ENVIRONMENTAL CHARACTERIZATION OF REFUSE DERIVED FUEL INCINERATOR TECHNOLOGY

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ABSTRACT

Environment Canada and the U.S. Environmental Protection Agency (EPA) have undertaken a joint program to evaluate means to control emissions from modern combustion systems burning Refuse Derived Fuels (RDF). An RDF combustion facility representing modern practice has been selected. A comprehensive environmental characterization of this facility has been planned which will evaluate the impact of operating variables on emissions of trace organics, metals in fly ash and the quality of the bottom ash and fly ash. This paper presents the results of the first phase of the program covering the site selection and the test program development.

INTRODUCTION

The increasing cost and complexity of landfilling municipal solid waste (MSW), combined with the difficulties of locating new sites and expanding existing ones, has forced municipalities in both Canada and the United States to seriously consider available alternatives. The significant volume and weight reduction, and the energy potential, have made incineration of MSW an attractive alternative.

Current predictions by the EPA indicate that a substantial growth in municipal solid waste incinerators will occur over the next 10–20 years. Today about 100 MSW incinerators burn about 4 percent of the annual volume of MSW generated in United States, whereas it is conceivable that by the year 2000, one-third of the MSW will be incinerated in more than 300 MSW incinerators. There is definite trend moving toward incineration of MSW in the United States, and away from exclusively landfilling the waste [1].

In Canada, the majority of municipalities are facing a crisis in the disposal of increasing volumes of MSW. At the present time only 8% of municipal solid waste is incinerated with less than 4% in energy from waste (EFW) facilities. Less than 2% of Canada's municipal solid waste is recycled. In the next decade, up to 50% of Canada's waste could be disposed of in EFW facilities, with the construction of over 40 new facilities across Canada. This would provide a potential saving of 8–120 million barrels of oil annually [1].

A concern raised repeatedly in connection with both existing and proposed MSW incinerators is their impact on health and the environment. Historically, poorly designed, controlled, and/or operated incinerators have resulted in nuisances and have demonstrated that environmental concerns can be sufficient to close facilities. More recently, the release of potentially toxic metal and organic emissions from these incinerators has become an issue.

In Canada, little or no development of MSW facilities will take place unless the public concern over the health and environmental impact of emissions from these facilities is satisfactorily managed. To deal with these concerns, Environment Canada established the National Incinerator Testing and Evaluation Program (NITEP) in 1984. This five year program is mandated: to identify the energy-from-waste technology most likely to be utilized in Canada; to assess relationships among state-of-the-art designs, operations, energy benefits and emissions; to examine the effectiveness of emission controls; and to provide input to National Guidelines for Emissions.

Under NITEP three incinerator technologies have been identified for study and assessment. Two of the assessments which have been completed to date. The first study was on two-stage modular incinerator technology suitable for small communities. The second study, on mass burning technology suitable for large communities, was completed in Quebec City in July 1986. The third test will be on a representative prepared refuse burning technology commonly referred to as refuse derived fuel (RDF). Comprehensive testing of this technology will begin in the summer of 1988 at the Mid-Connecticut Resource Recovery Project located in Hartford, Connecticut.

The NITEP III field test program will be a joint United States EPA/Environment Canada evaluation. Of significant interest to Environment Canada is the need to complete the series of tests begun in 1984 under NITEP as part of its regulatory developments. EPA's interests lie in sharing some of the developments achieved under NITEP, as well as obtaining first hand information on RDF incinerators for its regulatory requirements. In an effort to reduce the financial burden to both government agencies, a cost sharing approach has been developed under the auspices of a Memorandum of Understanding signed between both departments in 1985.

The aim of this paper is to report on the progress of NITIP III to evaluate the current technology in the area of Refuse Derived Fuel (RDF) incinerator technology including the selection of a site and preparation of the combustion test program and how the test program will be conducted.

DESCRIPTION OF REFUSE DERIVED FUEL (RDF) INCINERATORS

The main difference between incineration of municipal solid waste in mass burning and refuse derived fuel (RDF) facilities is that in the latter case, the refuse is processed prior to burning. Processing can vary from simple removal of bulky items and shredding, to extensive processing producing a fuel suitable for cofiring in coal-fired boilers. RDF-based technologies also differ in the extent and form of both the fuel preparation and as well as in the combustion system. RDF does not necessarily have to be combusted on-site in dedicated boilers, but can be sold for firing as a fuel off site. Some of the advantages of processing refuse is that it becomes more homogeneous and has a greater heating value per pound as well as requiring a smaller burning grate. Processing of the refuse prior to burning also allows a greater portion to be recovered for recycling.

Dedicated boilers used to combust RDF have basically the same design as those for coal-fired boilers, and can include suspension, stoker, and fluidized bed designs. If the RDF is sold as a fuel, it may be cofired with a fossil fuel (usually coal). Dedicated RDF-fired boilers can be designed to handle over 1000 TPD. A typical schematic of an RDF processing facility with on-site boiler firing and recycling is shown in Fig. 1.

Types of RDF

The American Society for Testing and Materials (ASTM) through its Committee E-38.01 on Resource Recovery Energy has established classifications defining different types of RDF. The seven classifications and the resultant fuel descriptions are summarized in Table 1.

RDF Technologies

RDF projects employ boilers systems manufactured by Combustion Engineering (CE), Babcock and Wilcox (B&W), Foster Wheeler (FW), Riley, or Zurn. CE and B&W combined represent approximately 80% (TPD basis) of the active RDF projects. For the projects using B&W and FW boilers, a majority employ combustion systems supplied by Detroit Stoker (DS). The CE facilities use firing systems designed by CE, and Riley and Zurn uses their own systems. To a large extent the Riley and Zurn systems are similar to the DS system. The following sections briefly describe the DS and CE firing systems.

Detroit Stoker RDF Firing Systems

Detroit Stoker Company has manufactured hardware for burning nontraditional fuels such as wood, sawdust, bagasse, etc., since the early 1940s. Firing systems developed for burning RDF result in semi-suspension burning where the fuel is injected through wall ports into the furnace. The fuel partially burns in the suspension phase with larger material falling to the grate for burnout on the fuel bed. Figure 2 shows a

