existing incinerators from within the structures intended for use in carrying out the research program

2. Purchase and installation--in accordance with architectural and engineering design plans and specifications developed during the first period of the study--of the incineration system in one structure, a compaction system in a second structure, and a wet-pulverization system in a third structure

3. Collection of data on operation and performance of installed equipment--in accordance with procedures and schedules established during the first study period--handling all refuse

4. Installation--in accordance with architectural and engineering design plans and specifications developed during the first study period--of the building sewer-sampling station to be used in obtaining data on composition and volume of wastes flowing through the drainage lines of one structure to be used in the study

5. Collection of data--in accordance with procedures and schedules established during the first study period--on composition and volume of wastes flowing through the building sewer of one test structure

6. Modifications--in accordance with preliminary plans developed during the first study period--of city refuse-collection trucks, as required, to accommodate refuse containers used in the program having weights in excess of those normally handled by the city

7. Determination of the degree of abatement of air pollution achieved by modest, low-cost improvements to an existing incinerator

8. Preparation of preliminary plans (mechanical, plumbing, and electrical), as required, for subsequent installation of garbage grinders

9. Initiation of a survey within the larger metropolitan areas of the nation to establish an inventory of available equipment for onsite handling of refuse and to obtain data on the performance and cost of such equipment for purposes of comparison with data on refuse equipment installed in the structures being used in the study

Third Study Period

1. Installation of sink garbage grinders in accordance with plans established during the second study period

2. Collection of data on operation and performance of equipment installed during the second study period handling only rubbish, i.e., with putrescible waste separated out by the use of garbage grinders

3. Collection of data on the composition and volume of wastes flowing through the building sewer of the test structure used in 5. of the second study period, with garbage grinders in operation

4. Collection of data on the performance and operation of garbage grinders installed during this period of the study

5. Continuation of the survey initiated during the second study period

6. Reduction and analysis of all data and information collected during conduct of the study and preparation of comprehensive final report with findings, conclusions, and recommendations

III
CONDUCT OF THE STUDY

Because of the complexity of the task and the need for careful organizational planning and coordination, the Building Research Advisory Board appointed four of its members as a Steering Committee to:

1. Select the structures to be used in the program

2. Provide guidance, oversee, and coordinate all preliminary activities until such time as the Special Advisory Committee on Solid Waste could be appointed for this purpose

After the structures had been selected and agreement for their use was assured, the Special Advisory Committee on Solid Waste was appointed to assume the technical responsibility of the study.

The following general guidelines were set forth as committee responsibilities:

1. Selection of equipment to be installed and investigated

2. Determination of kinds of data to be obtained

3. Establishment of an experimental program

4. Guidance to the committee staff

5. Review and analysis of data collected

6. Preparation and approval of all reports--complete with conclusions and recommendations--emanating from the study, including interim reports covering the efforts of each of the first two study periods, and a final comprehensive report on the overall study at conclusion of the third study period

The committee met periodically throughout the first study period to plan and conduct the detailed operation of the study. Where appropriate, various subcommittees of the full committee were established to plan specific areas of the study in sufficient depth to allow full committee consideration and determination of the action to follow.

This interim report covering the first study period was then prepared.

IV
THE TEST STRUCTURES

A. SELECTION OF THE STRUCTURES

Even before the official proposal for the research project was submitted to the Public Health Service, there were discussions with officials of the New York City Public Housing Authority concerning the possible use of their structures for the study. Because of the duration of the proposed study, and because many aspects of the project would be of concern to the city, the Steering Committee recognized the need for a formal agreement with both the city and the Public Housing Authority. During preliminary discussions with the city, certain aspects of the project appeared to be potential avenues of concern; namely, the use of incinerators and garbage grinders, and the attendant necessity for the city to waive existing ordinances to enable the project to be carried out. Because of these potential problems, it was deemed by the Steering Committee that the study might best be held on schedule if conducted elsewhere. Consequently, a search for an alternative site began.

Contacts were made with several other cities, including Chicago, Illinois; St. Louis, Missouri; and New Haven, Connecticut; in search of structures that would be typical of those in most of the Nation's major urban centers, so that the results of the project would have wide applicability. Pursuant to exploratory contact with New Haven, a formal meeting was held between officials of the New Haven Public Housing Authority, officials of the City of New Haven, and the Steering Committee. An inspection was made of the actual structures to be involved in the study. The high level of interest and enthusiasm expressed by officials of the City and the Housing Authority of New Haven, plus the suitability of the structures for the intended project, led to the decision to conduct the study in New Haven.

After an agreement was prepared that was satisfactory to the city and Housing Authority officials and to the National Academy of Sciences, the agreement was then submitted to the Board of Aldermen of the City of New Haven. Approval of the agreement by the Board of Aldermen made it possible for the city to enter into a contract. The agreement then had to be approved by both the Public Health Service and the Housing Assistance Administration of the Department of Housing and Urban Development.

Delays in starting the actual testing project were experienced because of the steps required to finalize the agreement. Initial contact with the New Haven Housing Authority was made in September 1967, and final approval by all parties involved was finally obtained in May 1968. The agreement that resulted (a copy of which is included in this interim report: Appendix A--Agreement for Conduct of Solid Waste Research Project) identified, among other things, the purpose of the study, how the study was to be conducted, and obligations of the Housing Authority, the City, and the National Academy of Sciences. The agreement now serves as a recognition by all concerned that participation in the project affords an opportunity to acquire knowledge that could contribute significantly to the solution of many problems associated with the handling of solid waste.

B. DESCRIPTION OF THE TEST SITE AND TEST STRUCTURES

The physical site is a publicly owned, low-income multifamily building complex located in a semi-industrial area approximately 2 miles from the center of the main business district of New Haven. The entire Housing Authority complex consists of some three blocks of two-story duplex apartments and a grouping of six multifamily high-rise brick-veneer structures, four of which were authorized for use in the conduct of the solid waste research project by the Housing Authority.

Figure 1 shows a plot plan of the high-rise portion of the Housing Authority complex, on which addresses and designations of the structures are given, and on which the location of structures relative to each other and the total land area can be seen.

As shown in Figure 1, five of the high-rise structures are within an area bounded on one side by Canal Street (approximate frontage 1,355 ft.), on one side by Webster Street (approximate frontage 625 ft.), on one side by Ashmun Street (approximate frontage 1,340 ft.), and on the remaining side by privately owned houses (approximate frontage 220 ft.). The sixth structure is across Ashmun Street (approximate frontage 345 ft.) and is bounded, in addition to Ashmun, by Admiral Street (approximate frontage 120 ft.), by Gregory Street (approximate frontage 140 ft.) and by the grounds of an elementary grade school. Entrances to all structures face Ashmun Street. An administration building and a central boiler plant that supplies hot water and heat for the entire complex--both shown on the plot plan--plus parking facilities and playground areas, complete the site complex.

All the high-rise structures are identical in floor plan and general layout, except that the two buildings on Canal Street are 10 stories high while all others are 8 stories high. Length and width (including balcony extension) dimensions of all structures are the same, 217 ft. by 43 ft., respectively. Laundry facilities are provided in each building, as is elevator service (stops being made at ground and corridor floors only). Total tenant population (adults and children) in the six high-rise apartment buildings is approximately 1,600. Figure 2 is a picture of a typical building, taken from atop the 225 Ashmun Street structure.

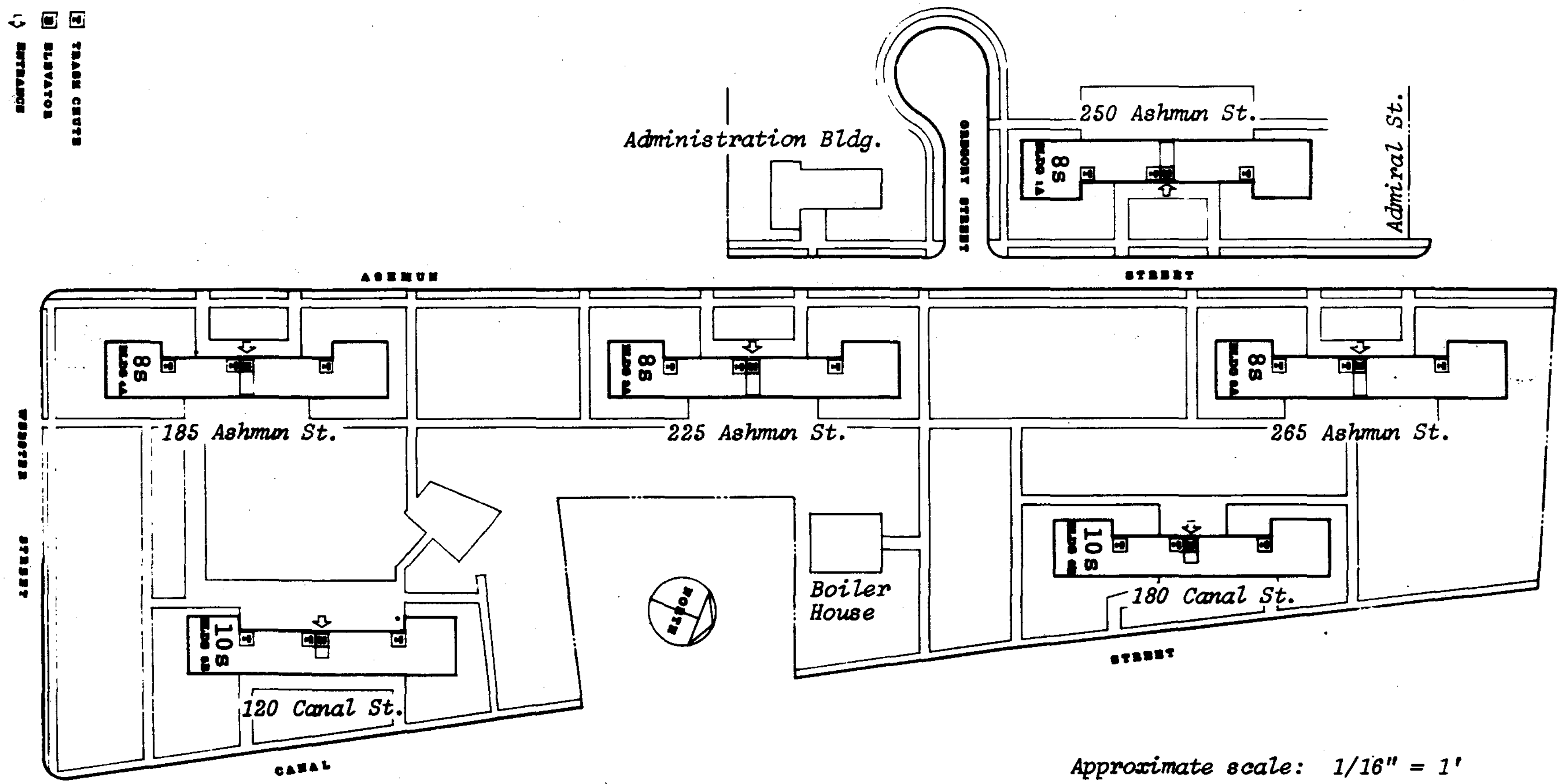

Figure 1. Plot Plan of Test Site

Figure 2. 180 Canal Street.

Apartment unit distribution within the structures is as follows:

8-Story Structures

	1 Br Units	2 Br Units	3 Br Units	4 Br Units	Total Number of Units
Ground Floors	1		4		5
Corridor Floors (4th, 7th)	2		4		12
Skip Floors (2nd, 3rd, 5th, 6th, 8th*)		2	4	2	40
Total Number of Units in Structures					57

*Those floors on which the elevator does not stop.

10-Story Structures

	1 Br Units	2 Br Units	3 Br Units	4 Br Units	Total Number of Units
Ground Floors			4		4
Corridor Floors (4th, 7th, 10th)	2		4		18
Skip Floors (2nd, 3rd, 5th, 6th, 8th, 9th)		2	4	2	48
Total Number of Units in Structures					70

C. DESCRIPTION OF EXISTING METHOD OF HANDLING REFUSE

Each of the high-rise structures on the site is equipped to handle refuse disposal by incineration. Three automatically operated incinerators (identical units--flue-fed, single-chamber, gas-fired, overfire air blower with an estimated capacity of 40 lb. per hr.) are located in the basement of each building and are electrically programmed to fire at 2-hour intervals between 7 a.m. and 11 p.m. and twice between 11 p.m. and 7 a.m. Auxiliary fuel is supplied for 15 consecutive minutes at the start of each firing.

Each corner chute and incinerator in each 8-story structure services 21 dwelling units (16 3-bedroom and 5 2-bedroom units), while the middle chute serves 15 dwelling units (10 4-bedroom and 5 1-bedroom units). In the 10-story structures, each corner chute and incinerator services 26 dwelling units (6 2-bedroom and 20 3-bedroom units), and the center chute 18 dwelling units (12 4-bedroom and 6 1-bedroom units).

Each chute is 22.5 in. square and firebrick-lined up to and including the fifth floor; above this point each chute is 24 in. square and lined with terra cotta tile the remaining distance. The chute extends approximately 9 ft. above the base of the roof and is capped with a wire-mesh spark arrester. Hopper doors, 14.5 in. square, are located on each floor of the buildings for refuse charging by tenants throughout the day. The incinerator system does not have automatic locks on the hopper doors.

Ash and residue of burned refuse are supposedly removed from the incinerator twice daily by custodians and placed in conventional metallic refuse containers. The residue is stored in the basement of each building until the next periodic pickup (twice weekly) by the city crews.

At the time of pickup, custodians hand-carry all loaded refuse containers to the street curb. Two-wheel carts are used to bring the refuse containers up stairwells to ground level. It should be noted here that a permanently installed hoist at the stairwell to each basement was used at one time to raise the refuse containers to ground level, but these hoists were abandoned because of continued vandalism.

Incineration system details are shown in Figure 3.

D. RELATION OF THE TEST STRUCTURES TO THE TEST PROGRAM

In order to conduct concurrent investigations of three different methods of handling solid waste, three of the six high-rise buildings at the New Haven complex were designated for this purpose. The pulverizer and compactor would replace the existing north incinerators in Buildings 6B and 5B, respectively, and the new incinerator would replace the existing south incinerator in Building 1A (see Figure 1 for building designations). To provide an indication as to whether any change in environmental or other conditions which occured in the test structures during the course of the investigation was attributable directly to the newly installed equipment, Building 4A was designated as a control test structure. Comparative data would then be available for assessment.

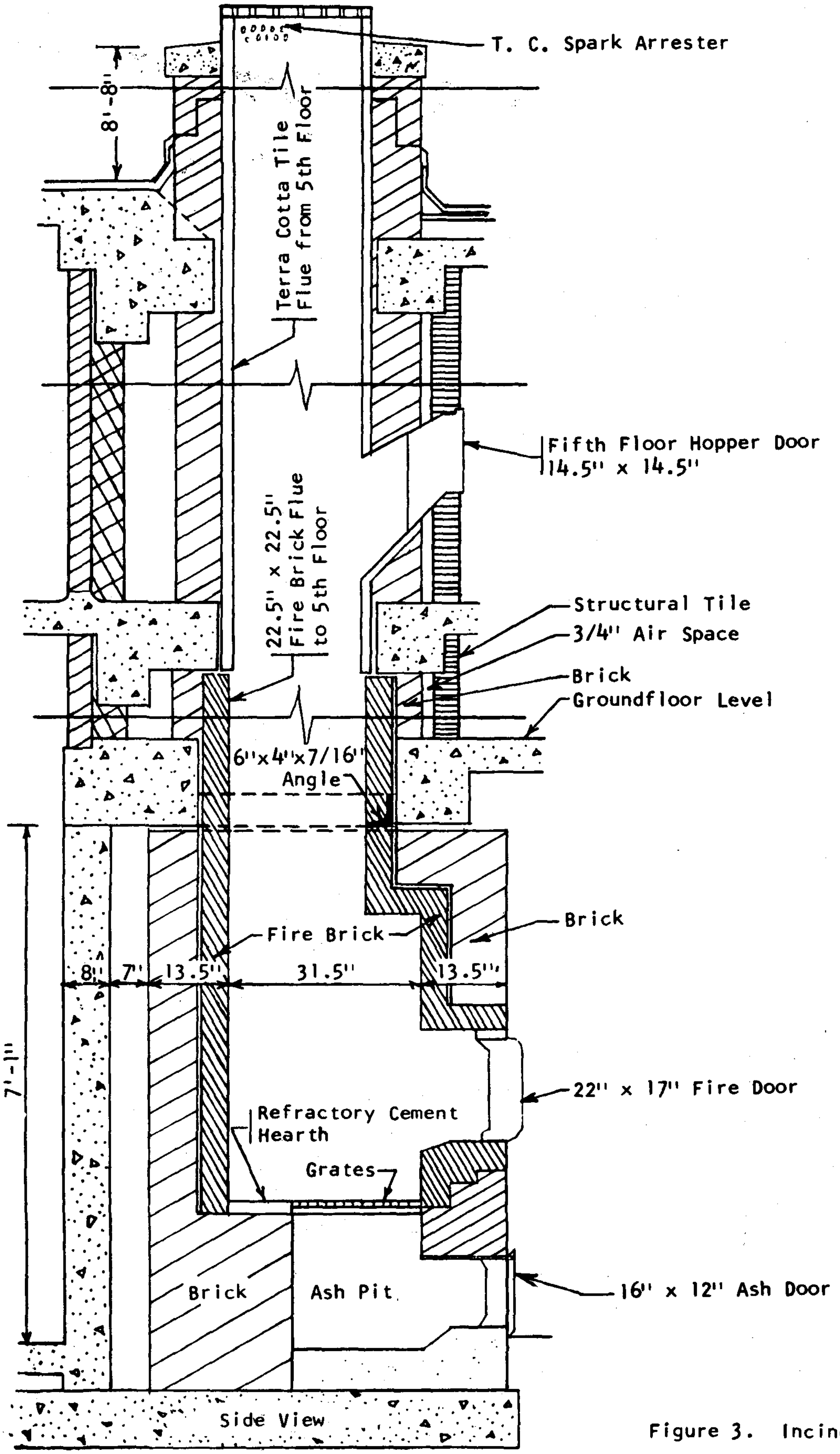

Figure 3. Incinerator details

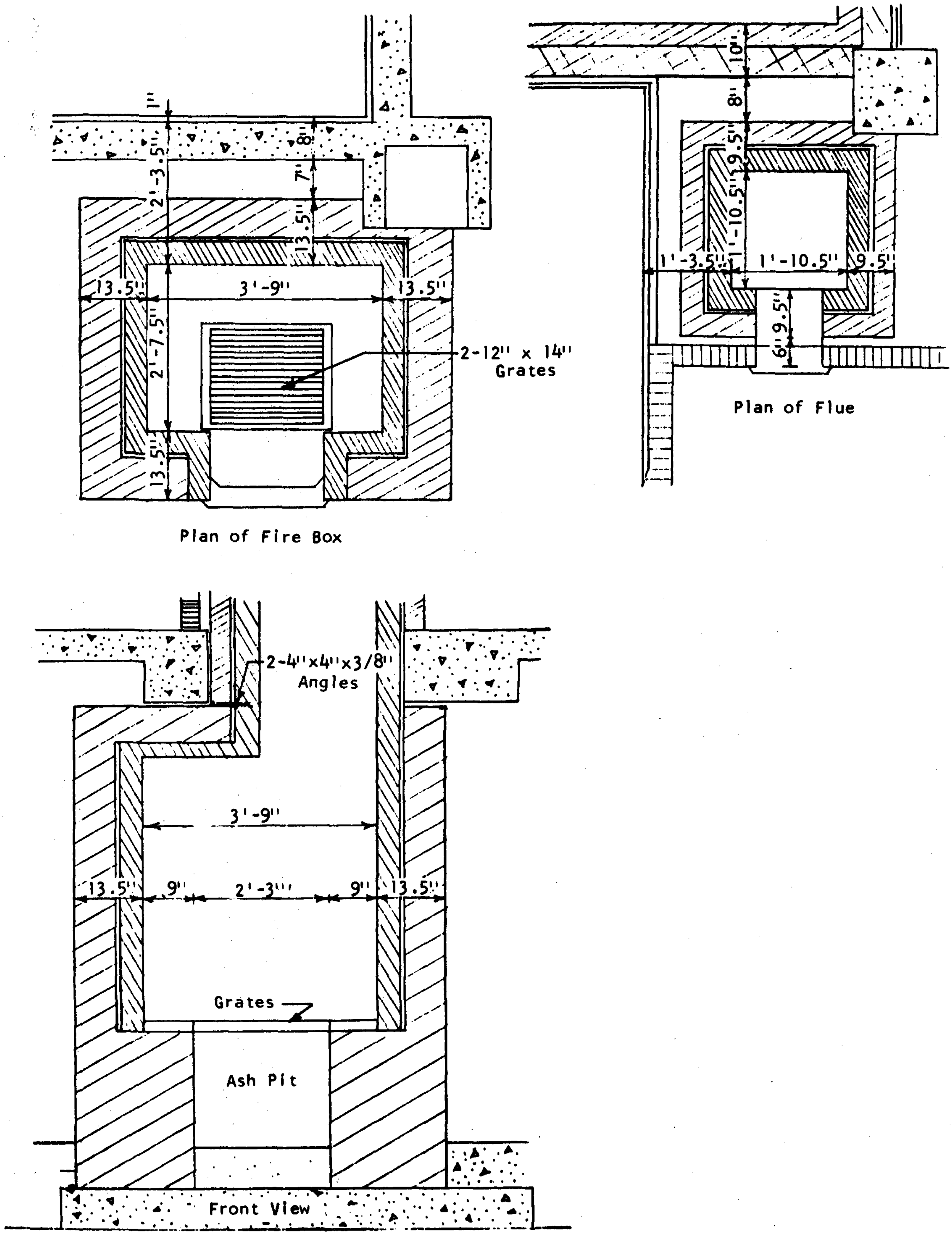

Figure 3. Incinerator details (Cont.)

Since each building has three chutes, various options were available for the installation of new equipment, including: (1) use of three buildings, each having three compactors, three pulpers, or three incinerators; (2) use of one building housing the compactor, the pulper, and the incinerator; (3) use of the three buildings each having only one compactor, one pulper, or one incinerator. Due to the prohibitive costs of the first approach, it was agreed that the last method would be most practical in achieving the goals of the program. Reasons supporting this position were: (1) the probability of obtaining a better distribution of the janitorial load, and (2) the possibility of making a better assessment of changes in insect and vermin infestation and other environmental conditions associated with each technique for handling the refuse.

It is intended to install garbage grinders during the third study period in the apartments served by the north chutes of Buildings 5B and 6B and the south chute of Building 1A. Building 6B will be used to determine the composition and volume of wastes flowing through the building sewer before and after installation of the garbage grinders.

E. TENANT LIAISON

In an effort to maintain good relations with tenants of the structures, one resident from each of the four structures involved in the project was engaged to serve as liaison between the tenants, Housing Authority management, and the advisory committee. Services provided by these individuals included personal contact with the families in their buildings, informing them of the scope and goals of the research project, alerting them to times when data collectors would be on the premises, soliciting tenant cooperation, especially during periods of inconvenience, conveying to the committee staff all tenant complaints and questions concerning the project, and obtaining some data required by the program.

V
ASSESSMENT OF EXISTING CONDITIONS

As noted in Section II of this report, the first study period was to be devoted principally to preparation for the second 12-month period and to assessment of conditions related to the existing method for handling refuse at the test site. Such conditions were defined to include the quantity and composition of refuse generated, the age and number of inhabitants, the contribution to air pollution from existing incinerators, the degree of vermin and insect infestation, and, for the existing system, the personnel and power requirements, costs, owner, tenant, and custodian-janitor acceptance, and effectiveness and limitations. Such a survey was deemed to be essential to establish a basis against which improvements or changes effected by the new equipment could be assessed. It would also provide necessary information for selecting (sizing) and programming the operation of the new equipment.

A. REFUSE QUANTITY AND COMPOSITION

Fundamental to the proper selection and programming of the operation of equipment for onsite handling of solid waste, and basic to any program of assessing capability and limitations of such equipment, is accurate information concerning the nature and quantity of refuse that the equipment is expected to process and when or over what period of time the processing will be effected. Thus, in the normal conduct of this program, it was necessary to collect data on quantity and composition of refuse generated by the tenants of the test structures. But, because the usefulness of such data extends beyond immediate application to this program, and because of the few opportunities in the past to characterize refuse generated at the actual source, especially in high-rise dwellings, particular care was taken to develop a program of data collection which would provide input in the national effort to establish: (1) the magnitude of the refuse load in terms of per capita generation; (2) the variation of quantity and composition of refuse generated with meteorological (seasonal) change, income level of generators, and type of dwelling units (e.g., single vs. multifamily); and (3) a definition of the physical characteristics of refuse for use not only in the development of new equipment and techniques for onsite handling but also for use in the development, designing, and planning of collection, storage, and disposal facilities on a municipal or regional scale. This resulted in a more extensive data-collection program than would have been required solely for the onsite study.

Responsibility for development of the data-collection program--or protocol (see Appendix B)--for determining the quantity and composition of refuse generated at the test structures was assigned to a subcommittee of the advisory committee. After review and further development by the full committee, the protocol served as the scope of work of a subcontract with York Research Corporation, a commercial laboratory located in Stamford, Connecticut, which was engaged to collect the data.

The protocol involves each of the three test structures, the control structure, and all the chutes within these buildings. It accounts separately for chute refuse, yard refuse, and bulky miscellaneous solid waste that is normally picked up on request from individual apartments by janitorial services. The protocol has applicability to any seven consecutive days or one complete calendar week and provides for collection of data on: (1) weight, volume, and physical composition (including moisture content) of chute refuse generated hourly, daily, and weekly; (2) weight and composition of chute residue following daily incineration; (3) weight and composition of bulky miscellaneous solid waste items generated weekly; and (4) weight and composition of yard refuse generated weekly.

In establishing the various categories for sorting the refuse to determine physical composition, and to make the data immediately comparable with data collected elsewhere, previous classifications by the Public Health Service were reviewed. As a result, the eight categories identified in the protocol are practically identical with those normally used by the Public Health Service, except that a category of leaves and grass was not included--since the structures involved were multifamily apartments--and that glass was assigned a specific category separate from ceramics.

A detailed account of the implementation of the protocol is given in Appendix B, and the data collected are presented in Tables I through XXI of Appendix C.

Conduct of the data-collection program proved to be more difficult than anticipated, partly because of the number of sorting sites (12) and their location in four different buildings somewhat removed from each other. Communications between the project director and the two professionals covering two buildings apiece, and between the professionals and laborers working each of their two buildings, posed a problem. Any change in personnel at the project director level, the professional level, or laborer level--except in the one case where the new project director arrived at the site already familiar with protocol procedure (Sunday)--resulted in a loss of efficiency. Even recognizing that man-hour requirements for laborers and professionals are at best difficult to estimate, it is important to note that, for the approximate amount of $18,500 provided in the subcontract for conduct of the field program, it was anticipated that 3 separate weeks of data could be collected. At the end of the seventh day of the first week of collecting data in accordance with the protocol, approximately $300 remained in the subcontract for field services. While many factors affected field costs,* the expenditure should be recognized as a conservative

*Any competent laborer was allowed to work as many hours a day (up to 16) as he felt capable. Thus, such laborers were reimbursed in accordance with Federal law at a rate of time and a half for all hours worked in excess of 8 in any given day. Such costs were not considered in the original estimate.

testimonial to the cost for such services. Information on man-hours provided each day by personnel at each level of responsibility (project director, professional, laborer) was not originally requested from the subcontractor, and, consequently, was not available at the time of this writing. This information has since been requested of the subcontractor and will be included in subsequent reports of the committee.

During the conduct of the field program, little time could be devoted to determination of the quantity and composition of yard waste; consequently, no data on such are presented in Appendix C. From discussions with the janitor responsible for yard waste, it was learned that he policed the grounds each morning and filled from two to three 70-gal. galvanized iron wicker baskets daily;* additional baskets are in the front and back of each building for use by the tenants. Several full and empty baskets were weighed by the subcontractor, and the averages were 70 lb. and 36 lb., respectively; visual inspections of the containers indicated that the composition was predominantly paper, leaves, and glass in that order. This is an area in which additional data must be collected during the second study period of the program.

It is perhaps significant to report that two professionals and one or two laborers became nauseated during the program in the field, while no one on the janitorial staff was affected. Further, several professionals suffered injuries; two slipped, one injuring his arm, the other his hip; a third walked into a low-hanging cast-iron soil pipe, and the wound received required six stitches to close.

During the 7-day data-collection period, several fires occurred in the incinerators in Building 1A--on two separate days in incinerator C_1 (three fires in one day), and on one day in both incinerators C_2 and C_3--resulting in the loss of some refuse. Approximate time of occurrence of the fires is identified on the appropriate tables in Appendix C, as are the daily totals affected. On several occassions, the volume of refuse by category was not recorded after sorting, and these are also identified in the tables in Appendix C. The absence in a relatively few instances of data on the volume of refuse after sorting is believed to be of no particular significance in an analysis of the data.

At least one blockage of a chute (A_3) occurred, probably sometime between 7 p.m. on 7 December and 7 a.m. on 8 December. Throughout 8 and 9 December, enough waste fell into the incinerator so that the blockage was not immediately detected. On the morning of 10 December the blockage was broken and 235 lb. of refuse with a volume of approximately 34.8 cu. ft. were removed from the incinerator. This and another possible blockage are indicated in the appropriate tables in Appendix C.

*A railway loading station is directly behind the Housing Authority complex across Canal Street, and during the 7-day data-collection period, it was noted that considerable paper waste was blown onto Housing Authority grounds during the loading and unloading of freight.

Bulky waste items collected during the week are listed in Table XIX of Appendix C. To a reasonable degree, these items were centrally stored within each building as collected by the janitorial staff; however, many bulky waste items (e.g., mattresses and boxes) found on the grounds of the Housing Authority complex could not be positively identified as to point of origin. It was simply assumed that the items came from the structure to which they were closest. Because the field personnel were fully engaged in sorting chute refuse, neither time nor labor could be devoted to determining the date of disposal of the bulky waste items. This, too, is an area in which additional data are required and will be collected during the second study period.

In fulfilling the requirements of the protocol (Appendix B), the sorting of residue after burning within incinerators C_3, D_1, D_2 and D_3 of the refuse collected each previous day was necessarily performed in a hurried manner. Consequently, in some instances, a disproportionately large amount of ash was sorted out with the noncombustibles and recorded as such. This accounts for those instances--evident on comparison of values given in Table XXI in Appendix C with values reported in earlier tables of Appendix C--where weights of noncombustibles following incineration exceed respective weights before incineration. While additional data must be collected to verify these percentages, the average reductions in weight and volume for all refuse incinerated were approximately 51% and 81%, respectively. Data obtained on the moisture content of refuse are reported in Table XVIII of Appendix C. A review of the data failed to associate a distinguishable trend with either of the two methods employed to obtain the moisture samples.* Average moisture content (i.e., the percentage of the weight lost through ovendrying) for samples of paper and paper products was approximately 17.9%; for composite samples of woods, plastics, rags, and all other combustibles except paper and organic garbage, approximately 12.8%; for metallic samples approximately 9.3%; and for samples of organic garbage, approximately 31.4%.

A total of 10,947 lb. of chute refuse with a volume of approximately 1960.9 cu. ft. was generated over the 7-day data-collection period by the tenants within the four buildings. (This does not include bulky solid waste items and yard waste.) Table I gives the percentage by weight and volume of each category of chute refuse. Values given in the table ignore the relatively small error imposed as a result of the occasional failure in the field to record the volume of refuse by category after sorting.

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*See Appendix B. One procedure was specified in the protocol for obtaining moisture samples. In practice, however, in order to expedite the field program, the subcontractor departed several times from the specified procedure.

TABLE I
REFUSE COMPOSITION

Category of Refuse	% by Wt.	% by Vol.
Paper and Paper Products	32.98	62.61
Wood and Wood Products	0.38	0.15
Plastic, Leather, and Rubber Products	6.84	9.06
Rags and Textile Products	6.36	5.10
Glass	16.06	5.31
Metallics	10.74	9.12
Stones, Sands, and other inerts	0.26	0.07
Garbage (organics)	26.38	8.58

Considering the total population (adults and children*) of the four structures and the total amount of chute refuse generated during the week, the per capita rate for generation was 1.48 lb. per day per person, a surprisingly low value; considering adults only, a value of 4.33 lb. per day per adult is obtained. On the basis of the total number of dwelling units occupied, a value of 6.23 lb. per unit per day is obtained. Table II summarizes this information on a per building basis.

TABLE II
PER CAPITA AND OTHER RATES OF REFUSE GENERATION

	Bldg. 6B	Bldg. 5B	Bldg. 1A	Bldg. 4A	Totals
Per Capita (lb/day)	1.69	1.75	1.30	1.25	1.48
Per Adult (lb/day)	4.45	4.34	4.58	3.98	4.33
Per Dwelling Unit (lb/unit)	6.06	6.14	6.46	6.33	6.23

The refuse density values given in Table III of Appendix C are significant. Considering the total weight and volume of refuse generated during the entire week, a value of 5.6 lb. per cu. ft. was obtained for density. Weekly averages of refuse density on a chute-by-chute basis ranged from a minimum of 4.7 lb. per cu. ft. to a maximum of 6.7 lb. per cu. ft., reflecting a surprisingly small deviation from 5.6 lb. per cu. ft. The small variation in density was also evident in the values determined for the total weight and volume of refuse generated at all chutes daily during each of the different periods of the day, i.e., values ranging from a minimum of 4.0 lb. per cu. ft. to a maximum of 7.6 lb. per cu. ft.

*See the following section for population data.

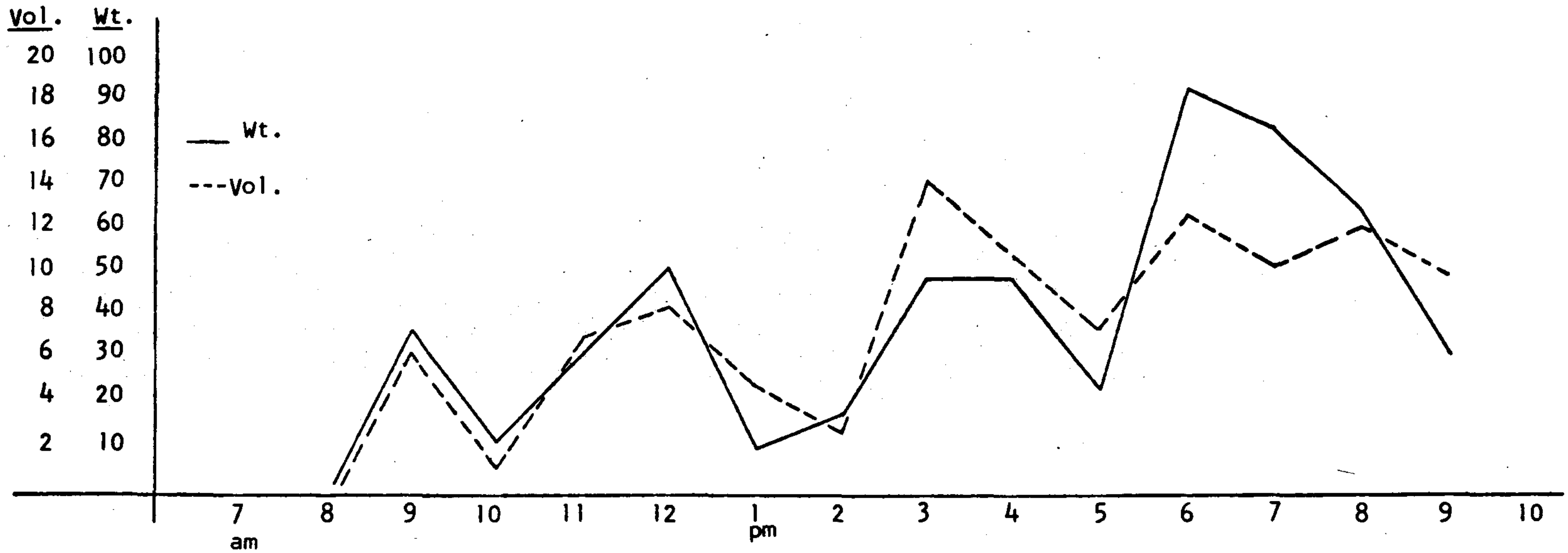
Hourly and weekly refuse generation rates in terms of both weight and volume are presented in Figure 4. On the hourly graph, four distinct peaks can be identified on the weight curve, at 9 a.m., noon, 3 to 4 p.m., and 6 to 7 p.m., with the magnitude increasing during the day. The same trend is also evident with volume, but the peaks are not as sharply defined, and the greatest peak occurs at 3 p.m.

Saturday, Sunday, and Monday were clearly the days when most refuse was discarded, the weight of refuse generated on each of these days being more than 50% greater than that generated on Wednesday, Thursday, or Friday. It is also obvious that the peak generation occurred on Saturday, with Sunday a close second, the downward trend continuing through Wednesday, when the minimum refuse was generated. It should be recognized, however, that in the development of this curve, 200 lb. of the refuse associated with the chute blockage on Tuesday was added to the weight of refuse shown in the tables of Appendix C for Monday's generation. Probably, some of the refuse in the blockage was actually generated on Sunday, and this could have been enough to establish Sunday as the peak refuse generation day. The daily volume curve shows a broad, relatively flat peak from Friday through Tuesday. This is significant, because volume rather than weight of refuse determines the relative ease and speed of sorting. In this curve, 24 cu. ft. of the refuse associated with the blockage freed on Tuesday morning was added to the volume shown in the tables of Appendix C for Monday's generation. Also, in both the volume and weight curve, the percentage of volume and weight of refuse generated after 7 p.m. Thursday at the incinerators, where sorting occurred hourly, was determined; a comparable percentage of the total weight and volume generated Thursday was then determined and added to the values recorded for Friday. In this way, each day, except Thursday, is represented by the 24 hours between 7 p.m. of the previous day and 7 p.m. of the day in question.

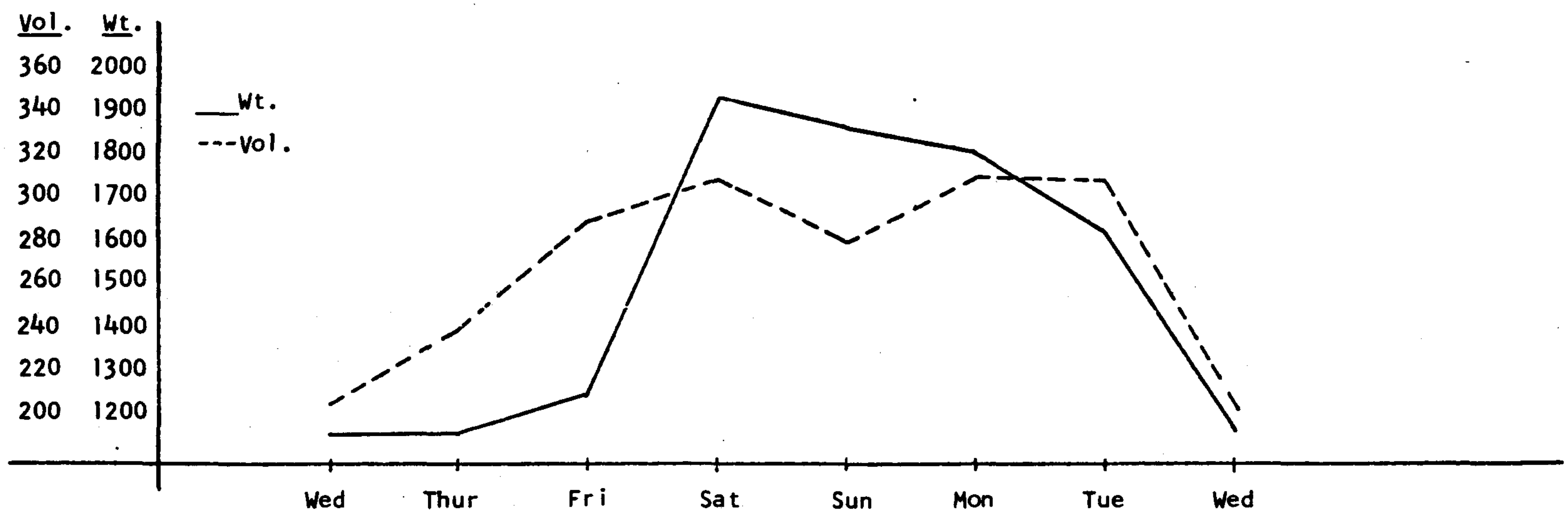
For future onsite programs, it is recommended that the effort be initiated on a Wednesday so that all personnel can become familiar with their duties while the rate of refuse generation is at its lowest.

