NATIONAL BUREAU OF STANDARDS REPORT

10313

A PERFORMANCE SPECIFICATION FOR A TOTAL ENERGY PLANT AT THE JERSEY CITY BREAKTHROUGH I SITE

Report to

Office of the Assistant Secretary
for Research and Technology
Department of Housing and Urban Development
Washington, D. C. 20410

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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The National Bureau of Standards [1] was established by an act of Congress March 3, 1901. Today, in addition to serving as the Nation's central measurement laboratory, the Bureau is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. To this end the Bureau conducts research and provides central national services in four broad program areas. These are: (1) basic measurements and standards, (2) materials measurements and standards, (3) technological measurements and standards, and (4) transfer of technology.

The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Center for Radiation Research, the Center for Computer Sciences and Technology, and the Office for Information Programs.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement; coordinates that system with measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of an Office of Measurement Services and the following technical divisions:

Applied Mathematics—Electricity—Metrology—Mechanics—Heat—Atomic and Molecular Physics—Radio Physics [2]—Radio Engineering [2]—Time and Frequency [2]—Astrophysics [2]—Cryogenics.[2]

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THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS and other agencies of the Federal government; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System, and provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world. The Office consists of the following organizational units:

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
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by

Sensory Environment Branch
Building Research Division
Institute for Applied Technology
National Bureau of Standards

Report to

Office of the Assistant Secretary
for Research and Technology
Department of Housing and Urban Development
Washington, D. C. 20410

NBS

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

PERFORMANCE SPECIFICATION

Total Energy Plant at Jersey City

1. Objective

The contractor shall design a total energy plant to provide all of the energy services hereinafter specified for the HUD BREAKTHROUGH I site at Jersey City, New Jersey. The total energy plant shall consist of the mechanical equipment for energy generation, conversion, and transfer; the building for housing the mechanical equipment, and the system for distributing the utilities to the dwellings and other buildings on the site. The installation will be the subject of a field study, after acceptance, to explore its performance with respect to economy, effectiveness, technical design, reliability, versatility, environmental factors, and occupant acceptance. To prepare for the field study, the system must be designed to incorporate or provide for the attachment of certain instruments and transducers, which will be further specified and described by the National Bureau of Standards during the design process.

2. Definitions

For the purpose of this specification, the total energy plant shall consist of a total energy system, the structure for housing the total energy system, and the systems and equipment for distributing the energy services to buildings and other points of utilization on the site, as further defined in the following paragraphs.

2.1

The total energy system shall comprise all of the equipment, piping, controls and auxiliaries to carry out the following functions.

a) Generation of all electric energy used on the site, except the generation of radio and television signals,

b) Recovery of waste heat from the fuel-burning prime movers to accomplish heating and/or cooling functions,

c) Generation of steam or hot water for space heating, heating of potable water, and other heating functions on the site,

d) Generation of chilled water for cooling and dehumidification at any location required on the site,

e) Disposal of excess waste heat, process heat and combustion gases from the above processes.

2.2

The structure shall comprise the building for enclosing the total energy system; the chimneys or stacks for discharge of combustion gases; fuel storage tanks; cooling towers or spray ponds;

and the structures, shields, materials, and landscaping required to provide acoustical control, air pollution control, odor control, limitations on magnetic interference, and visual privacy as further specified herein.

2.3

The distribution system shall comprise the transformer banks and other electrical switchgear, conduits, cables, piping, valves, fittings, insulation, hangers, supports, expansion devices, trenching if required, and other appurtenances and materials to distribute electrical energy, chilled and hot water or steam for heating and cooling purposes, and potable hot water from the total energy plant structure to the main electrical distribution panel, to the connection points at the exterior wall of each building, and to corresponding distribution points for other usages on the site.

3. Economics

Within the limits imposed by the following sections of this specification covering Design Requirements, Future Expansion, Integration of Service Systems, and Quality Assurance, the total energy plant shall be designed for minimum cost of energy to the users based on Present Value Techniques employing a discount rate of ten percent and a lifetime of 40 years for the plant.