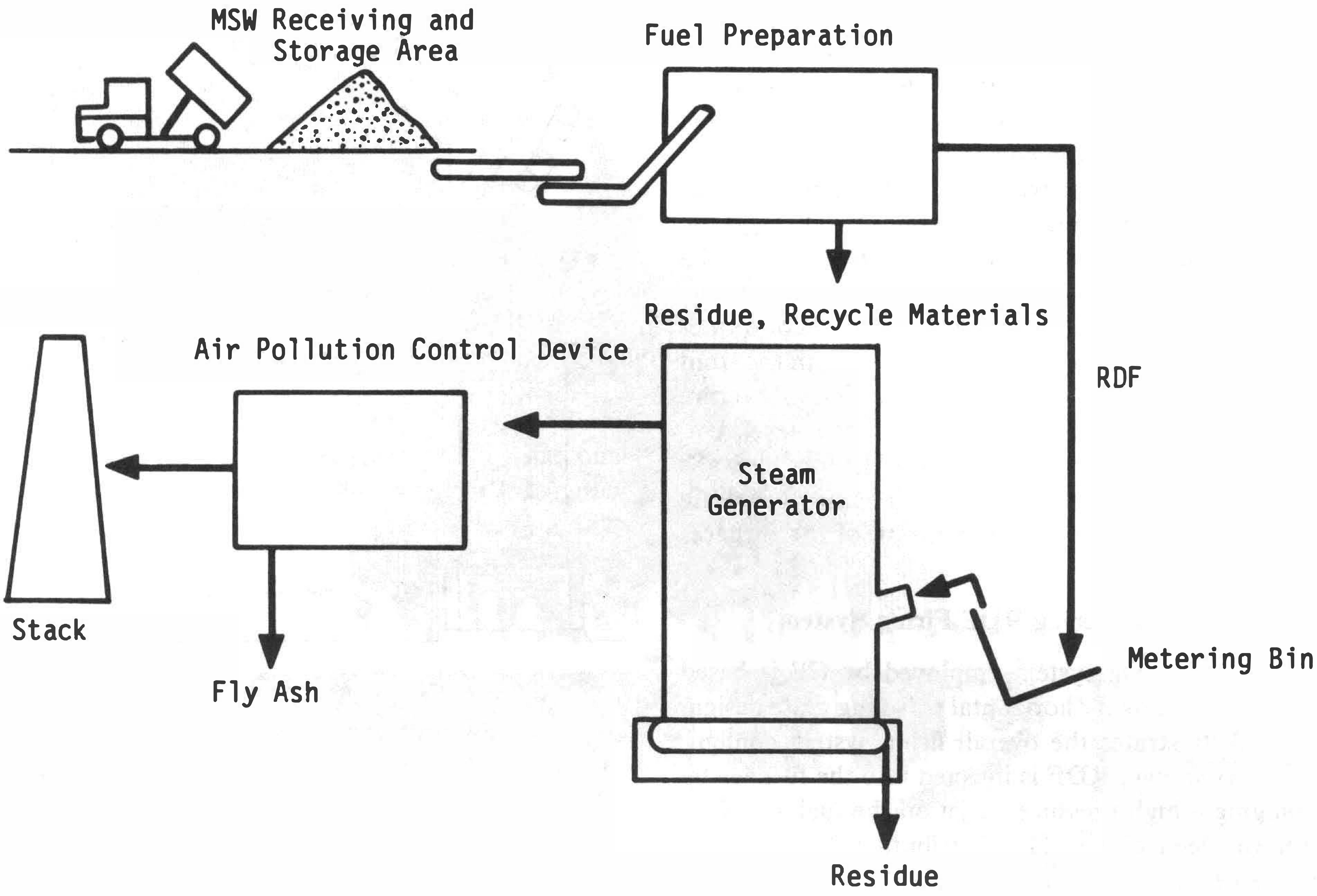

FIG. 1 RDF PROCESSING FACILITY WITH ON-SITE BOILER FIRING AND RECYCLING

typical Detroit Stoker, air swept fuel distributor system coupled with a traveling grate (Detroit Rotograte Stoker).

The traveling grate illustrated in Fig. 2 is based on the design developed for stoker coal firing. The grate forms a continuous loop driven by sprockets at the front and rear of the furnace chamber. As the grate travels from rear-to-front, the ash layer thickness increases. Ash is dumped from the grate at the front end of the boiler. Underfire or primary air is uniformly distributed through a single plenum under the grate with this system.

A critical component of the design is that the fuel injector can provide a thin bed of RDF which is uniformly distributed on the grate. The ash layer thickness will increase from the rear to the front of the boiler but the burning RDF layer thickness will be essentially constant. If that goal is achieved, spatially uniform underfire air addition would result in spatially uniform heat release and excess air levels in the furnace. To

TABLE 1 ASTM CLASSIFICATION OF RDFs

Class	Form	Description
RDF-1 (MSW)	Raw	Municipal solid waste with minimal processing to remove oversize bulky waste
RDF-2 (C-RDF)	Coarse	MSW processed to coarse particle size with or without ferrous metal separation such that 95% by weight passes through a 6 in. square mesh screen
RDF-3 (f-RDF)	Fluff	Shredded fuel derived from MSW processed for the removal of metal, glass, and other entrained inorganics; particle size of this material is such that 95% by weight passes through a 2 in. square mesh screen
RDF-4 (p-RDF)	Powder	Combustible waste fraction processed into powdered form such that 95% by weight passes through a 10 mesh screen (0.035 in. square)
RDF-5 (d-RDF)	Densified	Combustible waste fraction densified (compressed) into pellets, slugs, cubettes, briquettes, or similar forms
RDF-6	Liquid	Combustible waste fraction processed into a liquid fuel
RDF-7	Gas	Combustible waste fraction processed into a gaseous fuel

accomplish that objective, Detroit Stoker has developed a device they refer to as the Detroit rotor distributor refuse feeder. A stream of air impinges on the RDF as it falls down the feed chute, injecting the fuel into the boiler. A rotating damper is used to alternately increase the flow of distributor air. With the damper fully open, RDF is blown toward the rear of the grate. With the damper closed, RDF tends to fall near the front of the grate.

As shown in Fig. 2, Detroit Stoker incorporates several elevations of overfire air ports on both the front and rear walls of the boiler. One elevation of overfire air ports is provided below the fuel injector level. Unlike mass burning incinerator designs, the furnace walls are straight. Thus, the overfire air must penetrate across the entire plan view dimension of the furnace.

Combustion Engineering RDF Firing System

The RDF firing system employed by CE is based on a spreader stoker/horizontal traveling grate design. Figure 3 illustrates the overall firing system configuration. As shown, RDF is injected into the furnace by impinging a high pressure air jet on the fuel as it falls from the feed chute. The distribution air nozzle is adjustable which provides control over the spatial distribution of RDF on the grate.

The grate itself travels from the rear to the front of the boiler with ash dumping at the front of the boiler. The CE design incorporates multiple undergrate air compartments with a siftings screw conveyor in each compartment. The air flow to each undergrate air plenum is individually controllable. Thus, the air flow distribution through the grate can be adjusted to match the RDF flow pattern developed by the fuel feed system.

Overfire air, or secondary air, addition is accomplished through a tangential entry system characteristic of CE utility boilers. The tangential overfire air ports are located well above the fuel injection elevation. The design is obviously influenced by CE's utility boiler design philosophy but has also been optimized through extensive cold flow modeling studies.

PROGRAM

The overall program is divided into two phases with subphases as follows

Phase 1

Part 1. Site Selection.
Part 2. Combustion.