B. INHABITANTS

In order to establish the per capita rates of refuse generation just reported, it was necessary to know the number of persons responsible for the generation over the period of time involved. Because per capita rates are in themselves insufficient, in that they tend to mask the contributing effects of other factors--e.g., adults versus children--a door-to-door census was taken by tenant liaison and the Housing Authority Management in each of the four structures to determine the number of adults and children using each chute. Further, because of suspected and reported variations in the quantity and composition of refuse generated by different individuals and their families, the Housing Authority administrative regulations were reviewed to determine the average income level, the rate of tenant turnover, admission requirements, and any other such possibly revealing factors. Once sufficient data of this type are collected nationally on the physical characteristics of refuse generated by persons



Hourly variation in rate of refuse generation.



Daily variation in rate of refuse generation.

Figure 4. Hourly and daily variation in rate of refuse generation--weight (lb) and volume (cu. ft.)

with differing or associated characteristics, suspected variations can then be validated or disproved. The breakdown of the tenant population per building per chute, as determined from the door-to-door census, is shown in Table III.

TABLE III
POPULATION DATA

Building	Chute*	No. Adults	No. Children	Totals
6B - Test Structure A	A_1	38	45	83
70 apartments	A_2	17	73	90
(1 vacancy)	A_3	39	36	75
Subtotals		94	154	248
5B - Test Structure B	B_1	37	38	75
70 apartments	B_2	24	69	93
(no vacancy)	B_3	38	40	78
Subtotals		99	147	246
1A - Test Structure C	C_1	33	71	104
57 apartments	C_2	16	65	81
(1 vacancy)	C_3	30	63	93
Subtotals		79	199	278
4A - Control Structure D	D_1	34	67	101
57 apartments	D_2	16	59	75
(1 vacancy)	D_3	39	69	108
Subtotals		89	195	284
GRAND TOTALS		361	695	1056

*Designations as established in the protocol on refuse (Appendix B).

A review of Housing Authority regulations established that qualification for occupancy was dependent on income and family size, with the maximum allowable income for admission ranging from $3,700 for a family of one to $7,300 for a family of 14. Special income limits were in effect, and provisions were made for increased income during continued occupancy, but all reflected in general a low-income range. The rate of tenant turnover was relatively insignificant.

C. CONTRIBUTION TO AIR POLLUTION FROM EXISTING INCINERATORS

Because of widespread concern with onsite incineration and the few opportunities in the past to monitor stack emissions from incinerators of the size involved at the New Haven test site, particular care was taken to develop a program of data collection that would yield information having applicability beyond its immediate usefulness to the onsite program. As in the case of refuse quantity and composition, responsibility for development of the specific data-collection program (or protocol) for assessing air pollution from the existing incinerators was assigned to a subcommittee of the advisory committee. After careful review and further development by the full committee, the protocol served as the scope of work of another subcontract with York Research Corporation for conducting the test program in the field.

Because of the cost that would have been entailed, stack emissions from all 12 incinerators within the four test structures could not be monitored. Therefore, the protocol involved only test structure 1A--the structure in which it is intended to install the new incinerator and, hopefully, to upgrade an existing one--and incinerators C_1 and C_3 therein. (See Appendix D.)

Most of the protocol deals with incinerator C_3, since it is intended to replace this incinerator with the new one. Thus it was deemed desirable to obtain data from the widest range of test conditions possible to provide a broad basis for future comparisons. As developed, the protocol details the specific tests to be conducted, the data to be obtained from each test, and the test procedures to be used. It is important to note that in two tests to be conducted, the protocol requires that particulate emission rates be determined simultaneously using basically the test procedures specified in the ASME Test Code PTC 27-1957 and the test procedures developed by the National Air Pollution Control Administration, U. S. Public Health Service.

General testing was performed by the subcontractor during the last part of December 1968 and during January and February 1969. Data from these tests are given in Tables I through XI of Appendix E, along with a description by the subcontractor of methods of testing and collecting and analyzing samples and location of sampling ports on the stack.

For these tests, incinerator design capacity was calculated to be approximately 40 lb. per hr., using the procedure recommended by the Incinerator Institute of America. Thus, in the tests requiring charging of refuse at design capacity (i.e., Tests 1, 4, 5, 6, and 9), 40-lb. refuse samples were used. As estimated from the data collected on 5 December 1968 on the quantity of refuse generated hourly at incinerators A_1, B_1, C_3, and D_3, it appeared that the actual tenant charging rate was very close to the incinerator design capacity. Therefore, to obtain the desired variations in charging rate for the test involved, tc simulate incinerator overloading and to reflect peak refuse generation periods manifested by the 58 lb. collected on 5 December during 1 hour at incinerator C_3, the tenant charging rate was assumed to be 60 lb. per hr. Thus, for Test 2, which requires that charging of refuse be based on tenant charging rate, 60-lb. refuse samples were used. The third variation in charging rate (20 lb. per hr.) also was selected after review of the data collected on the quantity of refuse generated hourly on 5 December, to simulate underloading of the incinerator but yet to be of sufficient size to provide meaningful information. Thus, for Test 3, 20-lb. refuse samples were used. For Test 7, five refuse samples of random composition, reflecting charging rates of 4, 16, 30, 40, and 60 lb. per hr., were fed manually into the incinerator by the subcontractor during the course of a day, and stack emissions were determined for each sample. The period of time during which stack emissions were monitored varied from 30 minutes for the 4-lb. sample to 45 minutes for the 60-lb. sample; duration of stack sampling period per sample is given for this and other tests in the appropriate tables of Appendix E. The same procedure was repeated on another day for Test 8. Charging rates used in these tests also were selected to reflect the range of quantity of refuse generated hourly on 5 December at incinerators A_1, B_1, C_3, and D_3.

The composition of all samples burned was similar for all tests, except for Tests 7 and 8. While it was desirable to base sample composition on not less than one week's data on average composition of refuse generated within all test structures, the schedule imposed on the subcontractor precluded awaiting reduction of all data collected during the week of 5-11 December.* Therefore, sample composition was based only on that data collected during the first two days of the seven-day data-collection period. Following this procedure, sample composition (percentage by weight) was established by the subcontractor to be:

Sample Composition**

Category of Refuse	Percentage by Weight
Paper and Paper Products	34.2
Wood and Wood Products	0.8
Plastic, Leather, and Rubber Products	5.2
Rags and Textile Products	6.4
Glass	19.0
Metallics	10.8
Stones, sand, and other inerts	2.1
Garbage (organics)	21.5

It is revealing to compare these percentages with the percentages that would have resulted if sample composition had been based on data collected over the entire week, namely: 32.98, 0.38, 6.84, 6.36, 16.06, 10.74, 0.26, and 26.38.

*As noted elsewhere, it was initially intended that data on refuse quantity and composition would be collected during three separate 3-week periods. As envisioned, the second week's data were to be collected throughout the period during which incinerator stack sampling was performed and the data immediately reduced to determine whether it would be desirable to vary the composition of samples to be used in the stack sampling tests. The unexpected high cost for collection of data on refuse quantity and composition for a period of one week precluded this possibility.

**In the computation of sample composition, a weight of 24 lb. of organic garbage was inadvertently taken as the weight of stones, sands, and other inerts, resulting in the disproportionately high percentage shown for this category. This error was not detected until after conduct of the field program.

Although extremely cold weather caused the freezing of some solutions in the sampling train and the loss of some data, conduct of the program at the site was relatively routine. Prior to any test, all hopper doors to the incinerator involved were taped shut and signs were placed by each requesting tenants to refrain from charging refuse into the chute during the test. For the most part, tenant cooperation was excellent; however, during at least one test, tape was removed from a hopper door and refuse was charged inside by a tenant. This test and those affected by the freezing weather are identified on the appropriate tables in Appendix E.

Because carbon monoxide was not detected in stack emissions during Test 1 or Test 2, the subcontractor deleted monitoring of this gas in hallways near hopper doors as required by the protocol. It is also important to note, that in the conduct of Test 2, to determine particulate emission rates (lb. per hr.) during the period refuse samples were smoldering, a thimble change was made halfway through the burning of each sample (i.e., 15 minutes after ignition). Emission rates for each part of a burn are, thus, reported separately on Table II of Appendix E. Further, as indicated in the subcontractor's report contained in Appendix E, sticky paper samples were taken at least once during the burning of each refuse sample. In some instances, two sticky paper samples were taken during a burn. Particles per sq. in. and particle size distribution as determined from the sticky paper samples are given in Table X of Appendix E with the period of the burn during which the samples were obtained appropriately identified. Emission rates (number of particles per min.), as determined from sticky paper samples, are given for each refuse sample on Tables I through IX; as before, the period of the burn during which the sticky paper samples were obtained is identified.

As with data collected on refuse quantity and composition, it is not the intent at this time to analyze extensively the data collected on air pollutants. However, it is significant to point out that from only 6 of 45 refuse samples burned in the general testing was carbon monoxide actually detected, the maximum being 0.1% by volume in one sample. The average particulate emission rate of all tests (23 samples) conducted on incinerator C_3 at design capacity using samples of known and similar composition was 0.18 lb. per hr. per 40 lb. of refuse burned. This compares with an average of 0.08 lb. per hr. per 40 lb. of refuse burned for Test 9 (3 samples) conducted on incinerator C_1 using refuse samples of the same composition. Maximum Ringelmann reading observed was 2.5, and this was recorded during the burning of four different samples. Average Ringelmann for the 23 40-lb. samples of similar composition burned in incinerator C_3 was 2.3 units as compared to an average of 1.5 units for the three samples burned in incinerator C_1 during Test 9. Carbon dioxide content was low in all tests, ranging predominantly between 0.5% and 1.0% by volume when detected; maximum detected was 1.5% in two samples.

Simultaneous testing was performed on 11 and 12 March 1969. For these tests, arrangements were made with the U. S. Public Health Service to provide a stack sampling crew of its own thoroughly trained in the test procedures developed by the National Air Pollution Control Administration. Using the 3-in. sampling ports previously prepared by the subcontractor on one side of the incinerator stack, the particulate tests were run simultaneously by the subcontractor with his train and by the Public Health Service crew with the NAPCA train. Since the two smaller holes located on a second face of the incinerator stack were available, the PHS crew also took integrated bag samples and instantaneous grab samples for CO_2 and O_2; the subcontractor also obtained data in addition to the data on particulate emission rate as required by the protocol. Both the Public Health Service and the subcontractor delivered the data collected from these tests directly to the committee staff; results are given in Tables XII, XIII, and XIV of Appendix E.

For Test 10, 20-lb. refuse samples were used; for Test 11, 40-lb. (incinerator design capacity) refuse samples were used. It is important to note that in Test 11 the subcontractor determined the weight of particulates picked up in the impingers in addition to the weight of particulates picked up in the thimbles. The weight of particulates picked up in the impingers was surprisingly high, running some 30% of the total for two of the refuse samples burned. As expected, the NAPCA method of test resulted in higher particulate rates than those obtained using the ASME-PTC-27 method, but only when the weight of particulates in the impinger was considered were results comparable to what might have been anticipated.

D. VERMIN AND INSECT INFESTATION

Much has been written concerning the association of vector infestation--rodents, roaches, flies, and similar pests--with the presence of solid waste, especially about the waste serving as a source of food and harborage for these potential carriers of disease. Obviously, solid waste can contribute significantly to vector propagation in close proximity to man. Thus the onsite refuse-handling equipment or system can also significantly influence the degree of vector propagation and infestation. Therefore, it is believed that particular attention should be paid to this influence, and alternative methods of onsite handling of refuse should be rated accordingly. To provide a basis for judging the influence of the equipment on vector propagation, a program was developed to assess the degree of vermin and insect infestation associated with the existing refuse handling system. As with quantity and composition of refuse and air pollution, responsibility for development of the assessment program was assigned to a subcommittee of the full committee.

Discussions with the Housing Authority management revealed that the current extermination program consisted of annual or biennial inspection and treatment by the local exterminator of individual apartments and all public and other areas. Thereafter, for roaches, extermination service is provided on a tenant-request or complaint basis; if a heavy infestation or a bad sanitation condition conducive to infestation buildup is encountered when providing the service on request, a second treatment is provided on the exterminator's next visit to the premises. This, or a comparable uniform extermination service, is to be maintained in each of the four buildings involved throughout the period for assessment of existing conditions and during the second and third year of the program. The entire assessment program was conducted by the subcommittee, assisted by the staff of the National Pest Control Association.

1. Rodents

Discussions with the local exterminator and several inspections of the test structures made by the subcommittee throughout the study period revealed no evidence of a rat population. On 25 and 26 August 1969, a positive check was made on rodent activity around incinerators in the basement areas with the use of flow tracking powder. The incinerators checked were those to be removed and replaced with the new refuse handling equipment and the north incinerator of the control structure. Tracking powder was put down in 8-in. bands on each basement floor about 10 ft. from the incinerator and in such a manner that the incinerators were completely encircled. The bands of tracking powder were put down at approximately 4 p.m., and observations were made between 8 and 9 a.m. No evidence of rodent tracks was found in any of the tracking powder bands during periods of observation. Nothing was seen in the basement areas that appeared to be especially conducive to infestation of this vector. No rat burrows existed in the rather extensive areas of exposed soil in the basements around the incinerators.

During the formal observations, one mouse was seen in a pile of cans and other noncombustible materials that had been removed from an incinerator. It had not walked across the tracking powder band, but it could have jumped from the incinerator across the band and remained in the trash pile. Mouse holes in the exposed soil indicated that a significant mouse population had existed, but there was also evidence of heavy dusting in these areas with what looked like DDT dust. Tenants and the local exterminator reported that mice are a continuing problem. The exterminator also reported that the mouse population is centered around the refuse chutes feeding the incinerators. This would be the logical source for the one mouse seen during the formal observations.

2. Roaches

To assess the cockroach infestation, inspections were made of individual apartments and the basement areas of the test and control structures on the same days observations were made of rodent activity. Eighty-seven out of a possible 92 apartments were inspected, essentially all of those served by the three refuse chutes that will be used in conjunction with the new refuse-handling equipment and by the north chute of the control structure.

Apartment inspection involved use of an aerosol spray containing 0.5% pyrethrins as a flushing agent. In each apartment checks were made in five different locations-- three in the kitchen area and two in the bathroom--

as follows:

1. In the kitchen, above or behind the sink, by spraying in cracks between shelving and wall or in cracks between the sink top and wall, whichever presented an open crack
2. In the kitchen, inside a cabinet on one side of the sink choosing when possible a cabinet where foodstuffs were stored, by spraying the crack below a shelf where it contacted each side
3. In a storage closet adjacent to the kitchen, by spraying the ends of the metal shelves where they contacted the wall
4. In the bathroom, behind and under the wash basin, by spraying up under the fixture on each side at the point where it contacts the wall
5. In the bathroom, behind wooden waist-high molding, by spraying down or up into cracks that existed between the molding and the wall or, when no cracks existed behind the molding, by spraying the crack between the bathtub and the molding around its top

The sprayed areas were observed for approximately 1 minute after spraying or until a positive response by the roach population occurred. Responses were rated as follows:

No response....................0
1-3 roaches seen...............1
4-10 roaches seen..............2
More than 10 roaches seen......3

The inspections confirmed the presence of a general cockroach infestation. Of the 87 apartments inspected, only 26 were not infested; of 423 locations sprayed, roach response was positive in 163 cases. Intensity of infestation varied from building to building and from apartment to apartment within a building. To reflect the findings, each apartment was assigned an infestation score--arbitrarily calculated for each apartment, considering all five areas sprayed, by assuming 0 for each 0 rating, 2 for each 1 rating, 7 for each 2 rating, and 25 for each 3 rating. The following frequency distribution resulted:

INFESTATION SCORE	FREQUENCY*
0	26
1-3	14
4-10	14
11-20	13
21-30	4
31-40	6
41-50	2
51-60	4
61-70	0
71-80	2
81-90	2

*Frequency indicates the number of apartments in which the cited range of infestation score was observed.

No correlation of degree of infestation with the present method of handling refuse could be established. Other factors obviously influenced the infestation level more than the refuse-handling system, either for the building as a whole or for individual apartments. The roach populations were generally lower in cleaner apartments, in which waste food was disposed of carefully and foods stored in closed containers. But in some apartments even good housekeeping practices and proper waste disposal and food storage did not result in freedom from infestation.

3. Flies

Fly activity also was observed during the period when roach inspections were made and on several other occasions throughout the study period when the subcommittee was at the test site. No fly problem was observed in any of the apartments or in the basement areas at the time of the roach inspections. Observations in hallways were made in each of the test and control structures without seeing more than an occasional fly. The greatest concentrations of flies observed were groups of approximately 10, mostly blowflies, on or around deposits of dog dung. Nothing was seen on the premises that would be conducive to development of a large fly infestation.

E. MISCELLANY

All remaining factors deemed to constitute existing conditions associated with the present refuse-handling system--personnel requirements, power and fuel requirements, costs (operation and maintenance), owner, tenant, and custodian acceptance, and effectiveness and limitations--were grouped together and considered under the title "Miscellany." Although it was desirable to have quantitative data on all parameters required to assess each of the "Miscellany" factors, it was recognized that such data would not be readily available and the proper collection would require an excessive period of time. Consequently, the development of a program for assessment of these factors was assigned to a subcommittee, to establish a reasonable basis (subjective if necessary) against which the same factors associated with the new refuse handling equipment could be viewed. The assessment program and results of its implementation follow.

1. Personnel Requirements

Parameters identified as important with respect to personnel requirements for operation and maintenance of the existing refuse system include:

a. Number of personnel required at each level of responsibility

b. Skills required for personnel at each level of responsibility

   (1) Education
   (2) Experience
   (3) Physical attributes
   (4) On-job training

c. Man-hour requirements for personnel at each level of responsibility

d. Salary

e. Personnel turnover rate

f. Union affiliation

Information on these parameters was obtained through discussions held with the Housing Authority management and through review of existing files.

It was found that personnel requirements for the six high-rise structures (18 incinerators) involve three levels of responsibility: foreman, maintenance mechanic, and laborer (janitor-custodian). One foreman is used, and he spends approximately 2 hours a day on all 18 incinerators. He works a 40-hour week, but he is on call at all times. No formal educational requirements are mandatory. A job description for the position of foreman follows:

> FOREMAN: Supervises all maintenance within projects of his responsibility. Makes up daily work schedules and assigns jobs to maintenance personnel. Oversees all work performed by outside contractors. Supervises and assists in all emergency work where necessary. Processes all emergency calls after working hours, and on holidays and weekends. It is the duty of the foreman to perform maintenance work when he deems it necessary in the best interests of the Housing Authority or its tenants to do so. The foreman also handles all clerical duties involving his projects, such as receiving reports, time sheets, inventory, etc.

One maintenance mechanic is involved, and he spends approximately 1 day each month on all 18 incinerators. He works a 40-hour week, and no formal educational requirements are mandatory. A job description for the maintenance mechanic follows:

> MAINTENANCE MECHANIC: Makes all repairs to and keeps in proper condition the building and structures located on the project site, including the necessary painting, carpentry, and masonry work on the interiors and exteriors of, and approaches to, dwelling and non-dwelling units; adjusts and maintains in good working order operating and household machinery and mechanical equipment, including heating, plumbing, and electrical appliances and apparatus. The maintenance mechanic shall perform any duty relating to general maintenance when it is in the best interests of the New Haven Housing Authority or its tenants that he do so.

The Housing Authority uses one laborer per building 4 hours a day, 7 days per week to service the present incinerators. One laborer spends 40 hours per week collecting debris and litter on the grounds surrounding the six-building complex, and another spends approximately 24 hours per week on grounds cleanup, using a mechanical sweeper. Approximately 232 laborers' hours are used per week for the handling of refuse. All laborers must have a physical examination prior to reporting to work and must be capable of doing ordinary manual labor. A job description for a laborer follows:

> LABORER: Does work necessary to the upkeep and operating of project site and grounds and equipment by loading and unloading trucks, lubricating and changing oil in trucks or other automotive equipment, moving and hauling furniture and supplies, digging and backfilling trenches and gutters, removing trash and garbage, filling fuel tanks, watering and mowing lawns, rolling, tamping, and laying sod, other heavy manual labor, operating automotive equipment, and cleaning buildings and equipment.

The laborers are union affiliated, and union and Housing Authority job descriptions are compatible. The Housing Authority management indicated no problem of personnel turnover at any level of responsibility.

2. Power and Fuel Requirements

Power requirements involve only the electrical power required for operation of the automatic firing control panel and overfire air blower (fractional horsepower). Consumption was not monitored because it was believed that the cost involved for the amount of power used was negligible and could be estimated if later desired. Consumption of the natural gas used to facilitate the burning of refuse was monitored at incinerators C_1 and C_3 during the air pollution testing. From the air pollution test, it was determined that the average fuel consumption for each 15 minutes supplied was 108 cu. ft. Assuming that an incinerator is fired as scheduled, 11 times during each 24 hours, this would yield an average consumption of 1188 cu. ft. per day per incinerator.

3. Costs

The only items of cost considered to be useful for comparison with similar information to be collected during operation of the new equipment were determined to be those associated with normal operation and maintenance of the existing refuse-handling system. It was hoped that most of the desired information on costs could be taken directly from records of the Housing Authority, but records had not been maintained. Unquestionably, maintenance costs have been low, because little is required to maintain the incinerators in operational condition. The foreman did indicate that grate replacement is "frequent" and that all fireboxes had been rebuilt at least once since their installation in 1955. Trouble apparently is had with fuel supply, as many incinerators are being operated without gas--i.e., they are set off by hand by the laborers; no records are available, however, on any costs for repair of the gas supply. Operational costs include: (1) use of the laborers at $2.94 per hour, (2) use of maintenance aid at $3.64 per hour, (3) use of foreman at $4.25 per hour, and (4) use of natural gas at a rate of $0.149 per 100 cu. ft. Additional operational costs are associated with electrical consumption (negligible), replacement of refuse containers, incinerator cleanout equipment, and other miscellaneous items (e.g., clerical and insurance charges), but none of these could be assessed. There also is a charge for collection of the refuse by the city; however, this is masked in a charge to the Housing Authority for all utility services provided, a charge which depends upon the amount of revenue received by the Housing Authority from the tenants.

4. Owner, Tenant, and Custodian Acceptance

Assessment of owner, tenant, and custodian acceptance of the existing refuse-handling system was made entirely on the basis of interviews conducted by the committee staff. The interviews were somewhat ineffective in that none of the persons with whom discussions were held knew of alternative methods for onsite handling of refuse.

The four persons serving as liaison indicated that tenants for the most part are cognizant of the refuse system as seen from the hopper doors--dirty, odorous, generally unattractive, and small. They know that incinerators are used, but it was generally accepted that this is the way in which refuse is handled. Tenants were not particularly concerned by either noise or air pollution. Although odor was noticeable throughout the corridors and was commented upon by tenants, the odor could not be attributed solely or even principally to the refuse-handling system. In general, there was an understandable feeling of apathy regarding the present refuse-handling system.

Each janitor (laborer) with whom discussions were held expressed disenchantment with the existing refuse-handling system, while having no knowledge of alternative methods. Paramount among their comments were clumsiness of the task of cleaning out incinerators, general dirtiness, heat, and the carting up the stairwell of refuse containers, once filled.

The Housing Authority management was conscious of the existing system, particularly the air pollution aspects, pointing out that smoke emissions from incinerator stacks were often noted. Undeniably, a recently enacted city ordinance establishing emission criteria on incinerators was responsible for some of this awareness. The management was also cognizant of the large volume of refuse removed from the complex after incineration, principally because of 10 to 15 refuse containers placed before each structure twice weekly for pickup by the city. In general, the management expressed dissatisfaction with the present system of handling refuse but knew of no alternative.

5. Effectiveness and Limitations

To assess the effectiveness and limitations of the existing refuse-handling system, the items which follow were identified by the subcommittee as appropriate to be observed and assessed subjectively by the committee staff during "walk throughs" of the structures:

1. Convenience to tenants
   a. Requirement for storage of refuse in individual dwelling units
   b. Ability to handle all refuse
   c. Availability for use
2. Environmental conditions maintained
   a. Air pollution
   b. Odor
   c. Water pollution (sewer)
   d. Vermin and insect infestation
   e. Noise
   f. Aesthetics
3. General
   a. Degree of refuse volume reduction
   b. Specialized equipment requirements
   c. Serviceability (by janitors)

      Weight and size of refuse containers
      Accessibility for refuse removal
      Disposability of refuse containers
      Cleaning
      Storage capacity
      Complexity of operation

Several "walk throughs" were made between December 1968 and March 1969, while data were collected on refuse quantity and composition and air pollution. In addition, several "walk throughs" were made throughout 1968. The following summary is based on this series of "walk throughs."

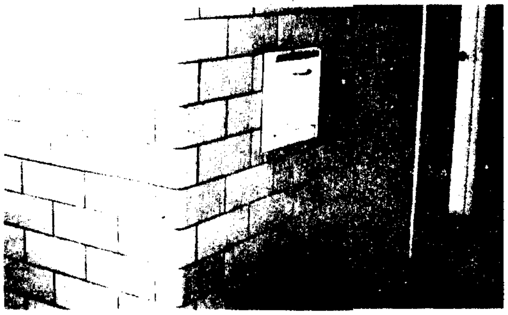
The availability of the system for use by the tenants, especially in the absence of hopper door locks, to prevent use during periods of burning, is virtually at the tenants' discretion. Inherently, the system imposes no storage time within individual dwelling units. Hopper doors are small (14.5 sq. in.) but will accept most of the normal household refuse generated. Special pickups of bulky items of waste are provided on request within a reasonable time, but often such requests are not made, and the waste ends up in the corridors or on the grounds of the complex. The three vertical chutes within each structure provide considerable convenience to the tenants, although use of the single flue for incineration does result in the inconvenience of smoke back in the face of users and the attendant odor and dust.

Environmental conditions maintained by the system are not particularly favorable. An understanding of the degree of air pollution associated with the refuse system can be gleaned from results of tests performed on incinerator C_1 (Appendix E), which must be multiplied by a factor of 18 to reflect the entire high-rise complex. Closely akin to air pollution is odor, which is particularly noticeable on the roofs and when charging waste through hopper doors during periods of refuse burning. The noticeable odor is due in part to the low temperatures maintained in the fire boxes during burnings. No contribution is made to the building sewer line by the incinerator system, since no cleaning with water is involved. The degree of noise associated with the system is favorable; this is due to use of the single flue and the attendant masonry walls which dampen noise to a greater extent than would a metallic refuse chute. As indicated previously, the presence of vermin and insects cannot be attributed directly to the refuse system, but both cockroaches and mice are known to be present. Specific quantitative data and additional investigation are required to assess the degree of infestation and an association, if any, with the refuse-handling system. Unquestionably, the presence of mice in the refuse chutes indicates that harborage is being provided.

Aesthetically, the system leaves much to be desired, ranging from hopper door appearance, particularly the inside which probably never receives adequate, if any, cleaning, to the refuse storage containers, which must be metallic since incineration is involved. The inability of the system to receive all waste is responsible at least in part for the general appearance of the grounds--litter breeding litter--and the piles of bulky miscellaneous waste items which tend to collect within each basement area. Despite the partial volume reduction effected by incineration, the number of refuse containers--which become unsightly very quickly--set out before each building twice weekly runs from 10 to 15. During different times of the day, collections of unburned and partially burned paper and other light refuse can always be seen within the wire mesh spark arrestors capping the incinerator stacks.

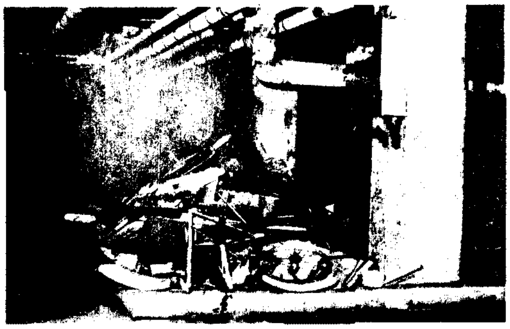
General effectiveness in terms of volume reduction also must be rated unfavorably, reduction actually realized running approximately only 81%. Standard 30-gal. metallic refuse containers are used, each weighing approximately 70 lb. when filled with incinerator residue. The containers must be carried with the use of two-wheel carts up the stairwell to the point of pickup by the city at the street curb twice weekly, and then returned. At one time specialized equipment in the form of a hoist arrangement was used at each building to lift the refuse containers to the ground level, but, as mentioned earlier, the hoists were abandoned due to continued vandalism. Except for the stairwell situation, accessibility for removal of refuse from the basement areas and storage capacity is excellent, but this is attributable more to building design than to the refuse system itself, the entire basement area of each building being devoted entirely to service equipment, utility piping, and waste-handling equipment. Operation is simple, the most complex aspect being removal of residue from the ashpit and firebox. This effort is hampered by inability of the incinerators to burn all refuse completely, the existence of wire grates, general incinerator design, and the absence of tools especially designed for this purpose.

Figure 5 illustrates photographically some of the points discussed.

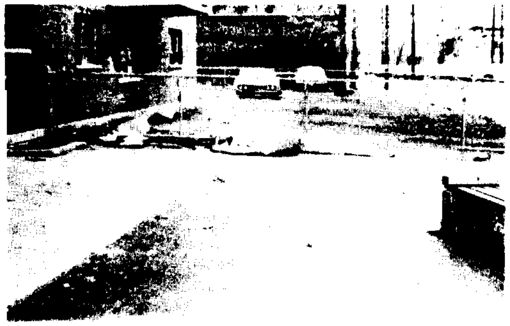


a. Limited hopper door

b. Inability to handle all refuse



c. Inability to handle all refuse

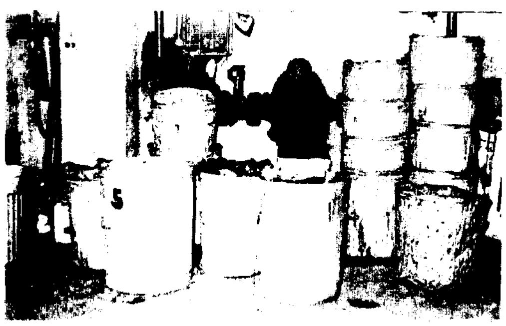


d. Yard litter

e. Yard waste

f. Condition of grates

g. Typical condition of incinerator



h. Condition of refuse containers

Figure 5. Effectiveness and limitations of existing refuse-handling system

VI
PREPARATION FOR STUDY PROJECTION

While assessments of existing conditions were being made, preparations were also under way for the program to be carried out during the second study period of the project. These preparations included selection of the specific refuse-handling equipment to be installed in the test structures, the development of preliminary installation plans, and, to the extent possible, development of the data-collection program to be implemented.

A. SELECTION AND DESCRIPTION OF EQUIPMENT INTENDED FOR INVESTIGATION

As indicated earlier in this report, Phase I was intended to permit concurrent onsite investigation of three concepts for handling refuse, compaction, wet pulverization, and incineration. To provide a basis for selection of equipment to be installed, various manufacturers of refuse-handling equipment utilizing any of the three concepts mentioned were asked to provide information relative to type of equipment manufactured, applicability of their equipment to the test structures (representatives of the manufacturers made personal inspections of the Housing Authority buildings), equipment capability, recommendations regarding installation, options available with equipment, attendant costs and cost options, and other pertinent data. Representatives of the manufacturers then met individually with the committee to make their presentations and to furnish pertinent literature on their equipment. Following committee consideration of the information submitted, it was deemed that insufficient information had been presented on which a selection could be based. Consequently, three subcommittees were established, one each for development of recommendations to the full committee on compactor, pulverizer, and incinerator selection.

1. Compactor

Further investigations by the subcommittee appointed to select the compactor led to the decision to purchase and install Wastepactor Model No. 157, manufactured by the Compactor Corporation of New York, chiefly because a comparatively large number of these units already were in operation in the New York City area and their capability could be witnessed first hand. At the time selection was made, available compactors applicable to the test structures were limited in number. Over the last 6 to 12 months, several new compactors have become available, some with automatic provisions for replacing full refuse containers with empties. Although the new compactors are applicable to the New Haven test structures, it is believed that given the conditions at these particular structures, the Wastepactor Model is still the most practical.

The Wastepactor unit, a photograph of which is shown in Figure 6, is a hydraulically operated machine employing a duplex horizontal ram mechanism to force refuse through a restricted or necked-down compaction chamber to effect volume reduction. The machine functions as follows:

1. Refuse is gravity fed through an extension from the vertical chute into a hopper located in front of the horizontal ram.
2. As the refuse falls through the vertical chute extension, a photoelectric cell initiates forward movement of the horizontal ram which pushes the refuse through the compaction chamber into a discharge tube. The top surface of the horizontal ram is equipped with a toothed shear plate which forces any refuse caught between the ram and hopper to be sheared.
3. When the horizontal ram will go no further, a second ram, or piston, extends from the middle and travels through the center of the compaction chamber to clear possible blockages and effect passage of the refuse.
4. Compacted refuse is extruded from the discharge tube (approximately 16 in. in diameter) and automatically loads into a refuse container that has been slipped over the tube.
5. As more refuse is extruded, the refuse container is pushed toward the edge of the discharge tube until it reaches a point approximately 10 in. from the edge, where a mechanical lever switch--normally held closed by the refuse container--is released to shut down the equipment and energize a light signal to advise service personnel that the container is full.
6. The filled refuse container is manually replaced with an empty container, and the operation begins again.

The compactor has a height of 2 ft. 2 in., a length of 7 ft. 10 in., and a width of 2 ft. which is equal to the size of the infeed opening; floor area required for installation is a minimum of 6 ft. x 12 ft. Approximate weight is 1,500 lb. and manufacturer-rated capacity is 1,500 lb. per hr. The ram housing, the compaction chamber, and the discharge tube are integrally welded to form one continuous structural element of wear-resistant 3/8-in. steel. Feed opening, welded to ram housing, is made of 0.25-in. wear-resistant steel, and the ram face of 0.75-in. wear-resistant steel. Chute adaptor, made of 10 gauge wear-resistant steel, contains an access door sized as required to fit. The equipment is operated by a 3-hp. motor requiring 208/60/3 phase electrical power. The compactor lists for $4,975.00, plus tax, f.o.b. Brooklyn, New York. This price includes the automatic light signal that advises when a refuse container is full and an automatic insecticide and deodorizing dispenser that is activated by movement of the horizontal ram.

The compactor described is to be installed in Building 5B in conjunction with the north chute (B_1).

Figure 6. Compactor selected for installation

2. Pulverizer

Selection of the wet pulverizer was difficult, because only two manufacturers were involved, both offered essentially the same equipment, and neither could claim an installation in an apartment building. Since no clear advantage could be associated with the equipment of either manufacturer, it was the recommendation of Wascon Systems, Inc., that its unit could be fed directly from the chute--i.e., without intermediate handling by custodial staff or conveyor equipment--that led to the selection of the equipment manufactured by this firm.

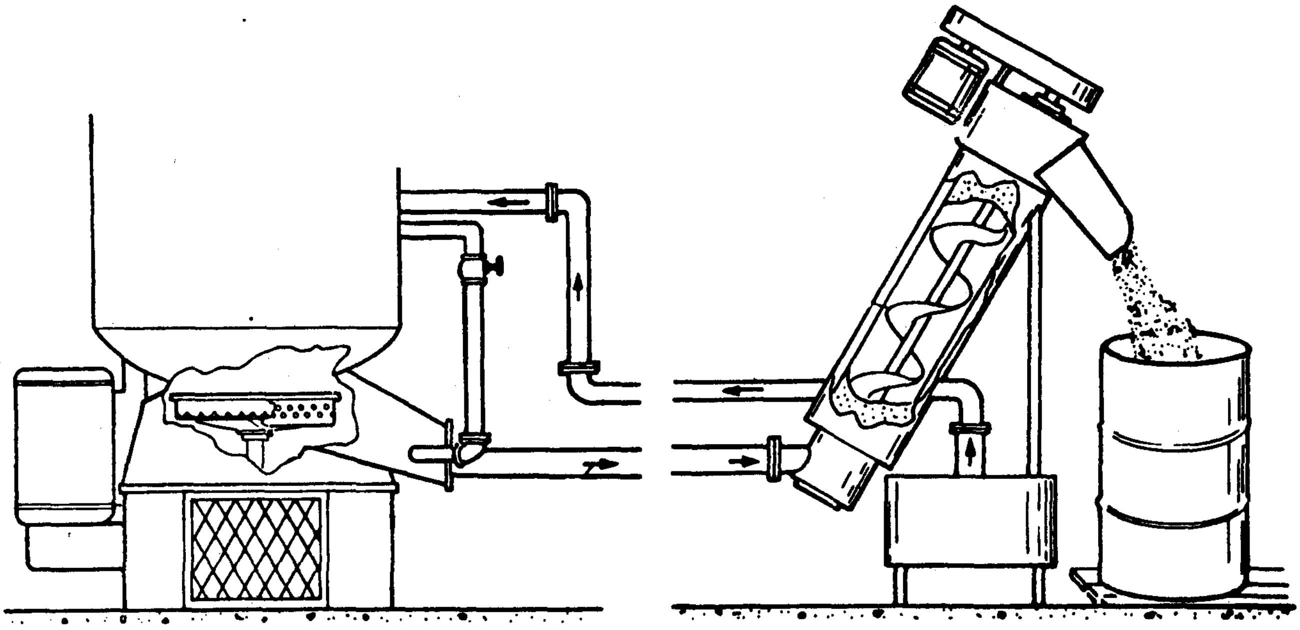
The pulverizer system, a schematic of which is shown in Figure 7, consists fundamentally of two principal components, the pulper itself and a dewatering press. Refuse from the vertical chute falls directly into the pulper tank, which is partially filled with water (automatically maintained at the proper level). At the bottom of the tank is a stainless steel impeller plate randomly studded with teeth, which rotates to create a vortex in the water. Refuse falling into the tank is drawn into the vortex and down onto the impeller plate where pulpable materials are abraded and mixed with water to form a slurry. Nonpulpables, such as pieces of metal and metal cans are, to some extent, reduced in size and then confined in a collection chamber at the bottom of the pulper where they can be removed automatically or manually. The slurry then is passed through a sizing ring which prevents oversized waste particles from leaving the tank and is pumped through pipes to the dewatering press placed in the most advantageous location possible. As the slurry enters the dewatering press, it is picked up by a helical screw contained in perforated housing. The squeezing action of the screw extracts water from the slurry and conveys the remaining semidry pulp to the top of the press, where it is discharged directly into a container. A number of different kinds of containers, ranging from standard refuse cans to large wheeled carts, can be used. Water extracted from the pulped waste is pumped back to the pulper tank for reuse and conservation.