4. Design Requirements

4.1 Calculation of Design Loads

Design loads shall be calculated in accordance with the following technical data and regulations and with the performance requirements contained in the Guide Criteria for Breakthrough Housing Systems; and shall take into account the kinds of equipment and appliances to be furnished by the Housing System Producers; the community, school, and commercial facilities planned for the site; and the requirements of the utility systems themselves.

4.1.1 Space Heating and Cooling Loads

The design space heating and cooling loads shall be calculated by one of the two following alternative methods to provide an indoor temperature, summer and winter, of 75 °F at the five-foot level in the center of each occupied space.

a. Methods described in ASHRAE Guide and Data Book, 1967, Handbook of Fundamentals, for residential and commercial buildings, respectively, using the following outdoor design conditions.

	DB Temp °F	WB Temp °F	Wind Velocity mph
Winter	11	-	12
Summer	92	77	9

b. Nationally recognized analytic or computer methods that take into account building heat capacity, cyclic weather conditions, and variable indoor heat generation.

4.1.2 Domestic Hot Water

Technical data on maximum demands and average usage for domestic hot water from the ASHRAE Guide and Data Book, 1970, Systems Volume, shall be used.

4.1.3 Electrical Loads

a. Electric energy usage and demands by the dwelling units shall be based on published surveys of industry associations, private or government research organizations, or other published sources.

b. Energy demands by community, school, and commercial facilities, and by on-site utility plants, shall be based on design values specified by the Site Planner and on design information for the equipment involved.

4.2 Fuel

The prime movers and other fuel-burning equipment shall be designed as convertible systems that can alternatively utilize natural gas, liquefied petroleum gas, diesel oil, No. 2 fuel oil, or JP-5 depending on the availability and cost of various fuels during the useful life of the system.

4.3 Equipment Selection

4.3.1

The total energy system shall have the capacity to meet the maximum demands for electrical energy, the design heating and cooling loads, and the maximum demands for domestic hot water as determined by the procedures described in Section 4.1 of the Specification and additionally to provide the required standby and future expansion capabilities hereinafter described.

4.3.2

The total energy system shall be designed to provide the reliability specified herein and to attain the objectives of low annual fuel consumption and low overall owning and operating costs.

4.3.3

Prime movers for electrical generators shall be turbines or reciprocating engines or a combination of both. The number of units used to handle the maximum demand shall be chosen to obtain a good balance between electrical loads and waste heat requirements without excessive total cost.

4.3.4

One or more types of chilled-water generators shall be chosen to obtain minimum overall fuel requirements for summer loads.

4.3.5

Waste heat recovery units shall be provided for all prime reciprocating and turbine prime movers to generate hot water for space heating and cooling and domestic use. Supplementary heat shall be provided, if required, by separate boilers or by auxiliary burners in the heat recovery units.

4.4 System Reliability

4.4.1

Sufficient standby power generating capacity shall be provided such that the unanticipated failure of any single power generating unit during any time of the year will not prevent the system from carrying the electrical demand on the system, and such that planned overhaul of each power-generating unit can be accomplished during some part of the year without jeopardizing the ability of the system to carry the electrical demand. The designer shall provide a justification for the number of power-generating units selected for the system.

4.4.2

The maximum air conditioning load shall be divided among at least two chilled water units.

4.4.3

Standby water circulation pumps shall be provided for the hot and chilled water circuits, the cooling tower circuit, and the boiler feedwater circuit.

4.4.4

All components of the power-generating units shall be designed for continuous duty at the generator nameplate rating and for intermittent duty at 110 percent of nameplate rating for periods up to two hours duration.

4.4.5

Engine- or turbine-driven water chiller units and absorption chillers shall be designed for continuous duty at the nameplate rating of the water chiller.

4.4.6

The power-generating units, the primary distribution system, waste heat recovery units, electrical switchgear, and all related components shall be designed for high reliability and supported by maintenance instructions directed toward the same end, such that interruptions to electrical service and/or waste heat recovery at the central station shall not average more than eight hours per year in the aggregate and shall not exceed a frequency of one interruption per month on the average, and no single interruption of service shall exceed four hours' duration.

