CHICAGO SMOKE ABATEMENT FAIR EXHIBIT

General Exhibits Building - Second Floor North
A CENTURY OF PROGRESS EXPOSITION
18th Street Entrance

CHICAGO, ILLINOIS

Mail Address
Lock Box 1048

Telephone
Calumet 1055

TRUSTEES

Frank A. Chambers - Chief Deputy Smoke Inspector, City of Chicago

Marc G. Bluth - Executive Secretary, Committee of Ten, Coal & Heating Industries, Inc.

Victor W. Landon - Secretary, Committee of Railroad Engineers

CONSULTING ENGINEER

Osborn Monnett

MANAGING ENGINEERS

H. D. Blackwell

R. B. McMullen, Jr.

Clint E. Beery

THE CHICAGO SMOKE ABATEMENT FAIR EXHIBIT

By

H. D. Blackwell, Managing Engineer

One of the most interesting scientific and educational exhibits at A Century of Progress Exposition in Chicago, and one that vitally affects every visitor financially and hygenically, is the Chicago Smoke Abatement Exhibit located on the second floor, north end, of the General Exhibits Building. The purpose of this free exhibit, so bubbling over with active displays, motion pictures and lectures, is to convey to every person not only the changing fuel and smoke producing conditions in Chicago, but the service offered by the Chicago Smoke Department to its citizens in smoke abatement, and to every fuel consumer the simple, effective rules and methods of properly firing furnaces that will reduce the annual coal costs and the volume of smoke that creates air pollution with its resulting detriment to health.

Offered to the public through the Department of Smoke Inspection and Abatement by Mr. Frank A. Chambers, Chief Deputy Smoke Inspector, the exhibit was made possible by the cooperative effort of Chicago's greatest industries as well as the fuel producing operators of the several states and many equipment manufacturers. The following list of sponsors gives the reader an idea of the important groups and corporations that consider public education of the changing fuel conditions, furnace operations and firing methods of coal a vital and economic necessity.

FINANCIAL SPONSORS

Chicago Railroads
Detroit Stoker Company
McClave-Brooks Company
Committee of Ten
National Coal Association
Appalachian Coals, Inc.
Illinois Coal Operators
Indiana Coal Operators
Pocahontas Operators Association
Chicago Coal Merchants Association
Iron Fireman Manufacturing Co.

SPACE BY

A Century of Progress - 1934.

EQUIPMENT SPONSORS

Olson Rug Company
Riley Stoker Company
Modern Coal Burner Company
Fred Harvey, Inc.
Kewanee Boiler Company
Museum of Science and Industry
American Arch Company
Baldwin Locomotive Works
Hayes Inst. of Combustion
American Flyer Mfg. Company
American Blower Company
T. W. McNeil Engineering Co.
Dr. E. V. Hill - Aerologist
Northwestern University
Heating Equipment Co. of America.

Few persons realize the tremendous cost in labor and money required to properly conduct a smoke survey of a city the size of Chicago. The first smoke and fuel survey conducted in Chicago was in 1911, and again in 1915, the last one being in 1934 when the City of Chicago and the Government agencies jointly cooperated through C.W.A. Project No. 1504 which employed a personnel of 117 engineers and field workers and expended $69,029.00 to bring down to date the changing fuel conditions as well as to conduct a survey of the equipment being employed. The total volume of smoke produced in the city as well as the smoke density of each individual Ward and the city as a whole was determined, therefore, for the first

time in the history of Chicago, the actual facts have been determined indicating which of the fifty odd Wards have the greatest smoke density and just what group or classification of fuel consumer located within that Ward is responsible for the production of the smoke.

Whenever a fuel and smoke survey of any city is conducted the entire tonnage of fuels transported into the city must be determined. The source of the fuel as well as the kind must be known, and the re-shipments from the city must be obtained and deducted from the total incoming tonnage before the final total tonnage of fuels consumed in the city has become a known factor.