Pulper Model No. ENS-18 and the corresponding dewatering press Model No. WPS-400, each having a manufacturer-rated capacity to reduce a minimum of 400 lb. of refuse per hr., was selected. The manufacturer quoted a list price of $14,985 f.o.b. New Haven, Connecticut, for this equipment and submitted the following system and equipment specifications:

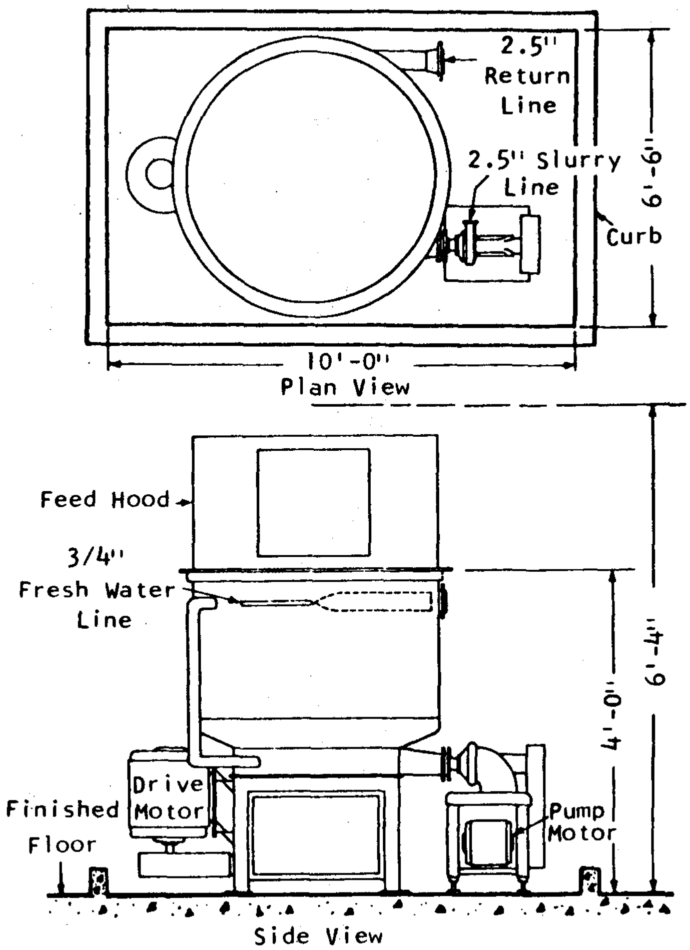
Manufacturer Specifications

A. General

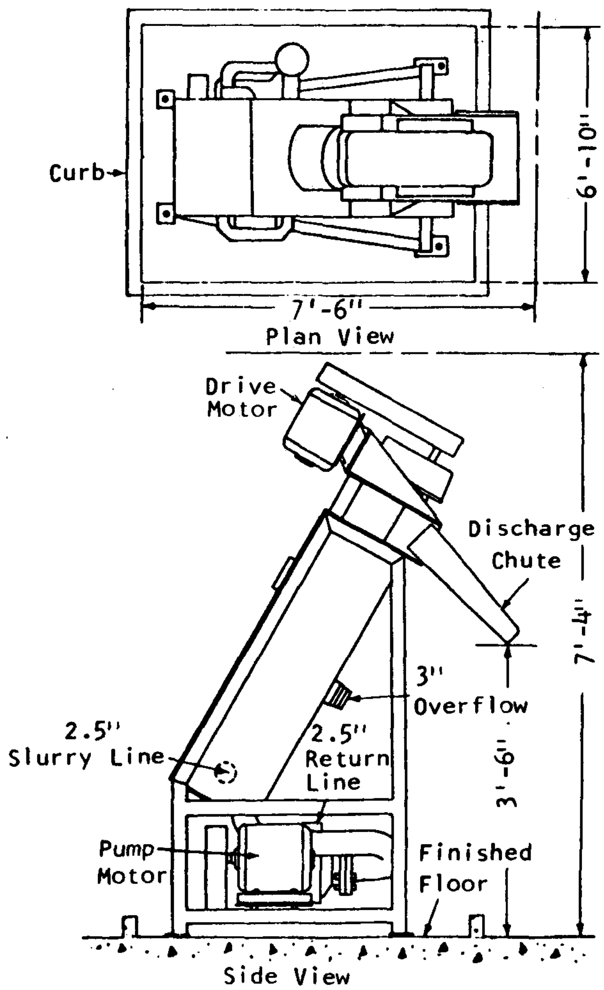
System shall be designed to reduce a minimum of 400 lb. per hr. of general building waste and transport this material in the form of a slurry to a remote dewatering device for discharge of semidry pulp into adjacent container and return excess water to pulpers for reuse. Equipment is to be capable of tolerating, without damage or jamming, small quantities of glass and light gauge metal. Equipment is to include one pulping unit, one dewatering unit, and all controls as described below.



Schematic of Pulverizer System Operation



Pulper Dimensions



Dewatering Press Dimensions

Figure 7. Pulverizer selected for installation

1. Pulping Unit

Unit shall be designed to reduce at least 400 lb. per hr. of general building waste combined into a pulp and pass resulting slurry to a remote extractor for discharge of semidry pulp into adjacent container.

2. Dewatering Press

Unit shall be designed to receive 400 lb. per hr. of general building waste slurry from pulper, dewater and discharge semidry pulp into adjacent container, and pump water back to pulpers for reuse.

B. System Specifics

1. Pulper Construction

Pulper impeller to be exactly one-half the diameter of pulping tank, rated capacity being directly proportional to impeller area. Pulping shell is to be minimum of 3/16 in. heavy gauge welded stainless steel fabricated with dished bottom head, slurry discharge and return water connections, fresh water connection, and bottom housing assembly. Pulper is to include horizontally mounted flat stainless steel pulping impeller with hardened pulsing vanes and C-10 blanking die grade formed carbide cutting teeth of modified pyramidal shape with backward sloped leading edge and a hardness of Rockwell "A" 88 or greater. Unit is to include stainless steel perforated waste sizing ring. Pulper impeller is to be belt driven with impeller keyed to shaft; shaft is to be sealed from leakage with mechanical seal. Motor mounting plate is to be hinged for ease of belt adjustment and maintenance. Base framing members and legs are to be made of carbon steel, square tubular construction with flanged feet. Base is to be enclosed with removable stainless steel panels. Unit is to include stainless steel feed hood with sliding access door and connection for chute attachment. Unit is to include stainless steel trash box and trash valve to enable trash box to be emptied with unit in operation. Unit is to include belt driven cast iron slurry pump with stainless steel paddle wheel impeller, complete with motor and pump stand having adjustable feet.

2. Pulper Drive

Pulper will be driven by belt, using open drip proof ten horsepower, 208-220/440 volt, 3 phase 60 cycle motor with encapsulated windings and poly-v cast steel sheaves; belt is to be suitably guarded. Drive shaft is to be mounted in antifriction bearings. Drive belt sheave is to be mounted outboard of bearings for ease of replacement.

3. Slurry Pump Drive

Slurry pump will be driven by belt, using open drip proof 3-hp., 208-220/440 volt, 3 phase, 60 cycle motor with encapsulated windings; belts and sheaves are to be suitably guarded.

4. Dewatering Press Construction

Dewatering press is to include motor and foot mounted gear reducer supported by structural steel base of square tubular construction with flanged feet. Stainless steel components include 6 in. diameter helix with stainless steel backed nylon brush, matching diameter solids separator, bottom guide and housing assembly, replaceable water jacket, slurry and return water connections, removable cover plate, and discharge chute. Unit includes cast iron return water pump and motor set. Drain is to be located at lowest point of water jacket, providing for complete drain down through fine mesh water solids separator without disturbing slurry or return water piping or drive assembly. Unit includes 3 in. stainless steel emergency overflow connection.

5. Dewatering Press Drive

Dewatering press is to be driven by belt connected to foot mounted gear reducer, using open drip proof 1.5 hp., 208-220/440 volt, 3 phase, 60 cycle motor with encapsulated windings; belts and sheaves are to be suitably guarded.

6. Return Pump Drive

Return pump is to be driven by belt, using an open drip proof 3 hp., 208-220/440 volt, 3 phase, 60 cycle motor with encapsulated windings; belts and sheaves are to be suitably guarded.

7. Control Panel Construction

A surface mounted main control panel with NEMA 12-Enclosure is to include: circuit breaker safety interlocked with door handle, 110 volt control circuit transformer, automatic reset fused magnetic starters for each motor, and three leg protection for each starter. Panel is to be shipped complete with separate field mounted controls including one NEMA four-enclosure start-stop button station at pulper, one safe run selector switch station at waterpress, and one fresh water solenoid valve. A separate water control panel with NEMA one-enclosure is to include 1/70 horsepower air pump, pneumatic actuated mercury switch, and 0.25 in. copper tube for connection of air pump to pulper shell.

8. Automatic Controls

System to be set up for completely automatic operation, including automatic start and stop. Controls to consist basically of a wall mounted control panel, in addition to item 7 above, and ultrasonic sensor unit mounted in the feed chute connection. Also included is a motorized valve for installation at the dewatering press to effect automatic drainage of the system.

9. Finish

Finish to be manufacturer-standard primer with enamel finish coat.

Equipment to be manufactured in accordance with preceding specifications as follows:

Item No. 1

Pulper with 36 in. diameter tank, 18 in. diameter impeller, 10 hp. drive motor, and 3 hp. slurry pump set.

Item No. 2

Dewatering unit with 6 in. diameter helix, 6 in. diameter solids separator, 1.5 hp. drive motor and 3 hp. return pump set.

Item No. 3

Main control panel NEMA 12; 42 x 36 x 8 in. Water level control panel NEMA 1; 15 x 13 x 6 in. Automatic start control panel NEMA 1; 8 3/4 x 5 3/8 x 4 3/8 in.

The pulper unit is to be installed in Building 6B in conjunction with the north chute (A_1). As discussed more fully in the section of the report which follows, the dewatering press will be located on ground floor level to eliminate the necessity of carrying the pulped waste up the flight of basement stairs.

3. Incinerator

Selection of the incinerator proved to be difficult. Fundamentally, it was the desire of the committee to install equipment that would yield results which would be representative of the state of the art of incinerators of the design used for the cost involved. Neither selection of equipment based on discussions with individual manufacturers nor the use of a consulting engineering firm to design the incinerator and receive bids from the various manufacturers appeared to fulfill this fundamental desire. Consequently, it was decided to request the Incinerator Institute of America to provide recommendations concerning the type of design and specific equipment. The Incinerator Institute of America agreed not only to prepare design drawings and specifications but also to submit a proposal for equipment cost and its installation.

General design and performance criteria were then developed for consideration by the Institute. The design criteria were submitted principally as guidelines rather than as fixed standards from which deviation could not be made; performance criteria also were submitted as guidelines against which performance would be measured rather than as standards which had to be met. A copy of the criteria follows:

General Design and Performance Criteria for New Incinerator

General Design Criteria

1. The unit should be a chute fed, multichamber type having at least one charging gate, burner, overfire air supply and gas scrubber with induced draft fan. System should have provisions for controlled charging and--if exhaust cannot be vented in corner of existing chute (or elsewhere)--for locking of hopper doors during periods of burning.

For consideration in its design, the incinerator is to serve 21 dwelling units of which 16 are 3-bedroom and 5 are 2-bedroom units; 100 people will occupy the units, of whom 32 will be adults and 68 will be children.

It is suggested that 5 lb. of refuse (Type No. 2) per person per day having a density of approximately 5 lb. per cu. ft. and a moisture content of 30% by weight be considered as design parameters; however, the following information--based on a week's survey of the quantity and composition of waste generated by the 100 people involved--is, in addition, forwarded for designer consideration. If on review of this information the designer desires to discuss variation from the above identified parameters, this is encouraged.

Refuse Category	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
Paper/Paper Products	53	30	57	49	37	27	36
Wood/Wood Products	0	0	0	0	12	1	0
Plastics/Leathers	12	4	6	9	3	2	9
Rags/Textiles	9	2	32	4	5	6	9
Glass	30	9	33	30	45	15	44
Metallics	18	7	20	11	10	7	14
Stones/Ceramics	0	0	0	0	14	0	0
Garbage (organics)	57	27	77	64	16	13	36
Total Wts. (lb)	179	79	225	167	142	71	148

For consideration by designer, the following data which relate to programming operation of the new incinerator are also provided.

Hourly generation rate of refuse for the above Tuesday:

Time	lb.	Time	lb.
7 a.m.	0	3 p.m.	13
8 a.m.	0	4 p.m.	14
9 a.m.	0	5 p.m.	15
10 a.m.	7	6 p.m.	55
11 a.m.	8	7 p.m.	3
12 a.m.	3	8 p.m.	16
1 p.m.	2	9 p.m.	4
2 p.m.	2		

2. Gas scrubber should be located in basement area if possible and should be of the type which forces the gases to pass through a flooded water bed or impingement system; corrosion resistant materials should be used in construction of the scrubber.

3. Unit should be so designed as to act as a temporary storage bin for refuse without attracting or serving as a harborage for either vermin or insects.

4. Unit should be simple to maintain and operate with all firing operations automatically controlled.

5. Burner should be natural gas type and located in the primary chamber. It should be of such size and so installed to provide the necessary temperatures in the primary chamber to consume smoke and maintain effective combustion. For positive temperature control, burner should be equipped with an intermittent electric pilot and normal combustion controls, with temperature actuating and sensing device preferably located in flame port.

6. Overfire air supply should be installed so as to provide moderate turbulence without impinging severly on burning refuse or chamber walls; approximately 60% to 80% of the combustion air should be overfire.

Fixed and automatic barometric draft-control dampers should be provided; the throttling damper should be placed ahead of the barometer damper in the hot gas flow, and should be normally open when scrubber is inoperative.

Combustion air to the incinerator room should be supplied through a fixed, dependable outside air source.

7. System should include a programming electric clock

with 24-hr. dial and with 15-min. adjustable contact pins.

8. All surfaces of the primary chamber should be of heat resistant materials capable of withstanding temperatures of 1800°F. without damage.

General Performance Criteria

1. Under all conditions of operation the incinerator should not produce particulate emissions which exceed 0.2 lb. per hr. of particulates for every 100 lb. per hr. of refuse burned; nor should the unit emit single visible particles of observable sparkles at night.

2. Under all conditions of operation, the incinerator should not emit smoke of an opacity denser than 20% or No. 1 on the Ringelmann chart or equivalent.

3. Under all conditions of operation, the incinerator should not emit exhaust gases containing a concentration of more than 50 ppm (vol) of total hydrocarbons.

4. Under all conditions of operation, the incinerator should not produce gases with objectionable odors.

5. The incinerator should not have more than 5% combustible residue following incineration.

6. Repairs should not exceed two in number for any given year and total costs for any one repair should not exceed 10% of installation cost.

To date, the Institute has submitted tentative drawings of the incinerator which convey probable dimensions only. In addition, the Institute has tentatively recommended Model No. 20 Gas Scrubber as manufactured by Pyro Industries, Inc.; Model No. 10/68 E Gas Burner as manufactured by the Eclipse Company; and Model No. VP-57-69 Pre-fab Exhaust Stack as manufactured by Van-Packer Products, the Flintkote Company. Because of its tentative nature, material thus far submitted by the Institute is not included in this interim report; a final proposal from the Institute is anticipated in the near future.

The new incinerator is to be installed in Building 1A in conjunction with the south chute (C_3).

B. PRELIMINARY INSTALLATION PLANS

Preliminary plans completed to date for installation of new equipment are summarized below. For all new equipment, it is intended to use, without modification, the existing incinerator flues as refuse chutes, the committee having decided that metallic liners--or liners of any other material--would be an unnecessary expense. Further, manufacturers of the equipment selected (the Incinerator Institute of America in the case of the incinerator) have agreed to assume responsibility for installation of their equipment so that no question as to liability will exist should the equipment fail to perform as anticipated.

1. Compactor

The simplest to install of the new equipment is the compactor, the most critical aspect being proper support of the structural angles which now support the existing flue lining, and which are themselves now supported by the existing incinerator walls. It is planned to accomplish this with the use of structural pipe bolted to the concrete floor on which the existing incinerator now rests. Thus, the basic modifications required for installation of the compactor are: (1) removal of existing incinerator, (2) support of existing flue, and (3) provisions for flue extension to feed refuse into the compactor. A schematic for the installation is shown in Figure 8. The manufacturer has indicated that details on structural support cannot be provided until the existing incinerator walls are opened up and it is determined exactly what is there. Figure 9 illustrates the required wiring. For complete installation of the compactor, the manufacturer has quoted a price of $3,175.

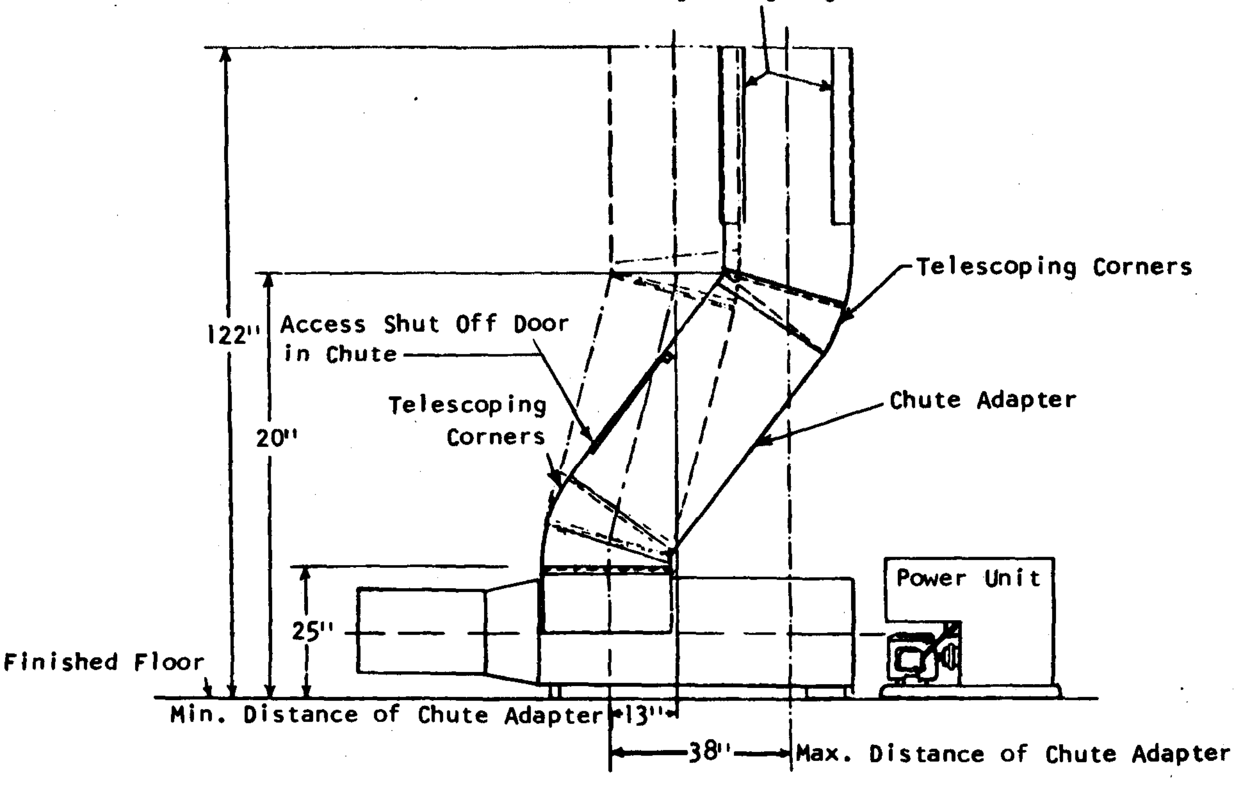


Figure 8. Compactor installation

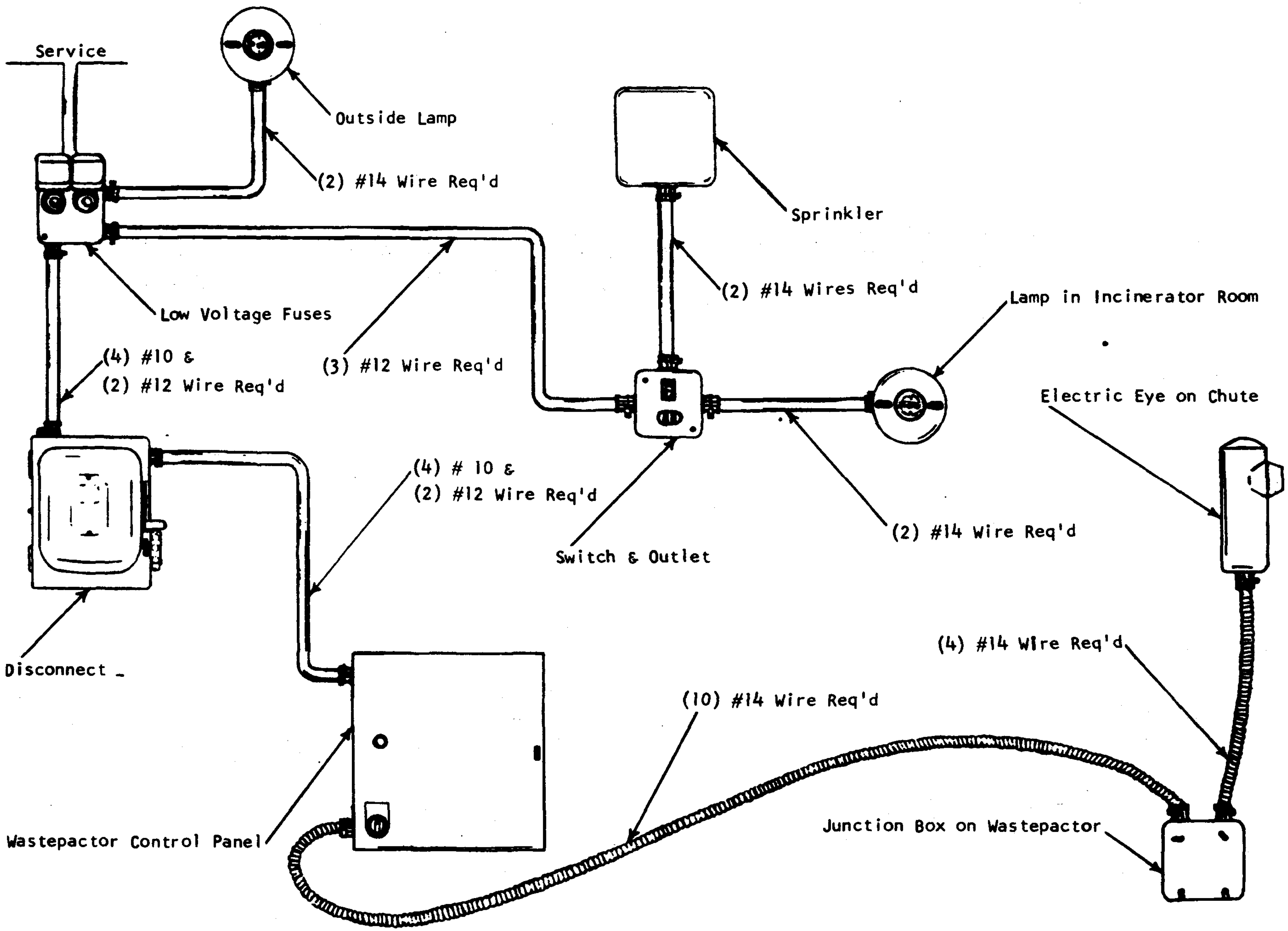


Figure 9. Wiring diagram for compactor

2. Pulverizer

Installation of the pulper beneath the existing flue will require, in addition to removal of the existing incinerator, support of existing flue, and provisions for flue extension, additional concrete slabbing and curbing to provide adequate space for servicing. To take advantage of the transportation feature inherent in the system, the dewatering press is to be installed in a laundry room on the ground floor level. The nozzle of the dewatering press is to extend through the exterior wall of the laundry room, from which point the pulper waste will fall directly into refuse containers located on the outside and housed within an aesthetically acceptable shelter heated if necessary to maintain a temperature in excess of 32°F.* The shelter to house refuse containers is to be located on the north side of the test structure, the side where refuse is collected at the street curb by the city.

Preliminary plans for installation of the pulverizer system are shown in Figures 10, 11, 12, 13, 14, and 15. The following sequence of operation was provided by the manufacturer (see Figure 15):

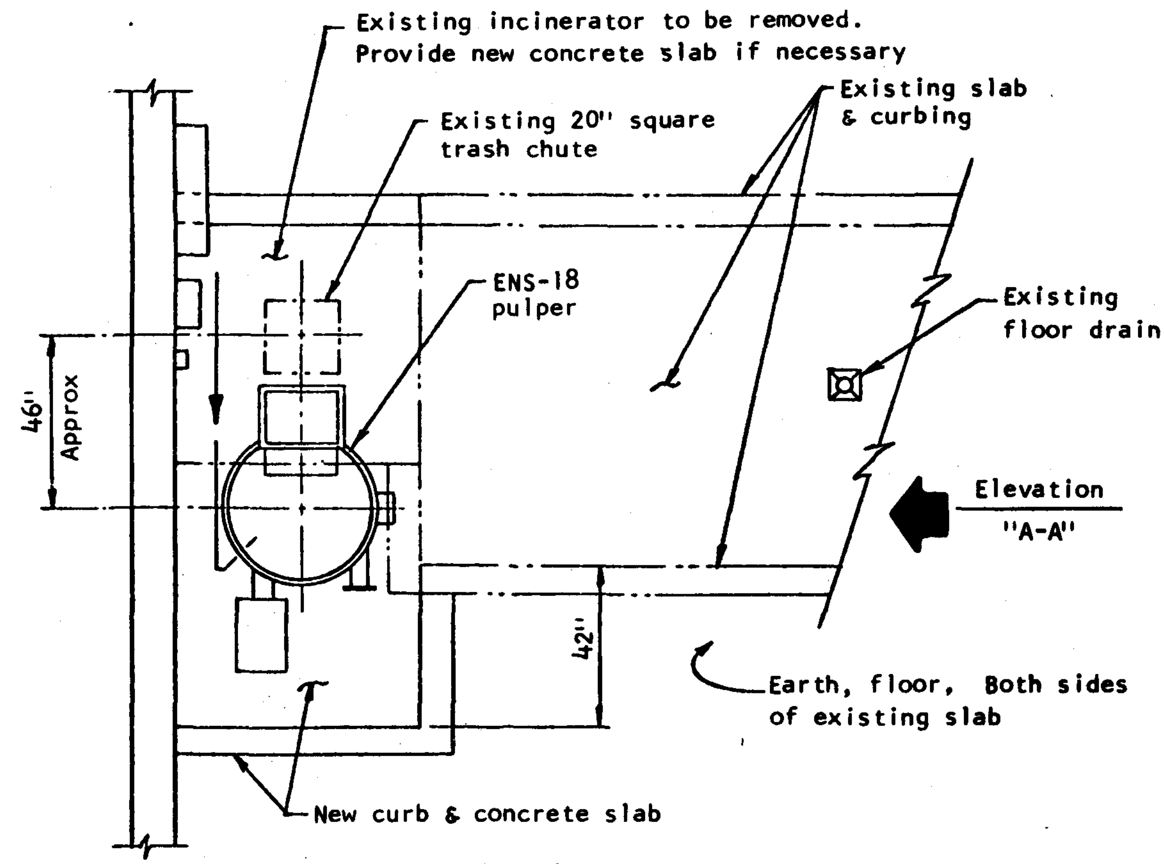
Sequence of Operation

To energize panel for operation, close circuit breaker CB. With the closing of the circuit breaker, air pump AP is energized.

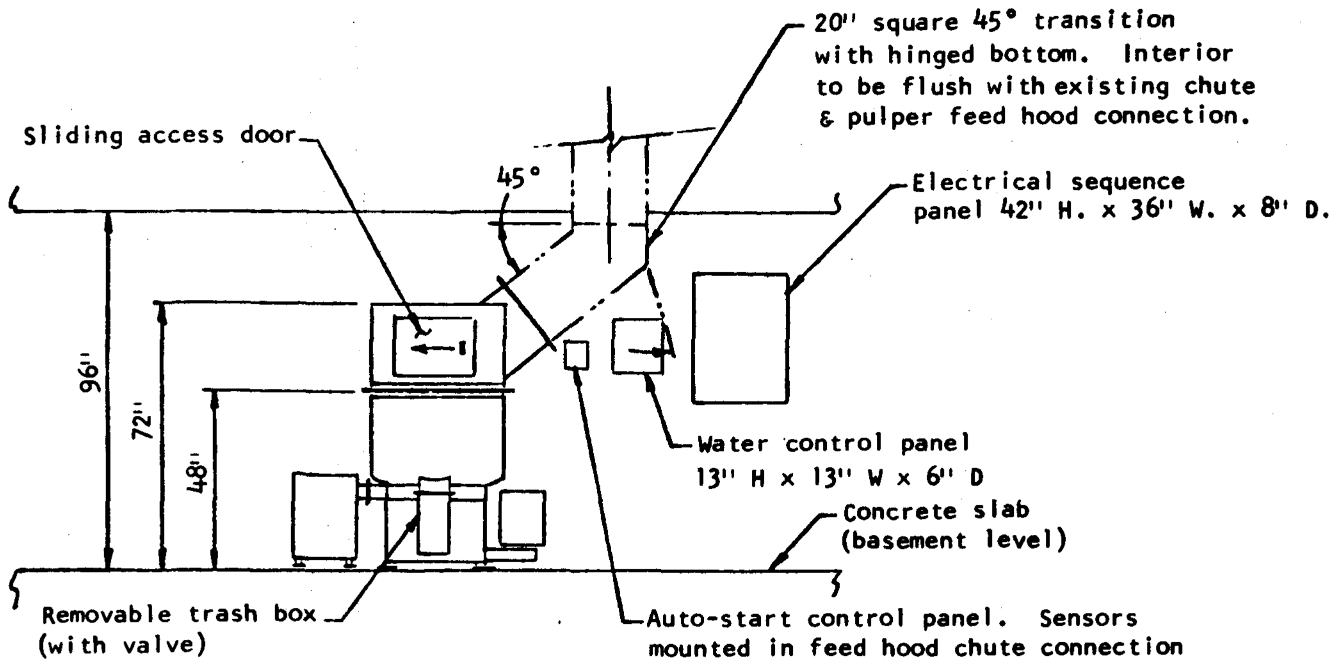
With selector switch SS-3 in the "SAFE" position the system cannot operate. By placing SS-3 in the "RUN" position the system is ready to be started.

Now select the mode of operation. This is done by placing SS-1 in the "HAND" position for manual operation or the "AUTO" position for automatic "START-STOP." When SS-1 is in the "AUTO" position, SS-2 must be in the "RUN" position or unit WILL NOT START.

*As mentioned in the Introduction and discussed in detail in Supplement A of this report, it is possible that a pneumatic system for centrally collecting refuse from a number of the Housing Authority structures will be installed and evaluated as a part of the Phase I program. If the pneumatic system is installed, a new central structure will have to be built on Housing Authority grounds to house all air-moving equipment, system controls and associated equipment, and a central compactor. Were such a structure available, it would be desirable to locate therein the dewatering press associated with the pulper. In view of the possibility that the structure may be erected fairly soon, the committee elected to place the dewatering press in the laundry room rather than in the shelter which is to house the refuse containers. In this manner, modifications to the test structure and attendant costs will be held to a minimum, the shelter to house refuse containers on the outside of the building can be considerably less elaborate, and any effort to relocate the dewatering press in the future greatly facilitated.

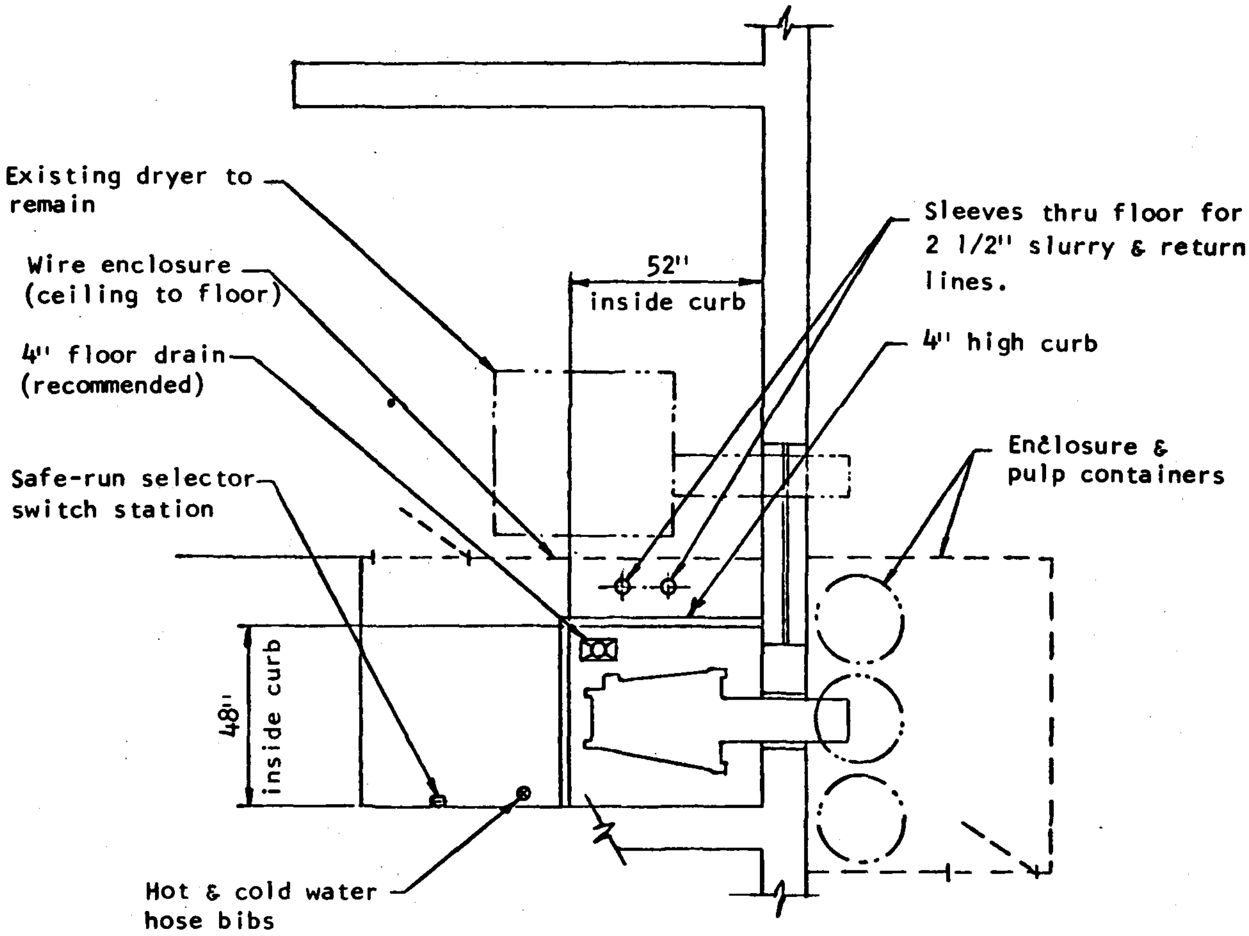


Plan View

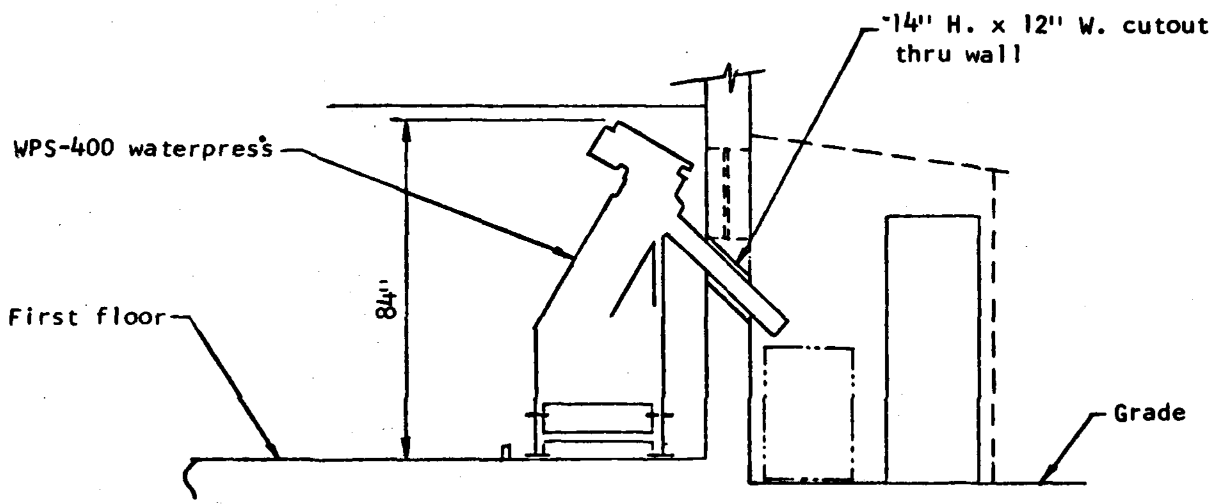


Elevation "A-A"