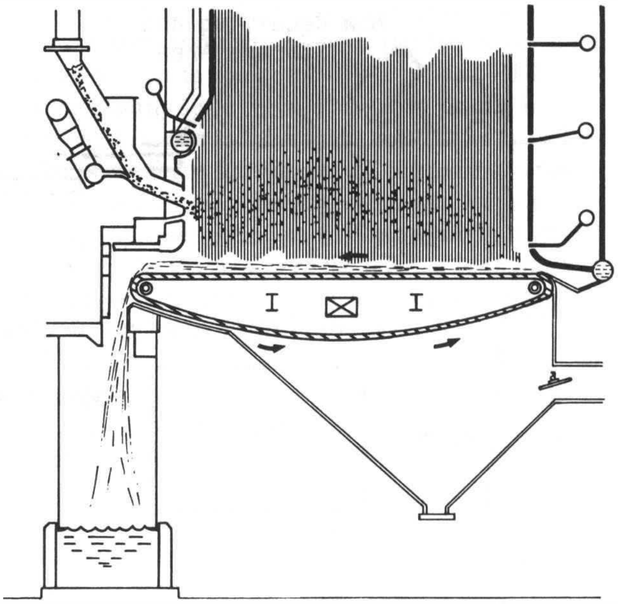

FIG. 2 SIDE SECTIONAL VIEW OF DETROIT ROTORGRATE STOKER EQUIPPED WITH DETROIT AIR SWEPT REFUSE DISTRIBUTOR SPOUTS

Phase 2

Stage 1. Mobilization and Set-Up.
Stage 2. Characterization Tests.
Stage 3. Performance Tests.
Stage 4. Data Processing and Reporting.

The product of Phase 1 will be used in developing a comprehensive test program on RDF incinerator technology. In addition to selecting the most appropriate site (Part 1), the program included setting preliminary test conditions, sampling locations and other relevant information necessary for designing a test program (Part 2). Two levels of testing will be employed in the program as follows:

(a) Characterization Tests
  (1) basis of understanding of the incinerator operating range, debugging of all systems, facility logistics and field crew familiarization
    (a) 4-hr duration
    (b) Continuous Emission Monitors (CEMs)
(b) Performance Tests
  (1) extensive sampling and analysis, process evaluation and data evaluation
    (a) 8-hr duration
    (b) CEMs
    (c) sampling and analysis of organic emissions

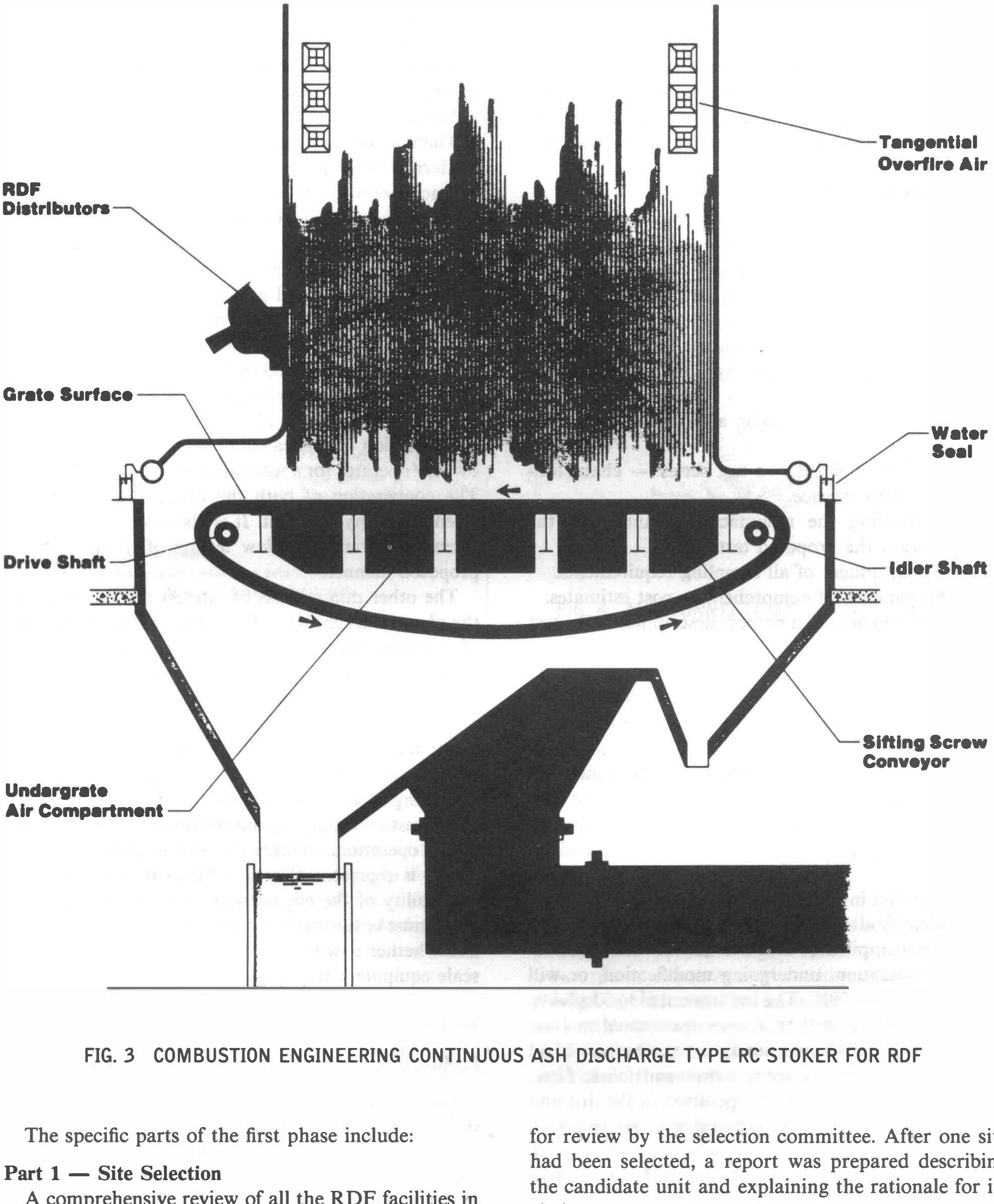

FIG. 3 COMBUSTION ENGINEERING CONTINUOUS ASH DISCHARGE TYPE RC STOKER FOR RDF

The specific parts of the first phase include:

Part 1 — Site Selection

A comprehensive review of all the RDF facilities in North America was conducted, their characteristics assessed and contacts were made with the owner/operators to determine whether they would participate in an evaluation program. After a ranking procedure had been established, five candidate sites were selected for review by the selection committee. After one site had been selected, a report was prepared describing the candidate unit and explaining the rationale for its choice.

Part 2 — Combustion Program

A document was prepared which will serve as a basis for setting preliminary test conditions, sampling locations, and other information which is necessary for designing a test program. The purpose of this test program is to develop criteria on the design and operating practices of RDF incinerators which will minimize emissions of toxic compounds without any adverse impact upon other emissions or the characteristics of solid residues. The test plan includes the following:

(a) Preparation of a host agreement.

(b) Resolution of economic impact of testing on the operation of the candidate unit.

(c) Preparation and documentation of a detailed test program which will assess all input and output streams as well as characterize the state of the unit.

(d) Development of test matrix test sheets on a spread sheet format defining specific operating conditions.