The second necessary requirement is to determine who consumes the fuels. Therefore, the consumers of the fuels are divided into general groups, as follows:

1. THE RAILROAD GROUP, which consists of, first, the locomotives operated within the City limits, and secondly the railroad roundhouses located within the City limits.

2. THE DOMESTIC GROUP, comprising, first, the small home owner and small apartment houses up to and including four flat buildings, and secondly the large apartment houses containing from six flats up, also small and large commercial heating plants, office buildings, banks, hospitals, etc.

3. THE POWER GROUP, that is composed of the large power producing enterprises and the general industrial and manufacturing plants.

4. THE METALLURGICAL or SPECIAL FURNACE GROUP, contains special furnace operations, annealing ovens and generally, high pressure boilers.

5. THE MARINE GROUP consists of Passenger, Freight, Tug, Sand Dredge, and other boats operating in the rivers and harbors of Chicago waters.

Many interesting facts concerning the fuel consumed and the volume and density of smoke produced in the City from 1911 to 1933 has unfolded. Let us examine some of the comparative figures.

CITY OF CHICAGO	1911	1933	Percent Reduction	Percent Increase
Tons of Solid Fuel Consumed	11,000,000	22,000,000	-	100.0
Smoke Density	9.6%	4.7%	51.04	-
RAILROAD GROUP				
Tons of Coal Consumed by locomotives operating within the City limits	1,850,000	1,102,053	40.4	-
Volume of Smoke Produced	43.0%	2.8%	93.4	-
Density of Smoke Produced	23.0%	4.5%	80.4	-
Density of Smoke Produced by Railroad Roundhouses located within City Limits	24.0%	4.0%	83.3	-

DOMESTIC GROUP	1911	1933	Percent Reduction	Percent Increase
Tons of Coal Consumed by Small Homes including 4-flat apartment buildings	650,000	3,800,000	-	484.6
Volume of Smoke Produced	2.0%	20.4%	-	920.0
Density of Smoke Produced	3.0%	3.2%		6.6
Tons of Coal Consumed by Large Apartment Buildings from six-flat and up	2,250,000	6,800,000	-	202.2
Volume of Smoke Produced	2.5%	43.0%	-	1620.0
Density of Smoke Produced	3.0%	5.4%	-	80.0
POWER AND INDUSTRIAL GROUP				
Tons of Coal Consumed	4,500,000	7,250,000	-	61.1
Volume of Smoke Produced	30.0%	25.0%	16.6	-
Density of Smoke Produced	6.5%	6.2%	0.4	-
METALLURGICAL OR SPECIAL FURNACE GROUP				
Tons of Coal Consumed	600,000	517,000	13.8	-
Volume of Smoke Produced	12.5%	2.4%	80.0	-
Density of Smoke Produced	20.0%	12.6%	76.9	-
MARINE GROUP				
Tons of Coal Consumed	150,000	126,000	16.0	-
Volume of Smoke Produced	4.0%	0.9%	77.5	-
Density of Smoke Produced	25.0%	11.5%	54.0	-

It is extremely interesting to examine the causes of the changing fuel and smoke densities surrounding each of the foregoing groups. Let us first examine the Railroad Group employing 65,000 persons within the City and distributing in annual payrolls over $75,000,000.00 In 1911 the Chicago Railroads operated 1850 locomotives within the City limits. By 1934 this number had been reduced to 1205. This great reduction of locomotive power was brought about by employing and constructing larger engines, relocating switching yards beyond the City limits, increasing the train loads, co-ordinated services and cooperation with City officials. The tremendous reduction in the Smoke Density of 93.4% from 1911 to 1934 is the railroad officials' answer to the wishes of a smoke-minded public. The attack upon the smoke problem by the railroads is an outstanding example of what a well planned cooperative effort continually applied over a period of time can actually accomplish. Chicago railroads have for years employed more smoke abatement engineers than the City of Chicago.