Figure 10. Pulper installation



Plan View



Elevation

Figure 11. Dewatering press installation

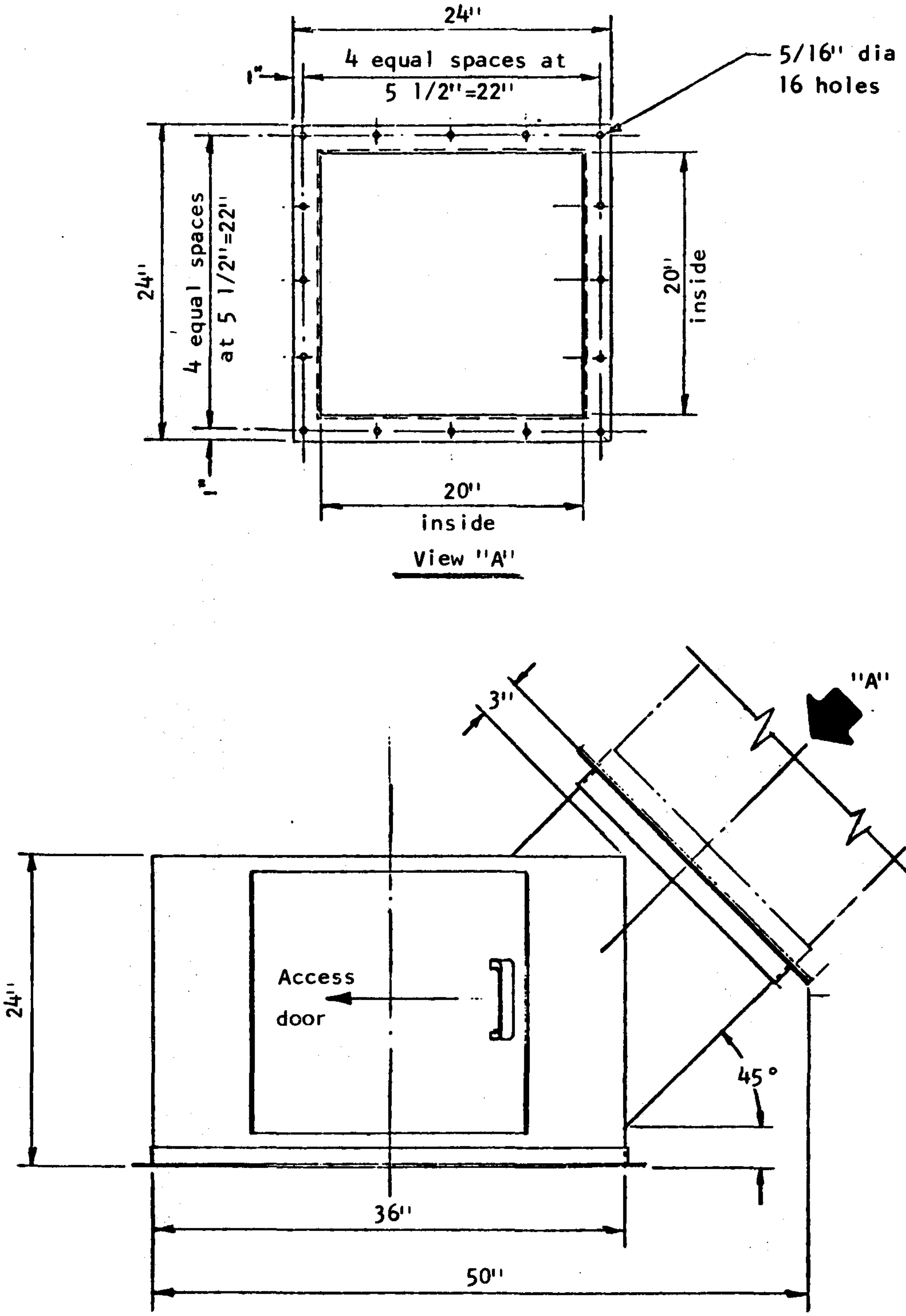


Figure 12. Chute feed connection

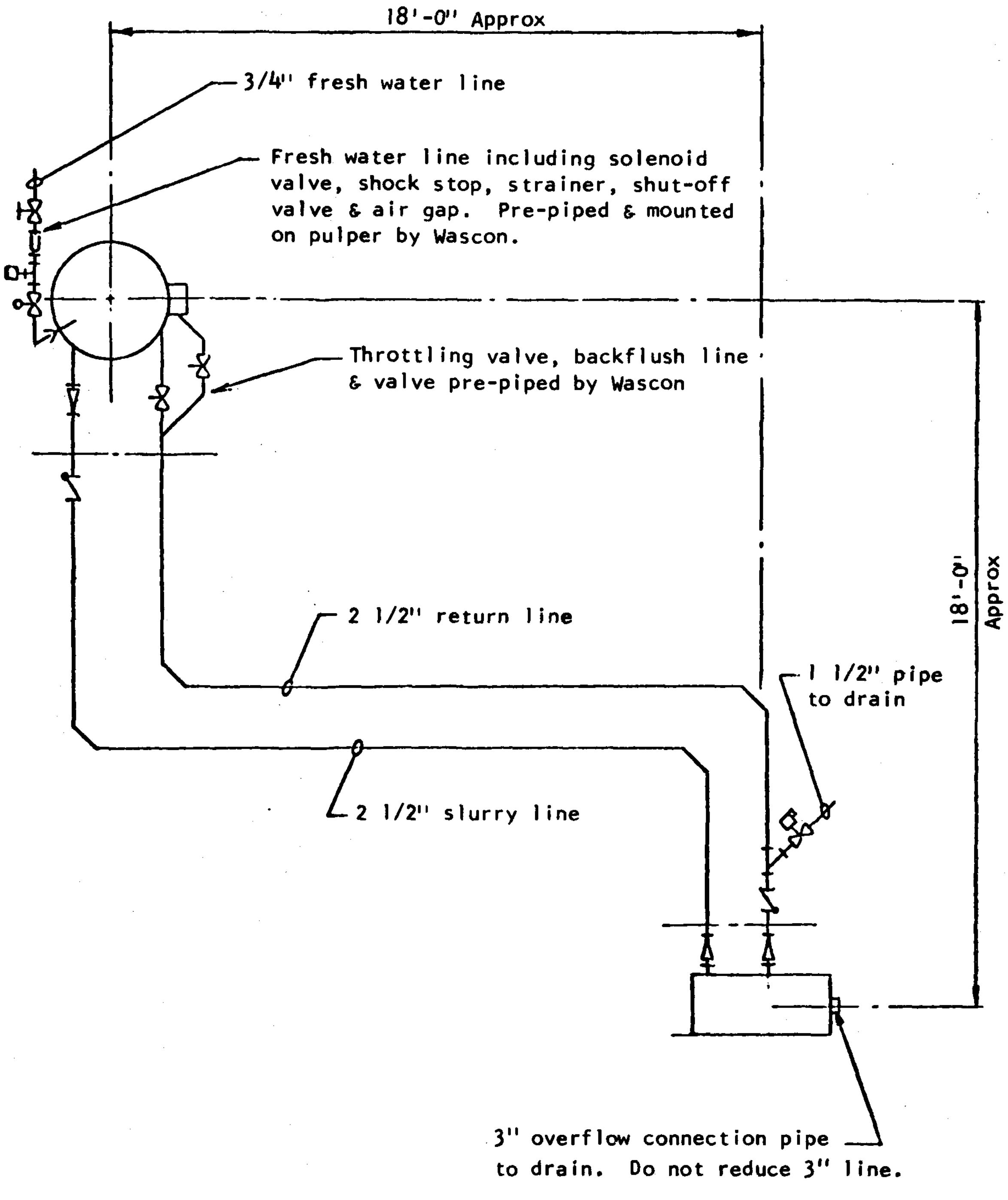


Figure 13. Piping schematic

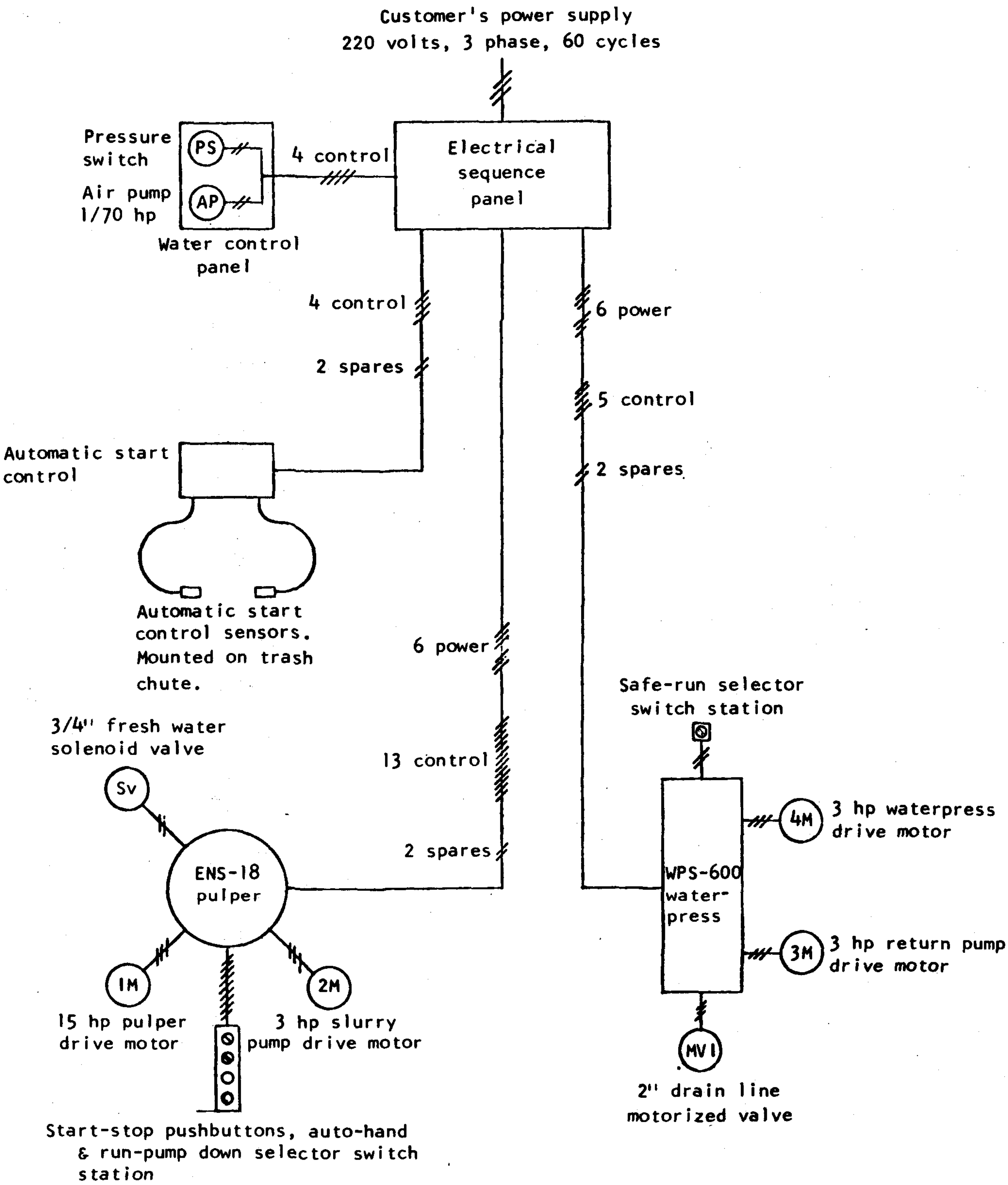


Figure 14. Wiring diagram

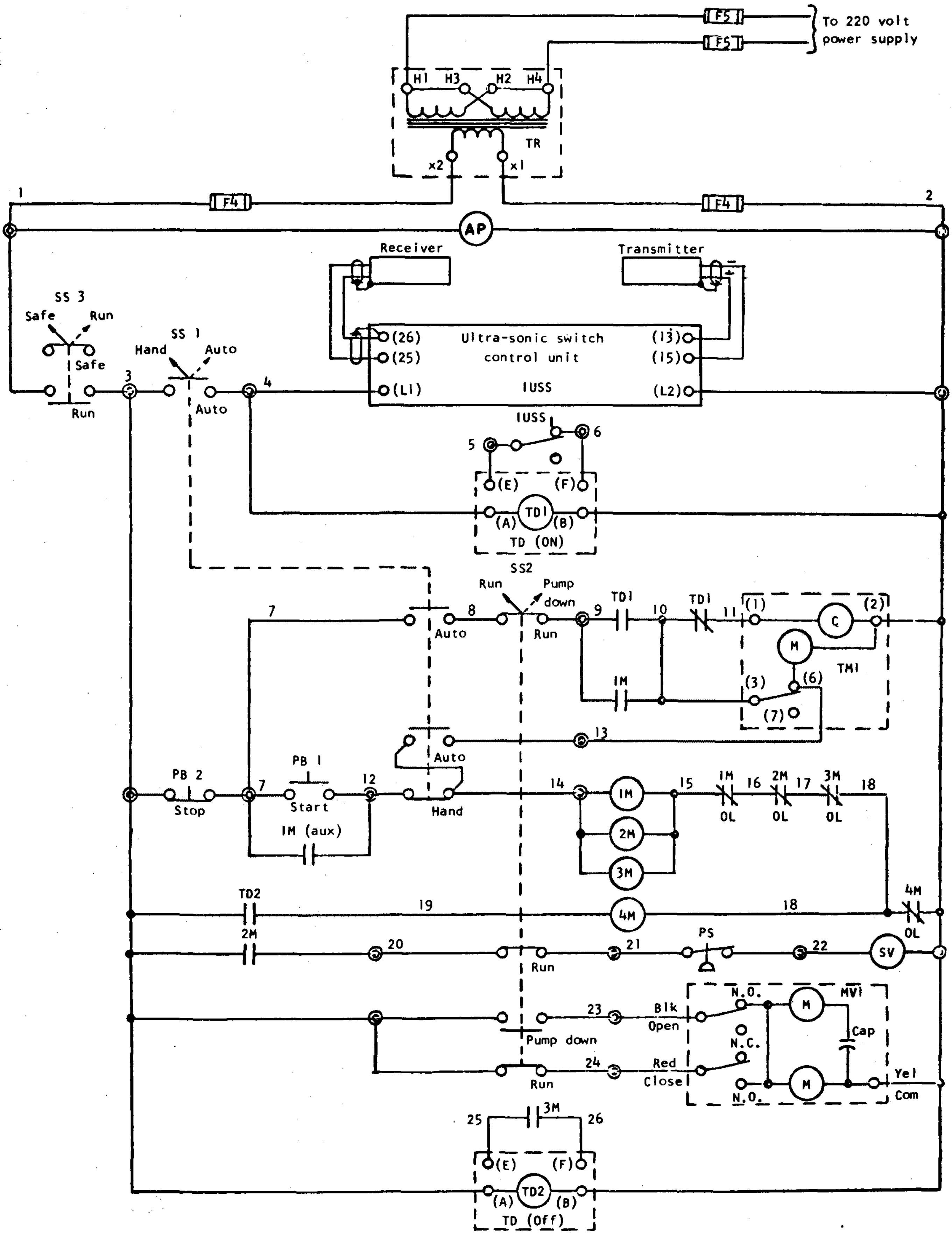


Figure 15. Schematic of control circuit

With SS-1 in "HAND" position, the unit is ready for manual operation. Depress the "START" pushbutton PB-1. This energizes the pulper, slurry pump, and return pump drives. The waterpress drive is energized through TD-2 which receives a signal from 3M contact. To shutdown the unit, depress the "STOP" pushbutton PB-2. The waterpress drive will continue to run through TD-2 for a predetermined amount of time, after 3 M is de-energized.

With SS-1 in "AUTO" position, the unit is ready for automatic operation. This brings the ultra-sonic switch 1USS, time delay relay TD-1 and timer TM-1 into the circuit. When the ultra-sonic switch beam is broken, it sends a signal to TD-1. After a short delay TD-1 energizes the clutch coil C in TM-1 pulper, slurry pump, and return pump drives. This starts the waterpress drive through TD-2. The unit will continue to run for a predetermined time (from 4 to 40 minutes). After the time has elapsed, motor coil M in TM-1 will drop out, de-energizing the pulper, slurry pump, and return pump drives. The waterpress drive will continue to run through TD-2 for a predetermined time after 3M is de-energized. The timer TM-1 will reset the time back to start at any time during the cycle by breaking the ultra-sonic beam.

For pumping down the unit, selector switch SS-1 must be in the "HAND" position. Then place selector switch SS-2 in the "PUMP DOWN" position. This opens the motorized valve MV-1 for cleanout and de-energizes the pressure switch PS preventing the addition of fresh water to the pulper tank. Then depress the "START" pushbutton PB-1. This energizes the pulper, slurry pump, and return pump drives. The waterpress drive starts through TD-2 which receives a signal from the 3M contact. The unit will continue to run until the "STOP" pushbutton PB-2 is depressed. The waterpress drive will continue to run through TD-2 for a predetermined amount of time after 3M is de-energized.

NOTE: The motorized valve MV-1 is closed at all times except when pumping down the unit.

The automatic and pump down cycles may be stopped at any time by depressing the "STOP" pushbutton PB-2.

The proper water level in the pulping tank is maintained in the manual and automatic cycles through the pressure switch PS-1. This is energized by 2M contact and works in conjunction with the air pump AP.

For complete installation of the pulverizer system, exclusive of the refuse container shelter, the manufacturer has quoted a price of $9,000.

3. Incinerator

Because selection of the incinerator has not yet been made, plans for its installation have not been detailed. Assuming, however, that the recommendations of the Incinerator Institute of America concerning the incinerator to be used are accepted by the committee, installation will be handled entirely by the Institute.

C. SUPPLEMENTAL FIELD SURVEY PROGRAM

While the equipment was being selected, consideration was also given to the evaluations to be made as a result of the study. There was concern that the results obtained on the equipment installed in the New Haven structures might be limited either to a particular concept for handling the refuse (e.g., compaction) or to equipment of the specific manufacturer involved. This point was repeatedly raised by various manufacturers, in addition to their concern that others would interpret: (1) the equipment selected for installation as the optimum available, and (2) the specific data obtained on equipment operation as applicable to or representative of all other equipment employing the same concept. Consequently, the committee recommended that a national field survey be conducted concurrently with the New Haven program to collect sufficient information on the operation and cost of refuse handling equipment (particularly compactors and pulverizers) of other manufacturers to provide a basis for addressing these concerns. In addition, it was recognized that implementation of such a survey for the duration of the New Haven program would tend to ensure current awareness of any new equipment which might become available, would establish an inventory of all equipment and techniques for the onsite handling of refuse, and, in general, would provide an invaluable supplement to the data collected in New Haven.

It is planned to request each manufacturer of onsite refuse handling equipment to provide a general description of his equipment and its operation, plus notification of all installations within high-rise structures as they occur. Several installations of each manufacturer's equipment will be inspected, and the following field survey questionnaire will be completed. Arrangements will be made with the management of each building visited to provide cost and other particularly pertinent information on a periodic basis.

Field Survey Questionnaire

A. GENERAL

1. Type of reduction unit (pulper, compactor, other): ______________________

    a. If other, describe: ______________________

2. Name and address of structure: ______________

____

3. Type of occupancy (Multifamily low income; Multifamily middle income; Multifamily high income or luxury; Other--describe):

____

4. Number of floors and individual dwelling units within structure: ______________

5. Frequency of pickup by offsite refuse collection agency (on a weekly basis):

____

6. Is refuse handling unit original or replacement: ______________

   a. If replacement, what was removed: ______________

B. <u>CHUTE</u>

1. Is central collection chute used (Yes or No): ______________

   If Yes:

   a. Chute material: ______________

   b. Chute diameter: ______________

   c. Cleaning and sanitation provisions provided: ______________

   d. Fire protection provisions provided (describe also chute ventilation):

   ____

   e. Are supplemental pickups of refuse within corridors (or within dwelling units) required (Yes or No): ______________

   If Yes, how often: ______________

C. <u>EQUIPMENT</u>

1. Manufacturer: ______________

2. Model & Model No: ______________

3. Date of installation: ______________

4. How is refuse fed into reduction unit (directly from central chute; conveyed from chute; manually): ______________

5. Does unit process both garbage and dry refuse (Yes or No): ______________

6. Can unit process all bulky and heavy wastes charged into chute (Yes or No): ______________

   a. If No, list troublesome items: ____________

7. Auxiliary power and/or utility requirements (electricity, air, water, etc.): ______________

8. Number of containers and/or bales of processed refuse produced daily: ______________

9. Dimensions of individual refuse containers and/or bales as processed: ________________

10. Weight of individual refuse containers and/or bales as processed: ______________________

    a. Can weight be varied at the site (Yes or No): ______________________

11. Manufacturer-rated volume compaction ratio:

    ____

    a. How rated: ______________________________

12. Reliability (to be assessed with following questions, if possible):

    a. Number of failures per given unit of time: ______________________________

    b. Major types of failures: ________________

    c. Average time unit is unavailable due to failure: ______________________________

13. Maintenance requirements (total weekly man-hours): ______________________________

    a. General description of procedure followed: ______________________________

14. Personnel requirements (total weekly man-hours and number of personnel involved):

    ____

    a. General description of procedure followed: ______________________________

15. Fire protection provisions provided: ___________

    a. Are these building code requirements (Yes or No): ______________________________

16. General description of unit operation considering: 1. Complexity of operation (degree of automation) and janitorial skill requirements; 2. safety and/or warning devices and/or signals; method used to get processed refuse to the curb; limitations (especially adapted collection trucks, ease of use by tenants, etc.): ______________

    ____

D. ENVIRONMENTAL CONDITIONS MAINTAINED BY REDUCTION UNIT

(To be assessed by questioner using the relative indicators given)

1. Noise level (not perceptible, slightly perceptible, strongly perceptible, disturbing):
   a. Within trash room: ______
   b. Within corridor on first floor having dwelling (or occupied) quarters: ______
2. Dust level (not perceptible, slightly perceptible, strongly perceptible, disturbing):
   a. Within trash room: ______
   b. Within corridor on first floor having dwelling (or occupied) quarters: ______
3. Odor (not perceptible, slightly perceptible, strongly perceptible, disturbing):
   a. Within trash room: ______
   b. Within corridor on first floor having dwelling (or occupied) quarters: ______
4. Vermin infestation within trash room (no evidence of such; evidence of such, non-assessable): ______
   a. Precautions recommended by manufacturer: ______
   b. Precautions taken: ______
5. General cleanliness of trash room (bad, acceptable, good): ______

E. COSTS

1. Initial cost of reduction unit (including all accessories): $______
2. Monthly operational costs for:
   a. Power and/or utilities: $______
   b. Personnel: $______
   c. Collection of refuse by offsite agency: $______

   Total $______

3. Maintenance costs (average monthly since installation exclusive of personnel costs reported above): $______________

4. Insurance costs per given unit of time:

   $______________

5. Space utilized (general description of height, width, and depth of reduction unit and storage space requirements): ______________

Respondent

Name: ______________

Address: ______________

D. SECOND STUDY PERIOD DATA-COLLECTION PROGRAM

Throughout the first study period, various discussions were held by the committee to identify the factors and parameters on which data should be collected during operation of the new refuse-handling equipment. It was decided to divide the data-collection program to be implemented into the following categories:

1. Refuse quantity and composition
2. Quantity and composition of waste flowing through building sewer line
3. Inhabitants
4. Costs
5. Environmental conditions maintained
6. Equipment effectiveness, requirements, and limitations

1. Refuse Quantity and Composition

During the second study period, additional data on refuse quantity and composition will be collected as part of the continuing effort to establish per capita generation rates and seasonal variations as well as to identify what the new refuse-handling equipment must process and when the processing should be done. For data on chute refuse, only the control structure (Building 4A) and the chutes therein will be used. The refuse quantity and composition protocol developed for and used during the first study period will be followed, but it will be reduced in detail to effect collection of data on weight, volume, and composition (including moisture) over a longer period of time for the same level of expenditure previously made for this effort.

Because little attention was given to yard waste during the first study period, when data are collected on chute refuse during the second study period, for at least one full week, data on yard waste will be collected in accordance with the detailed procedures of the developed protocol. A category including grass, leaves, and clippings, will, however, be added. In addition, a count of refuse containers filled each day with yard waste will be maintained throughout the second study period. Data on bulky items of waste also will be collected in accordance with protocol procedures during the period chute refuse is assessed. It is desired ultimately to compare data on the quantity and composition of refuse after processing by the new refuse-handling equipment with data on refuse processed by the existing equipment. Because of the suspected data collected during the first study period on quantity and composition of refuse following incineration, additional data on this aspect will be obtained while chute refuse is being assessed. As before, incinerator residue will be sorted into the categories of ashes, unburned combustibles, and noncombustibles, and weight and volume will be determined in accordance with protocol procedures. Only two chutes within the control structure will be used in this effort and data will be collected for no less than 5 days.

Development of the specific and detailed data-collection schedule to be used--i.e., the hour-to-hour and day-to-day requirements--is within subcommittee. As before, the data-collection effort is to be subcontracted, and the detailed schedule developed will serve as the scope of work of the subcontract. In addition to the data collected through subcontracting, the number and size of refuse containers filled each day with yard waste will be logged by the janitor responsible for cleanup of the Housing Authority grounds.

2. Quantity and Composition of Waste Flowing through Building Sewer

It is planned to install garbage grinders within the apartments served by the refuse chutes feeding the new refuse-handling equipment after the equipment has been in operation for a year. When they are installed, it is intended to collect data on operation and performance of the new equipment--particularly on the environmental conditions maintained--handling principally rubbish--i.e., with most of the putrescible waste separated out. In addition, the increased load on the building sewer line resulting from use of garbage grinders will be assessed. For this assessment, it is planned to determine quantity and composition of waste flowing through the sewer line before garbage grinders are installed. Data collected should be useful in determining whether existing building sewer lines are capable of assuming the added load resulting from use of garbage grinders and in estimating dimensions and layout of drainage lines within buildings and should also be useful in the planning of requisite sewage treatment plants and in the estimating of sewer lines throughout the community.

In planning this activity, manufacturers of garbage grinders were asked for recommendations regarding the data to be collected, applicable sampling procedures and, how long data would have to be collected to ensure truly representative results. Excellent recommendations were received, but all were considered to be more extensive and expensive than required. Consequently, responsibility for developing the required data-collection program and sampling procedures was assigned to a subcommittee.

The subcommittee has established that it would be sufficient to monitor only the sewer line of Building 6B. Building 6B was selected, because it is intended to install the pulverizer in this building which may possibly contribute significantly to the sewer line. As will be discussed later, waste water for the pulverizer is to be analyzed for composition. In anticipation that procedures used to sample the sewer line will be applicable, the effort would be facilitated if the sewer sampling equipment were located nearby.

The following factors on which data are to be collected have been divided into primary and secondary categories, the first category including those factors deemed to be the most important and thus those on which data collection should be more extensive.

Primary	Secondary
pH (hydrogen-ion concentration)	Phosphates (total)
Solids	Phosphates (ortho)
Total	Nitrogen (total)
Suspended	Nitrogen (NH_3)
Total volatile	Acidity
BOD (biochemical oxygen demand)	Alkalinity
COD (chemical oxygen demand)	Color
Grease	
Turbidity	

In the effort to establish appropriate sampling techniques, attendant equipment requirements, sampling frequency and duration to result in data in which 90% to 95% confidence could be expected, contact was made with the Industrial Waste Water Control Section of the New York City Department of Water Resources, which has had extensive experience in these areas. Officials of the Industrial Waste Water Control Section have indicated an unqualified willingness to aid the committee, offering their services and knowledge with respect to sampling station design, use of equipment for the sampling station, the possible use of their laboratory for analysis of collected samples, and the experience of their personnel in the development of a data-collection program that would yield the desired 90% to 95% confidence level. It is anticipated that development of the data-collection program will soon be completed.

3. Inhabitants

During the initial study period, information on inhabitants was obtained only during the time that the quantity and composition of refuse generated were assessed. Since a count of containers filled with refuse following processing by the new equipment will be made daily throughout the second study period, a periodic determination is to be made of the number and age of inhabitants using refuse chutes A_1, B_1 and C_3, i.e., the chutes to be associaed with the new equipment. With this information and other data to be collected on the processed refuse, it will probably be possible to determine the variation in per capita generation rate (by weight) for this entire study period. In addition, tenant population of the control structure, by age, will be determined during the time that data are obtained on the quantity and composition of refuse generated by its tenants.

4. Costs

Costs will be separated into the following categories:

1. Capital
2. Operating
3. Maintenance
4. General and administrative

Capital costs will include the specific initial cash outlay for the incinerator, pulverizer and compactor. Since responsibility for equipment installation is to be assumed by manufacturers of the equipment involved (the Incinerator Institute of America in the case of the incinerator) through subcontracts, each will be requested to provide a breakdown of the costs involved in terms of the following items, or such information will be obtained by audit.

1. Refuse-handling equipment, including all accessories and controls but no optional features
2. Optional features
3. Taxes
4. Architectural drawings and plans, if required
5. Labor and materials required for structure renovations (e.g., removal of existing incinerator)
6. Fire protection provisions
    a. Suggested by manufacturer
    b. Required by building codes
7. Labor and materials required for installation
8. Residue and refuse containers

Operating costs will include separate determination of the cost of operator personnel, fuel and utility consumption or use, residue and refuse removal, space utilization, depreciation, and miscellaneous expenditures.

Operator personnel costs will include wages, fringe benefits, and training as required for the normal operation and servicing of equipment and for routine maintenance. Information on operator salary and wages and fringe benefits will be obtained directly from Housing Authority records. An operator log will be used for each new piece of refuse-handling equipment, in which all work performed or services provided and the associated time (man-hours) will be recorded continuously by the operator. A realistic value can then be established for that part of the day spent by an operator in the normal operation and servicing of the equipment. Costs of training operators will be assessed on the basis of time spent by equipment manufacturers with the Housing Authority operator staff for this purpose. From all the information obtained, operator personnel costs then will be calculated, with appropriate consideration given to vacations and sick leave.

Fuel consumption will have to be determined only in the case of the new incinerator, which will be using gas. Consumption will be recorded on a continuous basis with a gas meter which is to be installed. Meter readings and time of readings will be logged daily by the operator and from this information fuel cost will be calculated. Utility charges will include those for electricity and water consumption and sewer use. For all three pieces of refuse-handling equipment, electricity consumption in kilowatt-hours will be recorded continuously with a kilowatt-hour meter having a cyclometer dial. Similarly, simple water meters will be used to record water consumption associated with the incinerator scrubber and the pulper. Meter readings and time of readings will be logged daily by the operator. Since water consumption by the compactor and the dewatering press (i.e., for cleaning) will not be significant, this will be estimated by the committee staff. Contribution to the building sewer line from the refuse-handling equipment also will be estimated by staff observation. If, however, such contributions are deemed to be sufficiently large, staff observation will be supplemented with actual measurements of the volume of water involved.

Residue and refuse removal costs associated with onsite handling will be recorded as normal operation charges reflected as operator personnel costs. To associate a cost with removal of the residue and refuse from the curb, observations of its collection by the city will be made by the committee staff. Particular attention is to be given to speed (time) and efficiency with which refuse containers associated with the new equipment can be handled, specialized equipment required, and the number and size of containers involved (specific counts of filled refuse containers and their weights will be obtained elsewhere and will be considered appropriately in this cost estimate).

Space utilization cost assessments will be based on the actual area required for equipment installation, for convenient servicing, and for refuse storage following processing by the equipment. In the establishment of storage space requirements, consideration will be given to possible interruption of service by the offsite collection agency. Depreciation costs will be assessed by dividing total initial or capital cost by the probable life expectancy of the equipment.

Miscellaneous costs will include expenditures for tools and materials used in the normal operation and servicing of the equipment and expenditures for the replacement of tools and damaged or disposable refuse containers, and other similar needs. All such goods and materials purchased by the Housing Authority are invoiced, and the invoices will be used as a record of expenditures.

Maintenance costs will include expenditures for repair and preventive maintenance work on the new refuse-handling equipment and related assessories. Work performed by operator and maintenance personnel is to be recorded in the operator log in terms of work performed, time required, and materials used; materials will be purchased by the Housing Authority and invoiced to provide a record. Work covered by equipment warranty will be noted and appropriately considered in the cost analysis. Repairs and preventive maintenance performed by outside personnel will be billed to the Housing Authority thus providing a record.

General and administrative costs will include personnel administrative costs for hiring and training and costs for clerical personnel, taxes, insurance, general management and overhead, and similar miscellaneous items. The Housing Authority management will be asked to provide input for committee consideration regarding an equitable distribution of these costs.

5. Environmental Conditions Maintained

Environmental conditions maintained by the new refuse-handling equipment include air pollution, odor, noise, contribution to sewer, vermin and insect infestation, and general aesthetic conditions, each of which will be discussed separately.

Air pollution will entail principally monitoring of the stack effluent from the new incinerator. It is recognized that an extensive program could be developed solely around the air pollution aspects of the new incinerator, but the data-collection program to be implemented is designed primarily to provide adequate information for assessment of incineration as a concept for handling refuse onsite. The program desired is one similar to that implemented during the first study period but with more emphasis placed upon assessing the effect of long-term equipment operation on emission characteristics. To the extent funds are made available for this purpose, the air pollution program previously developed will be used but will be reduced in number of test variations in order to span measurement of emissions throughout the study period. Measurements will be made when the scrubber is both in operation and shut down, with the incinerator charged at design, overdesign, and underdesign capacity. For each refuse sample burned, data similar to the data collected during the first study period again will be collected. To extend funds as far as possible, as the study period progresses, the number of samples to be burned in each test will be based on similarity of results with results of each previous test, so as to limit the number of samples to be burned to a minimum.

Sample composition again will be based on results obtained during the first study period but modified as appropriate in the light of additional data collected. Test methods to be employed will be those used during the first study period, since they are economical and thus will allow for collection of more data with specific application to the onsite refuse program. Although the data available are limited, it is hoped that a method can be established for correlating the data collected with the two test methods previously described.

For the compactor and pulverizer, the degree of dust in the vicinity of the processing equipment will be assessed subjectively.

Vermin and insect infestation will be assessed periodically throughout the study period using the assessment program implemented during the first study period.

Odor will be assessed subjectively by the committee staff within corridors, on roofs in the vicinity of refuse stacks and the new incinerator flue and sewer stacks, and in the basement areas near the refuse-handling equipment. Tenant and custodian reaction to the odor level will also be assessed. For tenant reaction, assessment will be based on interviews with tenants using questions to be developed by the committee sociologist. For the three test structures involved, only the tenants using the refuse chutes feeding the new refuse-handling equipment will be interviewed; for the control structure, tenants served by the north chute will be interviewed. (Consideration is being given to replacement of tenant interviews with interviews with week-end guards and similar personnel who do not normally live on the premises and thus perhaps would be better able to note a change in odor level.) For custodian reaction, assessment will also be based on interviews, using questions to be developed by the committee sociologist. The interviews will be held in basement areas while the new equipment is being serviced and while it is in operation.

In addition to this subjective information, data on odor will be available from ASTM dilution samples, to be taken during incinerator stack emission measurements, and from at least one sewer vent on the roof of one test structure.

Noise will be assessed both subjectively and quantitatively, subjectively in terms of tenant and custodian reaction and quantitatively in terms of decibel levels and frequency of occurrence. Tenant reaction and decibel level will be assessed during: (1) charging of chutes with samples containing metallic cans, (2) normally programmed operation of refuse-handling equipment, (3) cleaning of refuse-handling equipment, (4) transfer of refuse from basement to curb, and (5) pickup at the curb by the offsite collection agency. Assessment of custodian reaction will be made during each of these operations except the last.

As with odor, custodian and tenant reactions will be determined from interviews, but, in addition, subjective assessments will be made by the committee staff. As with odor, only those tenants using the chutes associated with the new refuse-handling equipment and the selected chute in the control structure will be interviewed, and only custodians actually servicing the new equipment will be interviewed.

For decibel level, data are to be recorded within individual apartments of the tenants interviewed, in the basement area of each test structure and control in vicinity of equipment, and at the pickup point for the offsite collection agency during each of the previously mentioned operations. For frequency of occurrence, data will be obtained from schedules established for each operation during which noise level is measured except chute charging; this frequency will be estimated.

Contribution to sewer will involve assessment of the additional load placed on the building sewer, the pulverizer since waste water will be involved from the pulper operation and from equipment cleaning, the compactor from equipment cleaning, and the incinerator from the scrubber and from equipment cleaning. Additions resulting from equipment cleaning will be estimated by the committee staff on the basis of observations. Contribution in terms of water volume from the scrubber and pulper will be based on measurements of the quantities involved. In addition, grab samples of the waste water from these pieces of equipment will be taken for laboratory analysis. Each sample will be analyzed for the following:

Carbonates	Solid insolubles
Nitrites	Oily insolubles
Nitrates	BOD (biochemical oxygen demand)
NH_3	COD (chemical oxygen demand)
Aldehydes	

General aesthetic conditions will be assessed by the committee staff during walkthroughs of the structures involved. Particular attention will be paid to the basement areas and to refuse pickup points.

6. Equipment Effectiveness, Requirements, and Limitations

In addition to the foregoing factors on which data are to be collected, there are others which must be assessed. These factors, considered below, will be assessed by the committee staff through observations or interviews, by information recorded on operator log sheets, or information otherwise obtained.

Reliability and availability will be assessed from information recorded in the operator log concerning time and date of failure, time down due to failure, and cause of failure.

Ability to handle all refuse will be assessed from information recorded on operator log concerning particularly troublesome items and through observations by the committee staff. This information will be supplemented with specific data on bulky miscellaneous items of refuse.

Weight, volume, and composition of refuse following processing will be assessed when data on refuse quantity and composition are obtained. For the new incinerator, residue will be separated daily into the categories of ashes, unburned combustibles, and noncombustibles. Weights and volumes of each category will be determined; in addition, moisture samples will be taken. For the pulverizer, daily weights and volumes will be determined for both pulped and nonpulped waste, and moisture samples will be taken from both categories; composition will be assumed to be the same as that prior to processing. For the compactor, daily weights and volumes will be determined; composition of refuse will be assumed to be the same as that prior to processing. Collection of data on moisture content and weights and volumes of incinerated residue by category will be subcontracted at the same time collection of data on refuse quantity and composition is subcontracted.

In addition to the foregoing determinations, the number of filled containers of processed refuse and their weights will be logged daily in the operator log.

Utilities and fuel requirements will be assessed from data collected for analysis of operating cost.

Operator personnel requirements will be assessed in terms of the following factors:

1. Number of personnel required at each level of responsibility
2. Skills required for each level of responsibility
    a. Education
    b. Experience
    c. Physical attributes
    d. On-job training
3. Man-hour requirements for personnel at each level of responsibility
4. Personnel turnover rate
5. Salary and wages
6. Union affiliation

Factors on which data are not already obtained for use in cost analyses, will be assessed through observations by the committee staff and consultations with the Housing Authority management.

Environmental conditions maintained will be assessed from data collected from previous effort.

Usable types of refuse containers will be assessed through investigations of various types of refuse containers--paper and plastic bags, metallic and plastic cans, and others as available and appropriate for the processed waste--to evaluate the capability and advantages associated with each. Leakages, ripping, and other types of damage to the containers will be recorded by operator personnel in the operator log. Information will also be obtained on lift and carry distances involved in transporting refuse containers to the curb for pickup, accessibility requirements, acceptance by the city of disposable containers, specialized equipment requirements, and the effect on storage requirements of each type of container. The effect on environmental conditions of the different types of containers, particularly odor and vermin infestation, will also be assessed.

Reserve capacity will be assessed by charging samples of composition as determined from refuse quantity and composition data, into each new piece of refuse equipment at its manufacturer-rated capacity. Reserve capacity will be considered to be the differential between tenant charging rate and the capacity of the equipment determined from these tests but not exceeding the manufacturer-rated capacity. For these tests, refuse samples will be fed into the equipment at a rate commensurate with demonstrated capability.

Storage requirements will be assessed in terms of type of refuse container used and floor space required for storage between pickups. Considerations will also be given to the possibility of disrupted offsite collection services, such as might result from labor strikes or bad weather conditions.

Fire protection requirements will be assessed in terms of manufacturer-suggested provisions and the requirements of local building codes.

Serviceability will be assessed in terms of ease of servicing by the operator staff and from information logged concerning troublesome areas.

Specialized equipment requirements will be assessed in terms of requirements imposed by the existing design of the Housing Authority structures and the equipment itself. Particular attention will be given to the manner in which processed waste is taken from basement area to ground level, from ground level to curb, and from curb to pickup truck.

Cleaning requirements will be assessed in terms of manufacturer-recommended procedures, equipment and material requirements, suggestions and requirements logged by operator staff, and environmental conditions (odor and vermin infestation) maintained.

Complexity and safety of operation and degree of automation will be assessed through observations by the committee staff of equipment operation, information logged or otherwise relayed by equipment operators, and in terms of degree of dependency on such factors as power and uninterrupted servicing.

Tenant, custodian, owner, and city acceptance will be assessed by interviewing the personnel involved, with consideration given such factors as convenience, degree of central collection, time refuse must be stored within individual dwelling units, availability, ability to handle all refuse, environmental conditions maintained, reliability, serviceability, and restrictions imposed by municipality--e.g., weight, size, and disposability of refuse containers, and air pollution standards.

APPENDIX A

AGREEMENT FOR CONDUCT OF
SOLID WASTE RESEARCH PROJECT

between the

National Academy of Sciences
The Public Housing Authority of the City of New Haven
and
The City of New Haven

AGREEMENT FOR CONDUCT OF
SOLID WASTE RESEARCH PROJECT

I. INTRODUCTION

Municipalities throughout the nation today are confronted with the need to dispose of staggering amounts of solid waste refuse that is being generated in increasing quantities. Many facets and elements of this critical problem are under study at present, but one fundamental area where little or no effort is being made involves the collection and reduction of refuse at the point of origin. One of the most readily available means of simplifying the municipal (and regional) problems of handling and disposing of refuse would be to decrease the weight and/or volume of the refuse at the source.

At the request of the U. S. Public Health Service (hereinafter referred to as "Public Health Service") of the Department of Health, Education, and Welfare, the National Academy of Sciences (hereinafter referred to as the "Academy") through its Building Research Advisory Board (hereinafter referred to as the "Board") agreed to undertake a study of onsite refuse collection and reduction systems for high-rise multifamily residential structures pursuant to Contract No. PH 86-67-167, dated May 23, 1967 (hereinafter referred to as the "prime contract"). It is the intent of the Academy to implement this contract through this agreement with the Housing Authority of the City of New Haven (hereinafter referred to as the "Authority") and the City of New Haven (hereinafter referred to as the "City").

II. PURPOSE OF AGREEMENT

The purpose of this agreement is to define the study contemplated by the parties hereto; to establish a basis of cooperation by and among the parties; to outline the terms and conditions under which the study shall be made; and to set the obligations and responsibilities of the respective parties. It is agreed that this study is for the mutual benefit and in the mutual interest of all parties hereto.

III. INTERESTED ORGANIZATIONS AND PARTIES

Under this agreement, the four principal organizations having an interest in the conduct of this study are the Academy, the Public Health Service, the Authority and the City. The parties to this agreement are: 1) the Academy, 2) the Authority and 3) the City; it is understood that this agreement shall be subject to the approval of the Public Health Service and the Housing Assistance Administration. It is recognized and agreed to by all parties hereto that participation in this study is in the public interest and that an opportunity is at hand to acquire knowledge that may contribute significantly to the solution of many refuse collection and disposal problems and to the establishment of environmental improvements from the standpoint of public health.

IV. STUDY GOALS

This study is designed and intended to permit onsite evaluation of currently available refuse waste collection, reduction and disposal systems and/or equipment applicable to the three structures designated in paragraph A of Article VI. Specifically, it is the intent to evaluate, concurrently, an incineration system in one structure; a system of the compactor type in a second structure; and a wet pulper/presser and/or shredder system in a third structure. In addition, sink garbage grinders will be evaluated as a variable parameter with respect to these three different refuse reduction techniques. The total effort is expected to cover three years and is divided into three 12-month phases (See Article IX below).

V. STUDY FUNDS

Funds for the first phase of this study have been provided to the Academy by the Public Health Service and it is contemplated that funding will be provided to implement each of the successive phases of the study as described in Article IX below. It is understood that continuation of this study after completion of the first phase is subject to the availability of funds.

In the operation of this agreement it is understood that there will be no exchange of funds between and among the Academy, the City, and the Authority.

VI. OBLIGATIONS OF THE AUTHORITY

A. Use of Residences[1] - The Authority agrees to grant to the Academy the right to conduct this research project at three high-rise residences hereinafter described for a period not to exceed four years from the date of this agreement. These residences are located at:

1) 225 Ashmun Street
2) 120 Canal Street
3) 180 Canal Street

B. Modification of Residences - The Authority grants to the Academy the right to modify or have modified solely at the expense of the Academy the residences designated in the paragraph above as required to install and make operable refuse collection and reduction equipment which is intended to be evaluated and to install instrumentation as required to obtain the desired data; it is understood that all such modifications shall include provision for utilities and shall not reduce the number or size of dwelling units. Prior to such modifications and installations the Academy shall obtain all approvals, licenses and permits required by the State or local law. All plans and specifications for any modifications and installations shall be approved by the authority, which approval shall not be unreasonably withheld.

[1] Agreement was subsequently modified to allow use of the four buildings: 185 Ashmun St., 250 Ashmun St., 120 Canal St., and 180 Canal St.