4.4.7

The total energy system shall be designed for full automatic operation of the power-generating units, the air-conditioning units, the domestic water-heating equipment, the supplementary heating boiler, and the apparatus for dumping excess waste heat.

Each power-generating unit, air-conditioning unit, boiler, water heater, waste heat recovery unit, the switchgear, the utility distribution system, and other major operating components shall be equipped with instruments and relays that will sense abnormal conditions of pressure, temperature, speed, fluid level, electrical characteristics, vibration, or other parameter that could permanently damage the unit, the plant, or personnel, or interrupt service to the site; that will automatically shut down the unit and transmit a signal for an alternate unit to be started; and will provide in the headquarters of the site manager and the office of the organization responsible for maintenance, visible and audible signals indicating a distress condition. The alternate unit shall be capable of coming up to full rated load operation in a period of time in accordance with the best state of the art for the system used but in any case not to exceed one minute. Annunciator panels and alarm systems shall be coordinated with the management concept of the site developer. The instruments and relays installed for sensing abnormal or unsafe operating conditions shall be coordinated with the instruments to be installed for long-term study of the system operation by the National Bureau of Standards.

4.4.8

In the event that an electrical overload occurs on the total energy system, segments of the electrical load shall be automatically and sequentially disconnected, starting with the least essential services and progressing toward more essential services, as defined by the site planner, until the available equipment can provide adequate capacity. These load segments shall be reconnected to the system automatically in reverse order as normal operation is restored. The segmenting of the electrical load for load-dumping purposes shall be coordinated with the housing site producers to obtain a practical subdivision of the loads in the housing units. Alternative sequences of load interruption shall be possible by manual operation of the switchgear. Where possible without complete duplication of facilities, the electrical distribution system shall be designed with alternate routing paths to avoid a complete outage by failure of a single segment of the electrical distribution system. The provision for alternate routing paths shall avoid the hazards of single phasing and short circuiting the electrical services.

4.4.9

Sufficient liquid fuel storage shall be provided to operate the total energy system for a period of one month at a load equal to the month of maximum calculated load.

4.4.10

Provide an outside weatherproof outlet of sufficient capacity so a portable generator can be connected to the plant to provide emergency electrical power to battery chargers, alarm systems, safety equipment, and other critical needs in the event of failure of the electrical service in the plant.

4.5 Stability of Electrical Service

Three-phase, four-wire electric service at 60 hertz shall be made available to each building on the site. The type of electric service furnished shall be coordinated with the Housing System Producers. The total energy system shall provide highly stable electrical service in terms of capacity, frequency, voltage fluctuations, and voltage level by incorporating the following automatic control features:

4.5.1

Each power-generating unit shall be equipped with adjustable high- and low-load sensing devices of the optical type; the high-load sensing device will automatically start and bring an additional generator on the line; the low-load sensing device will automatically disconnect a generator from the line and shut it off.

4.5.2

Each power-generating unit shall be equipped with a speed control system that will control the speed within ± 0.25% of synchronous speed at 60 hertz. The transient speed deviation shall be less than 0.4 hertz for sudden load changes up to 25% of full load, and recovery of the controlled speed shall occur within four seconds.

4.5.3

An automatic frequency control system operated from a separate regenerative battery power source shall be supplied for continuous automatic system speed correction. This device shall produce a 60-hertz signal capable of maintaining clock accuracy within ± 120 seconds over a 30-day period. The automatic frequency control system shall be designed so manual adjustments can be made periodically to restore the time indicated by electric clocks to U. S. Standard Time.

4.5.4

A synchronizing panel shall be provided that will automatically synchronize a power-generating unit coming on the line with the line frequency, and that contains the necessary instruments and relays for manual paralleling of units. The synchronizing panel shall divide the total load equally among operating units with a tolerance of ± 4% of rated unit load for the in-phase component and a tolerance of ± 5% for the reactive component.

4.5.5

Each generator shall be equipped with a replaceable voltage regulator. Voltage regulation shall be within ± 2% of rated voltage from no load to full load, and during the transition periods when generating units are brought on or dropped from the line. Voltage modulation at steady-state load shall not exceed ± 1%.