(e) Identification of major activities for the field program.

(f) Establishment of two test series — characterization and performance.

(g) Contacting the manufacturer/builder of the unit to review the proposed tests.

(h) Establishment of all sampling requirements.

(i) Preparation of comprehensive cost estimates.

(j) Development of a process description of the test unit.

SITE SELECTION

The activities leading to the site selection included the following

Available RDF Facilities

The first task in the site selection part of the program was to identify all RDF incinerators in North America. A list was compiled of all RDF units which are currently in operation, undergoing modification, or will be operational by 1989. The list amounted to 35 plants. Almost all of the units that were operational in July, 1987 utilized electrostatic precipitators. One plant had been retrofitted with a spray tower and fabric filter. Several plants scheduled for operation in the 3rd and 4th Quarters of 1987 are equipped with spray dryers and fabric filters.

Ranking Criteria

In order to select the best site to host the test program, a list of ranking criteria was developed. The characteristics of each of the candidate units were evaluated using standard guidelines to avoid any biasing which could occur without such a system. The criteria were separated into three separate categories, Modern Practice, Flexible Operation, and Additional Considerations. A list of the ranking criteria is specified in Table 2.

The unit selected must be representative of the most modern design, since the purpose of the tests is to characterize plants which exhibit current and projected future technological trends in design and operation. The specific areas to be ranked in the category of modern practice include RDF preparation, RDF feeding system, stoker and grate, boiler/combustion system, and Air Pollution Control Devices (APCDs). Each of these areas were given equal weighting of 20 points for a total of 100 in the first category.

The second category helps to evaluate the facility in terms of the flexibility of operation. The most important criterion in this category is the willingness of the owner/operator for a weighting of 50 out of 100 points. The cooperation of both the owner and operator is essential in any field test. It is also important that the permit requirements allow testing of the unit in the proposed manner.

The other minor areas of interest are the ability of the plant to accept RDF from other units, the number of units the plant has, and the plant set-up in terms of available space for trailers and test equipment.

The final category was the additional consideration of various factors. It is quite important to have adequate access for sampling of RDF, of the boiler, and of the stages in the APCD. This area was given a weighting of 40 out of the final 100 points. Other areas of interest in a test program would include the control of the operation, whether or not the plant fires RDF which is representative of a "typical" unit, and the availability of the engineering data. A final consideration must be the arrangement of the APCD equipment and whether it would be possible to arrange for pilot scale equipment to be tested.

Preliminary Review

The process of selection of a host site continued with an initial screening of the available RDF plants. Many units were eliminated due to fuel type, grate design or age of the unit. Other units which plan to be in operation in late 1988 or 1989 were also eliminated since they will not be completed in time for the test program schedule.

After a second review which was based quite heavily on new units and those employing the most recent technology, the possible candidate selection was re-

TABLE 2 SELECTION CRITERIA

Points	Modern Practice	
20	RDF Preparation	- Size Reduction/Classification - Metals Removal - Refuse Weighing Capability
20	Feeding Systems	- Controlled Uniform Feeding - Metered RDF Feeding
20	Stokers and Grates	- Design Representative of Modern Practice
20	Boiler/Combustion Systems	- Overfire/Undefire Air - Welded Walls - Refractory Cladding - Furnace Exit Temperature
20	APCD	- Ash Collection Capability - Type and Conditions
100		
	Flexible Operation	
50	Owner/Operator Willingness	
20	Permit Conditions	- Range of Operation - Ability to Modify
10	Accept RDF From Other Units	
10	Multiple Units	
10	Plant Set-Up	- Space
100		- Access
	Additional Consideration	
40	Sampling Access	- RDF - Number of Doors on Boiler - Flue Between Boiler & APCD - Stack Access - Plant Spacing
15	Control & Monitoring	- Metered Feeding - Btu Control System - Air Heaters - Plant Spacing
15	Representative RDF	
15	Availability of Engineering Data	
15	Spray Dryer/Baghouse Access for Pilot Scale	
-	Power Supplies	
-	Cost Sharing Possible	
-	Proprietary Information Identification	
100		
===		
Total 300		

duced again. The site visitation was accomplished in three days, with the site selection committee visiting three candidates. Each member of the committee was provided with a notebook containing the trip itinerary, some information on the layout and processing of each plant, and list of the ranking criteria for each plant.

Selected Site

The mid-Connecticut plant was selected; the plant was designed and built by Combustion Engineering [2]. An artist's version of the complete facility is shown in Fig. 4. The new boilers are housed in an old boiler house from which the old boilers were removed. The facility is located along the Connecticut River on the South side of Hartford in the South Meadow area. The plant is currently under construction with an anticipated start-up date of November, 1987 and commercial operation by June, 1988. The anticipated fuel capacity is 2000 TPD. The plant will have three boilers each producing 231,000 lb/hr (29.1 kg/s) of steam and 68.5 MW of power.

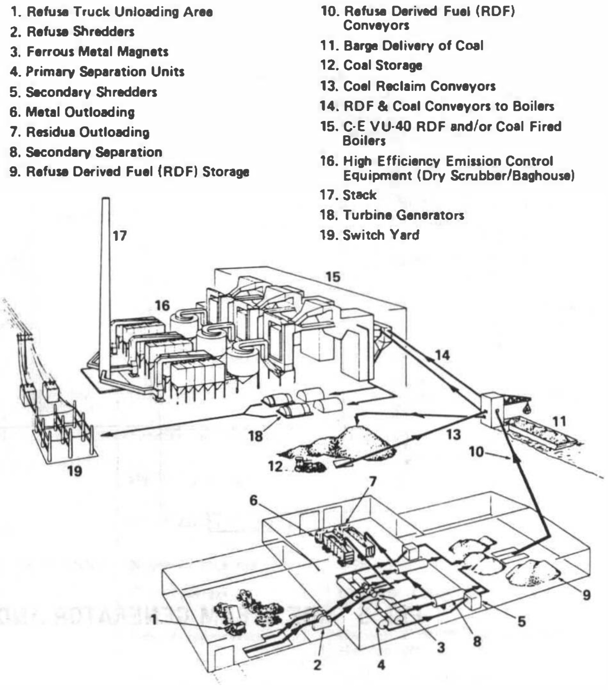

FIG. 4 MID-CONNECTICUT — FACILITY LAYOUT

The RDF processing is located in a building which is separated from the boiler house, with the RDF being transported to the boiler on covered conveyors. RDF processing at this facility can operate at a full load of 100 tons/hr on each of the two processing lines. MSW is received from trucks onto a tipping floor. The MSW is then inspected to remove bulky items and hazardous material before being transported to a flail mill. After bags are broken open, iron and steel are removed by drum type magnetic separators. The bulk of the waste is then conveyed to large rotary trommel screens, which allow noncombustible residue such as glass and sand to be removed. The second stage of the trommel separates out the combustible fraction which does not need further size reduction. Oversize material is conveyed to a hammermill shredder for final size reduction.