C. Services - All contractors, subcontractors and materialmen selected by the Academy shall be approved by the Authority, which approval shall not be unreasonably withheld.

The Authority agrees further to provide required custodial-janitorial personnel to operate and maintain the installed refuse collection and reduction systems and/or equipment on a day-to-day basis, in accordance with manufacturer recommended procedures, it being understood that provision of such services by the Authority is part of its normal effort to collect, reduce and remove the solid waste refuse from the residences involved in this study, provided, however, that the Authority shall not be required to increase the number of custodial-janitorial personnel.

VII. OBLIGATIONS OF THE CITY

A. The City agrees to exempt the residences designated in Paragraph A of Article VI of this agreement from restrictions that may be subsequently imposed upon onsite incineration of refuse.

B. The City agrees to exempt the residences designated in Paragraph A of Article VI of this agreement from existing restrictions on the use of sink garbage grinders.

C. The City agrees, if appropriate and based on consultations with the Academy, to establish specific schedules and ensure their adherence for the removal of collected and reduced refuse from the residences to be used in this study.

D. The City agrees to process structural and utility modification plans and drawings for the designated residences and to provide the required code inspections in a timely fashion, when required, in order that the progress of the study may continue as scheduled.

VIII. PUBLIC HEALTH SERVICE

Public Health Service is sponsor of the program under which this study is being conducted and has title, pursuant to the prime contract, of refuse waste collection, reduction and disposal equipment to be installed in the residences designated in Paragraph A of Article VI.

IX. PHASING

This study will be conducted at the site of the residences designated in Paragraph A of Article VI in accordance with the following phases:

A. The effort during the first 12-month period will entail collection of data on "as is" conditions, including, but not necessarily limited to, the extent of contribution to air pollution by existing equipment; personnel and power requirements, costs, efficiency and effectiveness, as well as owner/tenant/custodian-janitor acceptance of existing systems; weight, volume, and composition of generated refuse; composition and volume of waste flowing through structure drainage lines; and degree of vermin infestation associated with existing systems.

In addition, preliminary plans (architectural/mechanical/electrical) will be prepared as required for the installation of refuse reduction equipment intended for evaluation and modification of the City's refuse collection trucks to accommodate can weights in excess of normal. General preparation also will be made as necessary for the second and third 12-month phases. (Such preparations may, if required by existing conditions, include arrangements for installation of collection chutes.)

B. The effort during the second 12-month period will entail installation of refuse collection and reduction equipment and as appropriate modification of the City's refuse collection trucks to accommodate can weights in excess of normal, in accordance with preparations made during the first phase; and the subsequent collection, reduction, and analysis of data on performance and operation of the equipment handling both wet (garbage) and dry refuse.

C. The effort during the third 12-month period will entail installation of sink garbage grinders, and the subsequent collection, reduction, and analysis of data on performance and operation of equipment installed during phase two handling only dry waste. In addition, data will be collected on the composition and volume of waste flowing through the drainage lines of structures into which sink garbage grinders are installed.

Each of the three phases is designed to ensure that: (1) Useful results will have been obtained if the study is terminated upon completion of either the first or the first and second phase, and (2) in the event of such termination, no modifications to the structures involved will have been made that will require undoing subsequent to and in consequence of the unanticipated termination of the study.

X. <u>OBLIGATIONS OF THE ACADEMY</u>

A. The Academy shall commence the study outlined herein as soon as conveniently possible after all parties have executed this agreement and approval of the Public Health Service and the Housing Assistance Administration have been obtained.

B. <u>Responsibility for the Study</u> - The Academy through its appointed Advisory Committee of the Building Research Advisory Board, shall be solely responsible for the development, conduct and evaluation of this study. The Academy is obligated to provide to Public Health Service periodic reports and a final report upon completion of the prime contract. Subject to Public Health Service approval, copies of the final report will be provided the City and Authority and in the event of a publication emanating from this study, the City and Authority will receive a reasonable number of copies.

C. <u>Use of Contractors</u> - The Academy shall have the right to employ whatever contractors or subcontractors it deems necessary in the conduct of the study, subject to appropriate coordination with the Authority, and approval of the Public Health Service pursuant to prime contract.

D. Insurance - The Academy shall take out public liability insurance in the amount of $100,000 per person and $300,000 per accident, and property damage insurance in the amount of $100,000. All of the said policies shall be taken out in the Academy's name and in addition thereto the City and the Authority shall be named as insured and shall be protected by this insurance from any and all liability expense that may arise in consequence of personal injury or property damage to any person or organization (including employees of the Academy) as a direct result of the work performed or undertaken under this agreement by the Academy, its agents, employees, contractors, or subcontractors.

In addition, the Academy shall require that contractors or subcontractors whose services shall have been arranged for directly by the Academy, procure and maintain appropriate insurance in form and amounts as approved by the Academy.

The Academy shall cause all general contractors engaged by it in connection with this research project to provide payment and performance bonds in form and amounts as approved by the Academy in consultation with the Authority.

E. Restoration of Structure Modifications - Whenever modification has been made to one or more of the residences designated in paragraph A of Article VI as a result of or in conjunction with this study, the Academy shall restore the subject residences to substantially the condition which existed at the time of inception of this study, except in cases where the modification made is essential to operation of the refuse collection and reduction equipment that is to remain in the residences. The Academy, with approval of the Public Health Service, shall cause title to any equipment that is to remain in the residences to be transferred to the Authority.

F. It is further agreed between the parties hereto, that the Academy shall save the City and Authority harmless from any and all claims by any person that may arise as a direct result of the work performed or undertaken by the Academy or any of its agents, employees, contractors, or subcontractors under this agreement.

Accepted and agreed to, this____

day of__________________, 1968.

HOUSING AUTHORITY OF THE CITY OF NEW HAVEN

By____________________________

Title_________________________

CITY OF NEW HAVEN

By____________________________

Title_________________________

NATIONAL ACADEMY OF SCIENCES

By____________________________

Title_________________________

Approved:

HOUSING ASSISTANCE ADMINISTRATION

By____________________________

Title_________________________

Approved:

PUBLIC HEALTH SERVICE

By____________________________

Title_________________________

By its approval of this Agreement, the Public Health Service agrees that the study to be performed hereunder is consistent in accordance with the prime contract.

APPENDIX B

REFUSE QUANTITY AND COMPOSITION--
PROTOCOL AND CONDUCT OF THE FIELD PROGRAM

PROTOCOL

Refuse Quantity and Composition

Chute Refuse

General.—For purposes of identification and reference, the test structures involved, buildings 6B, 5B and 1A, are designated A, B, and C, respectively; and the control structure (building 4A) is designated D. Chutes (and/or existing incinerators) within test structures A are designated A_1, A_2, and A_3; within test structure B as B_1, B_2, and B_3; within test structure C as C_1, C_2, and C_3; and within control as D_1, D_2, and D_3. For chute designations, subscript 1 refers to north chutes, subscript 2 to center chutes, and subscript 3 to south chutes.

Categories of Refuse.—Refuse is to be sorted in accordance with the procedures and schedules which follow into the following categories:

1. Paper and paper products
2. Wood and wood products
3. Plastic, leather and rubber products
4. Glass
5. Metallics
6. Stones, sand and other inert or ceramic materials
7. Rags and textile products
8. Garbage (organics)

Weight and Volume of Refuse as Generated.—On the first day of data collection, all incinerators in the four buildings involved are to be cleaned of refuse, including ash, as well as practical by 7 a.m. Thereafter, on the first day of data collection--beginning at 8 a.m. and continuing through 9 p.m.--weight and volume of refuse generated at chutes A_1, B_1, C_3, and D_3 are to be recorded (per chute) hourly for each category of refuse. At all other chutes within each of the structures involved, weight and volume of refuse generated are to be recorded (per chute) twice daily--at noon and at 9 p.m.--for each category of refuse.

For the second through the seventh days, weight and volume of refuse generated at all chutes within each of the buildings involved are to be recorded (per chute) thrice daily--at 7 a.m., at noon, and at 7 p.m.--for each category of refuse.

Prior to each data recording period indicated above, and before sorting into categories begins, refuse is to be shoveled from each incinerator involved into containers of known volume and weight. As each container is completely filled (hourly schedule requirements may prevent this from occurring), weight is to be noted and volume recorded in cubic feet capacity of the container. Containers are to be deemed full when lids fit after refuse has been only lightly hand pressed. Volume of partially filled containers is to be estimated in terms of percent of containers filled and recorded in cubic feet.

After recording weight and volume data of full containers, refuse is then to be sorted and weight and volume of each category recorded in accordance with the times designated previously. In determining volume of each refuse category, the cubic foot volume of full containers is to be used, while for partially filled containers, volume is to be estimated as described previously.

Moisture Content of Refuse as Generated.—At end of each data collection day after all sorting has been completed and weight and volume of refuse by category has been recorded, moisture samples for laboratory analysis are to be taken from that refuse collected at chutes A_1, B_1, C_3, and D_3 as follows:

Three samples, five pounds each, are to be taken daily at each chute. One sample is to be taken from refuse in the category, Paper and Paper Products and one is to be taken from refuse in the category, Organic Garbage. The third sample is to be a composite taken from the combined refuse in the categories, Wood and Wood Products, Rags and Textiles, and Plastic, Leather and Rubber Products. In addition to the above, a 5-lb. grab sample is to be taken daily from refuse generated at chute D_3 in the category, Metallics.

To obtain the 5-lb. sample (excluding the grab sample of Metallics), the waste generated daily--i.e., from 7 a.m. to 9 p.m. on the first day of data collection, from 9 p.m. the previous day through 7 p.m. of the second day, and from 7 p.m. the previous day to 7 p.m. of each successive day--in the categories involved is to be placed on an appropriate surface, mixed and spread evenly into a shape approximately that of a square. The square is then to be quartered (using shears, if necessary, to cut rags and other items of refuse which might have been parts in each quarter) and the 5-lb. sample taken from one quarter. If the quarter does not contain 5 lb. of refuse, the entire quarter is to be used and additional refuse taken from a second quarter to complete the 5 lb. Moisture samples are then to be placed in plastic bags and the bags taped shut for subsequent moisture analysis in the laboratory.

Once within the laboratory, moisture samples are to be weighed while still within the sealed bags to within an accuracy of not less then 0.1 lb. Bags containing the moisture sample are then to be ripped open, placed in an oven and dried at a temperature of 105°C. until a constant weight is obtained; constant weight is to be assumed following any two consecutive weighings 1 hour apart which reflect no change in weight. The difference between original and dried weight of a sample--minus the nominal weight of the sealed plastic bag--is to be recorded as moisture contents and reported in terms of percent of total weight.

Weight and Volume of Refuse Following Incineration.—After weight and volume data and moisture samples have been obtained as required on each data-collection day, refuse collected daily at chutes A_1, B_1, C_3, and D_3 is to be set aside for burning in the respective incinerators each following day to obtain data on weight and volume of residue. (Refuse collected at all other chutes is to be discarded at the end of each data-collection day). This is to be accomplished as follows:

As soon as all refuse has been removed from within the incinerators fed by chutes C_3, D_1, D_2, and D_3 as required for daily noon data recordings, all hopper doors to these chutes are to be taped to prevent their use by tenants during burning in these incinerators of the refuse collected on each previous day. The refuse is then to be incinerated as rapidly as possible by inserting into each incinerator (per charge) two bags of previously sorted refuse, one bag to be composed of Paper and Paper Products, the second to be a composite of some refuse taken from each of the other categories. Each charge of refuse is to be mixed and distributed within the incinerator and then burned with auxiliary gas supply and blower on for a period of 15 min., the period of time for which this equipment is normally operated. Following the 15-min. period, refuse within the incinerator is to be allowed to burn until flames die out, at which time the second batch of refuse is to be charged, the gas supply and blower operated again for a period of 15 min., and the refuse again allowed to burn until flame dies out. This procedure is to be repeated until all refuse is incinerated.

Following incineration, residue is to be removed from each incinerator as promptly as possible and tape removed from hopper doors. As soon as temperature permits, incineration residue is to be sorted in the following categories:

1. Ash
2. Noncombustibles
3. Unburned Combustibles

Following sorting of the residue, weight and volume of each above category are to be determined in accordance with previous practices and data recorded daily on a per chute basis.

Bulky Refuse

All bulky waste and other refuse not charged directly into the chutes--i.e., miscellaneous waste items normally collected from individual dwelling units or picked up in corridors by janitorial services--and any building construction waste generated during the 7-day data-collection period is to be collected and assembled daily at a central point within each of the four buildings involved. Weight, approximate size and general description of each item so collected is to be recorded daily on a per structure basis.

Yard Refuse

Refuse found on the grounds of the Housing Authority Complex is to be collected during the 7-day data-collection period, sorted into the previously identified eight categories, and weight and volume per category recorded on a weekly basis.

Hourly Schedule for 7-Day Data-Collection Period[1]

The following schedule summarizes for each day of the 7-day data-collection period the hourly data-recording requirements:

First Day

7 a.m. Remove and discard all refuse, including ash residue, from all incinerators in each of the four structures involved.

8 a.m. Record weight and volume data by category of refuse collected at chutes A_1, B_1, C_3, and D_3.

9 a.m. Repeat 8 a.m. procedure hourly

through

11 a.m.

Noon Repeat 8 a.m. procedure plus record weight and volume data by category of refuse collected at all other chutes within each of the four structures involved.

1 p.m. Repeat 8 a.m. procedure hourly

through

8 p.m.

9 p.m. Repeat Noon procedure plus prepare moisture samples from refuse collected at chutes A_1, B_1, C_3, and D_3 for subsequent laboratory analysis.

Record for each of the structures involved, the weight, approximate size, and general description of all bulky miscellaneous waste items and construction waste collected throughout the day from within each of the structures involved.

Discard all refuse except that collected at chutes C_3, D_1, D_2, and D_3, which is to be burned in the respective incinerators the next day.

Second Through Sixth Day

7 a.m. Remove and separate by category, all refuse found at each chute (i.e., each incinerator) within each of the structures involved; record (per chute) weight and volume data on refuse by category.

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[1]Yard refuse is to be collected, sorted, and required data obtained at the time most convenient to data-collecting organization.

Noon Record weight and volume data by category of refuse collected since 7 a.m. at each chute within each structure involved. Tape all hopper doors to chutes C_3, D_1, D_2, and D_3, to prevent their use during the hours required for incineration; initiate burning in the respective incinerators of that refuse collected on the previous day at chutes C_3, D_1, D_2, and D_3.

Continue incinerating until completed and remove thereafter, as soon as possible, all residue from each incinerator and tapes on the hopper doors. Sort residue and record weight and volume of ashes, unburned combustibles and noncombustibles.

7 p.m. Record by category, weight and volume data on refuse collected since noon at each chute within each structure involved. Prepare moisture samples from refuse collected during the day at chutes A_1, B_1, C_3, and D_3.

Record--on a per structure basis--weight, approximate size, and general description of all bulky miscellaneous waste items and construction waste collected throughout the day from within each structure involved.

Discard all refuse except that collected at chutes C_3, D_1, D_2, and D_3, which is to be incinerated the next day.

Seventh Day

7 a.m. Remove and separate by category, all refuse found at each chute within each structure involved; record weight and volume data by category of refuse collected at each chute.

Noon Record weight and volume data by category of refuse collected since 7 a.m. at each chute within each structure involved. Tape all hopper doors to chutes C_3, D_1, D_2, and D_3 and initiate burning in the respective incinerators of that refuse collected on the previous day at these chutes.

Continue incinerating until completed and remove thereafter, as soon as possible, all residue from each incinerator and tapes on the hopper doors. Sort residues and record weight and volume of ashes, unburned combustibles and noncombustibles.

7 p.m. Record by category, weight and volume data on refuse collected since noon at each chute within each structure involved. Prepare moisture samples from refuse collected during the day at chutes A_1, B_1, C_3, and D_3.

Record--on per structure basis--weight, approximate size, and general description of all bulky miscellaneous waste items and construction waste collected throughout the day from within each structure involved.

Discard all refuse.

CONDUCT OF THE FIELD PROGRAM

Prior to initiation of the field program, a "dry run" of that part of the protocol concerned with chute refuse was conducted by the subcontractor on Monday, 2 December 1968 between 1 p.m. and 5 p.m. Only chute D_3 in building 4A was used. Purpose of the dry run was to familiarize the subcontractor's personnel with the procedure, to determine more specifically equipment needs, to determine adequacy of data log sheets, and generally to get a "feel" for what was to be involved. All personnel participating in the "dry run" were required to receive tetanus shots, as were all personnel who were to handle refuse subsequently in the conduct of the field program.

Equipment needs for conduct of the program on the site were relatively small, consisting of shovels (already available at the site) for use in removal of refuse from incinerators; 20-gal. plastic refuse containers (1 doz. at each of the 12 chutes involved--8 at each chute for use in sorting and, thus, labeled to identify refuse categories, and 4 for use in storing refuse as removed from incinerator); 12 scales, 1 at each chute for weighing refuse; thin polyethylene plastic sheets (10 ft. x 10 ft.) onto which refuse could be dumped for sorting or quartering to obtain moisture samples; thin polyethylene plastic bags for insertion into the plastic refuse containers prior to sorting, for storing refuse after sorting, and for storing moisture samples after they were taken; platform scales for measuring bulky waste items; and clipboards and data log sheets at each chute.

To the extent possible--on their days off and before and after their regular working hours--the Housing Authority's janitorial staff was used as project labor. All labor used in the conduct of the program, including that provided by the janitorial staff was obtained through Manpower, Incorporated, a New Haven firm that provides temporary labor on an hourly basis. In addition, arrangements were made with the Housing Authority management to have the janitorial staff store in a central place within each of the four buildings involved all bulky miscellaneous solid waste items collected during the week of data collection.

The formal data-collection program began at 6:30 a.m. on Thursday, 5 December, using three full-time laborers plus subcontractor personnel consisting of three professionals (engineers and chemists). One professional served as project director, one worked with one laborer in buildings 4A and 5B, and one worked with another laborer in buildings 1A and 6B; the third laborer was to "float" between all four buildings as the need dictated. By 7 a.m. all incinerators had been cleared of existing refuse and ashes, and, since refuse generation was light during these early hours, time was available to instruct the laborers, and the protocol schedule was readily met. At 5 p.m., while somewhat behind schedule already, the second or relief labor crew replaced the original three laborers, and instruction had to begin again--simultaneously with the increasing rate of daily refuse generation. By 11 p.m. only in building 4A was all refuse pulled from the incinerators at 9 p.m. in accordance with protocol schedule, completely sorted into categories. But because all personnel were exhausted, it was decided to leave the balance of sorting and the taking of moisture samples until the following day.

On Friday, 6 December, and daily thereafter, Housing Authority janitors, prior to reporting to their regular jobs, removed the refuse found within each incinerator at 7 a.m. Thus, on arrival at the site on Friday, sorters were faced with this refuse plus that remaining to be sorted from the previous day. Two of the three laborers available at the beginning of this day were new, as was the subcontractor professional working buildings 4A and 5B. Thus, instructions were again required. By noon, the program was so far behind schedule that the decision had to be made to forego burning in incinerators D_1, D_2, and C_3 of the refuse generated on the day before. At 7 p.m., all incinerators were cleaned of refuse in accordance with protocol schedule, and sorting continued until about 10 p.m., at which time only the refuse generated by noon of this day had been sorted. It was decided to forego taking of moisture samples from the refuse generated on Thursday, the sorting of which was not completed until late Friday. No moisture samples could be taken of the refuse generated on Friday, since sorting had not been accomplished. Late Friday it was evident that supervision would be required continuously of all work to be performed by laborers.

On the morning of Saturday, 7 December, sorters were faced with virtually all the refuse generated since noon Friday plus the refuse pulled from the incinerators at 7 a.m. Saturday. In an effort to get the program back on schedule, arrangements had been made to have additional labor present on Saturday--four between 7 a.m. and 5 p.m., and five between 5 p.m. and 9 p.m. Some of the labor did not arrive; at the expense of the schedule, supervisory time had to be taken to make additional arrangements for more men. A few laborers became inebriated while on the job, and some left before the agreed quitting time. Also on Saturday the subcontractor changed personnel at the project director level. Because of the time required to familiarize the new laborers with what was to be done, because of the unreliability of some of the laborers, and because of the loss in efficiency due to change of project director, little progress was made on Saturday toward getting the program back on schedule.

However, on Saturday it was possible to obtain moisture samples from the refuse generated on Friday and to burn on schedule at incinerators C_3, D_1, and D_3 the refuse collected from these incinerators on Friday. When burning was accomplished, hopper doors of incinerators in which refuse was to be burned were taped shut and signs were hung by each requesting tenants to refrain from charging refuse during the period of burn, usually 1 to 2 hours. After taping hopper doors, refuse was charged into the incinerator and generally burned in accordance with the procedure outlined in the protocol. However, the fuel supply system in two of the incinerators was not in working order, and refuse charges had to be lit by hand. In such instances, each charge was allowed to burn out before the second was added. After all refuse had been burned, the residue was removed from the incinerators, placed in metallic trash cans, and allowed to cool. After cooling, sorting of the residue into the categories of ash, unburned combustibles, and non-combustibles had to be accomplished hastily, so that the field personnel could devote as much time as possible to chute refuse. Consequently, ash was often left adhered to, within, or picked up with metallic cans and glass bottles during the sorting of the residue.

By quitting time, 10 p.m., virtually no sorting of any refuse generated since noon had been accomplished; again it was necessary to delay the taking of moisture samples from refuse generated on this day until the next day. To this point, neither time nor labor had been available for implementing previously prepared plans for removing refuse already sorted from the premises. Consequently, this refuse plus that still to be sorted was stacked in every corner. By evening, the basements were infested with mice that unhesitatingly approached refuse sorters in search of food. Evidence of rats was also manifest, particularly in the form of widely scattered refuse that heretofore had been sealed inside plastic bags.

On Sunday, 8 December, despite being faced at the onset with all the refuse generated since noon the previous day and the refuse removed from the incinerators at 7 a.m. on this morning, significant strides were made in moving the program back on schedule. By quitting time, approximately 11 p.m., at more than half of the chutes involved, even that refuse generated by 7 p.m. had been completely sorted, most scheduled burning had been accomplished, and all required moisture samples had been taken. It is significant to note that on this day--and although the largest sorting crew yet was used, five men--no new laborers were involved, that only the most capable and efficient of all laborers used previously were present, and that most of them put in a 16-hr. day. It is significant also to note that there was a change on this day at the project director level. The new project director knew the protocol procedure before arrival at the site, used the labor more efficiently than had been done on any previous day, and knew, apparently, how to manage the labor. However, in the effort to get back on schedule, deviation was made from the procedure in the protocol for obtaining moisture samples. The deviation was effected on 8, 9, and 10 December and consisted of taking three times daily, a 5-lb. sample from each category (or composite) of refuse for which moisture content was to be determined from each of the four chutes involved, (i.e., a total of 45 lb. of refuse was taken daily from each of the four incinerators). The first samples were taken (after sorting was completed) from the refuse removed from the incinerators at 7 a.m., the second samples were taken from the refuse removed from the incinerators at noon, and the third samples were taken from the refuse removed from the incinerators at 7 p.m. As before, these samples were sealed in plastic bags, taken to the laboratory, and immediately quartered in accordance with the procedure to obtain 5-lb. samples required for the determination of moisture content. Once in the laboratory, the 5-lb. moisture samples were supported on a chicken wire/wood platform enclosed within a walk-in stainless steel heating chamber. The samples were dried overnight at 105°C. as the chamber was purged continuously with dry air. After weighing the following morning, the samples were again placed within the chamber, heated an additional two hours, and required to ascertain whether a constant weight had been attained overnight. Samples showing a weight change after the additional 2-hr. heating period were placed in the chamber for an additional 2-hr. period, removed and then weighed. This procedure was followed until a constant weight was attained.

On Monday, 9 December, the situation had improved to the point that it was possible to hold the first coffee break at 10 a.m. No new personnel was now or hereinafter to be involved. The fact that the program was virtually back on schedule was undoubtedly due to the experience gained over the previous four days. On this morning, however, since no refuse had been removed from the buildings since Wednesday of the previous week (4 December), the odor was obnoxious. Consequently, considerable labor and time were spent on this day removing old refuse from the buildings and transporting it to the city incinerator, using a large side panel truck supplied by the Housing Authority.

On Tuesday and Wednesday, 10 and 11 December, the chute refuse schedule was maintained in an almost routine manner, reflecting again the experience gained over the previous days. On Wednesday night, approximate size and weight of all bulky solid waste items collected during the week were recorded, all chute refuse was returned to the incinerators and burned, the basement areas were cleaned up, and the first week of data collection on refuse quantity and composition ended at 10 p.m.

APPENDIX C

REFUSE QUANTITY AND COMPOSITION--
DATA

TABLE I. ESTIMATED VOLUME (FT^3) OF REFUSE AS REMOVED FROM INCINERATORS DAILY--BEFORE SORTING

TIME PERIOD	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 a.m. through 9:00 p.m. 12/5/68													
7:00 a.m. - Noon	4.8	8.1	2.7	8.7	6.7	10.7	2.7	2.7	2.1	6.7	2.7	6.7	65.3
Noon - 9:00 p.m.	33.5	16.1	8.1	29.5	17.4	18.8	20.8	14.1	19.4	14.7	21.4	22.2	236.0
Daily Totals	38.3	24.2	10.8	38.2	24.1	29.5	23.5	16.8	21.5	21.4	24.1	28.9	301.3
9:00 p.m. 12/5/68 through 7:00 p.m. 12/6/68													
9:00 p.m. - 7:00 a.m.	2.7	2.7	5.4	--	--	--	2.7	2.7	2.7	--	--	6.7	25.6
7:00 a.m. - Noon	5.4	5.4	8.1	8.1	5.4	8.1	10.7	2.7	5.4	4.1	5.4	5.4	74.2
Noon - 7:00 p.m.	5.4	8.1	8.1	10.7	13.4	13.4	10.7	10.7	5.4	13.4	5.4	8.1	112.8
Daily Totals	13.5	16.2	21.6	23.6	18.8	21.5	24.1	16.1	13.5	17.5	10.8	20.2	212.6
7:00 p.m. 12/6/68 through 7:00 p.m. 12/7/68													
7:00 p.m. - 7:00 a.m.	13.4	5.4	10.7	8.1	5.4	5.4	10.7	8.1	*	10.7	5.4	10.7	94.0
7:00 a.m. - Noon	10.7	5.4	10.7	8.1	10.7	9.5	8.1	8.1	8.1	5.4	5.4	8.1	98.3
Noon - 7:00 p.m.	8.1	10.7	8.1	16.1	10.7	10.0	10.7	10.7	5.4	6.7	9.5	13.4	120.1
Daily Totals	32.2	21.5	29.5	32.3	26.8	24.9	29.5	26.9	13.5*	22.8	20.3	32.2	312.4
7:00 p.m. 12/7/68 through 7:00 p.m. 12/8/68													
7:00 p.m. - 7:00 a.m.	10.7	9.5	**	5.4	16.1	10.0	10.7*	5.4	8.1	10.7	8.1	10.7	105.4
7:00 a.m. - Noon	10.7	5.4	--	5.4	10.7	8.1	*	8.1	9.5	8.1	8.1	8.1	82.2
Noon - 7:00 p.m.	10.7	5.4	2.7	8.1	8.1	4.1	8.1*	10.7	10.7	8.1	10.7	8.1	95.5
Daily Totals	32.1	20.3	2.7	18.9	34.9	22.2	18.8*	24.2	28.3	26.9	26.9	26.9	283.1

--Denotes no refuse.
*Fire occurred in incinerator, part or all of sample lost.
**Blockage of chute began.

TABLE I. ESTIMATED VOLUME (FT^3) OF REFUSE AS REMOVED FROM INCINERATORS DAILY--BEFORE SORTING (Cont'd.)

TIME PERIOD	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/8/68 through 7:00 p.m. 12/9/68													
7:00 p.m. - 7:00 a.m.	10.7	13.4	8.1	5.4	8.1	8.1	8.1	5.4	***	6.7	8.1	13.4	95.5
7:00 a.m. - Noon	8.1	2.7	6.7	5.4	10.7	5.4	2.7	6.7	16.1	10.7	--	13.4	88.6
Noon - 7:00 p.m.	10.7	13.4	--	13.4	8.1	13.4	10.7	13.4	--	8.1	8.1	8.1	107.4
Daily Totals	29.5	29.5	14.8	24.2	26.9	26.9	21.5	25.5	16.1	25.5	16.2	34.9	291.5
7:00 p.m. 12/9/68 through 7:00 p.m. 12/10/68													
7:00 p.m. - 7:00 a.m.	10.7	5.4	34.8	2.7	8.1	8.1	5.4	5.4	13.4	13.4	2.7	8.1	118.2
7:00 a.m. - Noon	5.4	5.4	10.7	5.4	8.1	12.1	5.4	2.7	8.1	5.4	10.7	5.4	84.8
Noon - 7:00 p.m.	8.1	13.4	17.4	8.1	6.7	8.7	13.4	13.4	16.1	9.5	8.1	13.4	136.3
Daily Totals	24.2	24.2	62.9	16.2	22.9	28.9	24.2	21.5	37.6	28.3	21.5	26.9	339.3
7:00 p.m. 12/10/68 through 7:00 p.m. 12/11/68													
7:00 p.m. - 7:00 a.m.	5.4	5.4	8.1	2.7	5.4	8.1	5.4	2.7	5.4	5.4	2.7	10.7	67.4
7:00 a.m. - Noon	5.4	2.7	2.7	2.7	10.7	5.4	5.4	8.1	5.4	2.7	13.4	5.4	70.0
Noon - 7:00 p.m.	13.4	5.4	10.7	2.7	10.7	10.7	*	*	5.4	10.7	1.4	6.8	77.9
Daily Totals	24.2	13.5	21.5	8.1	26.8	24.2	10.8*	10.8*	16.2	18.8	17.5	22.9	215.3
Weekly Totals	194.0	149.4	163.8	161.5	181.2	178.1	152.4*	141.8*	152.1*	161.2	137.3	192.9	1960.9

***Chute possibly blocked.

TABLE II. WEIGHT (LB) OF REFUSE CORRESPONDING TO ESTIMATED VOLUMES OF TABLE I.--BEFORE SORTING

	Building 6B			Building 5B			Building 1A			Building 4A			
TIME PERIOD	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	Total
7:00 a.m. through 9:00 p.m. 12/5/68													
7:00 a.m. - Noon	36	69	28	18	16	52	17	6	15	43	10	14	324
Noon - 9:00 p.m.	191	106	31	96	42	118	93	71	127	74	85	77	1111
Daily Totals	227	175	59	114	58	170	110	77	142	117	95	91	1435
9:00 p.m. 12/5/68 through 7:00 p.m. 12/6/68													
9:00 p.m. - 7:00 a.m.	18	15	31	--	--	--	12	25	10	--	--	30	141
7:00 a.m. - Noon	29	26	39	46	58	44	53	7	28	19	17	24	390
Noon - 7:00 p.m.	33	54	56	29	46	36	23	18	33	44	29	54	455
Daily Totals	80	95	126	75	104	80	88	50	71	63	46	108	986
7:00 p.m. 12/6/68 through 7:00 p.m. 12/7/68													
7:00 p.m. - 7:00 a.m.	51	32	45	38	33	41	61	30	*	55	23	56	465
7:00 a.m. - Noon	36	42	61	30	78	65	57	29	101	37	30	45	611
Noon - 7:00 p.m.	73	105	31	114	86	71	65	50	47	42	74	102	860
Daily Totals	160	179	137	182	197	177	183	109	148*	134	127	203	1936
7:00 p.m. 12/7/68 through 7:00 p.m. 12/8/68													
7:00 p.m. - 7:00 a.m.	34	32	**	65	100	99	67*	38	63	61	39	63	661
7:00 a.m. - Noon	51	76	--	44	61	44	*	33	75	34	37	46	501
Noon - 7:00 p.m.	91	54	15	76	68	64	46*	92	41	78	67	36	728
Daily Totals	176	162	15	185	229	207	113*	163	179	173	143	145	1890

--Denotes no refuse.
*Fire occurred within incinerator, part or all of sample lost.
**Blockage of chute began.

TABLE II. WEIGHT (LB) OF REFUSE CORRESPONDING TO ESTIMATED VOLUMES OF TABLE I.--BEFORE SORTING (Cont'd.)

TIME PERIOD	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/8/68 through 7:00 p.m. 12/9/68													
7:00 p.m. - 7:00 a.m.	60	42	26	69	94	40	47	46	***	35	37	42	538
7:00 a.m. - Noon	39	19	37	43	43	43	21	53	79	68	--	62	507
Noon - 7:00 p.m.	114	60	--	53	32	56	74	106	--	47	33	36	611
Daily Totals	213	121	63	165	169	139	142	205	79	150	70	140	1656
7:00 p.m. 12/9/68 through 7:00 p.m. 12/10/68													
7:00 p.m. - 7:00 a.m.	54	29	235	17	52	60	20	39	82	65	14	64	731
7:00 a.m. - Noon	29	32	70	34	40	65	15	22	43	8	30	30	418
Noon - 7:00 p.m.	62	77	50	66	38	47	48	70	100	55	46	54	713
Daily Totals	145	138	355	117	130	172	83	131	225	128	90	148	1862
7:00 p.m. 12/10/68 through 7:00 p.m. 12/11/68													
7:00 p.m. - 7:00 a.m.	38	26	45	9	32	43	28	3	51	41	8	54	378
7:00 a.m. - Noon	14	13	32	9	48	33	11	24	42	13	60	20	319
Noon - 7:00 p.m.	51	43	39	13	67	83	*	*	74	49	12	54	485
Daily Totals	103	82	116	31	147	159	39*	27*	167	103	80	128	1182
Weekly Totals	1104	952	871	869	1034	1104	758*	762*	1011*	868	651	963	10947

***Chute possibly blocked.

TABLE III. ESTIMATED DENSITY (LB/FT^3) OF REFUSE CORRESPONDING TO VALUES OF TABLES I AND II--BEFORE SORTING

TIME PERIOD	Building 6B			Building 5B			Building 1A			Building 4A			Avg.
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 a.m. through 9:00 p.m. 12/5/68													
7:00 a.m. - Noon	7.5	8.5	10.4	2.1	2.4	4.9	6.3	2.2	7.2	6.4	3.7	2.1	5.0
Noon - 9:00 p.m.	5.7	6.6	3.8	3.3	2.4	6.3	4.5	5.0	6.6	5.0	4.0	3.5	4.7
Daily Avg.	6.0	7.3	5.5	3.0	2.4	5.8	4.7	4.6	6.6	5.5	3.9	3.2	4.8
9:00 p.m. 12/5/68 through 7:00 p.m. 12/6/68													
9:00 p.m. - 7:00 a.m.	6.7	5.6	5.7	--	--	--	4.4	9.4	3.7	--	--	4.5	5.5
7:00 a.m. - Noon	5.4	4.8	4.8	5.7	10.8	5.4	5.0	2.6	5.2	4.6	3.1	4.4	5.3
Noon - 7:00 p.m.	6.1	6.7	6.9	2.7	3.4	2.7	2.2	1.7	6.1	3.3	5.4	6.7	4.0
Daily Avg.	5.9	5.9	5.8	3.2	5.5	3.7	3.7	3.1	5.3	3.7	4.3	5.4	4.6
7:00 p.m. 12/6/68 through 7:00 p.m. 12/7/68													
7:00 p.m. - 7:00 a.m.	3.8	5.9	4.2	4.7	6.1	7.6	5.7	3.7	*	5.1	4.3	5.2	4.9
7:00 a.m. - Noon	3.4	7.8	5.7	3.7	7.3	6.9	7.0	3.6	12.5	6.7	5.6	5.6	6.2
Noon - 7:00 p.m.	9.0	9.7	3.8	7.1	8.0	7.1	6.0	4.7	5.7	6.3	7.8	7.6	7.2
Daily Avg.	5.0	8.3	4.7	5.6	7.4	7.1	6.2	4.1	10.0*	5.9	6.3	6.3	6.2
7:00 p.m. 12/7/68 through 7:00 p.m. 12/8/68													
7:00 p.m. - 7:00 a.m.	3.2	3.4	**	12.0	6.2	9.9	6.3*	7.0	7.8	5.7	4.8	5.9	6.3
7:00 a.m. - Noon	4.8	14.1	--	8.1	5.7	5.4	*	4.1	7.9	4.2	4.6	5.7	6.1
Noon - 7:00 p.m.	8.5	10.0	5.6	9.4	8.4	15.6	5.7*	8.6	3.8	9.7	6.3	4.5	7.6
Daily Avg.	5.7	8.0	5.6	9.8	6.6	9.3	6.0*	6.7	6.3	6.4	5.3	5.4	6.7

--Denotes no refuse.
*Fire within incinerator, part or all of sample lost.
**Blockage of chute began.

TABLE III. ESTIMATED DENSITY (LB/FT^3) OF REFUSE CORRESPONDING TO VALUES OF TABLES I AND II--BEFORE SORTING (Cont'd.)

TIME PERIOD	Building 6B			Building 5B			Building 1A			Building 4A			Avg.
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/8/68 through 7:00 p.m. 12/9/68													
7:00 p.m. - 7:00 a.m.	5.6	3.4	3.2	12.8	11.6	4.9	5.8	8.5	***	5.2	4.6	3.1	5.6
7:00 a.m. - Noon	4.8	7.0	5.5	8.0	4.0	8.0	7.8	7.9	4.9	6.4	--	4.6	5.7
Noon - 7:00 p.m.	10.7	4.5	--	4.0	4.0	4.2	6.9	7.9	--	5.8	4.1	4.4	5.7
Daily Avg.	7.2	4.1	4.3	6.8	6.3	5.2	6.6	8.1	4.9	5.9	4.3	4.0	5.7
7:00 p.m. 12/9/68 through 7:00 p.m. 12/10/68													
7:00 p.m. - 7:00 a.m.	5.0	5.4	6.8	6.3	6.4	7.4	3.7	7.2	6.1	4.9	5.2	7.9	6.2
7:00 a.m. - Noon	5.4	5.9	6.5	6.3	5.9	5.4	2.8	8.2	5.3	1.5	2.7	5.6	4.9
Noon - 7:00 p.m.	7.7	5.7	2.9	8.2	5.7	5.4	3.6	5.2	6.2	5.7	5.7	4.0	5.2
Daily Avg.	6.0	5.7	5.7	7.2	5.7	6.0	3.4	6.1	6.0	4.5	4.2	5.5	5.5
7:00 p.m. 12/10/68 through 7:00 p.m. 12/11/68													
7:00 p.m. - 7:00 a.m.	7.1	4.8	5.6	3.3	5.9	5.3	5.2	1.1	9.5	7.6	3.0	5.0	5.6
7:00 a.m. - Noon	2.6	4.8	11.8	3.3	4.5	6.1	2.4	3.0	7.8	4.8	4.5	3.7	4.6
Noon - 7:00 p.m.	3.8	8.0	3.6	4.8	6.3	7.8	*	*	13.7	4.6	8.6	7.9	6.2
Daily Avg.	4.3	6.1	5.4	3.8	5.5	6.6	3.6*	2.5*	10.3	5.5	4.6	5.6	5.5
Weekly Avg.	5.7	6.4	5.3	5.4	5.7	6.2	5.0*	5.3*	6.7*	5.4	4.7	5.0	5.6

***Chute possibly blocked.

TABLE IV. WEIGHT (LB) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 A.M. THROUGH 9:00 P.M. 12/5/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 a.m. through Noon 12/5/68													
Paper/Paper Products	15	32	12	7	7	19	13	5	3	9	4	5	131
Wood/Wood Products	--	--	--	--	--	1	--	--	12	1	--	--	14
Plastic/Leather/Rubber	1	6	--	1	1	3	--	--	--	1	1	--	14
Rags/Textiles	--	4	5	1	1	1	--	--	--	--	--	--	12
Glass	11	9	5	4	1	10	2	--	--	8	--	1	51
Metallics	3	6	3	3	1	4	1	1	--	6	2	3	33
Stones/Ceramics/etc.	--	--	3	--	--	--	--	--	--	--	--	--	3
Organic Garbage	6	12	--	2	5	14	1	--	--	18	3	5	66
Sub-totals	36	69	28	18	16	52	17	6	15	43	10	14	324
Noon through 9:00 p.m. 12/5/68													
Paper/Paper Products	61	29	11	36	16	38	23	29	34	32	37	29	375
Wood/Wood Products	--	3	--	--	--	--	--	--	--	--	2	--	5
Plastic/Leather/Rubber	15	12	1	3	4	4	4	1	3	4	2	2	55
Rags/Textiles	9	14	1	7	3	6	5	6	5	3	1	4	64
Glass	38	19	7	15	4	24	23	9	45	11	15	13	223
Metallics	17	9	5	9	7	13	11	6	10	7	11	10	115
Stones/Ceramics/etc.	11	--	--	--	--	--	--	--	14	--	--	--	25
Organic Garbage	40	20	6	26	8	33	27	20	16	17	17	19	249
Sub-totals	191	106	31	96	42	118	93	71	127	74	85	77	1111
Daily Totals	227	175	59	114	58	170	110	77	142	117	95	91	1435

--Denotes no refuse.