4.6 Maintenance Requirements

4.6.1

Fuel-burning engines and turbines and water-chilling equipment shall be designed so all removable parts can be renewed or replaced on site during major overhauls such that the performance can be restored to essentially that of new equipment without removing the chassis from the plant.

4.6.2

Fuel-burning engines and turbines shall be designed to operate at least 15,000 hours between major overhaul periods.

4.6.3

Heat recovery equipment shall be designed with removable access elements so the combustion side of the heat transfer surfaces can be brushed or cleaned. This equipment shall be designed so all heat transfer surfaces can be cleaned on site during major scheduled overhauls of the power-generating equipment.

4.7. Noise and Vibration Control Requirements

4.7.1

With all equipment operating that is required to meet maximum energy demands during winter or summer, air-borne noise generated by the total energy plant shall not exceed 53 dBA at any of the following locations.

a) At any window or door opening in the walls of occupied buildings directly visible from the total energy plant, throughout the height of the occupied building, measured three feet outside the wall surface.

b) Within the boundaries of any outdoor recreation area or other regularly occupied outdoor area in the zone surrounding the total energy plant, measured five feet above the immediate surface.

c) Along the boundary line between the BREAKTHROUGH site and all adjacent property, measured five feet above ground level.

The reference ambient sound pressure level at these stations shall be determined by site noise surveys conducted by the National Bureau of Standards before and after construction on the site is completed.

4.7.2

Any common wall, floor, or ceiling between the total energy plant and adjoining occupied spaces shall have a sound transmission loss sufficient to meet the NC levels specified in the Guide Criteria for the Design and Evaluation of Breakthrough Housing and in Chapter 20 of the book "Noise Reduction," edited by L. L. Beranek, McGraw-Hill 1960, referenced therein.

4.7.3

Operation and maintenance personnel required to work in the total energy plant shall be protected against exposure to noise in excess of the limits specified in the Walsh Healy Act. The required acoustic environment may be attained by selection of equipment, by acoustical treatment of equipment and enclosures, by providing adequate protective devices for the personnel, or by a combination of these techniques.

4.7.3.1

The noise level in the area of the total energy plant occupied by the control systems, instrumentation panels, and switchgear shall not exceed 70 dBA when all of the mechanical equipment required to handle the maximum winter or summer energy demands is in operation in order to promote reliability of voice communication between operating personnel. Acoustically protected areas of booth size are not considered adequate to meet this requirement.

4.7.3.2

In order to promote reliability of communication, and the safety and health of operating and maintenance personnel, the noise level in the areas of the total energy plant where two or more personnel must cooperate in carrying out regularly assigned operating or maintenance duties shall be controlled at 85 dBA or lower by permanent or portable acoustical treatment.

4.7.4

All rotating and reciprocating equipment shall be mounted on vibration isolators providing a minimum isolation efficiency of 85 percent at a frequency corresponding to the design speed of the equipment for this plant.

4.7.5

Metal piping connected to power-driven equipment shall be ently supported from or on the building structure for a d of 50 pipe diameters from the power-driven equipment. T resilient isolators shall provide a minimum isolation e of 85 per cent at a frequency corresponding to the de of the equipment for this plant.

4.7.6

Vibration eliminators shall be used to connect pumps, engines, and other rotating machinery to pipe and duct systems.

4.8 Air Pollution Control

4.8.1

Fuels for the prime movers and supplementary heating boilers shall be selected and the combustion processes shall be controlled so the combustion effluents can meet the air pollution limitations contained in the New Jersey Air Pollution Control Code and the Federal Regulations and Amendments issued by the Department of Housing and Urban Development pursuant to Executive Order 11282, "Prevention, Control, and Abatement of Air Pollution by Federal Activities."

4.8.2

Combustion gases, the ventilation air from the engine room, and the air from the cooling towers shall not be discharged directly toward any nearby building, recreation area, or other occupied space, and shall not result in offensive odors, detectable by sense of smell, in any regularly occupied building or recreation area, or in any regularly used thoroughfare. The moist air from the cooling tower shall not create visible fog nor produce detectable mist or frost in recreation or traffic areas.