The CE steam generating units shown in Fig. 5 are natural circulation welded-wall boilers with a 2½ in. (64 mm) O.D. tubing on 3-in. (76 mm) centers. The upper section of the furnace contain widely spaced screen panels which cool the gases below the ash fusion temperature before they enter the superheater. The superheater consists of a vertical two-stage pendant platen design which is located over the furnace's nose arch to protect it from direct radiation. Following the

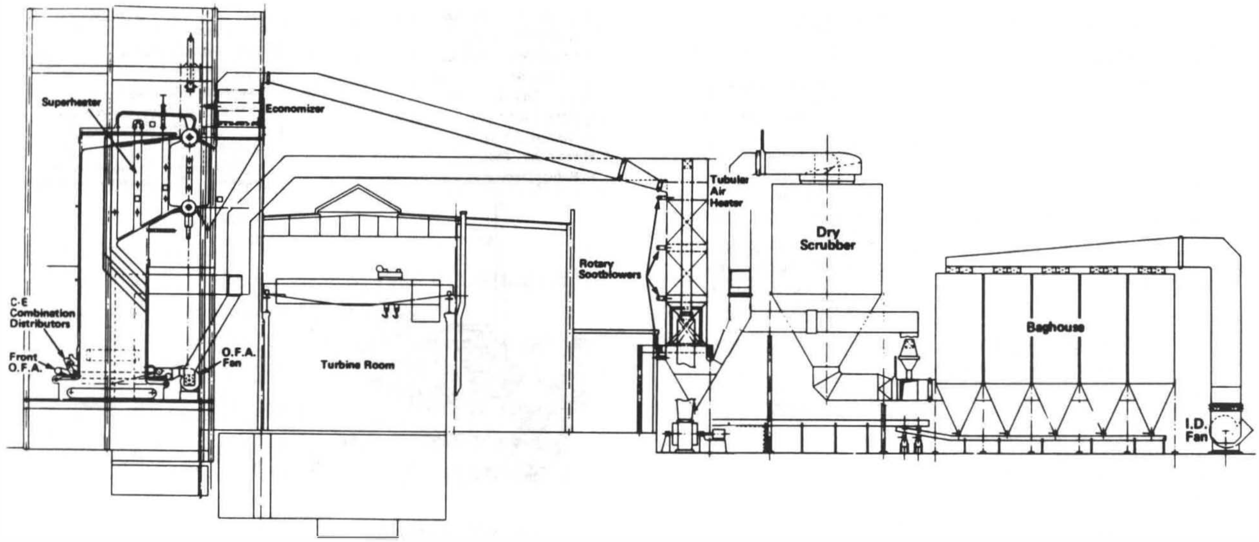

FIG. 5 RDF STEAM GENERATOR AND APC EQUIPMENT FOR MID-CONNECTICUT

superheater is the economizer which consists of two horizontal banks of in-line tubes.

The fuel burning system consists of a CE Refuse Combustor Stoker and specially designed grate. The grate includes a self-cleaning key design to remove fused or clinkered ash during grate operations. Multiple undergrate air zones provide controlled air flow to ten areas of the grate. The fuel is conveyed from the RDF storage area to surge bins located at the front of each boiler. A vibrating pan feeder is used to feed the fuel uniformly to the stoker.

The overfire air system is separate for the coal and the RDF burning. The RDF system consists of four tangential overfire air windbox assemblies located in the furnace corners. Preheated air is admitted tangentially to form a vortex. Overfire air ports for the coal combustion are located on the front and rear walls. One row of ports is provided on the front wall and two rows on the rear wall. Thus overfire air either in tangential or wall-mode, or a combination of both modes is possible.

The ash removal system consists of two streams which are later combined and stored for eventual storage. The first stream collects the bottom ash, economizer ash and stoker siftings. The second stream collects baghouse and air heater ash. After this has been conditioned in a pug mill, it is combined with the first stream and transported to a three-sided storage bin.

The flue gas cleaning system consists of a lime-based dry scrubber followed by reverse-air fabric filter. The scrubber has a separate control for both the flue gas flow rate and the limestone slurry addition flow rate, which is governed by the SO_2 and HCl levels downstream of the scrubber and the gas flow rate from the boiler. The fabric filters have twelve compartments, each with 168 woven glass filter bags.

Some of the other major advantages to this CE system include the multiple plenum undergrate air and the variety of overfire air configurations possible. Some of the key parameters to be examined in the testing include the various arrangements of overfire air and the impact which segregated undergrate air has upon emissions levels. Another significant factor which has a major impact on the decision of which facility will host the test program is the willingness of the owner/operator to cooperate. Combustion Engineering and the other owner-operator groups — the Connecticut Resources Recovery Authority and the Metropolitan District Commission — have been quite open in their desire to accommodate this program at their plant.

COMBUSTION PROGRAM

The activities leading to the combustion program are derived from previous NITEP combustion programs and include the following:

Requirements

The focus of the field combustion program for RDF units is on the following:

(a) Defining conditions where potentially hazardous pollutants (e.g., chlorinated dibenzodioxin (CDD)/chlorinated dibenzofuran (CDF) are formed (both high temperature and post combustion zones).

(b) Validate the principal hypothesis that "good combustion" yields low CDD and hazardous hydrocarbon emissions.

(c) Define criteria for "good combustion" including design, operation, verification and monitoring and generate information that will promote improvement in incinerator technology.

(d) Provide data that will create confidence in the public that RDF incineration does not impose a serious health hazard.

The program plan must address these issues and be structured in such a manner to allow these goals to be achieved. A series of preliminary "combustion" design and operating guidelines have been defined for RDF units that can serve as the hypothesis for the test plan [1]. These combustion practices are shown in Table 3. The test plan will specifically address each of these elements as thoroughly as possible. In addition, the test plan will address the critical issues of the location of CDD/CDF formation and destruction. Without this information, it will be difficult to develop advanced control schemes to minimize the emissions of CDD and related organic species. Appropriate measurements in full scale equipment will supply vital information on mechanisms that cannot be obtained reliably in any other manner. Finally, the combustion conditions which minimize the emissions of CDD and related trace organics can have an adverse impact on the formation of other pollutants — notably NO_x and metal fume. The impacts of proposed CDD control on these measures will be quantified and options to minimize the impacts evaluated.

A key requirements for the combustion program is to use the available money in an efficient manner to maximize the progress towards the technical goals. The planning phase will consider the resources and weigh the relative value of different activities on the basis of cost and technical reward.

The information generated in this test program will be specific to a single unit — the unit on which the testing is taking place. The data generated will undoubtedly be incomplete in terms of variations in parameters and detailed characteristics due to restrictions placed on the test from permits, operators and resources available. It is crucial that the data are interpreted and extended to be able to assess the full range of parametric effects on the test unit. Also, the data must be generalized to other units to develop combustion design and operating conditions which apply to all RDF incinerator systems. Only in this way will the data be useful for development of design and operating criteria that are generally applicable. Thus the test planning phase will define an approach that will not only obtain performance data but that will also allow the data to be interpreted and generalized.