TABLE V. WEIGHT (LB) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (9:00 P.M. 12/5/68 - 7:00 P.M. 12/6/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
9:00 p.m. 12/5/68 through 7:00 a.m. 12/6/68													
Paper/Paper Products	8	5	12	--	--	--	4	4	3	--	--	9	45
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	--	--	3	--	--	--	1	2	--	--	--	1	7
Rags/Textiles	--	2	--	--	--	--	--	--	--	--	--	6	8
Glass	5	2	4	--	--	--	2	5	3	--	--	3	24
Metallics	--	2	3	--	--	--	1	6	2	--	--	5	19
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	5	4	9	--	--	--	4	8	2	--	--	6	38
Sub-totals	18	15	31	--	--	--	12	25	10	--	--	30	141
7:00 a.m. 12/6/68 through Noon 12/6/68													
Paper/Paper Products	5	6	11	17	19	13	12	4	6	5	8	10	116
Wood/Wood Products	--	--	--	--	--	--	--	--	1	--	--	--	1
Plastic/Leather/Rubber	2	1	4	1	2	--	2	--	1	1	1	1	16
Rags/Textiles	2	6	2	5	1	3	3	2	6	--	--	3	33
Glass	8	2	7	8	12	14	20	--	7	3	4	4	89
Metallics	4	2	4	6	6	4	8	1	2	2	4	2	45
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	8	9	11	9	18	10	8	--	5	8	--	4	90
Sub-totals	29	26	39	46	58	44	53	7	28	19	17	24	390
Noon 12/6/68 through 7:00 p.m. 12/6/68													
Paper/Paper Products	10	18	19	10	13	5	11	8	18	14	12	23	161
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	--	2	--	3	6	5	--	1	1	1	4	10	33
Rags/Textiles	2	5	4	5	3	7	--	--	--	7	1	3	37
Glass	6	12	8	2	9	5	4	3	5	11	5	6	76
Metallics	2	8	7	5	6	5	2	3	3	1	1	6	49
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	13	9	18	4	9	9	6	3	6	10	6	6	99
Sub-totals	33	54	56	29	46	36	23	18	33	44	29	54	455
Daily Totals	80	95	126	75	104	80	88	50	71	63	46	108	986

--Denotes no refuse.

TABLE VI. WEIGHT (LB) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/6/68 - 7:00 P.M. 12/7/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/6/68 through 7:00 a.m. 12/7/68													
Paper/Paper Products	18	7	7	10	9	11	20	13		28	6	18	147
Wood/Wood Products	--	--	7	4	--	--	--	--		--	--	--	11
Plastic/Leather/Rubber	1	1	2	5	2	2	2	1		5	--	3	24
Rags/Textiles	1	2	1	4	--	2	6	1		--	1	2	20
Glass	14	6	12	6	6	8	13	2		8	6	12	93
Metallics	3	5	6	5	3	6	7	7		5	5	3	55
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--		--	--	--	--
Organic Garbage	14	11	10	4	13	12	13	6		9	5	18	115
Sub-totals	51	32	45	38	33	41	61	30	*	55	23	56	465
7:00 a.m. 12/7/68 through Noon 12/7/68													
Paper/Paper Products	9	9	19	12	36	33	14	11	20	12	9	16	200
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	--	2	3	1	6	--	3	4	5	3	1	2	30
Rags/Textiles	4	8	2	2	6	--	1	1	5	4	--	7	40
Glass	8	4	8	3	7	11	14	7	37	6	1	6	112
Metallics	4	7	4	2	10	5	14	3	7	5	4	5	70
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	11	12	25	10	13	16	11	3	27	7	15	9	159
Sub-totals	36	42	61	30	78	65	57	29	101	37	30	45	611
Noon 12/7/68 through 7:00 p.m. 12/7/68													
Paper/Paper Products	17	12	11	57	39	24	28	23	16	22	37	47	333
Wood/Wood Products	--	6	--	--	--	--	--	--	--	--	--	--	6
Plastic/Leather/Rubber	5	7	5	6	6	10	7	4	4	3	8	8	73
Rags/Textiles	3	16	1	2	6	9	7	1	4	--	5	5	59
Glass	21	23	8	14	12	6	7	3	7	9	--	10	120
Metallics	4	13	3	13	10	11	4	6	7	8	6	12	97
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	23	28	3	22	13	11	12	13	9	--	18	20	172
Sub-totals	73	105	31	114	86	71	65	50	47	42	74	102	860
Daily Totals	160	179	137	182	197	177	183	109	148*	134	127	203	1936

*Fire occurred within incinerator, part of sample lost.

--Denotes no refuse.

Blank space denotes that estimates of volume of refuse were not recorded.

TABLE VII. WEIGHT (LB) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/7/68 - 7:00 P.M. 12/8/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/7/68 through 7:00 a.m. 12/8/68													
Paper/Paper Products	17	13	--	26	35	41	24	7	15	20	5	21	224
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	2	2	--	7	13	7	4	4	4	6	5	9	63
Rags/Textiles	2	2	--	--	6	11	4	2	--	8	10	6	51
Glass	3	8	--	12	13	15	14	6	18	4	7	6	106
Metallics	5	4	--	8	13	10	8	6	9	10	5	9	87
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	5	3	--	12	20	15	13	13	17	13	7	12	130
Sub-totals	34	32	--	65	100	99	67*	38	63	61	39	63	661
7:00 a.m. 12/8/68 through Noon 12/8/68													
Paper/Paper Products	22	23	--	14	22	13		9	26	15	12	21	177
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	1	9	--	3	9	3		5	5	2	7	2	46
Rags/Textiles	2	9	--	3	2	--		6	6	2	2	3	35
Glass	11	9	--	3	9	12		6	8	4	6	6	74
Metallics	4	7	--	7	6	3		2	7	5	7	4	52
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	11	19	--	14	13	13		5	23	6	3	10	117
Sub-totals	51	76	--	44	61	44	*	33	75	34	37	46	501
Noon 12/8/68 through 7:00 p.m. 12/8/68													
Paper/Paper Products	25	28	5	27	30	23	11	22	12	30	9	12	234
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	4	4	4	11	7	4	3	12	3	6	9	2	69
Rags/Textiles	7	5	--	8	--	4	1	20	3	--	6	--	54
Glass	16	4	--	12	9	12	10	5	4	20	16	3	111
Metallics	15	4	--	8	8	7	9	3	2	7	12	4	79
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	24	9	6	10	14	14	12	30	17	15	15	15	181
Sub-totals	91	54	15	76	68	64	46*	92	41	78	67	36	728
Daily Totals	176	162	15	185	229	207	113*	163	179	173	143	145	1890

--Denotes no refuse.
Blank space denotes that estimates of volume of refuse were not recorded.
*Fire occurred in the incinerator, part or all of sample lost.

TABLE VIII. WEIGHT (LB) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/8/68 - 7:00 P.M. 12/9/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/8/68 through 7:00 a.m. 12/9/68													
Paper/Paper Products	25	9	12	14	21	6	17	9	--	11	13	16	153
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	1	3	--	4	5	1	2	7	--	3	2	3	31
Rags/Textiles	1	3	1	--	2	1	3	6	--	--	1	--	18
Glass	14	7	3	13	16	11	6	9	--	6	5	7	97
Metallics	4	6	2	9	8	3	7	6	--	3	2	7	57
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	15	14	8	29	42	18	12	9	--	12	14	9	182
Sub-totals	60	42	26	69	94	40	47	46	--**	35	37	42	538
7:00 a.m. 12/9/68 through Noon 12/9/68													
Paper/Paper Products	9	6	11	13	16	11	4	18	30	24	--	21	163
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	2	2	2	3	7	5	2	5	4	3	--	6	41
Rags/Textiles	2	--	1	--	--	4	2	1	2	--	--	2	14
Glass	7	5	6	9	4	5	3	4	9	13	--	11	76
Metallics	4	2	7	5	3	6	4	15	7	7	--	10	70
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	15	4	10	13	13	12	6	10	27	21	--	12	143
Sub-totals	39	19	37	43	43	43	21	53	79	68	--	62	507
Noon 12/9/68 through 7:00 p.m. 12/9/68													
Paper/Paper Products	23	17	--	20	17	37	22	21	--	12	10	11	190
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	4	13	--	4	2	1	3	5	--	2	3	2	39
Rags/Textiles	4	10	--	1	--	7	2	24	--	1	--	1	50
Glass	17	12	--	10	3	--	17	11	--	9	9	3	91
Metallics	5	5	--	6	3	4	8	5	--	6	5	6	53
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	61	3	--	12	7	7	22	40	--	17	6	13	188
Sub-totals	114	60	--	53	32	56	74	106	--	47	33	36	611
Daily Totals	213	121	63	165	169	139	142	205	79	150	70	140	1656

--Denotes no refuse.
**Chute possibly blocked.

TABLE IX. WEIGHT (LB) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/9/68 - 7:00 P.M. 12/10/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/9/68 through 7:00 a.m. 12/10/68													
Paper/Paper Products	15	7	88	5	15	15	7	16	13	27	3	14	225
Wood/Wood Products	1	--	--	--	--	--	--	--	--	--	--	--	1
Plastic/Leather/Rubber	2	2	11	1	2	2	1	4	2	3	1	2	33
Rags/Textiles	1	3	8	--	2	2	1	4	16	3	--	--	40
Glass	5	4	41	2	4	--	4	4	14	9	4	7	98
Metallics	4	3	9	2	6	3	3	4	6	6	2	8	56
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	26	10	78	7	23	38	4	7	31	17	4	33	278
Sub-totals	54	29	235	17	52	60	20	39	82	65	14	64	731
7:00 a.m. 12/10/68 through Noon 12/10/68													
Paper/Paper Products	5	10	15	9	13	32	6	5	10	3	18	8	134
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	3	2	6	2	3	2	2	6	--	--	--	2	28
Rags/Textiles	3	2	3	--	2	--	--	1	--	--	--	2	13
Glass	2	3	18	9	5	2	--	3	6	--	4	4	56
Metallics	6	3	9	2	4	5	3	2	8	2	3	5	52
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	10	12	19	12	13	24	4	5	19	3	5	9	135
Sub-totals	29	32	70	34	40	65	15	22	43	8	30	30	418
Noon 12/10/68 through 7:00 p.m. 12/10/68													
Paper/Paper Products	28	18	31	22	12	19	15	23	34	15	9	15	241
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	5	13	4	4	1	1	2	6	4	5	19	5	69
Rags/Textiles	5	12	1	4	1	3	4	2	16	6	--	7	61
Glass	6	7	2	8	3	4	8	7	13	14	9	5	86
Metallics	4	6	4	6	5	2	5	7	6	7	3	6	61
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	14	21	8	22	16	18	14	25	27	8	6	16	195
Sub-totals	62	77	50	66	38	47	48	70	100	55	46	54	713
Daily Totals	145	138	355	117	130	172	83	131	225	128	90	148	1862

--Denotes no refuse.
Blank space denotes that estimates of volume of refuse were not recorded.

TABLE X. WEIGHT (LB) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/10/68 - 7:00 P.M. 12/11/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/10/68 through 7:00 a.m. 12/11/68													
Paper/Paper Products	8	9	17	1	6	11	5	3	13	12	2	16	103
Wood/Wood Products	3	--	--	--	--	--	--	--	--	--	--	--	3
Plastic/Leather/Rubber	--	1	10	1	1	2	2	--	3	2	--	4	26
Rags/Textiles	3	--	2	1	3	3	1	--	4	1	--	--	18
Glass	6	4	2	2	7	5	4	--	7	9	1	8	55
Metallics	5	4	7	2	2	5	4	--	6	5	2	7	49
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	13	8	7	2	13	17	12	--	18	12	3	19	124
Sub-totals	38	26	45	9	32	43	28	3	51	41	8	54	378
7:00 a.m. 12/11/68 through Noon 12/11/68													
Paper/Paper Products	8	3	10	4	16	8	4	5	22	--	31	5	116
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	1	2	4	1	3	2	1	1	2	2	4	3	26
Rags/Textiles	--	--	2	2	10	3	--	--	--	--	4	5	26
Glass	3	3	8	2	--	7	--	3	9	2	4	1	42
Metallics	--	1	3	--	7	3	2	2	2	1	6	2	29
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	2	4	5	--	12	10	4	13	7	8	11	4	80
Sub-totals	14	13	32	9	48	33	11	24	42	13	60	20	319
Noon 12/11/68 through 7:00 p.m. 12/11/68													
Paper/Paper Products	19	14	9	6	16	21			14	15	--	30	144
Wood/Wood Products	--	--	--	--	--	--			--	--	--	--	--
Plastic/Leather/Rubber	3	5	4	--	5	3			4	2	--	--	26
Rags/Textiles	6	--	3	--	5	28			--	1	--	--	43
Glass	9	--	4	5	10	12			14	5	10	9	78
Metallics	3	5	8	2	7	8			3	3	2	6	47
Stones/Ceramics/etc.	--	--	--	--	--	--			--	--	--	--	--
Organic Garbage	11	19	11	--	24	11			39	23	--	9	147
Sub-totals	51	43	39	13	67	83	*	*	74	49	12	54	485
Daily Totals	103	82	116	31	147	159	39*	27*	167	103	80	128	1182
Weekly Totals	1104	952	871	869	1034	1104	758	762	1011	868	651	963	10947

--Denotes no refuse. *Fire occurred within incinerator, part or all of sample lost.
Blank space denotes that estimates of volume of refuse were not recorded.

TABLE XI. ESTIMATED VOLUME (FT^3) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 A.M. THROUGH 9:00 P.M. 12/5/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 a.m. through Noon 12/5/68													
Paper/Paper Products	3.2	5.6	1.3	2.4	2.7	4.9	2.3	2.7	0.4	2.7	1.4	2.7	32.3
Wood/Wood Products	--	--	--	--	--	0.1	--	--	0.7	0.1	--	--	0.9
Plastic/Leather/Rubber	0.1	0.5	--	0.5	0.1	0.4	--	--	--	0.4	0.1	--	2.1
Rags/Textiles	--	0.4	0.3	0.1	0.2	0.1	--	--	--	--	--	--	1.1
Glass	1.3	0.5	0.1	0.2	0.1	0.2	0.1	--	--	0.4	--	0.2	3.1
Metallics	0.2	0.4	0.4	0.5	0.1	0.4	0.1	0.1	--	1.4	0.2	0.3	4.1
Stones/Ceramics/etc.	--	--	0.1	--	--	--	--	--	--	--	--	--	0.1
Organic Garbage	0.1	0.5	--	0.1	0.2	0.4	0.1	--	--	1.1	0.1	0.7	3.3
Sub-totals	4.9	7.9	2.2	3.8	3.4	6.5	2.6	2.8	1.1	6.1	1.8	3.9	47.0
Noon through 9:00 p.m. 12/5/68													
Paper/Paper Products	19.0	5.4	5.4	10.3	5.4	9.8	10.7	12.2	15.0	8.1	10.7	10.8	122.8
Wood/Wood Products	--	0.1	--	--	--	--	--	--	--	--	0.1	--	0.2
Plastic/Leather/Rubber	1.9	2.7	0.1	1.5	1.4	0.4	0.3	0.1	0.2	2.1	0.9	2.1	13.7
Rags/Textiles	0.5	1.3	0.1	1.3	0.5	0.2	0.1	0.5	0.2	1.3	0.1		6.1
Glass	2.3	0.7	0.8	0.7	0.1	0.4	0.8	0.5	0.9	1.0	0.9	0.7	9.8
Metallics	1.3	1.3	0.8	1.5	0.4	0.9	0.7	0.5	0.8	1.4	1.8	2.7	14.1
Stones/Ceramics/etc.	0.8	--	--	--	--	--	--	--	0.4	--	--	--	1.2
Organic Garbage	2.6	2.0	0.8	1.1	0.7	0.9	1.1	0.7	0.5	1.0	1.8	0.9	14.1
Sub-totals	28.4	13.5	8.0	16.4	8.5	12.6	13.7	14.5	18.0	14.9	16.3	17.2	182.0
Daily Totals	33.3	21.4	10.2	20.2	11.9	19.1	16.3	17.3	19.1	21.0	18.1	21.1	229.0

--Denotes no refuse.
Blank space denotes that estimates of volume of refuse were not recorded.

TABLE XII. ESTIMATED VOLUME (FT^3) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (9:00 P.M. 12/5/69 - 7:00 P.M. 12/6/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
9:00 p.m. 12/5/68 through 7:00 a.m. 12/6/68													
Paper/Paper Products	2.4	2.1	4.8	--	--	--	2.4	2.1	2.3	--	--	2.7	18.8
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	--	--	0.1	--	--	--	0.1	0.1	--	--	--	0.2	0.5
Rags/Textiles	--	0.1	--	--	--	--	--	--	--	--	--	2.0	2.1
Glass	0.1	0.1	0.1	--	--	--	0.1	0.1	0.1	--	--	0.2	0.8
Metallics	--	0.1	0.1	--	--	--	0.1	0.1	0.1	--	--	0.3	0.8
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.1	0.2	0.1	--	--	--	0.1	0.1	0.1	--	--	0.3	1.0
Sub-totals	2.6	2.6	5.2	--	--	--	2.8	2.5	2.6	--	--	5.7	24.0
7:00 a.m. 12/6/68 through Noon 12/6/68													
Paper/Paper Products	3.8	4.0	5.4	4.0	6.7	5.4	4.6	2.4	2.7	2.7	2.7	4.0	48.4
Wood/Wood Products	--	--	--	--	--	--	--	--	0.1	--	--	--	0.1
Plastic/Leather/Rubber	0.1	0.1	1.1	0.3	1.3	--		--	0.1	0.3	0.3	0.7	4.3
Rags/Textiles	0.1	0.1	0.8	1.3	0.3	0.7		1.9	0.8	--	--	2.0	8.0
Glass	0.6	0.1	0.1	0.3	0.3	0.7		--	0.8	0.3	0.2	0.3	3.7
Metallics	0.3	0.1	0.1	1.3	1.3	0.7		0.1	0.1	0.3	0.7	0.3	5.3
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.6	0.5	0.5	0.7	0.7	0.7		--	0.8	0.7	--	0.7	5.9
Sub-totals	5.5	4.9	8.0	7.9	10.6	8.2	4.6	4.4	5.4	4.3	3.9	8.0	75.7
Noon 12/6/68 through 7:00 p.m. 12/6/68													
Paper/Paper Products	6.7		6.6	4.0	6.7	8.0	4.6	4.8	4.6	10.7	5.4	10.7	72.8
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	--		--	0.7	1.3	0.7	--	0.1	0.1	0.7	0.4	2.7	6.7
Rags/Textiles	0.1		0.1	0.7	0.7	2.0	--	--	--	1.3	0.4	0.7	6.0
Glass	0.8		0.1	0.3	0.3		0.3	0.1	0.3	0.7	0.3	0.7	3.9
Metallics	0.3		0.1	0.7	0.7	0.7	0.1	0.1	0.1	0.7	0.7	2.7	6.9
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.7		0.3	0.1	0.3	0.7	0.4	0.1	0.3	0.7	0.3	0.3	4.2
Sub-totals	8.6		7.2	6.5	10.0	12.1	5.4	5.2	5.4	14.8	7.5	17.8	100.5
Daily Totals	16.7	7.5	20.4	14.4	20.6	20.3	12.8	12.1	13.4	19.1	11.4	31.5	200.2

--Denotes no refuse.
Blank space denotes that estimates of volume of refuse were not recorded.

TABLE XIII. ESTIMATED VOLUME (FT^3) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/6/68 - 7:00 P.M. 12/7/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/6/68 through 7:00 a.m. 12/7/68													
Paper/Paper Products				2.7	2.7	2.7	5.4	5.4		8.0	2.4	8.0	37.3
Wood/Wood Products	--	--		0.7	--	--	--	--		--	--	--	0.7
Plastic/Leather/Rubber				1.3	0.7	0.7		0.1		1.3	--	0.7	4.8
Rags/Textiles				1.3	--	0.3		0.1		--	0.1	0.7	2.5
Glass				0.3	0.3	0.3		0.1		0.7	0.3	0.3	2.3
Metallics				1.3	0.7	1.3		0.9		0.7	0.7	2.0	7.6
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--		--	--	--	--
Organic Garbage				0.3	0.7	0.7		1.3		0.7	0.3	0.7	4.7
Sub-totals				7.9	5.1	6.0	5.4	7.9	*	11.4	3.8	12.4	59.9
7:00 a.m. 12/7/68 through Noon 12/7/68													
Paper/Paper Products				5.3	6.0	8.0		5.4		5.4	2.4	5.4	37.9
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	--			0.3	0.7	--		2.0		0.7	0.7	0.7	5.1
Rags/Textiles				0.3	0.7	--		0.1		0.7	--	1.3	3.1
Glass				0.3	0.1	0.1		0.3		0.3	0.1	0.3	1.5
Metallics				0.3	1.3	0.1		0.1		0.7	0.7	0.7	3.9
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage				0.7	0.7	0.7		0.1		0.3	0.7	0.3	3.5
Sub-totals				7.2	9.5	8.9		8.0		8.1	4.6	8.7	55.0
Noon 12/7/68 through 7:00 p.m. 12/7/68													
Paper/Paper Products				13.4	8.1	4.0	9.1	8.0		5.4	8.0	10.7	66.7
Wood/Wood Products	--		--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber				0.7	1.3	1.3	0.5	1.3		0.7	0.7	0.7	7.2
Rags/Textiles				0.1	0.7	1.3		0.1		--	0.7	0.7	3.6
Glass				0.7	1.3	0.7	0.3	0.1		0.7	--	0.7	4.5
Metallics				1.3	0.7	2.7	0.3	0.1		0.7	0.7	1.3	7.8
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage				0.7	0.7	0.3	0.5	0.9		--	0.7	1.3	5.1
Sub-totals				16.9	12.8	10.3	10.7	10.5		7.5	10.8	15.4	94.9
Daily Totals				32.0	27.4	25.2	16.1	26.4	*	27.0	19.2	36.5	209.8

--Denotes no refuse.
Blank space denotes that estimates of volume of refuse were not recorded.
*Fire occurred within incinerator, part of sample lost.

TABLE XIV. ESTIMATED VOLUME (FT^3) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/7/68 - 7:00 P.M. 12/8/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/7/68 through 7:00 a.m. 12/8/68													
Paper/Paper Products	5.4	1.5	--	5.4	8.1	9.4	10.7	2.7	5.4	5.4		5.4	59.4
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	1.3	0.3	--	0.3	2.7	0.7	2.0	0.7	0.7	0.7		2.7	12.1
Rags/Textiles	0.3	0.3	--	--	1.4	1.3	0.3	0.3	--	0.7		0.7	5.3
Glass	0.3	0.3	--	0.3	1.3	1.3	1.0	0.3	0.1	0.7		0.1	5.7
Metallics	1.1	0.5	--	0.7	1.3	0.7	2.4	0.7	0.7	1.3		0.7	10.1
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.3	0.4	--	0.7	1.3	1.3	1.0	1.3	1.3	0.7		0.7	9.0
Sub-totals	8.7	3.3	--	7.4	16.1	14.7	17.4*	6.0	8.2	9.5		10.3	101.6
7:00 a.m. 12/8/68 through Noon 12/8/68													
Paper/Paper Products	8.1	5.4	--	2.7	5.4	3.0		5.4	5.4	2.7	2.7	5.4	46.2
Wood/Wood Products	--	--	--	--	--	--		--	--	--	--	--	--
Plastic/Leather/Rubber	0.5	1.3	--	0.3	2.0	0.5		0.7	0.7	0.4	0.1	0.3	6.8
Rags/Textiles	0.3	1.3	--	0.3	0.3	--		1.3	0.7	0.4	0.1	0.1	4.8
Glass	0.4	0.3	--	0.3	0.8	0.4		0.7	0.7	0.4	0.1	0.4	4.5
Metallics	0.4	0.7	--	0.7	0.9	2.3		0.7	0.7	0.7	2.0	0.7	9.8
Stones/Ceramics/etc.	--	--	--	--	--	--		--	--	--	--	--	--
Organic Garbage	0.5	1.3	--	0.7	1.1	0.3		0.7	1.3	1.1	0.1	0.3	7.4
Sub-totals	10.2	10.3	--	5.0	10.5	6.5	*	9.5	9.5	5.7	5.1	7.2	79.5
Noon 12/8/68 through 7:00 p.m. 12/8/68													
Paper/Paper Products	5.4			5.4	5.4	0.5	5.4	5.4	8.1	5.4	8.1	5.4	54.5
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	0.7		--	0.7	1.3	2.0	1.1	2.0	1.1	0.7	2.7	0.7	13.0
Rags/Textiles	0.7		--	1.3	--	0.7	0.1	2.7	0.3	--	--	--	5.8
Glass	0.7		--	0.3	0.3	0.7	0.3	0.1	0.1	1.3	0.7	0.1	4.6
Metallics	2.4		--	0.7	0.3	1.3	2.7	1.3	0.1	0.7	2.0	0.3	11.8
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	1.3			1.3	0.7	0.7	1.0	2.0	1.1	0.7	2.0	0.3	11.1
Sub-totals	11.2			9.7	8.0	5.9	10.6*	13.5	10.8	8.8	15.5	6.8	100.8
Daily Totals	30.1	13.6		22.1	34.6	27.1	28.0*	29.0	28.5	24.0	20.6	24.3	281.9

--Denotes no refuse.
Blank space denotes that estimates of volume of refuse were not recorded.
*Fire occurred in the incinerator, part or all of sample lost.

TABLE XV. ESTIMATED VOLUME (FT^3) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/8/68 - 7:00 P.M. 12/9/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/8/68 through 7:00 a.m. 12/9/68													
Paper/Paper Products	6.7	5.4	5.4	5.4	8.1	5.4	2.0	2.7	--	5.4	5.4	7.8	59.7
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	1.3	1.3	0.7	1.3	1.3	1.0	1.0	0.3	--	1.0	1.1	1.8	12.1
Rags/Textiles	0.3	0.7	0.1	--	0.7	0.4	0.7	0.7	--	--	0.1	--	3.7
Glass	0.7	0.7	0.1	1.3	0.7	0.4	0.3	0.1	--	0.4	0.3	0.3	5.3
Metallics	1.1	0.7	0.7	1.3	1.3	0.8	1.3	--	--	0.3	0.4	2.2	10.1
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	1.1	1.1	0.7	1.3	2.0	1.0	0.7	0.7	--	0.7	1.0	0.5	10.8
Sub-totals	11.2	9.9	7.7	10.6	14.1	9.0	6.0	4.5	--**	7.8	8.3	12.6	101.7
7:00 a.m. 12/9/68 through Noon 12/9/68													
Paper/Paper Products	4.0	2.7	4.0	2.7	5.4	2.7	2.7	5.4	10.7	8.1	--	8.1	56.5
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	0.7	0.3	1.3	0.7	1.3	0.3	0.7	0.7	1.3	1.3	--	0.7	9.3
Rags/Textiles	0.7	--	0.1	--	--	0.3	0.3	0.1	0.7	--	--	0.1	2.3
Glass	0.7	0.3	0.3	0.7	0.7	0.7	0.3	0.1	0.7	0.7	--	0.7	5.9
Metallics	0.7	0.3	1.3	0.7	0.7	0.7	0.7	0.7	2.0	1.3	--	2.0	11.1
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.7	0.3	0.7	0.7	1.3	0.5	0.3	0.7	1.3	0.7	--	0.7	7.9
Sub-totals	7.5	3.9	7.7	5.5	9.4	5.2	5.0	7.7	16.7	12.1	--	12.3	93.0
Noon 12/9/68 through 7:00 p.m. 12/9/68													
Paper/Paper Products	4.0	5.4	--	7.5	8.1	10.7	7.4	5.4	--	5.4	5.4	5.4	64.7
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	1.3	2.7	--	1.3	1.3	0.1	1.6	2.0	--	0.7	0.3	1.0	12.3
Rags/Textiles	1.3	2.0	--	0.1	--	0.7	0.1	1.3	--	0.1	--	0.1	5.7
Glass	1.0	0.7	--	0.4	0.7	--	1.0	0.7	--	0.7	0.7	0.1	6.0
Metallics	1.3	1.3	--	1.5	0.7	0.1	2.1	0.7	--	0.7	1.3	1.3	11.0
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	5.4	0.7	--	0.5	0.7	0.1	1.1	1.3	--	1.3	0.7	0.5	12.3
Sub-totals	14.3	12.8	--	11.3	11.5	11.7	13.3	11.4	--	8.9	8.4	8.4	112.0
Daily Totals	33.0	26.6	15.4	27.4	35.0	25.9	24.3	23.6	16.7	28.8	16.7	33.3	306.7

--Denotes no refuse.
**Chute probably blocked

TABLE XVI. ESTIMATED VOLUME (FT^3) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/9/68 - 7:00 P.M. 12/10/68)

REFUSE CATEGORY	Building 6B			Building 5B			Building 1A			Building 4A			Total
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3	
7:00 p.m. 12/9/68 through 7:00 a.m. 12/10/68													
Paper/Paper Products	5.4	5.4	29.5	2.3	6.7	5.4	2.7	8.1	5.4	8.1	2.7	5.4	87.1
Wood/Wood Products	0.1	--	--	--	--	--	--	--	--	--	--	--	0.1
Plastic/Leather/Rubber	0.9	1.1	2.7	0.3	0.7	0.7	0.1	0.1	0.7	1.3	0.1	0.1	8.8
Rags/Textiles	0.1	0.4	2.0	--	0.1	0.7	0.3	0.1	2.7	0.7	--	--	7.1
Glass	0.3	0.1	2.7	0.3	0.3	--	0.3	0.1	1.0	1.3	0.1	0.7	7.2
Metallics	0.5	0.7	5.4	0.5	0.7	0.7	0.7	0.1	0.4	1.3	0.1	1.3	12.4
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	1.3	0.5	4.0	0.4	0.7	2.0	0.3	0.1	1.3	1.3	0.1	1.3	13.3
Sub-totals	8.6	8.2	46.3	3.8	9.2	9.5	4.4	8.6	11.5	14.0	3.1	8.8	136.0
7:00 a.m. 12/10/68 through Noon 12/10/68													
Paper/Paper Products	2.7	5.4	5.4	2.7	4.0	10.7	2.7	1.9	2.7	1.3	5.4	2.7	47.6
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	0.7	0.7	1.3	0.7	0.7	0.7	0.7	0.3	--	--	--	1.3	7.1
Rags/Textiles	0.7	0.7	0.1	--	0.3		--	0.1	--	--	--	0.3	2.2
Glass	0.7	0.7	0.7	0.7	0.3	0.7	--	0.1	0.7	--	0.7	0.3	5.6
Metallics	0.7	0.7	2.0	0.7	0.7	0.7	0.4	0.1	0.8	0.7	0.7	0.7	8.9
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.7	0.7	0.7	0.7	0.7	2.7	0.7	0.1	1.1	0.3	0.7	0.7	9.8
Sub-totals	6.2	8.9	10.2	5.5	6.7	15.5	4.5	2.6	5.3	2.3	7.5	6.0	81.2
Noon 12/10/68 through 7:00 p.m. 12/10/68													
Paper/Paper Products	8.1	2.0	9.3	8.1	4.9	6.7	6.7	10.7	10.1	5.4	5.4	5.4	82.8
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	1.3	2.0	2.7	0.7	0.5	1.0	1.3	2.7	0.7	0.7	1.3	1.6	16.5
Rags/Textiles	0.7	2.0	0.1	0.7	0.1	0.3	0.7	0.7	2.7	0.7	--	2.0	10.7
Glass	0.7	0.3	0.3	0.7		0.1	0.7	0.7	0.7	0.7	0.1		5.0
Metallics	0.7	1.3	0.5	0.7	1.2	0.4	0.7	0.7	1.3	0.7	0.7	1.1	10.0
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.7	0.7	1.1	0.7	0.8	1.1	0.7	1.3	1.3	0.7	0.1	0.7	9.9
Sub-totals	12.2	8.3	14.0	11.6	7.5	9.6	10.8	16.8	16.8	8.9	7.6	10.8	134.9
Daily Totals	27.0	25.4	70.5	20.9	23.4	34.6	19.7	28.0	33.6	25.2	18.2	25.6	352.1

--Denotes no refuse.
Blank space denotes that estimates of volume of refuse were not recorded.

TABLE XVII. ESTIMATED VOLUME (FT^3) BY CATEGORY OF REFUSE GENERATED DAILY--AFTER SORTING (7:00 P.M. 12/10/68 - 7:00 P.M. 12/11/68)

REFUSE CATEGORY	Building 6B A_1	Building 6B A_2	Building 6B A_3	Building 5B B_1	Building 5B B_2	Building 5B B_3	Building 1A C_1	Building 1A C_2	Building 1A C_3	Building 4A D_1	Building 4A D_2	Building 4A D_3	Total
7:00 p.m. 12/10/68 through 7:00 a.m. 12/11/68													
Paper/Paper Products	2.7	2.7	8.1	1.3	1.3	2.7	2.0	2.0	5.4	2.0	0.7	5.4	36.3
Wood/Wood Products	0.7	--	--	--	--	--	--	--	--	--	--	--	0.7
Plastic/Leather/Rubber	--	0.7	2.0	0.1	0.3	0.7	1.3	--	0.7	0.4	--	2.0	8.2
Rags/Textiles	0.7	--	0.1	0.1	0.7	0.7	0.7	--	0.7	0.3	--	--	4.0
Glass	1.3	0.7	0.1	0.1	0.7	0.7	0.7	--	0.3	0.3	0.3	0.7	5.9
Metallics	1.0	0.7	1.3	0.1	0.4	1.0	0.7	--	0.7	0.5	0.7	0.7	7.8
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.7	0.7	0.7	0.1	0.7	0.7	1.3	--	1.0	0.7	0.3	0.7	7.6
Sub-totals	7.1	5.5	12.3	1.8	4.1	6.5	6.7	2.0	8.8	4.2	2.0	9.5	70.5
7:00 a.m. 12/11/68 through Noon 12/11/68													
Paper/Paper Products	1.3	1.3	5.4	2.3	4.0	4.2	1.3	2.7	4.8	--	6.8	2.7	36.8
Wood/Wood Products	--	--	--	--	--	--	--	--	--	--	--	--	--
Plastic/Leather/Rubber	0.3	2.0	0.3	0.1	0.1	0.1	0.1	0.7	0.1	0.3	0.7	1.3	6.1
Rags/Textiles	--	--	0.7	0.1	1.2	0.1	--	--	--	--	0.1	0.3	2.5
Glass	0.4	0.3	0.3	0.1	--	0.3	--	0.3	0.4	0.3	0.3	0.1	2.8
Metallics	--	0.3	0.7	--	1.3	0.1	0.3	0.1	0.1	0.1	0.7	0.3	4.0
Stones/Ceramics/etc.	--	--	--	--	--	--	--	--	--	--	--	--	--
Organic Garbage	0.3	0.7	0.7	--	0.7	0.5	0.3	0.4	0.4	0.7	0.7	0.1	5.5
Sub-totals	2.3	4.6	8.1	2.6	7.3	5.3	2.0	4.2	5.8	1.4	9.3	4.8	57.7
Noon 12/11/68 through 7:00 p.m. 12/11/68													
Paper/Paper Products	1.3	5.4	4.0	0.7	4.0	5.4			4.7	6.8	--	8.1	40.4
Wood/Wood Products	--	--	--	--	--	--			--	--	--	--	--
Plastic/Leather/Rubber	0.7	0.3	0.3	--	0.7	1.3			0.3	0.1	--	--	3.7
Rags/Textiles	0.7	--	0.3	--	0.7	1.3			--	0.7	--	--	3.7
Glass	1.3	--	0.3	0.3	0.3	0.7			0.7	0.3	1.3	0.7	5.9
Metallics	0.7	0.3	0.3	0.1	0.7	0.7			--	0.3	0.3	0.7	4.1
Stones/Ceramics/etc.	--	--	--	--	--	--			--	--	--	--	--
Organic Garbage	0.7	0.7	0.3	--	0.7	0.7			1.3	0.7	--	0.5	5.6
Sub-totals	5.4	6.7	5.5	1.1	7.1	10.1	*	*	7.0	8.9	1.6	10.0	63.4
Daily Totals	14.8	16.8	25.9	5.5	18.5	21.9	8.7*	6.2*	21.6	14.5	12.9	24.3	191.6
Weekly Totals	154.9	111.3	142.4	142.5	171.4	174.1	125.9	142.6	132.9	159.6	117.1	196.6	1771.3

--Denotes no refuse. *Fire occurred within incinerator, part or all of sample lost.
Blank space denotes that estimates of volume of refuse were not recorded.

TABLE XVIII. MOISTURE CONTENT (% - WT) OF SELECTIVE CATEGORIES OF REFUSE GENERATED DAILY.

REFUSE CATEGORY	CHUTE											
	A_1	B_1	C_3	D_3	A_1	B_1	C_3	D_3	A_1	B_1	C_3	D_3
	12/6/68				12/7/68				12/8/68			
Paper and Paper Products	14.7	15.4	27.9	22.2	20.5	15.8	48.5	12.3	17.7	17.7	18.8	15.6
Composite (Woods, Plastics, Rags)	15.4	13.3	6.7	10.7	38.6	0	24.2	16.1	14.3	19.0	10.0	25.0
Metallics								31.3				15.4
Organic Garbage	49.2		29.0	20.5	28.6	39.5	37.3	37.3	31.7	44.5	24.7	29.7
	12/9/68				12/10/68				12/11/68			
Paper and Paper Products	16.0	10.0	12.8	9.0	10.8	11.3	15.6	14.7	12.3	16.7	22.2	12.8
Composite (Woods, Plastics, Rags)	3.9	4.2	0	16.7	15.8	9.2	10.5	6.3	11.3	3.9	5.6	25.0
Metallics		4.0		0			4.0	3.7				6.7
Organic Garbage	36.3	32.5	35.6	20.6	25.8	20.0	30.3	30.0	21.4	53.0	19.8	22.8

Blank space denotes that no sample was taken.

TABLE XIX. WEIGHT (LB) AND SIZE (FT) OF BULKY SOLID WASTE ITEMS COLLECTED.[a]

Building	Item	Weight (~ lb)	Size (~ ft)
1A	Mattress	50	6 x 4
1A	Mattress	45	5 x 4
1A	Mattress	60	7 x 5
1A	Dresser (Wood)	65	4.5 x 2.5 x 2
1A	Rug	50	12 x 8
4A	Dresser (Wood)	50	4 x 2 x 2
5B	Table (Wood)	10	3 x 4
5B	Chairs (Metal)	20	3.5 x 2
5B	Boxes (Cardboard)	26	Various
5B	Furniture (Aluminum)	25	Various
5B	Mirror (Glass)	25	3 x 2.5
5B	Boxes (Wood)	18	Various
5B	Table Top (Metal)	25	3 x 4
5B	Flooring (Linoleum)	38	10 x 10

[a] Items were collected during the seven consecutive days between 12/5/68 and 12/11/68; specific day of disposal of each item could not be determined.