4.8.3

Any chimney or stack used to discharge combustion gases shall comply with the requirements of the New Jersey State Building Code and NFPA Standard 211-1969.

4.8.4

The effluent combustion gases from the total energy plant shall not impinge upon or envelop any door, window, air intake opening, outdoor recreation area or other regularly occupied outdoor space for wind velocities in the range from 0-15 miles per hour from any direction as determined by tracer gas techniques or other methods.

4.9 Thermal Environment and Ventilation

4.9.1

The air temperature at the five-foot level in all enclosed spaces in the total energy plant that are utilized by operating or maintenance personnel shall be maintained in the range from 65°F to 90°F for the specified range of design outdoor conditions, by a combination of heating, air conditioning, and ventilating systems.

4.9.2

Stacks, exhaust systems, hot water and steam pipes, and other heated surfaces shall be insulated, where practical, to the extent that it will lower overall combined cost of the insulation and the heating, air conditioning, and ventilating system.

4.9.3

The common walls, floor, or ceiling between the total energy plant and any adjoining occupied spaces shall be thermally insulated such that the heat gain in the occupied space from the total energy plant shall not exceed 5 Btu/hour (sq. ft.).

4.9.4

The total energy plant shall be ventilated with outdoor air to satisfy combustion and fresh air requirements for the equipment and maintenance personnel in the engine rooms, offices, shops, and toilets.

4.10 Aesthetic Requirements

4.10.1

Architectural, landscaping, or other decorative treatment shall be provided for plant chimneys or stacks, air intakes or discharge openings, cooling tower components, and other exterior or rooftop auxiliaries that are in direct line of sight from ground level or window of an occupied building at a distance of 200 feet or less from the perimeter of the total energy plant. A scale model of the total energy plant; the architectural, landscaping, and decorative features identified above; and the pertinent nearby building exposures shall be provided along with the working drawings and specifications for visual evaluation of the aesthetic features of the design.

4.11 Illumination Requirements

A level of illumination of 30 footcandles shall be provided in the areas occupied by power-generating units, chilled water units, heat

recovery units and boilers. The front faces of vertical switchboards and control panels shall be illuminated at a level of 30 footcandles in a manner that will prevent glare and reflections from meter faces and panels. The level of illumination on the rear of switchboard panels shall be at least 10 footcandles. Areas occupied by auxiliary equipment shall have a level of illumination of 20 footcandles.

4.12 Safety Requirements

The total energy plant and energy distribution system shall be designed for an acceptable level of personnel safety, fire safety, equipment safety, and plant safety. Recognized standards pertaining to prevention of explosions, fires, floods, and unnecessary equipment failures are listed in the Appendix and form a part of this specification.

4.12.1 Explosions

Each component in the total energy plant and the piping and pressure vessels of the distribution system shall be designed and constructed according to recognized national or industry standards. Fired and unfired pressure vessels, compressed air tanks, waste heat boilers, chillers, condensers, etc., shall be designed in accordance with the ASME Boiler and Pressure Vessel Code. All pressure vessels must be registered by the American Society of Mechanical Engineers and must have ASME numbers stamped on the outer shell. The air conditioning equipment and system shall be designed and constructed to comply with the USA Standard Safety Code for Mechanical Refrigeration. The combustion control system must be UL approved and meet applicable safety standards of the Factory Mutual Corporation or the Factory Insurance Association. Burners must be designed to start up and shut down automatically and must be provided with continuous flame monitoring controls. All pressure vessels shall be designed with ASME approved safety valves. Plant and distribution piping shall be designed according to good practice and USASI standards. Thermal expansion in the piping system shall be provided for by expansion loops or expansion joints.

Combustion systems on the engines, turbines, and boilers shall be provided with a pre-ignition purge cycle to ensure against explosions. The total energy plant and utility systems must comply with the New Jersey State Code.

4.12.2 Fires

A central fire alarm system meeting the requirements of NFPA, New Jersey State and Jersey City Codes must be installed and connected to the alarm system for the entire site. All wiring and electrical components must comply with the National Electrical Code. Where applicable, the electrical components and systems must be UL approved and also comply with the New Jersey State Code.