As indicated above the Smoke Department has succeeded in reducing the Smoke Density in Chicago 51.04% since 1911 and continued cooperative efforts between the Department officials and the Industrial and Domestic Groups will eventually place all Groups on a parity with the Railroad Group insofar as air pollution by fuel combustion is concerned. Observation of any locomotive running through the City will reveal the extremely low volume of smoke emitted from the stack. How has this been made possible?

1st. By placing new modern locomotives with smoke abatement equipment in operation.

2nd. Re-equipping old locomotives with modern smoke abatement apparatus such as Steam Jets, Stokers, Syphons, Nozzles, Blowers, Netting Boxes, Sealed Arches, Improved Grates.

3rd. By a consistent smoke eliminating, fuel economy and educational policy whereby all engineers and firemen and other personnel are placed under a demerit system of efficiency.

4th. Maintaining on the payrolls over a period of years smoke abatement engineers who as a group meet with the officials of the City Smoke Department to discuss, adjust and regulate all complaints of smoke, inefficient operation of equipment or improvements affecting fuel economy or better combustion.

The facts surrounding the 83% reduction in the Railroad Roundhouse smoke density from 1911 to 1934 is equally interesting. Over one and one-half million dollars have been expended to improve seven locomotive railroad terminals located within the City limits of Chicago to provide smoke reducing and abatement apparatus. Among the more outstanding improvements are -

1. Direct steaming at locomotive terminals where locomotives are prepared for service runs by charging them with preheated hot water and sufficient steam pressure that will enable an engine to pick up its load of cars and leave the City without forcing its own fire. The importance of this is that it enables the fireman to slowly build up/fire-bed without production of smoke. the

2. Installation of smoke-jacks, or an apparatus that is dropped over the stack of a waiting locomotive and through suction within this smoke-jack that is created by large powerful motors and fans the locomotive smoke is sucked from the locomotive and conveyed to a washer stack, where it is washed through water removing therefrom all of the soot, carbon and other solids, leaving only the clear washed smoke to be omitted. The residue of this smoke-washing system is then carried away in gondola cars for proper disposition. Annual maintenance of these washer-systems is a tremendous item of expense to the railroads.

The record of the DOMESTIC GROUP is far from satisfactory. If we combine the total coal consumed by the small home owner including the apartment up to four-flat with the coal consumed by the large apartment from six flats and up it will be noted that combined they burn 47% of Chicago's annual solid fuel consumption of approximately 22,000,000 million tons. In the terms of smoke, however, these two divisions produce 63% of the total smoke created within the City limits of Chicago. In 1911 there were approximately 169,324 small homes and 3,845 apartments; while in 1933 there were 302,000 small homes including four-flat apartment buildings and 16,000 apartments of six flat and up, or an increase of 78.3% in the small homes and four-flat buildings and 316% increase in large six-flat or more apartment buildings.

While there has been a tremendous increase in the construction of small homes and apartment buildings from 1911 to 1933 it is interesting to compare the construction figures with the increase in the volume and density of smoke produced by this group.

	1911	1933	% Increase
Number of small homes and small apartments	169,324	302,000	78.3
Total Volume of Smoke Produced	2.0	20.4	920.0
Smoke Density	3.0	3.2	6.6
Number of large apartments	3,845	16,000	316.1
Total Volume of Smoke Produced	2.5	43.0	1620.0
Smoke Density	3.0	5.4	80.0
Population of Chicago	2,249,363	3,524,000	56.7

What is the cause of this tremendous increase in the volume and density of smoke produced by the Domestic Group?

1. Increase in homes and apartments by the natural process of city growth.

2. Expansion and growth of the city to include areas not supervised by the Smoke Department, such supervision being impossible due to a reduction rather than an increase in the personnel of the Smoke Department.

3. Tremendous increase in the use of solf Bituminous coal and especially of the Semi-Bituminous Medium Volatile type of coals as a substitute for the true low volatile smokeless coals which were supplied to the coal consuming public by the dealers and shippers.