TABLE XX. WEIGHT (LB) AND ESTIMATED VOLUME (FT^3) OF REFUSE GENERATED HOURLY ON 12/5/68--AFTER SORTING

HOUR	CHUTE									
	A_1		B_1		C_3		D_3		TOTALS	
	lb.	ft^3	lb.	ft^3	lb.	ft^3	lb.	ft^3	lb.	ft^3
7:00 a.m.	--	--	--	--	--	--	--	--	--	--
8:00 a.m.	--	--	--	--	--	--	--	--	--	--
9:00 a.m.	24	2.7	9	2.3	--	--	5	1.3	38	6.3
10:00 a.m.	--	--	--	--	7	0.3	5	1.3	12	1.6
11:00 a.m.	12	2.1	9	2.7	8	0.8	4	1.3	33	6.9
12:00 Noon	36	3.3	7	2.3	3	0.4	5	2.7	51	8.7
1:00 p.m.	--	--	5	2.3	2	0.3	4	2.7	11	5.3
2:00 p.m.	17	2.0	--	--	2	1.3	--	--	19	3.3
3:00 p.m.	9	2.7	14	6.3	13	2.7	14	2.7	50	14.4
4:00 p.m.	9	2.7	25	2.7	14	2.7	2	2.7	50	10.8
5:00 p.m.	--	--	8	2.7	15	2.7	3	2.3	26	7.7
6:00 p.m.	22	4.3	3	2.7	55	3.3	12	2.7	92	13.0
7:00 p.m.	39	4.9	20	2.7	3	1.3	26	2.7	88	11.6
8:00 p.m.	38	5.6	12	2.7	16	2.7	2	1.3	68	12.3
9:00 p.m.	21	2.0	2	2.7	4	2.7	9	2.7	36	10.1
TOTALS	227	32.3	114	32.1	142	21.2	91	26.4	574	112.0

--Denotes no refuse.

TABLE XXI. WEIGHT (LB) AND ESTIMATED VOLUME (FT^3) OF REFUSE FOLLOWING INCINERATION

INCINERATOR	DATE	UNBURNED REFUSE		RESIDUE					
				ASH		UNBURNED COMBUSTIBLES		NONCOMBUSTIBLES	
		lb.[a]	ft^3 [b]	lb.	ft^3	lb.	ft^3	lb.	ft^3
D_3	12/5/68	91	21.1	11	0.7	12	0.7	24	2.8
C_3	12/6/68	56	13.4	15	0.5	3	0.3	13	0.5
D_1	12/6/68	63	19.1	2	0.3	4	0.3	10	0.7
D_3	12/6/68	93	31.5	8	0.7	9	0.7	21	2.8
D_1	12/7/68	134	27.0	16	0.7	15	0.7	52	4.2
D_2	12/7/68	127	19.2	11	0.7	11	0.7	31	3.0
D_3	12/7/68	188	36.5	12	0.7	7	0.7	39	4.9
C_3	12/8/68	134	28.5	21	0.7	18	0.7	72	4.2
D_1	12/8/68	173	24.0	7	0.7	10	0.7	15	2.8
D_2	12/8/68	143	20.6	3	1.4	24	0.7	52	5.6
D_3	12/8/68	95	24.3	2	0.7	8	0.7	21	2.8
D_1	12/9/68	150	28.8	21	0.7	39	2.1	48	4.9
D_2	12/9/68	70	16.7	4	0.7	11	2.1	10	2.1
D_3	12/9/68	90	33.3	23	2.1	13	0.7	29	4.9
C_3	12/10/68	175	33.6	18	0.1	40	0.7	72	5.6
D_1	12/10/68	128	25.2	8	0.7	14	0.7	7	0.7
D_2	12/10/68	90	18.2	15	0.7	5	0.7	24	1.4
D_3	12/10/68	103	25.6	9	0.3	7	0.3	8	1.4
TOTALS		2103	446.6	206	13.1	250	14.2	548	55.3

[a]Values reported are weights of refuse after taking moisture samples.

[b]Values reported are those obtained after sorting and prior to taking moisture samples.

APPENDIX D

AIR POLLUTION--
PROTOCOL

PROTOCOL

Air Pollution

General Testing

Incinerator C_3.—The eight tests which follow are to be conducted on this incinerator:

Test No. 1--is to be conducted with five (5) separate samples of refuse of similar composition charged into the incinerator at its design capacity with the incinerator operated as normal (i.e., with overfire air blower and auxiliary gas supply on for 15 min. at the beginning of each burn).

Test No. 2--is to be conducted with three (3) separate samples of refuse of similar composition charged into the incinerator on the basis of tenant charging rate with the incinerator operated as normal.

Test No. 3--is to be conducted with three (3) separate samples of refuse of similar composition charged into the incinerator at a rate different from that used in either Test No.'s 1 and 2 above and the incinerator operated as normal.

Test No. 4--is to be conducted with three (3) variations of overfire air supply with refuse charged into the incinerator at its design capacity and with auxiliary fuel supplied for the normal 15-min. period; three (3) samples of similar composition will be tested for each variation of overfire air.

Test No. 5--is to be conducted with three (3) variations in the amount of auxiliary fuel used with refuse charged into the incinerator at its design capacity and with the overfire air blower operated for the normal 15-min. period; three (3) separate samples of similar composition will be tested for each variation of auxiliary fuel.

Test No. 6--is to be conducted with the flame from the auxiliary fuel port deflected upwards to simulate a blockage that might occur under normal operating conditions; only one (1) angle of deflection is to be used and three (3) separate samples of similar composition will be tested under this condition.

Test No. 7--is to be conducted with stack emissions taken throughout a day during the normal operation of the incinerator with refuse randomly charged into the incinerator by the tenants.

Test No. 8--is to be a repeat of Test No. 7 above.

Incinerator C_1.—The test detailed below is to be conducted on this incinerator.

Test No. 9--will be conducted with three (3) separate samples of refuse of similar composition charged into the incinerator at its design capacity and the incinerator operated as normal.

Sample Composition.—With the exception of Test No.'s 7 and 8, to the extent possible composition of samples to be used in all tests is to be based on results obtained during the first week of data collection on quantity and composition of refuse generated at all test structures involved.

Charging Rates.—Design capacity of the incinerators is to be calculated in accordance with normally accepted procedures, and the determined value used for sizing refuse samples in those tests requiring a charging rate equal to that of incinerator design capacity. Tenant charging rate is to be based on results of data collected previously on quantity of refuse generated. In the burning of individual samples, the total sample is to be charged into the incinerator at the onset of the burn.

Data Collection.—For each of the tests and samples enumerated above, the following data are to be collected:

1. Particulate emission rate in pounds per hour per pound of refuse charged
2. Percent burn-out of refuse sample
3. Fuel consumption
4. Fire box temperature
5. Stack gas temperature and velocity
6. Gaseous emissions for

O_2 (%)	SO_x (ppm)
CO_2 (%)	NO_x (ppm)
N_2 (%)	Hydrocarbons (ppm)
H_2O (%)	Carbonyls (ppm)
CO (%)	Aldehydes (ppm)

7. Particulate loading and size distribution
8. Odor
9. Ringelmann readings for density and color.

In addition to the above, data also are to be obtained on the following:

1. during Test No. 1, NH_3 stack emissions in ppm and CO content at the hopper doors in the hall on the first and on the top floors;
2. during Test No. 2, particulate emission rate during the period when the refuse is smoldering after burning.

Test Methods.—In the conduct of the above tests, particulate emission rates (pounds per hour per pound of refuse burned) are to be determined using the basic test procedures as outlined in the ASME Test Code for Dust Separating Apparatus PTC 21-1941 and the ASME Test Code for Determining Dust Concentrations in Gas Stream PTC 27-1957 using isokinetic sampling and sampling nozzles having an inside diameter no less than 0.75 inches. Particulate loading and size distribution are to be determined using the sticky paper method described by Gruber and Shumann in their presentation at the 55th annual meeting of the Air Pollution Control Association, 20-24 May 1962.

Gaseous emissions are to be sampled and analyzed in accordance with the appropriate procedures as outlined in the Los Angeles County Testing Manual and the San Francisco Bay Area Air Pollution Control District Source Test Methods. Odor is to be determined using ASTM: D 1391-57, Standard Method for Measurement of Odor in Atmospheres (Dilution Method).

Simultaneous Testing

Incinerator C_3.—The two tests which follow below will be conducted on this incinerator and particulate emission rate determined simultaneously using the ASME test procedures and the test procedure described by the National Air Pollution Control Administration, U. S. Public Health Service, in their publication "Specifications for Incinerator Testing at Federal Facilities."

Test No. 10--is to be conducted with three (3) samples of refuse as generated randomly by the tenants and charged into the incinerator at one of the rates used previously in either Test No. 2 or Test No. 3 and the incinerator otherwise operated under normal conditions.

Test No. 11--is to be a duplicate of Test No. 10 above except that charging rate is to be based on design capacity.

APPENDIX E

AIR POLLUTION--

INCINERATOR STACK-SAMPLING TEST DATA

INCINERATOR STACK-SAMPLING TEST DATA

Presented in this appendix are the results obtained from conducting the incinerator stack-sampling program as specified in the air pollution protocol in Appendix D. Results of general testing (i.e., protocol tests 1 through 9) are given in Tables I through XI and results of simultaneous testing (i.e., protocol tests 10 and 11) are given in Tables XII (NAPCA method) and XIII and XIV (ASME-PTC-27 method). In addition, a summary, as prepared by the subcontractor, is presented of the test methods used in the collection and analysis of incinerator stack samples.

Summary of Methods of Testing (Subcontractor Report)

1. Location of Incinerator Stack-Sampling Ports

Figure 1 [of this appendix] is a representation of an incinerator stack showing the relative positions of the sampling ports used in the collection of the required data. Sampling ports were located approximately five feet above the roof line, were approximately three stack diameters from the top of the stack, and more than 10 diameters upstream from any bends or constrictions. The two three inch ports shown on Figure 1 were used to sample particulate emission rates, particulate size and loading distributions, sulphur oxides, velocities, and temperatures. The two side ports [approximately 1.5 inches in diameter] were used to sample aldehydes, carbonyls, hydrocarbons, nitrogen oxides, oxygen, carbon monoxide, carbon dioxide, and odor.

2. Particulate Emission Rates

Particulates were sampled using the Null Balance Tube Method and a large diameter (0.82) inch nozzle following the basic procedures as outlined in ASME-PTC-27. The sampling train is shown in Figure 2. Isokinetic conditions were obtained by equalizing static pressure inside the nozzle and the static pressure just outside the nozzle. Differential pressure was measured on an inclined manometer and the pumping rate was varied in order to maintain a balance. The particulate material was trapped in an alundum thimble which was placed ahead of the impingers in the sampling train. The thimble was sealed and returned to the laboratory for analysis. In the laboratory, the thimble containing the sample and a blank one were dried at 105°C, cooled in a dessicator, and weighed. The weight change (if any) in the blank was calculated for the weight of the sample thimble.

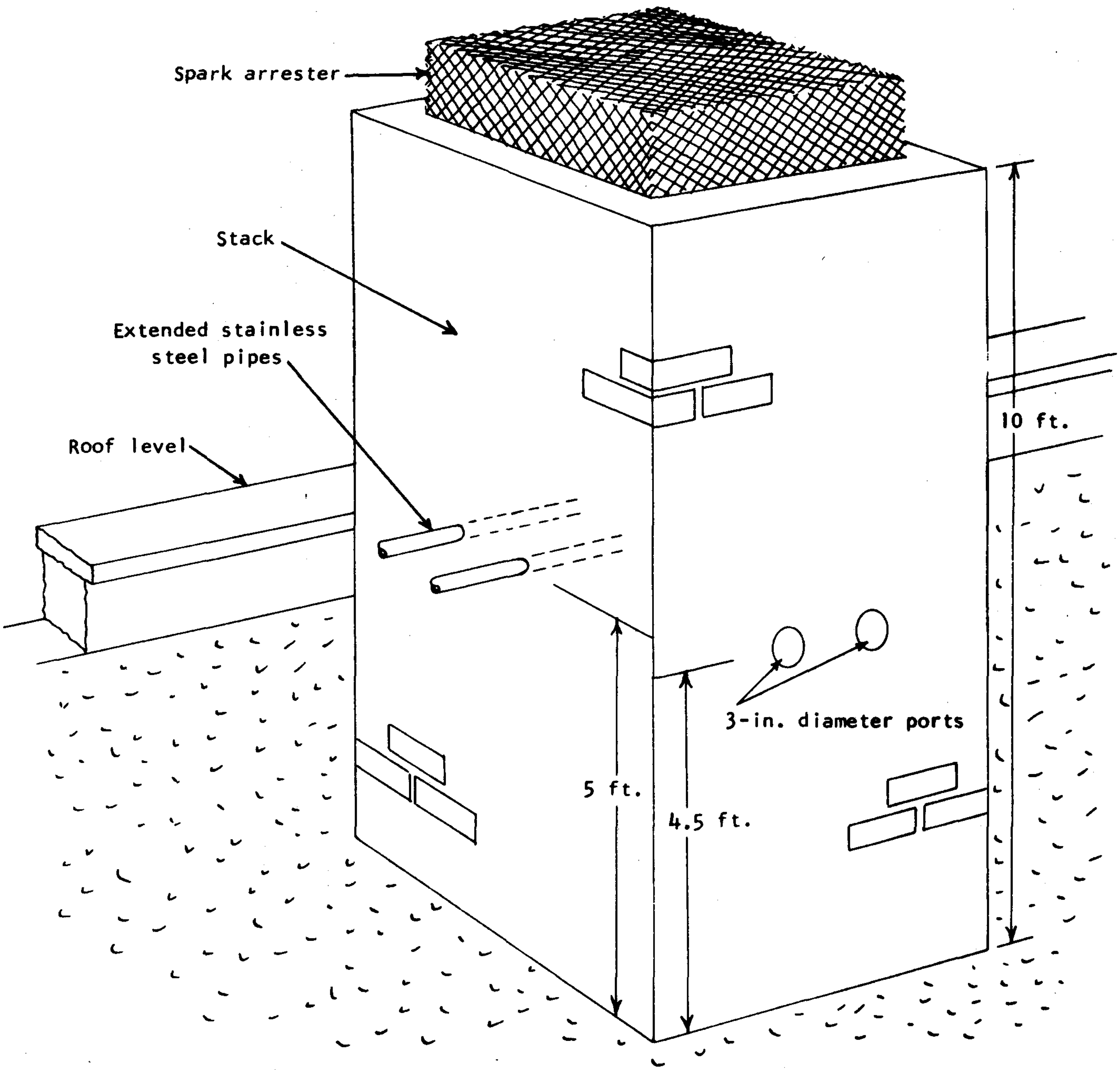
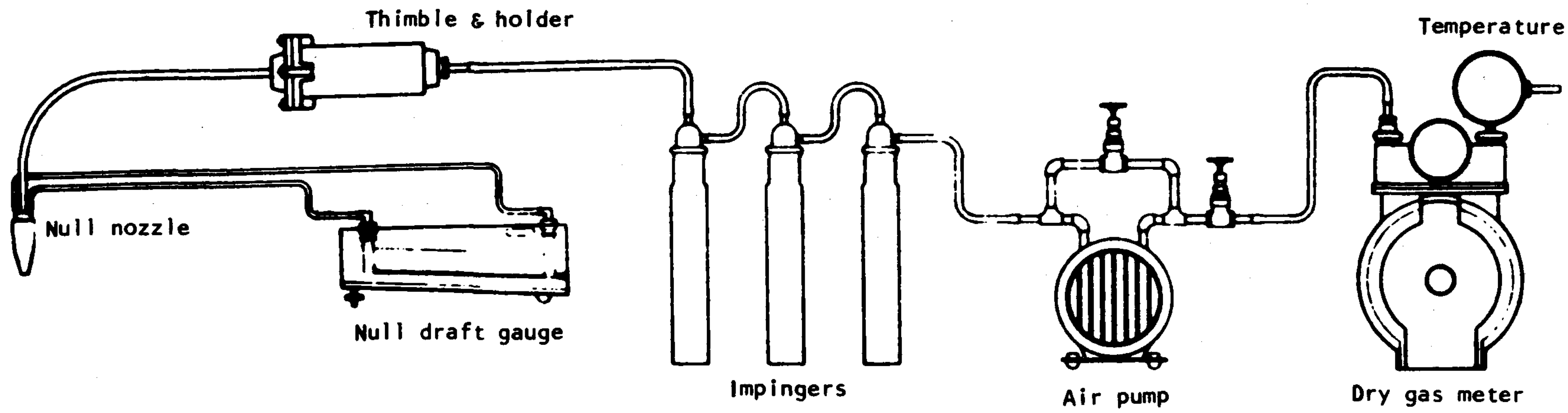
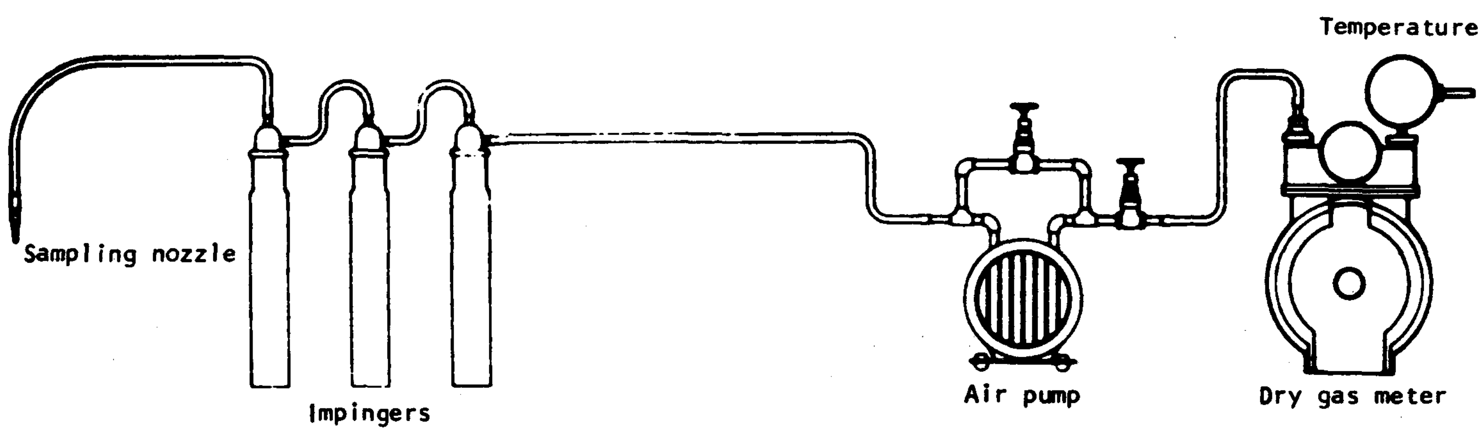


Figure 1. Location of sampling ports.



For Particulates and SO_x Emissions



For Aldehydes and Carbonyls

Figure 2. Sampling trains

3. Particulate Loading and Size Distribution

Particulate loading distribution was determined using the method of Gruber and Shumann as presented at the 55th Annual Meeting of APCA, May 20-24, 1962. The adhesive paper was obtained from Fasson Products, Division of Avery Adhesive Products, Inc. R-135 on Pli-aprint, the type used, has a removable backing and is available in sheets 25.5 x 20 inches. The tackiness of the adhesive surfaces of different sheets varies significantly and the same paper sheet was used throughout the testing to obtain the greatest degree of correlation.

The sampling jars were prepared as follows: Strips of adhesive paper were cut into 2 x 10 inch sizes and wrapped around the outside of the jars with the sticky sides out. The backing was kept in place on the adhesive paper until the time of test.

At least one sticky paper sample was taken during the burning of each refuse sample, either at the beginning of each burn (between approximately two to five minutes after ignition) or at the ending of each burn (between approximately 20 to 25 minutes after ignition). Predominantly, sticky paper samples were obtained at the beginning of each burn and on occasion it was possible to obtain a sample at both the beginning and ending of a burn. All sticky paper samples were obtained through the 3 inch ports in the stack, extreme care taken to avoid touching the adhesive on the stack surface. The jar was held in horizontal position by means of a jar cap mounted on a suitable length of stainless steel pipe. Exposure time was usually 30 seconds but under heavy loading conditions this was varied since particle counting is difficult and sometimes impossible under such conditions. Immediately after the samples was collected, it was placed in a closed container for transport to the laboratory.

The microscopic particle counting of the exposed area of the adhesive surface was made at a magnification of 15X. At this magnification particles of 20 microns were easily distinguished. The number of particles per square inch was obtained by comparison with the Cincinnati Visual Standards, A-3. The number of particles per minute was calculated from the following equation:

$$\frac{\text{Particles per/in.}^2 \times 60 \times \text{flue area (in.}^2\text{)}}{\text{Exposure time in seconds}}$$

Particulate size distribution was determined by micro and macroscopic observation on adhesive coated paper. For each sticky paper sample, the exposed area was examined and measured, and the percent of the total exposed area occupied by particles 2.5mm or greater, 0.5 to 2.5mm, 0.1 to 0.5mm, and less than 0.1mm were recorded separately.

4. Velocity and Temperature of Gas Stream

Velocity was determined by Pitot tube in accordance with Western Precipitation Co. "Bulletin WP-50".

It was necessary to determine the velocity and temperature of the gas stream in order to determine the volume carried by the flue. Since the volume of gas passing any given cross-section of a flue is the product of the average velocity of that gas and the area of the cross-section, determination of the gas volume involved measuring the area of the cross-section and determining the average velocity of the gas. The velocity of the gas was determined by means of a Pitot tube and a differential pressure gauge. The velocity determination was made at a point where the gas flow was as uniform as possible and it was convenient to set up the equipment. To insure a uniform gas flow, the place for the test was chosen in a straight section of the flue, away from bends and other points of disturbance of gas flow. The cross-section of the flue was laid out in a number of equal areas, the center of each area being the point where the measurement was to be taken. The number of areas was large enough to insure a reasonably accurate measurement of the average velocity over the entire cross-section. After selecting the test location, openings were made in the flue large enough to permit insertion of the Pitot tube and sampling tube.

The draft gauge was set up as follows: Two adapters were screwed in tightly and a suitable length of rubber tubing was connected to one terminal of each. A clamp was placed on this tubing in order to close it off. The gauge was firmly fastened and leveled. The gauge liquid was poured in until the meniscus read zero. The Pitot tube was connected with the bypass tube open and the other tubes clamped closed. The gauge was adjusted to zero. The Pitot tube was inserted in the flue and the bypass clamp closed. The tube pointed directly into the flow of gas when readings were taken. At each point of measurement the draft gauge was read and the difference from the zero point was a measure of the velocity pressure. The temperature of the flue was taken with a thermocouple and a pyrometer. After the measurements were completed, the average velocity was calculated. Because the stack gases were nearly saturated with condensable constituents and carried heavy dust loads, the Pitot tube tended to stop up and the Special Pitot Tube (Type S) was used.

Stack temperatures were determined by thermocouple and pyrometer as the velocity was being measured.

5. Sulphur Oxides

Sulphur oxides were determined using method 5.4.7 as described in the Los Angeles Source Testing Manual.

Sulphur dioxide was collected by continuous sampling with an impinger absorption train containing a caustic solution (See Figure 2). An alundum thimble immediately preceded the impingers in order to collect particulate matter. The impinger solution was analyzed for sulfate by the gravimetric barium-sulfate method. The lower measurement limit of the method, when analyzing a total collected sample equal to 30 cubic feet of gas, is about 1 ppm each of sulphur dioxide and sulphur trioxide.

This method has been found suitable for use in determining compliance with APCD Rules and Regulations.

The first two impingers each contained 100 ml of a 5% sodium hydroxide solution (prepared by dissolving 50 g of reagent grade sodium hydroxide in water and diluting to one liter). The third impinger was operated dry to catch any carry-over spray and to protect the gas meter. An ice bath was used to cool the impingers. A stainless steel sampling probe was used. All equipment was tested for proper operation and freedom from leaks. The sampling rate did not exceed one cubic foot per minute. The thimble temperature was regulated to remain above the dew point temperature (i.e., above the condensation temperature corresponding to the water vapor concentration) by insulating the thimble with heating tape. The data recorded during sampling included:

a. Time (clock) of test and data recordings

b. Gas meter reading, ft^3 (initial)

c. Gas meter vacuum, in. Hg below atmospheric

d. Gas meter temperature, °F

At the completion of sampling, the pump was shut off and the train was allowed to come to atmospheric pressure before disconnecting the vacuum line. The final gas meter reading was recorded. The sample probe, thimble, impingers, and associated tubing were suitably sealed for transfer to the laboratory.

The reagents prepared for the laboratory analysis were 10% barium chloride solution, 1% silver nitrate solution, and saturated bromine water. To prepare the latter, 100 ml of water was added to a reagent bottle and chilled. After the water was thoroughly chilled, approximately 4 ml of chilled liquid bromine was added.

The analysis for sulphur dioxide was performed as follows: The two impinger solutions were combined and the volume was carefully measured. The combined solutions were transferred to a 250 ml volumetric flask and diluted to volume with water. A suitable aliquot was taken and checked for alkalinity with litmus paper. Saturated bromine water was added in excess and the solution was boiled for 5 minutes. Then the solution was neutralized with concentrated hydrochloric acid and about 2 ml excess was added. The boiling was continued until all the free bromine was expelled. Water was added to maintain the volume. The solution was free of bromine when a drop of methyl red indicator did not decolorize on the addition of water to the solution. The solution was filtered and heated to boiling temperature. Hot 10% barium chloride was added until no more precipitate was formed and the precipitate was digested at 60°C for several hours. The precipitate was collected by filtration using ashless filter paper and washed with distilled water until the filtrate was free of chloride ion. This was determined when the addition of a few drops of 1% silver nitrate produced no turbidity in the filtrate. The filter paper was placed in a tared crucible, ignited at 800°C, cooled in a dessicator and weighed. The difference in weight of the crucible from the tare weight was recorded as the weight of barium sulfate equivalent to the sulphur dioxide in the sample.

6. Aldehydes

Aldehydes were collected using the impinger train as shown in Figure 2 and determined using a slight modification of the method in Regulation 3, Bay Area Air Pollution Control District, page 40. The following reagents were required for the laboratory analysis:

a. Chromotropic acid (r,5-dihydroxy -2,7-napthalene-disulfonic acid, disodium salt), 0.5% solution in distilled water. This solution was kept refrigerated and prepared fresh every week.

b. Concentrated sulfuric acid.

The volume of liquid in the impingers was measured and recorded. The liquid and washings were transferred to a 250 ml volumetric flask and diluted to volume with distilled water. When the liquid was cloudy, it was filtered before an aliquot was taken. A suitable aliquot was transferred to a 25 ml graduated cylinder. 0.2 ml of chromotropic acid solution was added and the solution was mixed well. Then, 5 ml of concentrated sulfuric acid was carefully added to the cylinder and the solution was mixed again. The mixture developed a violet color when aldehydes were present. The cylinder was placed in a hot water bath for 15 minutes to fully develop the color. It was cooled, diluted to 10 ml with water, and cooled again. The absorbance of the solution was read on a spectrophotometer at 580 mμ against a blank which was prepared in the same manner as the sample using 0.5% sodium bisulfite solution. The aldehyde content was determined from a standard curve.

7. Carbonyls

Carbonyls were collected using the impinger train shown in Figure 2 and determined using a slight modification of the method in Regulation 3, Bay Area Air Pollution Control District, page 30.

Each of the first two impingers in the sampling train contained 100 ml of 0.5% sodium bisulfite, while the third was operated dry to catch any carry-over spray and to protect the gas meter. An ice bath was used to cool the impingers. A stainless steel sampling probe of a suitable size was used. All equipment was tested for proper operation and freedom from leaks.

The sampling rate did not exceed one cubic foot per minute. The data recorded during sampling included:

a. Time (clock) of test and data recordings

b. Gas meter reading, ft^3 (initial)

c. Gas meter vacuum, in. Hg.

d. Gas meter temperature, °F

At the completion of sampling, the pump was shut off and the train allowed to come to atmospheric pressure before disconnecting the vacuum line. The final gas meter reading was recorded. The impingers and associated tubing were suitably sealed for transfer to the laboratory. The condensate in the probe and inlet tubing was allowed to flow into the first impinger.

The total volume of liquid contained in the impinger was carefully measured. The difference from the initial volume was recorded as the condensate volume. The impingers and associated tubing were carefully rinsed with small portions of distilled water, the liquid and washings being kept in a flask. Since aliquots were to be taken for analysis, the combined liquid and washings were made up to an exact volume. The size of the aliquot depended on the expected carbonyl content. The following reagents were needed:

a. 0.1 N iodine solution (does not need to be standardized).

b. 0.005 N iodine solution. This solution was prepared by diluting 50 ml of 0.1 N iodine solution to one liter and was standardized with 0.05 N $Na_2S_2O_3$.

c. 0.05 N $Na_2S_2O_3$. This solution was prepared with freshly boiled and cooled distilled water and standardized against potassium dichromate (primary standard).

d. 1% starch solution.

e. Buffer solution, pH 9.6. Dissolved 80 g of sodium carbonate in 500 ml of distilled water; added 20 ml of glacial acetic acid and dilute to 1 liter; adjusted the pH to 9.6 (±0.1) with sodium carbonate (or acetic acid) using a pH meter.

A suitable aliquot of the sample was pipetted into a 250 ml Erlenmeyer flask. When the liquid was cloudy, it was filtered before the aliquot was taken. A milliliter of starch solution was added slowly from a burette until a blue color was produced. The solution was decolorized with 0.05 N $Na_2S_2O_3$ and 0.005 N I_2 was added until a faint blue color was obtained. 50 ml of buffer solution was added to the solution. It was mixed well and allowed to stand for 15 minutes, then the solution was titrated with 0.005 N I_2 using the starch indicator until the blue endpoint was reached. A blank of 0.5% sodium bisulfite solution was made up and run in parallel with the sample.

8. Hydrocarbons

Hydrocarbons were determined using the Infrared Absorption method 5.4.8.1 in the Los Angeles Source Testing Manual.

The absorption of infrared radiation by a gas furnished a means of determining the concentration of various components in the sample.

In the case of hydrocarbons, the APCD method was used based on the analysis of total hydrocarbons to the point of maximum absorption in the range of 3 to 4μ, usually close to 3.45μ. Normal hexane was selected as the calibration standard for the infrared spectrophotometers used by the APCD; hence, the analyses of unknown samples are reported in terms of parts per million by volume, as n-hexane. Hexane was selected because it is the standard comparison for organic vapors as commonly used in air pollution studies for auto exhausts and ambient air monitoring. Hydrocarbons, together with aldehydes and carbonyls gives a cross-section of organic vapors present.

The lower limit of the method, using one-meter absorption cells and pressures near atmospheric is about 10 parts per million by volume of hydrocarbons, expressed as hexane.

This method also has been routinely used for many years for the analysis of gas samples from various industrial sources. Hydrocarbons differing greatly in structure from hexane (methane, ethane, propane, the corresponding olefins, acetylene, and aromatic hydrocarbons) are not effectively measured.

Grab samples of stack gas were collected with evacuated dry flasks. The total hydrocarbons were determined by absorption at the 3.45μ wavelength, using an infrared spectrophotometer calibrated for n-hexane, the absorbance readings calculated to parts per million by volume of hexane.

One-lier round bottom flasks, were used for sampling. Prior to sampling, the clean dry flasks were evacuated to 1 mm Hg (or less) absolute pressure, the screw clamp closed, and the solid glass plus inserted into the open end of the tubing until ready for use.

Sampling itself was performed in the same manner as described for oxides of nitrogen. However, stainless steel tubing was used for sample line, to eliminate the rubber tubing.

Standards were calibrated by plotting known concentrations of hexane (in nitrogen) vs absorbance at 3.45μ. Concentrations of 25, 75, and 150 ppm hexane were seen in a 10 cm gas cell on a 20x scale expansion using the Perkin-Elmer, Model 21, Infra-Red Spectrophotometer. To remove water and carbon dioxide from the gases, the one liter flask was connected to the gas cell through a small tube containing Ascarite. The cell was evacuated before opening the stopcock to the sample flask. The final pressure of the system and the transmission values at the selected wavelengths were recorded. The hdyrocarbon concentration, in ppm by volume, was calculated from the calibration curve.

9. Nitrogen Oxides

Oxides of nitrogen were determined by mèthod 5.4.5 in the Los Angeles Source Testing Manual.

Samples were collected by grab sampling, using evacuated flasks containing a dilute solution of hydrogen peroxide and sulfuric acid.

The hydrogen peroxide oxidized the lower oxides of nitrogen (with the exception of nitrous oxide) to nitric acid. The resultant solution was evaporated to dryness and treated with phenoldisulfonic acid reagent and ammonium hydroxide. The yellow trialkali salt of 6-nitro-1-phenol-2,4-disulfonic acid which formed, was measured colorimetrically. The procedure is effective for the determination of total oxides of nitrogen in industrial effluents where the concentration range is five to several thousand parts per million. Results were expressed as nitrogen dioxide.

One-lier round bottom flasks, were used for sampling. Twenty five ml of 0.1 N sulfuric acid, containing 0.5 ml of 3% hydrogen peroxide, were added to each flask. The hydrogen peroxide was freshly prepared daily from acetanilide free, 30% hydrogen peroxide, which was stored under refrigeration. The flask was evacuated to the vapor pressure of the solution, the screw clamp closed, and the solid glass plug inserted into the open end of the tubing until ready for sampling.

The inlet tube of the flask was connected to a three-way stopcock attached to the sampling line. A glass wool filter plug was placed in the sampling line, and an aspirator bulb was used for flushing the sample probe and tubing with stack gas just prior to sampling. Sufficient flushing was employed to raise the temperature of the sampling line above the dew point of the stack gases. The screw clamp was opened to admit gas to the evacuated flask and when the flow of gas ceased, the screw clamp was closed and the glass plug reinserted into the short rubber tube of the flask.

The sealed collection flasks were shaken thoroughly with frequent rotation to provide a thorough scrubbing action to ensure complete oxidation and absorption of the oxides of nitrogen by the solution. When absorption was complete, the oxides of nitrogen (except nitrous oxide) were converted to nitric acid.

The special reagents required for analysis of the absorbing solutions were sodium hydroxide solution (approximately 1.0 N), phenoldisulfonic acid solution, and standard potassium nitrate solutions. The reagents were prepared as follows:

a. 1.0 N sodium hydroxide solution: Dissolved 40 g of sodium hydroxide pellets in water, and diluted to one.

b. Phenoldisulfonic acid solution: Dissolved 25 g of pure white phenol in 150 ml of concentrated sulfuric acid (sp. gr. 1.84) on a steam bath; cooled and 75 ml of fuming sulfuric acid (15 - 18% by weight of free sulfuric anhydride) added. Heated at 100°C for two hours and stored in a brown glass stoppered bottle. (Phenoldisulfonic acid solution may also be prepared by adding 40 ml of phenoldisulfonic acid to 222 ml of concentrated sulfuric acid.)

The temperature and absolute gas pressure in each flask were recorded and the contents were rinsed into a 200 ml beaker using three 15 ml portions of water. A blank was prepared using the same amount of absorbing solution and wash water as used for each sampling flask. 1 N sodium hydroxide was added to the sample and the blank until each solution was just alkaline to litmus paper. Each solution was evaporated to dryness and cooled. 2 ml of phenoldisulfonic acid solution were added to the residue which was triturated thoroughly using a glass rod to make sure all of it came into contact with the acid. 1 ml of water and 4 drops of sulfuric acid were added and the solution was heated and cooled. Then, 20 ml of water were added to it. 10 ml of ammonium hydroxide were added with constant stirring. The solution and washings were transferred to a 50 ml volumetric flask and diluted to volume with water. The absorptions of the solution and the blank were read on a spectrophotometer at 420 mμ. The weight of nitrogen dioxide (milligrams) was determined from a standpoint calibration curve which was prepared from standard solutions treated in the same manner as the samples.

10. Odor

Odor was determined using method 6.1 as described in the Los Angeles Source Testing Manual.

Because no comparable mechanical or chemical detector has yet been developed, methods of odor detection and comparison must rely on the sense of smell. In view of the fact that the response of the human olfactory system does not allow an absolute or quantitative measurement of odor intensity, only relative intensities of odors were compared. Relative levels were determined by comparing the dilutions to which each of two or more odorous gases must be subjected in order that equal odor intensities result. As individuals vary widely in their relative sensitivity to odors, test panels were used, and the comparisons of relative odor intensities were made by diluting each odor to its limit of detectability, called the odor threshold.

The method used was based upon the ASTM Standard Method D 1391-57, termed Standard Method for Measurement of Odor in Atmospheres (Dilution Method). The technique disregards the character, causes, or absolute concentration of the odor-producing constituents in a sample. However, since the odor measurement is relative, the method can be used for determining the odor removal efficiency of odor control equipment by measuring the relative odor intensities of the inlet and exit gases.

A sample of the odorous gas was diluted with odor free air to the point where an odor could be detected by only 50 per cent of a selected test panel. The ratio of the total volume of diluted sample available to the panelist for test to the volume of the original sample represented in this diluted sample was a measure of the concentration of odor in the original sample.

The sample was collected in an evacuated 250 ml gas collection tube. The sample probe was flushed with a pump before the sample was taken. The tube was connected to the probe and opened to allow the gas to enter. Then the tube was sealed for delivery to the laboratory.

A portion of the contaminated air sample (50 ml or more) was transferred from the 250-ml gas collection tube to a 100-ml syringe equipped with an 18-gauge hypodermic needle. Mercury from a reservoir displaced the sample in the tube. The 18-gauge needle was held in the ball joint with a cork stopper. Transfer was as rapid as possible to minimize any possible chemical reaction with the mercury.

A 10 ml portion of the undiluted odor sample in the syringe was next transferred to a second 100-ml syringe using another 18-gauge needle. The seal between these two syringes was made by a cork stopper. The 10 ml sample in the second syringe was then diluted with fresh air to 100 ml, yielding an odor dilution factor of 10. Additional dilutions using 10 ml or more of the last diluted sample were then similarly made to desired concentrations. The final dilution was made in the individual 100-ml syringe assigned to each panel member. While the panel member drew back the plunger, 10 ml of the diluted sample was injected into his syringe through an 18-gauge hypodermic needle. The panelist then drew back the plunger to the 100-ml mark and waited approximately 10 seconds for diffusion to be complete.

The sample was then expelled into the nostril, with breathing suspended, over a period of two to three seconds. A record (yes or no) was made as to whether an odor was perceived in the diluted sample. As indicated by the ASTM method, successive dilutions of the original odor were presented to the panel in a random order. The dilution at which only 50 per cent of the panel could detect an odor corresponded to the odor threshold concentration. Precautions were taken not to destroy the odor sensitivity of the panelist by needlessly subjecting them to high odor concentrations or without allowing for adequate rest periods.

11. Oxygen, Carbon Dioxide, and Carbon Monoxide

Oxygen, carbon dioxide, and carbon monoxide were determined by an Orsat type analysis. Samples were taken in the field with the Fyrite Gas Analyzer manufactured by Bacharach Instrument Company. Oxygen and carbon dioxide were determined by absorbing the flue gases into the Fyrite solution in the analyzer. Before sampling, the probe was thoroughly flushed with flue gas by vacuum pumping. The analyzer was used in accordance with the manufacturer's directions. Carbon monoxide was determined with the Bacharach "Monoxor", a carbon monoxide indicator tube.

12. Water Content

The water content of the stack gas was determined from condensate in the impinger train since the ambient air temperature was too low to allow moisture determinations by the wet and dry bulb method.

13. Ringelmann Readings, Fuel Consumption, Fire Box Temperature, Percent Burn-Out

Ringelmann readings were obtained by visual comparison with a Micro Ringelmann Chart by trained observers. The readings shown in the report are the maximum observed during the testing.

Fuel consumption was determined by gas meter reading on the auxiliary fuel burner.

Fire box temperatures were determined by thermocouple and pyrometer with the thermocouple inserted 18 inches into the incinerator through the fire box door.

Percent burn-out was done by visual estimate of the total refuse left at the conclusion of each test.

TABLE I. TEST NO. 1--INCINERATOR C_3 STACK EMISSION DATA

(Incinerator charged at design capacity and operated as normal; five samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	12/27/68	12/27/68	12/27/68
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	30.24	30.24	30.24
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min.)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	9.34	13.07	
Av. Gas Temp (°F)	298	277	275
Gas Flow Rate (cfm)	2836	3968	
Apparent Molecular Wt. (lb/ft^3)	28.81	28.65	28.83
Gas Analysis, Dry Basis			
CO_2 (%)	0.1	0	0.5
O_2 (%)	20	21	21
CO (%)	0	0	0
N_2 (%)	79	79	78.5
H_2O (%)	1.30	1.82	0.79
SO_x (ppm)	1.49	1.22	0
NO_x (ppm)	41.7	19.7	5.7
Aldehydes (ppm)	2.60	1.80	0.09
Carbonyls (ppm)	8.21	6.22	0.58
NH_3 (ppm)	210	200	150
Hydrocarbons (ppm)	<10	35	75
Odor ($units/ft^3$)	120	10	33

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	5	7	1
Vol. of Water Vapor, Meter Condition (ft^3)	0.22	0.30	0.04
Vol. of Gas Sampled, Meter Condition (ft^3)	28.28	24.40	14.47
Total Vol. Sampled, Meter Condition (ft^3)	28.50	24.70	14.51
Vol. of Gas Sampled, Stack Condition (ft^3)	44.09	37.00	21.85
Vol. of Gas Sampled, Standard Conditions (ft^3)	30.59	26.62	15.64
Net Wt. Gain from Thimbles (grams)	0.0257	0.0269	0.0050
Particulate Emission rate (lb/hr)	0.16	0.17	0.03
Particulate Loading (No. particles x 10^6/min)			
Beginning of test	14.58	51.03	
Ending of test	<7.29	<7.29	<7.29
Ringelmann (units)	1.5	1.0	2.0

TABLE I. TEST NO. 1--INCINERATOR C_3 STACK EMISSION DATA (Cont'd)

(Incinerator charged at design capacity and operated as normal; five samples.)