Fire protection systems complying with New Jersey State Code and applicable NFPA (National Fire Protection Association) standards shall be provided. If required, special fire protection systems shall be provided for the fuel oil handling systems, lubrication storage area and for wooden cooling towers. An emergency fire water pump and standpipe system must be provided for the plant. Stacks, exhaust systems, hot water and steam pipes in accessible locations shall be insulated to prevent burns of personnel, and where required, to prevent scorching, charring, or ignition of adjacent equipment or building components.

4.12.3 Floods

The total energy plant shall be designed to guard against flooding from either internal or external causes. Drainage systems and overflow features in the plant and utility areas must be sized to permit rapid drainage of chilled water systems, hot water systems, boilers, and cooling towers; and to prevent flooding of electrical components and prime mover components in the event of accidental breakage of water-containing systems.

Outside grading shall be designed to provide rapid run-off away from the plant under anticipated normal and abnormal rainfall conditions. Gravity run-off may be supplemented or replaced by an automatically-started sump pump system.

4.12.4 Equipment and Operator Safety

Equipment shall be arranged and spaced for safe and effective operation, servicing, and repair. Maintenance of one piece of equipment should not endanger an adjacent piece of operating equipment or place the personnel in a dangerous position relative to other equipment. Rotating machinery, hot surfaces, sharp projections, components with low clearance, and operating levers of switches, relays, and safety devices shall be protected from accidental contact by operating and maintenance personnel.

4.13 Magnetic Interference Suppression

Magnetic interference suppressors shall be provided for the ignition systems on the fuel-burning prime movers, the commutators of motors and generators; and other electrical systems, controls, and apparatus, if needed to control interference with radio and television reception in the buildings on the BREAKTHROUGH site and the immediate vicinity.

4.14 Distribution Systems

The contractor shall design a system for distribution of the various energy forms from the total energy plant to the main electrical distribution panel and to a connecting station five feet from the exterior wall of each building served by the system. The distribution system shall be designed to use a minimum amount of above-grade and visible components.

The design of the water-containing conduits shall utilize the procedures and criteria described in the District Heating Handbook, International District Heating Association, 1969, and in Underground Heat Distribution Systems BRAB-FCC Report 30R-64, with respect to expansion and contraction of pipes, methods of support, protection of pipes from water and corrosion, for insulation requirements, and for mechanical protection of the conduits from surface loads or shifting earth.

The hot water distribution systems for space heating and for domestic use shall be designed as medium temperature distribution systems; viz. for water temperatures up to 250 °F. The design procedures described in the ASHRAE Handbook of Fundamentals, Chapter 18, 1967 for protection of water piping against freezing shall be utilized. The pipes for supply and return hot water for space heating, the domestic hot water pipe, the chilled water lines, and the electrical conduit shall be suitably insulated from each other to control undesirable exchanges of heat.

The electrical distribution system shall comply with the provisions of NBS Handbook 81 of the National Electric Safety Code, Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines (1961) with Supplement No. 1 (1965) and Supplement No. 2 (1968, with respect to both underground and aboveground portions of the system.

5. Future Expansion

5.1

The design of the electrical distribution system from the transformer bank at the total energy plant to the distribution panel in each residential unit shall be sized to accommodate a future increase in electrical power demand of 25%, and for a future increase in electrical power demand of 50% in each commercial unit.

5.2

The building for the total energy system and its auxiliaries shall provide space for future installation of an additional conventional or innovative power-generating unit having a capacity equal to the originally installed units.

6. Integration of Service Systems

6.1

If economy, performance, environmental quality, or space saving is enhanced thereby, the structures and distribution or collection systems for the total energy system, the solid and liquid waste disposal systems, and any other service systems for the site shall be integrated in accordance with good engineering design.

6.2

The electrical demand of other service systems shall be taken into account in determining the maximum electrical load in the total energy system. The intermittent use of significant increments of power by these other service systems shall be coordinated with the electrical loads in the occupied buildings to improve rather than reduce the load factor on the total energy system.

6.3

Common or adjacent plant space shall be used for all centrally located service systems, if possible, and the methods used to control air pollution, noise, vibrations, odor, and undesirable aesthetic appearance shall be designed to serve the common needs of all service systems.