TABLE 3 GOOD COMBUSTION PRACTICES FOR MINIMIZING TRACE ORGANIC EMISSIONS FROM RDF COMBUSTORS

Element	Component	Recommendations
Design	Temperature at fully mixed height	1800°F at fully mixed height
	Underfire air control	As required to provide uniform bed burning stoichiometry (see Ref. 1)
	Overfire air capacity (not necessary operation)	40% of total air
	Overfire air injector design	That required for penetration and coverage of furnace cross-section
	Auxiliary fuel capacity	That required to meet start-up temperature and 1800°F criteria under part-load operations
Operation/ Control	Excess air	3-9% oxygen in flue gas (dry basis)
	Turndown restrictions	80-110% of design - lower limit may be extended with verification tests
	Start-up procedures	On auxiliary fuel to design temperature
	Use of auxiliary fuel	On prolonged high CO or low furnace temperature
Verification	Oxygen in flue gas	3-9% dry basis
	CO in flue gas	50 ppm on 4 hour average - corrected to 12% CO_2
	Furnace temperature	Minimum of 1800°F (mean) at fully mixed height
	Adequate air distribution	Verification Tests (see Ref. 1)

Technical Approach

In Fig. 6 is shown the procedure that has been followed in developing the characterization and performance test plan. In this part of the program, the characterization plan will be finalized. The performance plan will be defined but not finalized until the characterization tests and engineering analysis on these tests have been completed. This will ensure that the performance tests are of maximum utility for the development of design and operating criteria since the plan will be based on preliminary analysis of the criteria when applied to this unit.

The development of the plan will be initiated by the gathering of all engineering data concerning the design of the system and current operating practices. The engineering data are those required to perform the engineering analysis task and to make decisions regarding the test conditions which must be characterized. In Table 4 are shown the engineering data requirements for the selected unit. These data are suf-

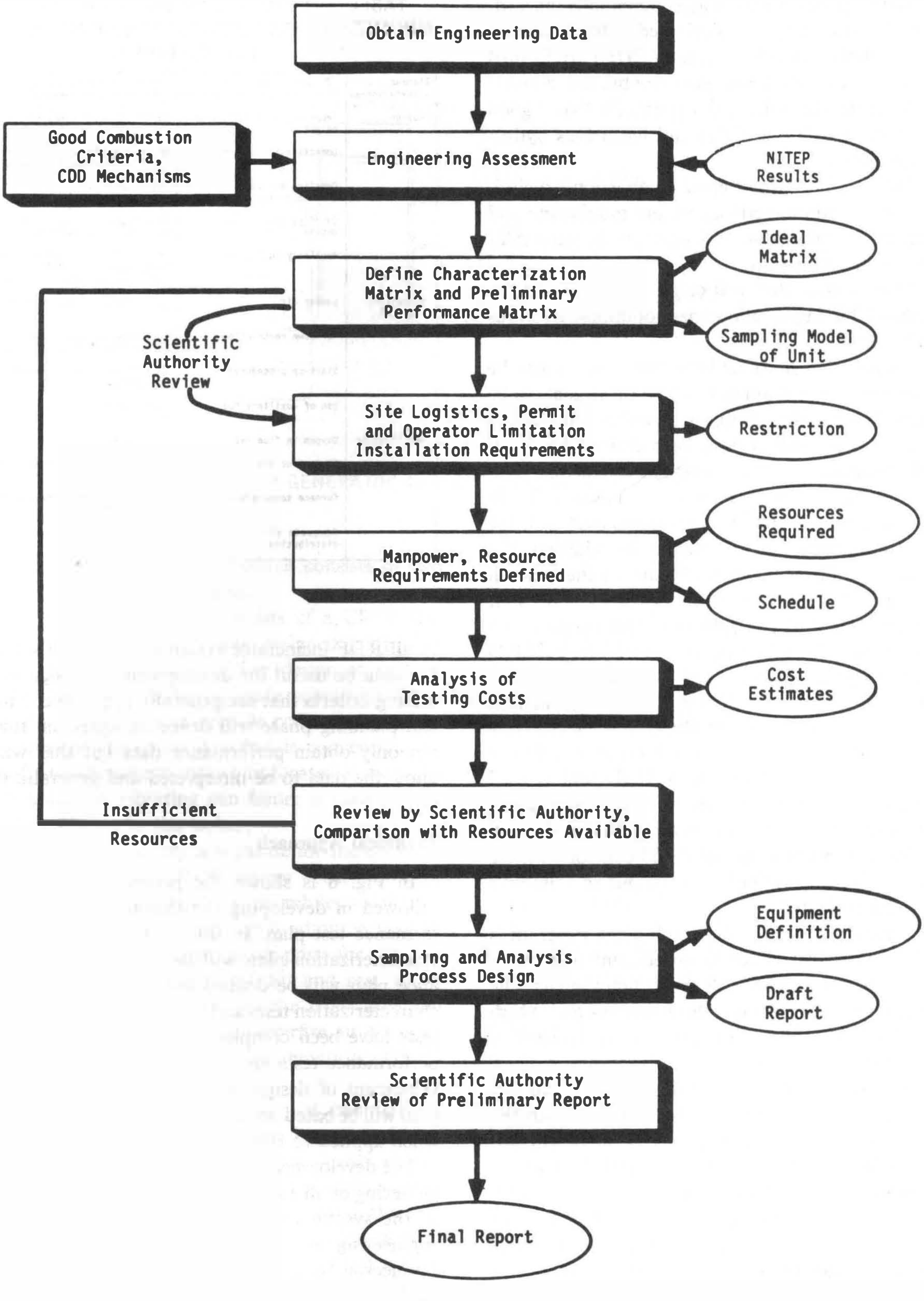

FIG. 6 TECHNICAL APPROACH TO DEVELOPMENT OF COMBUSTION PROGRAM PLAN

TABLE 4 ENGINEERING DATA REQUIRED

- Sectional Drawing of Furnace
  - Construction
  - Dimensions
  - Materials
- Detailed Drawing of Convective Pass
  - Layout
  - Dimensions
- Detailed Drawings of Auxiliary Burners
- Design and Operation of RDF Feed and Spreader
- Design and Operation of Grate
- Operating Conditions (Range of Loads)
  - Air and Fuel Flow Rates
  - Combustion Air Temperature
  - Underfire Air/Overfire Air Flow Distribution
- Air Pollution Control Devices
  - Design/Operation
- RDF Preparation Equipment and Operation

ficient to allow engineering analysis to be carried out. The operational data required are not only the baseline operations but also the restrictions on the operating range due to:

(a) Owner/operator flexibility.
(b) Permit conditions.
(c) Equipment specification.

The test site was selected after consideration of the restrictions to operating condition; nonetheless, certain restrictions will remain that must be factored into the design of the test plan. The operating permit will be obtained from the owner/operator so that the specific permit conditions are known.

The next step is to use the engineering data to assess how the good combustion practices that were developed by EER for RDF units apply specifically to the test unit. The criteria were translated to this unit to define the recommended conditions for minimizing emissions of trace organics such as CDD/CDF. These preliminary criteria represent the hypothesis that will be evaluated in the test program. The engineering assessment also included an evaluation of the current understanding of CDD/CDF formation/destruction in RDF plants and an identification of the potential locations of formation in the test unit. The mechanisms included the major mechanisms proposed in the literature to date, including:

(a) Trace organics in the feed which are not destroyed.