GENERAL DATA:

Sample Number	4	5
Date of Test	12/27/68	1/2/69
Sample Weight (lb)	40	40
Barometric Pressure (in. Hg.)	30.24	29.93
Stack Area (ft^2)	5.06	5.06
Elapsed Sampling Time (min)	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)		13.35
Av. Gas Temp (°F)	275	152
Gas Flow Rate (cfm)		4053
Apparent Molecular Wt. (lb/ft^3)	28.65	28.77
Gas Analysis, Dry Basis		
CO_2 (%)	0	0.5
O_2 (%)	21	21
CO (%)	0	0
N_2 (%)	79	78.5
H_2O (%)	1.72	1.35
SO_x (ppm)	0	0.67
NO_x (ppm)	28.3	--
Aldehydes (ppm)	2.48	0.87
Carbonyls (ppm)	6.86	2.75
NH_3 (ppm)	190	--
Hydrocarbons (ppm)	<10	<10
Odor ($units/ft^3$)	2000	50

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	3	5
Vol. of Water Vapor, Meter Condition (ft^3)	0.13	0.22
Vol. of Gas Sampled, Meter Condition (ft^3)	10.00	27.07
Total Vol. Sampled, Meter Condition (ft^3)	10.13	27.29
Vol. of Gas Sampled, Stack Condition (ft^3)	15.32	34.08
Vol. of Gas Sampled, Standard Conditions (ft^3)	10.96	28.99
Net Wt. Gain from Thimbles (grams)	0.0062	0.0063
Particulate Emission rate (lb/hr)	0.04	0.04
Particulate Loading (No. particles x 10^6/min)		
Beginning of test	29.16	
Ending of test	<7.29	7.29
Ringelmann (units)	2.5	0.5

--Denotes no sample.

TABLE II. TEST NO. 2--INCINERATOR C_3 STACK EMISSION DATA

(Incinerator charged at tenant charging rate and operated as normal; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/2/69	1/2/69	1/2/69
Sample Weight (lb)	60	60	60
Barometric Pressure (in. Hg.)	29.90	29.90	29.90
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	12.80	15.63	
Av. Gas Temp (°F)	103	133	150
Gas Flow Rate (cfm)	3886	4745	
Apparent Molecular Wt. (lb/ft^3)	28.90	28.50	28.53
Gas Analysis, Dry Basis			
CO_2 (%)	1	1	0.5
O_2 (%)	20	17	20.5
CO (%)	0	0	0
N_2 (%)	79	82	79
H_2O (%)	0.55	3.17	3.36
SO_x (ppm)	0	2.08	1.98
NO_x (ppm)	25.9	27.5	23.8
Aldehydes (ppm)	1.68	0.89	1.57
Carbonyls (ppm)	5.64	3.10	6.02
Hydrocarbons (ppm)	<10	<10	<10
Odor (units/ft^3)	100	100	300

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	0	12	12
Vol. of Water Vapor, Meter Condition (ft^3)	0	0.53	0.53
Vol. of Gas Sampled, Meter Condition (ft^3)	24.05	20.35	18.07
Total Vol. Sampled, Meter Condition (ft^3)	24.05	20.88	18.60
Vol. of Gas Sampled, Stack Condition (ft^3)	27.63	25.06	23.16
Vol. of Gas Sampled, Standard Conditions (ft^3)	25.52	21.98	19.74
Net Wt. Gain from Thimbles (grams)			
first 15 mins of test	0.0074	0.0115	0.0151
last 15 mins of test	--[a]	0.0153	0.0113
Particulate Emission rate (lb/hr)			
first 15 mins of test	0.05	0.07	0.09
last 15 mins of test	--[a]	0.10	0.07
Particulate Loading (No. particles x 10^6/min)			
Beginning of test	72.9	25.52	<7.29
Ending of test		<7.29	<7.29
Ringelmann (units)	2.5	1.5	0.5

[a]Thimble chipped during testing of sample number 1.

TABLE III. TEST NO. 3--INCINERATOR C_3 STACK EMISSION DATA

(Incinerator charged at underload rate and operated as normal; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/24/69	1/24/69	1/24/69
Sample Weight (lb)	20	20	20
Barometric Pressure (in. Hg.)	30.04	30.03	30.03
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	31	30

GAS DATA:

Av. Gas Velocity (ft/sec)	10.09	8.50	10.02
Av. Gas Temp ($^{\circ}F$)	117	237	225
Gas Flow Rate (cfm)	3063	2581	3042
Apparent Molecular Wt. (lb/ft^3)	28.39	28.58	28.54
Gas Analysis, Dry Basis			
CO_2 (%)	0	0.5	0.5
O_2 (%)	21	20	21
CO (%)	0	0	0
N_2 (%)	79	79.5	78.5
H_2O (%)	4.13	2.81	3.48
SO_x (ppm)	2.1	0.5	0.5
NO_x (ppm)			
Aldehydes (ppm)	1.1	0.98	0.11
Carbonyls (ppm)	1.9	1.4	0.64
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	20	50	20

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	13	10	15
Vol. of Water Vapor, Meter Condition (ft^3)	0.58	0.45	0.67
Vol. of Gas Sampled, Meter Condition (ft^3)	17.18	23.04	26.24
Total Vol. Sampled, Meter Condition (ft^3)	17.76	23.49	26.91
Vol. of Gas Sampled, Stack Conditions (ft^3)	20.41	32.55	36.50
Vol. of Gas Sampled, Standard Conditions (ft^3)	18.47	24.37	27.81
Net Wt. Gain from Thimbles (grams)	0.1588	0.0073	0.0299
Particulate Emission rate (lb/hr)	0.99	0.04	0.19
Particulate Loading (No. particles x 10^5/min)			
Beginning of test		14.58	7.29
Ending of test	<7.29		
Ringelmann (units)	0.5	0.5	0.5

TABLE IV. TEST NO. 4--INCINERATOR C_3 STACK EMISSION DATA

(Incinerator charged at design capacity and operated with no overfire air[a]; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/4/69	1/4/69	1/4/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	30.09	30.09	30.07
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	20.5

GAS DATA:

Av. Gas Velocity (ft/sec)	6.48	6.37	9.62
Av. Gas Temp (°F)	271	283	231
Gas Flow Rate (cfm)	1967	1934	2921
Apparent Molecular Wt. (lb/ft^3)	28.93		28.68
Gas Analysis, Dry Basis			
CO_2 (%)	0.5		0
O_2 (%)	20.5		20.5
CO (%)	0		0
N_2 (%)	79		79.5
H_2O (%)	0.60	3.51	1.33
SO_x (ppm)	0	3.06	3.04
NO_x (ppm)	19.7	29.9	26.8
Aldehydes (ppm)	0.81	0.90	2.80
Carbonyls (ppm)	5.06	6.00	9.20
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	20	20	100

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	0	15	5
Vol. of Water Vapor, Meter Condition (ft^3)	0	0.65	0.22
Vol. of Gas Sampled, Meter Condition (ft^3)	22.54	21.27	27.46
Total Vol. Sampled, Meter Condition (ft^3)	22.54	21.92	27.68
Vol. of Gas Sampled, Stack Condition (ft^3)	33.49	33.24	39.03
Vol. of Gas Sampled, Standard Conditions (ft^3)	23.97	23.41	29.54
Net Wt. Gain from Thimbles (grams)	0.0251	0.0188	0.0334
Particulate Emission rate (lb/hr)	0.16	0.12	0.21
Particulate Loading (No. particles x 10^5/min)			
Beginning of test	14.58	14.58	14.58
Ending of test	<7.29	<7.29	<72.9[b]
Ringelmann (units)	1.5	1.0	2.0

[a] Fan off, damper closed. [b] Hopper door to chute opened by tenant.

TABLE IV. TEST NO. 4--INCINERATOR C_3 STACK EMISSION DATA (Cont'd)

(Incinerator charged at design capacity and operated with 50% overfire air[a]; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/4/69	1/7/69	1/7/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	30.08	29.41	29.39
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	12.67	9.11	14.74
Av. Gas Temp (°F)	231	239	245
Gas Flow Rate (cfm)	3847	2766	4475
Apparent Molecular Wt. (lb/ft^3)	28.77	28.73	28.52
Gas Analysis, Dry Basis			
CO_2 (%)	1	1	1
O_2 (%)	20	20	20.5
CO (%)	0.05	0	0
N_2 (%)	78.95	79	78.5
H_2O (%)	1.81	2.07	2.74
SO_x (ppm)	1.20	2.33	2.5
NO_x (ppm)	15.0	35.0	29.3
Aldehydes (ppm)	3.2	2.0	1.65
Carbonyls (ppm)	11.15	7.0	6.27
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	50	20	33

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	5	7	10
Vol. of Water Vapor, Meter Condition (ft^3)	0.22	0.32	0.46
Vol. of Gas Sampled, Meter Condition (ft^3)	26.00	25.37	28.13
Total Vol. Sampled, Meter Condition (ft^3)	26.22	25.69	28.59
Vol. of Gas Sampled, Stack Condition (ft^3)	35.95	35.91	39.68
Vol. of Gas Sampled, Standard Conditions (ft^3)	27.22	26.28	28.77
Net Wt. Gain from Thimbles (grams)	0.0192	0.0337	0.0085
Particulate Emission rate (lb/hr)	0.12	0.21	0.05
Particulate Loading (No. particles x 10^5/min)			
Beginning of test		25.52	14.58
Ending of test	<7.29		
Ringelmann (units)	1.5	1.5	1.5

[a]Damper half closed.

TABLE IV. TEST NO. 4--INCINERATOR C_3 STACK EMISSION DATA (Cont'd)

(Incinerator charged at design capacity and operated with full overfire air[a]; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/7/69	1/7/69	1/7/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	29.37	29.35	29.34
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	12	30

GAS DATA:

Av. Gas Velocity (ft/sec)	9.22	6.53	6.49
Av. Gas Temp (°F)	254	259	246
Gas Flow Rate (cfm)	2799	1983	1970
Apparent Molecular Wt. (lb/ft^3)	28.71	28.78	28.69
Gas Analysis, Dry Basis			
CO_2 (%)	0.5	1	1
O_2 (%)	20.5	21	20
CO (%)	0	0	0
N_2 (%)	79	78	79
H_2O (%)	1.77	2.04	2.44
SO_x (ppm)	1.94	5.8	1.5
NO_x (ppm)	31.7	26.4	35.7
Aldehydes (ppm)	2.1	3.5	3.1
Carbonyls (ppm)	9.46	13.0	12.2
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	50	50	16

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	5	7	10
Vol. of Water Vapor, Meter Condition (ft^3)	0.23	0.32	0.46
Vol. of Gas Sampled, Meter Condition (ft^3)	26.17	26.16	27.77
Total Vol. Sampled, Meter Condition (ft^3)	26.40	26.48	28.23
Vol. of Gas Sampled, Stack Condition (ft^3)	37.55	38.08	39.86
Vol. of Gas Sampled, Standard Conditions (ft^3)	26.86	27.03	28.81
Net Wt. Gain from Thimbles (grams)	0.0365	0.0436	0.0424
Particulate Emission rate (lb/hr)	0.23	0.68	0.26
Particulate Loading (No. particles x 10^6/min)			
Beginning of test	7.29	14.58	14.58
Ending of test			
Ringelmann (units)	2.0	1.0	1.5

[a]Damper completely opened.

TABLE V. TEST NO. 5--INCINERATOR C_3 STACK EMISSION DATA

(Incinerator charged at design capacity and operated with no auxiliary fuel; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/15/69	1/15/69	1/15/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	30.27	30.27	30.25
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	8.12	5.67	5.80
Av. Gas Temp (°F)	114	104	126
Gas Flow Rate (cfm)	2465	1721	1761
Apparent Molecular Wt. (lb/ft^3)	28.91		29.25
Gas Analysis, Dry Basis			
CO_2 (%)	1		1
O_2 (%)	19.5		20
CO (%)	0.1		0
N_2 (%)	79.4		79
H_2O (%)	0.60	0.76	1.61
SO_x (ppm)	9.4	0.8	2.7
NO_x (ppm)	7.6	22.4	30.7
Aldehydes (ppm)	1.8	1.9	2.1
Carbonyls (ppm)	8.7	8.2	8.6
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	100	25	25

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	0	0	5
Vol. of Water Vapor, Meter Condition (ft^3)	0	0	0.22
Vol. of Gas Sampled, Meter Condition (ft^3)	23.95	23.42	25.39
Total Vol. Sampled, Meter Condition (ft^3)	23.95	23.42	25.61
Vol. of Gas Sampled, Stack Condition (ft^3)	27.94	26.52	30.14
Vol. of Gas Sampled, Standard Conditions (ft^3)	25.61	24.74	27.04
Net Wt. Gain from Thimbles (grams)	0.0452	0.0237	0.0295
Particulate Emission rate (lb/hr)	0.28	0.15	0.18
Particulate Loading (No. particles x 10^5/min)			
Beginning of test		14.58	
Ending of test	<7.29		7.29
Ringelmann (units)	2.5	1.5	2.0

TABLE V. TEST NO. 5--INCINERATOR C_3 STACK EMISSION DATA (Cont'd.)

(Incinerator charged at design capacity and auxiliary fuel supplied for 10 minutes; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/15/69	1/15/69	1/15/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	30.24	30.23	30.51
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	5.73	8.51	7.16
Av. Gas Temp (°F)	112	172	142
Gas Flow Rate (cfm)	1740	2584	2174
Apparent Molecular Wt. (lb/ft^3)	28.83		28.87
Gas Analysis, Dry Basis			
CO_2 (%)	1		1
O_2 (%)	20		20
CO (%)	0		0.1
N_2 (%)	79		78.9
H_2O (%)	1.25	2.13	0.88
SO_x (ppm)	1.3	1.8	2.1
NO_x (ppm)	6.2	27.8	19.7
Aldehydes (ppm)	1.2	2.0	3.1
Carbonyls (ppm)	4.7	8.9	13.5
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	100	25	100

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	2	7	0
Vol. of Water Vapor, Meter Condition (ft^3)	0.09	0.31	0
Vol. of Gas Sampled, Meter Condition (ft^3)	23.94	26.03	20.20
Total Vol. Sampled, Meter Condition (ft^3)	24.03	26.34	20.20
Vol. of Gas Sampled, Stack Condition (ft^3)	27.38	33.03	24.22
Vol. of Gas Sampled, Standard Conditions (ft^3)	25.16	27.46	21.34
Net Wt. Gain from Thimbles (grams)	0.0124	0.0284	0.0551
Particulate Emission rate (lb/hr)	0.08	0.18	0.34
Particulate Loading (No. particles x 10^5/min)			
Beginning of test		36.45	7.29
Ending of test	<7.29		
Ringelmann (units)	1.5	2.0	1.0

TABLE V. TEST NO. 5--INCINERATOR C_3 STACK EMISSION DATA (Cont'd.)

(Incinerator charged at design capacity and operated with auxiliary fuel supplied for 30 minutes; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/17/69	1/17/69	1/17/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	30.53	30.52	30.48
Stack Area (ft^3)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	8.91	7.85	6.45
Av. Gas Temp (oF)	233	254	264
Gas Flow Rate (cfm)	2705	2383	1958
Apparent Molecular Wt. (lb/ft^3)	28.67	28.55	28.61
Gas Analysis, Dry Basis			
CO_2 (%)	1	0.5	0.5
O_2 (%)	20	20	20
CO (%)	0	0.1	0.1
N_2 (%)	79	79.4	79.4
H_2O (%)	2.62	3.06	2.46
SO_x (ppm)	1.1	28.6	0.9
NO_x (ppm)	10.4	43.7	26.6
Aldehydes (ppm)	0.89	3.0	3.1
Carbonyls (ppm)	2.8	12.7	17.9
Hydrocarbons (ppm)	<10	<10	<10
Odor (units/ft^3)	100	133	200

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	10	10	7
Vol. of Water Vapor, Meter Condition (ft^3)	0.44	0.45	0.31
Vol. of Gas Sampled, Meter Condition (ft^3)	26.91	24.40	26.05
Total Vol. Sampled, Meter Condition (ft^3)	27.35	24.85	26.36
Vol. of Gas Sampled, Stack Condition (ft^3)	37.46	34.65	37.27
Vol. of Gas Sampled, Standard Conditions (ft^3)	28.68	25.74	27.27
Net Wt. Gain from Thimbles (grams)	0.0090	0.0210	0.0207
Particulate Emission rate (lb/hr)	0.06	0.13	0.13
Particulate Loading (No. particles x 10^5/min)			
Beginning of test	14.58	7.29	7.29
Ending of test			
Ringelmann (units)	1.0	0.5	1.5

TABLE VI. TEST NO. 6--INCINERATOR C_3 STACK EMISSION DATA

(Incinerator charged at design capacity and operated as normal but with auxiliary fuel flame defected at 45° angle; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/24/69	1/24/69	1/24/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	29.99	29.95	29.96
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	7.41	8.48	7.63
Av. Gas Temp (°F)	226	155	275
Gas Flow Rate (cfm)	2250	2575	2316
Apparent Molecular Wt. (lb/ft^3)	28.63	28.72	28.76
Gas Analysis, Dry Basis			
CO_2 (%)	0.5	1	1.5
O_2 (%)	21	20.5	20.5
CO (%)	0	0	0.1
N_2 (%)	78.5	78.5	77.9
H_2O (%)	2.70	2.37	2.71
SO_x (ppm)	1.0	0.8	1.7
NO_x (ppm)			2.8
Aldehydes (ppm)	2.0	1.1	0.77
Carbonyls (ppm)	6.6	3.3	2.6
Hydrocarbons (ppm)	<10	<10	<10
Odor (units/ft^3)	500	50	100

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	11	8	10
Vol. of Water Vapor, Meter Condition (ft^3)	0.49	0.36	0.45
Vol. of Gas Sampled, Meter Condition (ft^3)	27.62	25.05	27.44
Total Vol. Sampled, Meter Condition (ft^3)	28.11	25.41	27.89
Vol. of Gas Sampled, Stack Condition (ft^3)	38.26	31.01	40.67
Vol. of Gas Sampled, Standard Conditions (ft^3)	29.07	26.24	28.81
Net Wt. Gain from Thimbles (grams)	0.0256	0.0171	0.0238
Particulate Emission rate (lb/hr)	0.16	0.11	0.15
Particulate Loading (No. particles x 10^5/min)			
Beginning of test	25.52		7.29
Ending of test		<7.29	
Ringelmann (units)	2.0	2.5	1.5

TABLE VII. TEST NO. 7--INCINERATOR C_3 STACK EMISSION DATA

(Incinerator charged at various rates with refuse of random composition and operated as normal; five samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	2/4/69	2/4/69	2/4/69
Sample Weight (lb)	4	16	30
Barometric Pressure (in. Hg.)	29.64	29.63	29.63
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	6.83	7.32	8.31
Av. Gas Temp (°F)	217	161	252
Gas Flow Rate (cfm)	2074	2222	2523
Apparent Molecular Wt. (lb/ft^3)	28.79	28.60	28.57
Gas Analysis, Dry Basis			
CO_2 (%)	0.5	0.5	0.5
O_2 (%)	19	19	19
CO (%)	0	0	0
N_2 (%)	80.5	80.5	80.5
H_2O (%)	0.53	2.25	2.54
SO_x (ppm)	0	0	1.1
NO_x (ppm)	4.5[a]	10.5	27.4
Aldehydes (ppm)	0	0.6	2.2
Carbonyls (ppm)	0.4	0.9	8.0
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	20	100	100

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	0	7	10
Vol. of Water Vapor, Meter Condition (ft^3)	0	0.31	0.45
Vol. of Gas Sampled, Meter Condition (ft^3)	20.80	18.80	23.18
Total Vol. Sampled, Meter Condition (ft^3)	20.80	19.11	23.63
Vol. of Gas Sampled, Stack Conditions (ft^3)	28.80	24.02	34.06
Vol. of Gas Sampled, Standard Conditions (ft^3)	21.91	19.92	24.63
Net Wt. Gain from Thimbles (grams)	--[b]	0.0023	0.0146
Particulate Emission rate (lb/hr)	--[b]	0.01	0.09
Particulate Loading (No. particles x 10^5/min)			
Beginning of test	<7.29	<7.29	<7.29
Ending of test			
Ringelmann (units)	0	0.5	1.0

[a]Absorbing solution froze during testing of sample number 1.

[b]Refuse sample did not ignite.

TABLE VII. TEST NO. 7--INCINERATOR C_3 STACK EMISSION DATA (Cont'd.)

(Incinerator charged at various rates with refuse of random composition and operated as normal; five samples.)

GENERAL DATA:

Sample Number	4	5
Date of Test	2/4/69	2/4/69
Sample Weight (lb)	40	60
Barometric Pressure (in. Hg.)	29.64	29.65
Stack Area (ft^2)	5.06	5.06
Elapsed Sampling Time (min)	45	45

GAS DATA:

Av. Gas Velocity (ft/sec)	10.41	9.48
Av. Gas Temp (°F)	268	251
Gas Flow Rate (cfm)	3160	2878
Apparent Molecular Wt. (lb/ft^3)	28.53	28.66
Gas Analysis, Dry Basis		
CO_2 (%)	0.5	1.5
O_2 (%)	18.5	18.5
CO (%)	0	0
N_2 (%)	81	80
H_2O (%)	2.70	2.86
SO_x (ppm)	2.0	0.2
NO_x (ppm)	9.8	32.2
Aldehydes (ppm)	3.7	1.9
Carbonyls (ppm)	22.14	14.14
Hydrocarbons (ppm)	<10	<10
Odor ($units/ft^3$)	333	200

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	10	10
Vol. of Water Vapor, Meter Condition (ft^3)	0.45	0.44
Vol. of Gas Sampled, Meter Condition (ft^3)	21.81	19.15
Total Vol. Sampled, Meter Condition (ft^3)	22.26	19.59
Vol. of Gas Sampled, Stack Conditions (ft^3)	32.74	28.31
Vol. of Gas Sampled, Standard Conditions (ft^3)	23.17	20.51
Net Wt. Gain from Thimbles (grams)	0.0511	0.0446
Particulate Emission rate (lb/hr)	0.21	0.19
Particulate Loading (No. particles x 10^6/min)		
Beginning of test	25.52	14.58
Ending of test		
Ringelmann (units)	1.0	2.0

TABLE VIII. TEST NO. 8--INCINERATOR C_3 STACK EMISSION DATA

(Incinerator charged at various rates with refuse of random composition and operated as normal; five samples.)

GENERAL DATA

Sample Number	1	2	3
Date of Test	2/6/69	2/6/69	2/6/69
Sample Weight (lb)	4	16	30
Barometric Pressure (in. Hg.)	29.99	29.98	29.97
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	13.96	8.36	9.79
Av. Gas Temp (°F)	163	216	240
Gas Flow Rate (cfm)	4238	2538	2972
Apparent Molecular Wt. (lb/ft^3)	28.79	28.69	28.69
Gas Analysis, Dry Basis			
CO_2 (%)	0.5	0.5	0.5
O_2 (%)	20	19	20
CO (%)	0	0	0
N_2 (%)	79.5	80.5	79.5
H_2O (%)	0.84	1.37	1.68
SO_x (ppm)	0.1	1.1	0.6
NO_x (ppm)	5.5	24.1	21.6
Aldehydes (ppm)	0	0	2.1
Carbonyls (ppm)	0.4	0.8	6.4
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	5	200	100

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	0	4	6
Vol. of Water Vapor, Meter Condition (ft^3)	0	0.18	0.26
Vol. of Gas Sampled, Meter Condition (ft^3)	15.43	26.73	25.30
Total Vol. Sampled, Meter Condition (ft^3)	15.43	26.91	25.56
Vol. of Gas Sampled, Stack Condition (ft^3)	19.23	36.68	36.22
Vol. of Gas Sampled, Standard Conditions (ft^3)	16.08	28.27	26.95
Net Wt. Gain from Thimbles (grams)	--[a]	0.0109	0.0077
Particulate Emission rate (lb/hr)	--[a]	0.07	0.05
Particulate Loading (No. particles x 10^6/min)			
Beginning of test	<7.29	<7.29	<7.29
Ending of test			
Ringelmann (units)	0	0.5	1.0

[a] Refuse sampled did not ignite.

TABLE VIII. TEST NO. 8--INCINERATOR C_3 STACK EMISSION DATA (cont'd)

(Incinerator charged at various rates with refuse of random composition and operated as normal; five samples.)

GENERAL DATA:

Sample Number	4	5
Date of Test	2/6/69	2/6/69
Sample Weight (lb)	40	60
Barometric Pressure (in. Hg.)	29.94	29.92
Stack Area (ft^2)	5.06	5.06
Elapsed Sampling Time (min)	45	45

GAS DATA:

Av. Gas Velocity (ft/sec)	6.70	6.72
Av. Gas Temp (°F)	196	150
Gas Flow Rate (cfm)	2034	2040
Apparent Molecular Wt. (lb/ft^3)	28.72	28.56
Gas Analysis, Dry Basis		
CO_2 (%)	0.5	0.5
O_2 (%)	19.5	20.5
CO (%)	0	0
N_2 (%)	80	79
H_2O (%)	1.27	3.20
SO_x (ppm)	1.7	0.4
NO_x (ppm)	25.1	19.0
Aldehydes (ppm)	2.0	3.0
Carbonyls (ppm)	7.4	28.5
Hydrocarbons (ppm)	<10	<10
Odor ($units/ft^3$)	200	100

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	7	11
Vol. of Water Vapor, Meter Condition (ft^3)	0.31	0.49
Vol. of Gas Sampled, Meter Condition (ft^3)	50.16	19.53
Total Vol. Sampled, Meter Condition (ft^3)	50.47	20.02
Vol. of Gas Sampled, Stack Condition (ft^3)	67.02	24.52
Vol. of Gas Sampled, Standard Conditions (ft^3)	53.16	20.90
Net Wt. Gain from Thimbles (grams)	0.0336	0.0418
Particulate Emission rate (lb/hr)	0.14	0.17
Particulate Loading (No. particles x 10^6/min)		
Beginning of test	36.45	36.45
Ending of test		
Ringelmann (units)	2.0	2.0

TABLE IX. TEST NO. 9--INCINERATOR C_1 STACK EMISSION DATA

(Incinerator charged at design capacity and operated as normal; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	1/28/69	1/28/69	1/28/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	30.74	30.73	30.71
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling Time (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	10.49	8.82	9.40
Av. Gas Temp (°F)	238	252	179
Gas Flow Rate (cfm)	3185	2678	2854
Apparent Molecular Wt. (lb/ft^3)	28.86	28.72	28.72
Gas Analysis, Dry Basis			
CO_2 (%)	1	0.5	0.5
O_2 (%)	19	19.5	20
CO (%)	0	0	0
N_2 (%)	80	80	79.5
H_2O (%)	0.54	1.29	1.45
SO_x (ppm)	0.5	0.4	0.6
NO_x (ppm)[a]	3.2	3.0	2.8
Aldehydes (ppm)	0.3	1.3	1.2
Carbonyls (ppm)	1.4	5.7	6.0
Hydrocarbons (ppm)	10	<10	10
Odor (units ft^2)	3	4	50

PARTICULATE EMMISSION DATA

Vol. of Water Condensed (cc)	0	4	5
Vol. of Water Vapor, Meter Condition (ft^3)	0	0.17	0.21
Vol. of Gas Sampled, Meter Condition (ft^3)	23.94	23.94	23.94
Total Vol. Sampled, Meter Condition (ft^3)	23.94	24.11	24.15
Vol. of Gas Sampled, Stack Condition (ft^3)	31.10	34.89	31.37
Vol. of Gas Sampled, Standard Conditions (ft^3)	26.10	26.17	26.20
Net Wt. Gain from Thimbles (grams)	--[b]	0.0116	0.0131
Particulate Emission rate (lb/hr)	--[b]	0.07	0.08
Particulate Loading (No. particles x 10^5/min)			
Beginning of test	7.29	14.58	14.58
Ending of test			
Ringelmann (units)	1.5	1.0	2.0

[a]Freezing of absorbing solution resulted in low values reported.

[b]Refuse sample did not ignite.

TABLE NO. X. PARTICULATE LOADING AND SIZE DISTRIBUTION (TESTS NO.'s 1 through 9)

Test No.	Sample No.	Exposed Area (in.^{2})	Particles/in.^{2} (<20 μ)	Percent Exposed Area Covered by Particles ≤2.5mm	2.5 to 0.5mm	1.5 to 0.1mm	<0.1mm
1	1[a]	7	10,000	8	7	5	80
	1[b]	6	5,000	6	9	5	80
	2[a]	6	3,500	10	5	5	80
	2[b]	8	2,500	5	5	10	80
	3[b]	7	5,000	8	7	0	85
	4[a]	8	7,500	10	10	5	75
	4[b]	7	2,500	7	8	5	80
	5[b]	7	5,000	8	5	7	80
2	1[a]	6	10,000	10	10	5	75
	2[a]	7	7,500	20	2	0	78
	2[b]	5	12,500	15	5	2	78
	3[a]	6	10,000	10	5	5	80
	3[b]	6	10,000	15	5	2	78
3	1[b]	4	1,000	1	2	1	96
	2[a]	4	3,000	2	1	0	97
	3[a]	4	2,000	0	3	2	95
4[c]	1[a]	6	7,500	10	2	3	85
	1[b]	7	10,000	10	3	5	82
	2[a]	7	10,000	10	3	2	85
	2[b]	5	12,500	5	5	5	85
	3[a]	5	12,500	10	3	2	85
	3[b]	7	10,000	10	3	2	85
4[d]	1[b]	6	1,500	20	0	1	79
	2[a]	6	3,500	10	5	1	84
	3[a]	5	5,500	15	3	1	81
4[e]	1[a]	6	2,000	40	10	5	45
	2[a]	6	2,000	35	10	10	45
	3[a]	6	2,000	45	10	0	45
5[f]	1[b]	4	3,000	5	2	3	90
	2[a]	4	2,000	5	3	2	90
	3[b]	5	1,000	5	4	2	89
5[g]	1[b]	4	5,000	10	3	2	85
	2[a]	4	4,000	15	0	1	84
	3[a]	4	6,000	5	7	3	85
5[h]	1[a]	7	1,000	10	0	0	90
	2[a]	7	3,000	1	5	4	90
	3[a]	6	2,000	5	3	2	90

[a] Beginning of test.
[b] Ending of test.
[c] No overfire air.
[d] 50% overfire air.
[e] Full overfire air.
[f] No auxiliary fuel.
[g] Auxiliary fuel on for 10 minutes.
[h] Auxiliary fuel on for 30 minutes.

TABLE NO. X. PARTICULATE LOADING AND SIZE DISTRIBUTION (TESTS NO.'s 1 through 9) Cont'd.

Test No.	Sample No.	Exposed Area (in.^{2})	Particles/in.^{2} (<20 μ)	Percent Exposed Area Covered by Particles ≤2.5mm	2.5 to 0.5mm	1.5 to 0.1mm	<0.1mm
6	1[a]	6	3,500	15	5	5	75
	2[b]	6	3,500	15	10	5	70
	3[a]	7	3,500	15	8	5	72
7	1[a]	6	<1,000	0	0	0	0
	2[a]	5	1,500	1	5	5	89
	3[a]	7	5,000	10	10	5	75
	4[a]	7	7,500	15	10	5	70
	5[a]	6	10,000	20	15	5	60
8	1[a]	6	<1,000	0	0	0	0
	2[a]	8	2,000	1	5	10	84
	3[a]	9	5,000	5	10	10	75
	4[a]	8	7,500	10	20	10	60
	5[a]	8	10,000	5	20	12	63
9[i]	1[a]	7	2,000	30	5	5	60
	2[a]	8	2,000	25	10	5	60
	3[a]	8	2,000	20	15	5	60

[i]This test conducted on incinerator C_1 ; all others on incinerator C_3 .

TABLE XI. FUEL CONSUMPTION, FIRE BOX TEMPERATURE, AND PERCENT BURN-OUT REFUSE

Test No.	Sample No.	Fuel Consumption[a] (ft.^{3})	Fire Box Temp. (Max. °F)	Refuse Burn-out (%)
1	1	100	950	>60
	2	110	980	>60
	3	80	850	>30
	4	90	950	>60
	5	120	550	>50
2	1	50	550	>50
	2	90	1280	>50
	3	80	500	>50
3	1	80	950	>50
	2	100	350	>50
	3	120	1100	>50
4[b]	1	110	1200	>40
	2	110	750	>50
	3	100	750	>60
4[c]	1	130	830	>70
	2	130	700	>70
	3	100	750	>65
4[d]	1	120	920	>60
	2	130	1200	>70
	3	130	1100	>65
5[e]	1	0	500	>50
	2	0	520	>50
	3	0	540	>50
5[f]	1	65	550	>40
	2	75	950	>85
	3	40	1220	>65
5[g]	1	160	600	>65
	2	190	800	>65
	3	210	1400	>65

[a] It should be noted that variations occurred in gas supply from one sample to another during the 15 minutes period it was supplied.

[b] No overfire air.

[c] 50% overfire air.

[d] Full overfire air.

[e] No auxiliary fuel.

[f] Auxiliary fuel on for 10 minutes.

[g] Auxiliary fuel on for 30 minutes.

TABLE XI. FUEL CONSUMPTION, FIRE BOX TEMPERATURE, AND PERCENT BURN-OUT REFUSE (Cont'd.)

Test No.	Sample No.	Fuel Consumption ($ft.^3$)	Fire Box Temp. (Max. °F)	Refuse Burn-out (%)
6	1	120	980	>65
	2	110	900	>50
	3	115	850	>50
7	1	120	290	> 0
	2	120	925	>80
	3	130	360	>60
	4	100	1210	>70
	5	80	1000	>60
8	1	110	420	> 0
	2	70	500	>80
	3	120	620	>80
	4	70	780	>65
	5	120	1100	>65
9[h]	1	90	580	>65
	2	160	1500	>65
	3	140	920	>65

[h]This test conducted on incinerator C_1, all others on incinerator C_3.

TABLE XII. TEST NO.'s 10 and 11--INCINERATOR C_3 STACK EMISSION DATA (NAPCA METHOD[a])

(Incinerator charged at underload rate for Test No. 10, at design capacity for Test No. 11 and otherwise operated as normal. Refuse of random composition, three samples each test.)

Test No.	Sample No.	Date	Sample Weight (lb)	Duration of Test (min)	gr/scf*	gr/scf* at 12% CO_2	Emission Rate (lb/hr)	Emission Rate (lb/ton Charged)	lb/1000 lb Dry Flue Gas at 50% Excess Air
10	1	3/11/69	20	30	0.07	1.31	0.77	38.51	2.50
	2	3/11/69	20	30	0.06	1.05	0.61	30.72	2.00
	3	3/11/69	20	30	0.08	1.46	0.83	41.39	2.79
11	1	3/12/69	40	60	0.07	1.14	0.80	39.87	2.17
	2	3/12/69	40	60	0.06	0.97	0.66	33.24	1.85
	3	3/12/69	40	60	0.06	0.92	0.62	30.86	1.75

* Standard Conditions:

Temperature = 70° F.
Pressure = 29.92 in. Hg.

The CO_2 reading ranged between 0.60 and 0.75 percent by volume, thus greatly increasing the loadings when corrected to 12 percent CO_2. These readings were taken after the auxiliary burner was turned off. The reason for the low CO_2 and high O_2 [not shown] readings was because of the large amount of excess air (over 2000 percent) being used.

[a]Data is reported as presented by U.S. Public Health Service.

TABLE XIII. TEST NO. 10--INCINERATOR C_3 STACK EMISSION DATA (ASME-PTC-27 METHOD)

(Incinerator charged at underload rate and operated as normal; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	3/11/69	3/11/69	3/11/69
Sample Weight (lb)	20	20	20
Barometric Pressure (in. Hg.)	29.40	29.39	29.39
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling (min)	30	30	30

GAS DATA:

Av. Gas Velocity (ft/sec)	7.31	7.36	7.32
Av. Gas Temp (°F)	143	148	148
Gas Flow Rate (cfm)	2219	2234	2222
Apparent Molecular Wt. (lb/ft^3)	28.93	28.79	29.05
Gas Analysis, Dry Basis			
CO_2 (%)	1.0	1.0	3.5
O_2 (%)	21.0	21.0	17.0
CO (%)	0	0	0.05
N_2 (%)	78.0	78.0	79.45
H_2O (%)	0.62	1.86	1.68
SO_x (ppm)	0.45	0.23	2.05
NO_x (ppm)	2.24	13.97	8.90
Aldehydes (ppm)	1.87	1.82	2.39
Carbonyls (ppm)	9.52	8.44	11.81
Hydrocarbons (ppm)	<10	<10	<10
Odor (units/ft^3)	7	3	50

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	0	6	5
Vol. of Water Vapor, Meter Condition (ft^3)	0	0.27	0.22
Vol. of Gas Sampled, Meter Condition (ft^3)	22.40	21.20	19.33
Total Vol. Sampled, Meter Condition (ft^3)	22.40	21.47	19.55
Vol. of Gas Sampled, Stack Condition (ft^3)	27.45	26.53	24.21
Vol. of Gas Sampled, Standard Conditions (ft^3)	23.26	22.29	20.34
Net Wt. Gain from Thimbles (grams)	0.0209	0.0032	0.0179
Particulate Emission rate (lb/hr)	0.13	0.02	0.11

TABLE XIV. TEST NO. 11--INCINERATOR C_3 STACK EMISSION DATA (ASME-PTC-27 METHOD)

(Incinerator charged at design capacity and operated as normal; three samples.)

GENERAL DATA:

Sample Number	1	2	3
Date of Test	3/12/69	3/12/69	3/12/69
Sample Weight (lb)	40	40	40
Barometric Pressure (in. Hg.)	29.55	29.56	29.56
Stack Area (ft^2)	5.06	5.06	5.06
Elapsed Sampling (min)	60	60	60

GAS DATA:

Av. Gas Velocity (ft/sec)	7.52	7.79	7.78
Av. Gas Temp (°F)	180	225	225
Gas Flow Rate (cfm)	2283	2365	2362
Apparent Molecular Wt. (lb/ft^3)	28.83	28.78	28.82
Gas Analysis, Dry Basis			
CO_2 (%)	1.0	1.0	1.5
O_2 (%)	20.0	19.5	19.0
CO (%)	0.05	0.05	0.4
N_2 (%)	78.95	79.45	79.10
H_2O (%)	1.17	1.45	1.67
NO_x (ppm)	16.82	37.20	
Hydrocarbons (ppm)	<10	<10	<10
Odor ($units/ft^3$)	33.3	5.0	

PARTICULATE EMISSION DATA:

Vol. of Water Condensed (cc)	2	7	9
Vol. of Water Vapor, Meter Condition (ft^3)	0.09	0.31	0.40
Vol. of Gas Sampled, Meter Condition (ft^3)	15.23	36.10	40.11
Total Vol. Sampled, Meter Condition (ft^3)	15.32	36.41	40.51
Vol. of Gas Sampled, Stack Condition (ft^3)	19.97	50.69	56.06
Vol. of Gas Sampled, Standard Conditions (ft^3)	16.02	38.02	42.04
Net Wt. Gain from Thimbles (grams)	0.1825	0.0540	0.0518
from Impingers (grams)	0.0404	0.0252	0.0241
Total	0.2229	0.0792	0.0759
Particulate Emission rate (lb/hr)	0.68	0.24	0.23

APPENDIX F

BIBLIOGRAPHY

BIBLIOGRAPHY

A continuous literature search for papers, reports, and articles on solid waste is being conducted during the study, with particular emphasis on references pertaining to the onsite handling of refuse but with some attention to references dealing with solid waste in general. Some 226 references have been collected, of which 168 are related to onsite refuse handling and are listed in this bibliography. Numbers in parentheses on the right of entries are for internal identification.

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