6.4

Annunciator panels, alarms, safety controls, etc., shall be designed to satisfy the requirements for all service systems, insofar as possible.

6.5

The design of the various service systems should facilitate joint use of operating and maintenance personnel.

7. Quality Assurance

Assurance of compliance with the design and performance requirements of this specification will be provided by a combination of reviews of design procedures, plans, and specifications; pre-installation tests of components; examination of manufacturers' test data; inspection of equipment; certification and labelling of components and systems; and monitoring of acceptance tests at the time the plant is put into service. The quality assurance activities will be carried out by technical representatives of the Department of Housing and Urban Development and the National Bureau of Standards. These quality assurance activities are further detailed as follows:

7.1

Adequacy of the load calculations; the analysis of load diversity and load balance; the calculations of monthly energy use, fuel requirements and cost; the aesthetic treatment of the plant components; and the required capacity of the principal system components will be determined by detailed review of the preliminary plans and the working drawings and specifications at prearranged stages in the design process.

7.2

Cost estimates for fuel, capital equipment, and maintenance and operation will be reviewed by technical representatives of HUD and NBS.

7.3

Test results obtained by the suppliers of major equipment components in their own laboratories will be reviewed for comparison with ratings and performance used in design. Prequalification tests will be requested if existing information is inadequate.

7.4

The design, performance test results, and national labelling and listing of instruments, controls, and relays designed for sensing abnormal operating conditions and as operating controls will be studied prior to installation. The performance of these devices will be observed during prequalification tests and/or during the acceptance tests of the plant.

7.5

The models of power-generating units, water-chilling equipment, heat recovery units, boilers, and switchgear proposed for the installation will be studied in advance for maintainability, ease of repair, and potential for complete renewal.

7.6

Compliance with safety requirements will be determined by inspection, labelling, certification, and comparison of design with the requirements of safety standards.

7.7

The acceptance tests performed by the contractor on the site after the installation is completed will be monitored for completeness and for compliance with plans and specifications.

7.8

Tests for compliance with the performance requirements on noise and vibration control, air pollution control, ventilation, thermal environment, aesthetics, magnetic interference, and illumination will be performed during the acceptance tests of the plant or as soon thereafter as the necessary climatic and operating conditions occur. Corroborative tests may be made by the National Bureau of Standards, if required.

7.9

Long-term reliability and durability can be evaluated only during long-term field observations or tests. These aspects of the performance specification will not be covered by the acceptance tests.

7.10

Systems, equipment, or apparatus which do not comply with the details of this specification, but which perform in accordance with its intent, may be approved for installation by the Department of Housing and Urban Development, with appropriate guidance from the National Bureau of Standards.

Appendix

List of Standards Related to Fire, Safety, Explosions and Protection against Equipment Failures

NFPA No 54-1969 "Combustion Air and Ventilation."
NFPA No. 85 - 1967 "Prevention of Furnace Explosions in Natural Gas-Fired Watertube Boiler-Furnaces with One Burner"
NFPA No. 85D-1969 "Fuel Oil-Fired Multiple Burner Boiler-Furnaces"(over 300 HP)
NFPA No. 54-1969 "Installation of Gas Appliances and Gas Piping"
NFPA No. 214-1968 " Water Cooling Towers"
NFPA No. 70-1968, USAS C1 - 1968 (Rev. of C1 - 1965), "National Electrical Code."
NFPA No. 30-1969 "Flammable & Combustible Liquids Code"
NFPA No. 31 - 1968 "Oil Burning Equipment"
NFPA No. 328-1964 "Flammable and Combustible Liquids and Gases in Manholes and Sewers"
NFPA No. 329-1965 "Leakage from Underground Flammable & Combustible Liquid Tanks"
NFPA No. 13 - 1969 "Installation of Sprinkler Systems"
NFPA No. 29 - 1969 "Installation of Centrifugal Fire Pumps"
NFPA No. 211 - 1969 "Chimneys, Fireplaces and Venting
NFPA No. 12-1968 "Carbon Dioxide Extinguishing Systems"
NFPA No. 14- 1969 "Installation of Standpipe and Hose Systems"
NFPA No. 15-1967 "Water Spray Fixed Systems for Fire Protection"
NFPA No. 26 - 1958 "Supervision of Valves Controlling Water Supplies for Fire Protection"
NFPA No. 291 - 1935 "Marking of Hydrants"
NFPA No. 71 - 1969 "Installation, Maintenance and Use of Central Station Protective Signalling Systems (Watchman, Fire Alarm and Supervisory Service)"
NFPA No. 72B-1967 "Installation, Maintenance and Use of Auxiliary Protective Signalling Systems for Fire Alarm Service"