(b) Formation of CDD/CDF in fuel rich zones in the near grate region and failure to destroy these species in the furnace.

(c) Formation of precursors with similar structure to CDD/CDF in the fuel rich zones in the near grate regions and conversion in the furnace by a chlorine donor.

(d) Formation of CDD/CDF on fly ash by a catalyzed reaction from precursors.

The characteristic temperatures for the mechanisms were identified and compared to the temperature profile within the test unit in order to identify candidate sampling positions for evaluating the validity of the different mechanisms.

The characterization and performance tests were then defined based upon the results of the engineering assessment, as shown in Figs. 7 and 8. The test plan serves to define conditions within the unit that can be used to address specific hypotheses based upon the mechanisms of CDD/CDF formation and the combustion criteria for preventing emissions.

This type of field test schedule has been prepared for the overall program and for each one of the following major elements:

(a) Mobilization and setup.
(b) Characterization tests.
(c) Engineering analysis.
(d) Performance tests.
(e) Interpretation/generalization of data.
(f) Development of final report.

From the schedule, manpower, and equipment requirements the projected costs of the testing proposed have been determined. The costing was performed on an element by element basis such that decisions regarding priorities can be made by comparing tradeoffs of cost versus benefit.

Upon review by Environment Canada and EPA the sampling and analysis process design was undertaken to specify all equipment, sampling ports, electrical power, RDF and ash sampling stations and other requirements of the plan. The design was in sufficient detail to allow subsequent procurement of equipment and modification of the system. A draft test plan was prepared including the following:

(a) Engineering assessment and rationale of tests.
(b) Spread sheet information on test plan showing characterization and performance test variables and locations.
(c) Detailed program implementation schedule.
(d) Cost estimates of each element of test plan.
(e) Sampling and analysis procedures.
(f) Equipment and resource specifications.
(g) Recommendation for engineering analysis of data.

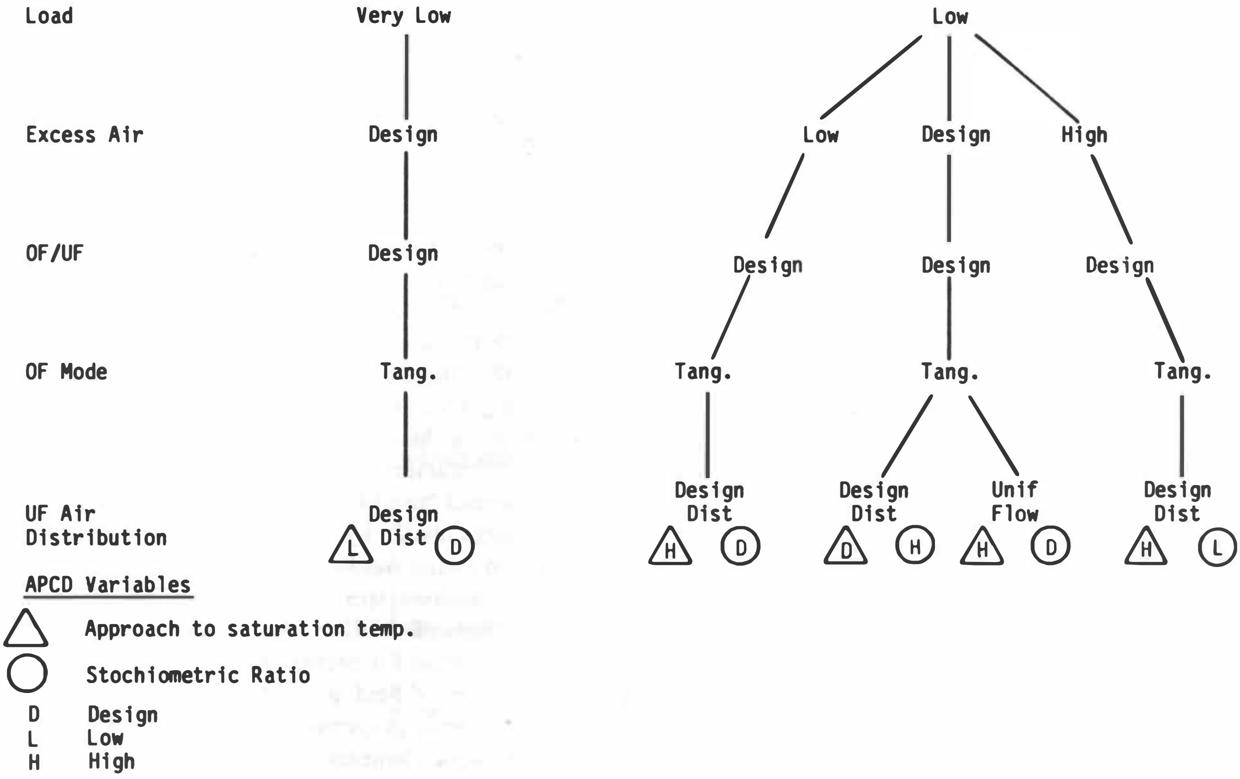

FIG. 7(a) CHARACTERIZATION TEST CONDITIONS

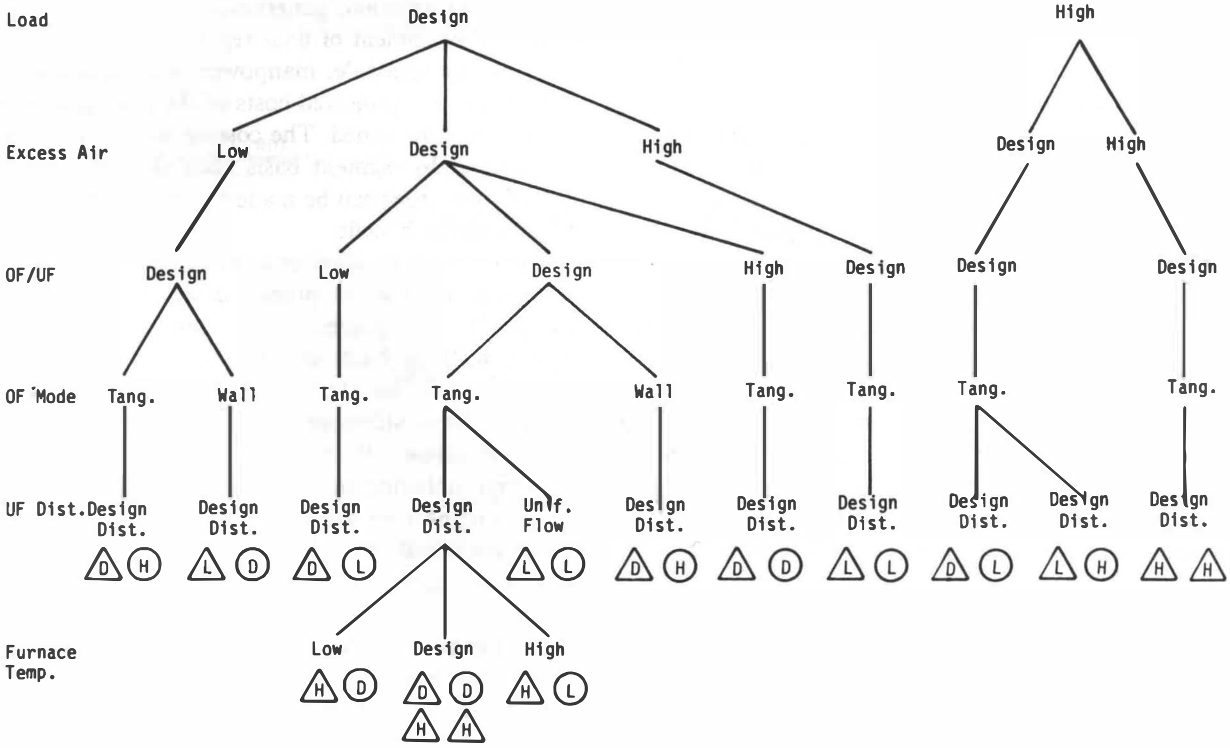

FIG. 7(b) CHARACTERIZATION TEST CONDITIONS

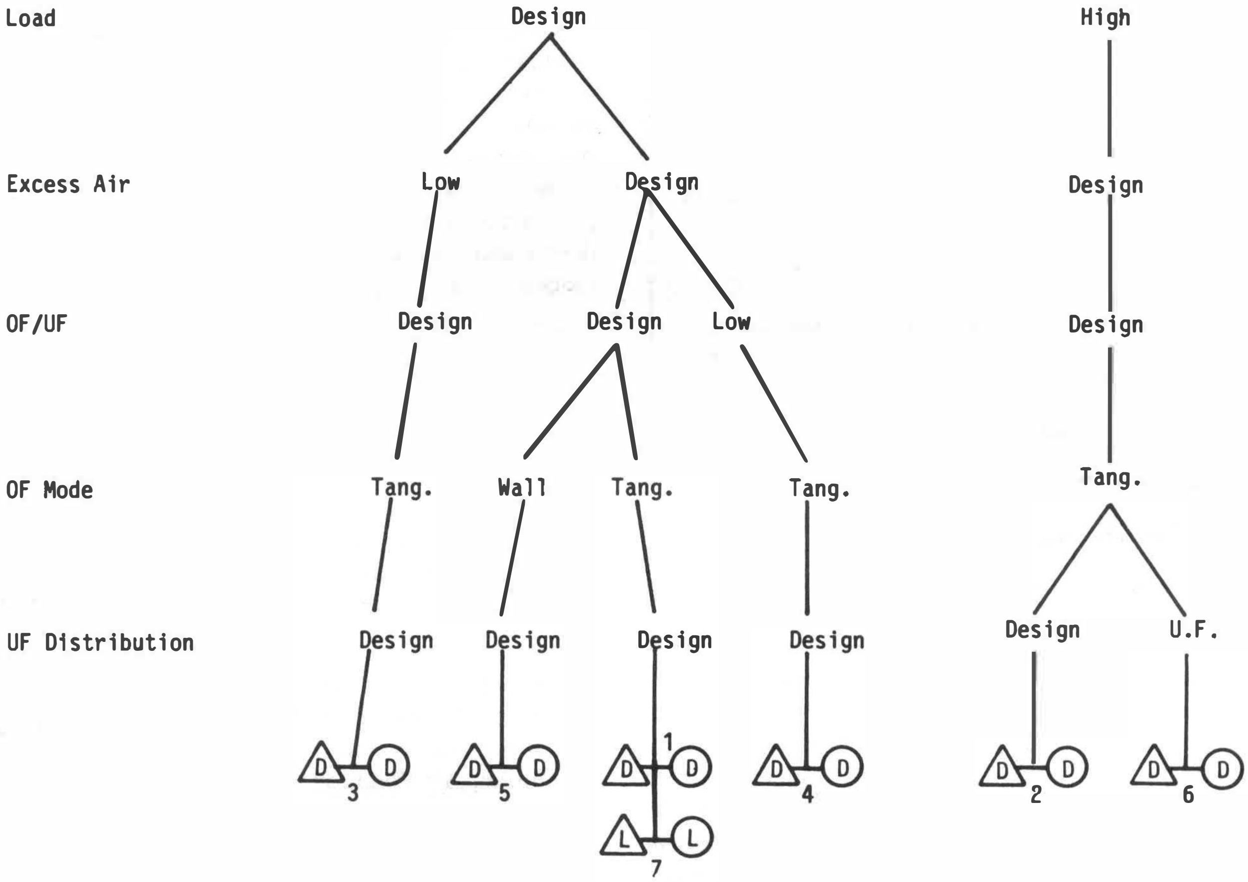

FIG. 8 PERFORMANCE TEST CONDITIONS

TABLE 5 JOINT PROGRAM OBJECTIVES

- National Incineration Testing and Evaluation Program
  1. Define Optimal Design and Operating Characteristics
  2. Relate Operating Conditions to Emissions
  3. Identify Best Practical Control Options
  4. Design and Operating Guidelines for Future Applications
  5. Incorporate Accepted Dioxin/Furan Sampling and Analysis Protocol
  6. Investigate Dioxin Surrogate
  7. Facilitate Construction of New Incinerators
- U.S. EPA Goals
  1. Establish Baseline Emissions
  2. Compare Classes of MWC Systems
  3. Evaluate Design and Operating Parameters
  4. Evaluate Add-On Pollution Control Devices
  5. Establish Design and Operating Criteria

Interpretation and Generalization of Field Tests

The focus of this program is to address the joint Environment Canada and U.S. EPA objectives for the characterization and control of emissions from MSW incineration as shown in Table 5. This program will produce a test plan for RDF incinerator systems which will supply much needed information on the appropriate design, operation and monitoring of RDF incinerators to prevent or minimize the emissions of trace organics such as CDD/CDF. That which is desired is a verified design and operating guidelines that can be generally applied to RDF units and will ensure optimum control of all emissions. The data generated in the testing of the single RDF unit chosen in this program must be sufficient to generate the appropriate design and operating guidelines for all RDF incinerators.

REFERENCES

[1] Seeker, W. R., Lanier, W. S., and Heap, M. P. "Municipal Waste Combustion Study: Combustion Control of MSW Combustors to Minimize Emission of Trace Organics." Prepared for the U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. Report No. EPA/530-SW-87-021C.

[2] Mirolli, M. D., Ferguson, W. B., and Bump, D. L. "Mid-Connecticut Resource Recovery Project," presented at the 1986 Joint Power Generation Conference, Portland, Oregon, October 19–23, 1986.

Key Words: Municipal Solid Waste (MSW); Refuse Derived Fuel (RDF); Spreader Stoker; Steam Generator; Dry Scrubber; Dioxin; Furan; Air Pollution Control.