ASME Boiler and Pressure Vessel Code- 1965 (amendments to 1969). Section IV, Heating Boilers (1966).
ASME Boiler and Pressure Vessel Code - 1965 (amendments to 1969). Section VIII, Unfired Pressure Vessels (1965).

USASI Standard Safety Code for Mechanical Refrigeration, B 9.1 1969.

UL 795 Standard for Gas Heating Equipment, (Commercial-Industrial) 1964.
Regulations for the Construction and Maintenance of Hotels and Multiple Dwellings, State of New Jersey, July 19, 1968.
New Jersey Air Pollution Control Code of 1954, with amendments to Jan 1970.
NBS Handbook 81 Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines (1961), with Supplement No. 1 (1965) and Supplement No. 2 (1968).
ANSI, National Electric Safety Code, Part 1, Rules for the Installation and Maintenance of Electric Supply Stations and Equipment (1970).

INTERFACE MATRIX BETWEEN SYSTEM COMPONENTS AND PERFORMANCE ATTRIBUTES FOR A TOTAL ENERGY PLANT*

System Component:	Economics	Reliability	Stability of Service	Maintainability	Noise	Vibration	Air Pollution	Ventilation	Illumination	Aesthetics	Magnetic Interference	Quality Assurance	Safety: Explosion	Safety: Fire	Safety: Flood	Safety: Operator Protection
Building:																
Envelope (Structure)	3*	3		3	4.7	4.7.4	4.8.2	4.9.4	4.11	4.10		7	4.12.1	4.12.2	4.12.3	4.12.4
Landscape, Shielding					4.7.1		"			"		"			"	
Distribution System:																
Electrical	4.14	4.4.8	4.5	4.14						4.14	4.13	7		"		4.14
Hot&Chilled Water	"	4.14	4.14	4.14	"	4.7.5				"		"	"		4.13	"
Fuel	4.2	4.4.9	4.4.9				4.8.1	4.8.2		4.10		"	"	"		
Total Energy System:																
Generators	4.3.1	4.4.1	4.5	4.4.6	"	4.7.4		4.9	"		"	"		"		4.12.4
Engines/Turbines	"	"	"	4.6	"	"	4.8	"	"		"	"	"	"		"
Boilers	4.3.5	4.4.7	4.4.7	"			"	"	"			"	"	"	4.12.3	"
Waste Heat Recov. Units	"	4.4.6	4.5	"	"		"	"	"			"	"	"	"	"
Water Chillers	4.3.4	4.4.2	4.4.7	"	"	"		"	"			"	"	"	"	"
Switchgear	3	4.4.6	"	4.12.4					"		"	"	"	"		"
Hot Water Stor.	4.3.1	4.4.7	4.5	4.6				"	"			"	"		"	"
Cooling Tower	3	4.4.3	4.4.3	4.12.4	"	"	4.8.2			"		"				"
Chimney					"		4.8			"		"		"		
Ventilating System	4.9	4.9	4.9	"	"	4.7.5	4.8.2	"		"		"	"	"		"
Piping	3	4.4.6		"		"			"			"	"	"	"	"
Auxiliaries	3	4.4.3	4.4.6	"		4.7.6		"	"			"	"	"	"	"
Control Systems	3	4.4.7	4.5	"				"			"	"	"	"		4.4.7
Alarm Systems	4.4.7	"		"								"	"	"		"
Lighting Systems									"		"	"		"		4.11

* Numbers in matrix identify the paragraphs in the specification related to the various matrix intercepts.

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