4. Improper care and condition of the fuel consuming equipment resulting in complaints to the dealers of fuel.

5. General misunderstanding by the average home and apartment coal consumer in the simple rules and methods of fuel conbustion.

6. Furnishing of fuel to janitors by the owners or agents of property that is not always suitable in quality or adaptable to the type of installed equipment.

From the above we can but conclude that the human angle in the Domestic Group is extremely important. It is this group that must be reached and continually educated in the proper firing methods and correct fuel combustion principles. The public as represented by this group is ready, willing and eager to know of and learn the economy through proper fuel firing and to cooperate in every manner to reduce and prevent air pollution by improper fuel combustion. The problem is present. Coal, the natural product and fuel in this territory will be consumed in the domestic and industrial centers. The duty falls equally upon the coal operators and dealers alike to lend a helping hand through cooperative efforts to provide a means of continually educating the coal consumer through an unbiased public source.

THE POWER-INDUSTRIAL GROUP

Efficiency in equipment and personnel has long been a driving force in this group, the improvement indicated in the 1934 smoke survey of a reduction from 30% to 25% in the volume of smoke produced, while not large, shows a consistent trend to better conditions. Industrial officials are fully aware of the advantages of smoke elimination and are exerting every effort to cooperate in the progressive plans of the Smoke Department.

THE METALLURGICAL or SPECIAL FURNACE GROUP

The 1934 smoke survey developed facts surrounding this group that represent an improvement somewhat more favorable than the true operating conditions would warrant. Operating capacities of this group stood at about 60% of normal, and this lends reasons to believe that a 50% reduction in the volume of smoke produced in lieu of 80% as was actually developed would be more representative. An outstanding example of the cooperation between industrial officials and the Smoke Department is conveyed when it is realized that the Steel Mills alone have recently expended over $70,000,000.00, in new plants and other equipment to improve the condition of air pollution.

THE MARINE GROUP

Water traffic on Lake Michigan and its tributary rivers entering and departing at Chicago has recently indicated an upward trend following a severe drop. In 1911, 5,757 water crafts entered and departed from Chicago waters. In 1933 there were 2,195 incoming and outgoing crafts. The Marine group at present is a minor factor in the problem of Chicago's air pollution though a continual policy of policing the lake front, harbor and river waters is a necessary function. In 1911 the Marine Group had a smoke density of 25%. In 1934, it stood at 11.5%. The volume of smoke produced in 1911 was 4.0% while in 1934 it was 0.9%.

HIGH vs LOW VOLATILE COAL

The Smoke Department long ago recognized the inefficiency of endeavoring to maintain a public contact, education or knowledge of the ever changing individual brands of coal reaching this market. The public should be taught to clearly know and define the various kinds of coals - NOT by a brand or trade name but by their real classification. Why maintain one standard or yardstick of measurement at a mine door only to have it reach the consumer under one of a dozen trade names or brands that readily lends itself to unethical methods of dealing with the coal consuming public.

What are some of the simple coal facts the public should know?

1. What is Coal?
   A block of solid combustible mineral substance formed by the partial decomposition of vegetable matter without free access of air and under the influence of moisture, pressure and temperature and containing carbon, hydrogen, mitrogen and sulphur.

2. What are the kinds of Coal?
   (a) Anthracite
   (b) Semi-Anthracite
   (c) Semi-Bituminous
   (d) Bituminous

3. What does the term Volatile in coal mean?

   (a) Volatile when applied to coal indicates the "gaseous content in coal".

4. What does the term "Fuel Ratio" mean?

   As shown above, coal contains carbon, therefore, the term "Fuel Ratio" when applied to coal means the amount of fixed carbon divided by the volatile (gas) as may be shown by an analysis of any given amount of coal.

5. What is Anthracite Coal?

A coal that has a ratio of fixed carbon of not less than ten times the volatile (gas) content.

6. What are the grades of anthracite coal sold by dealers?

Egg size	Chestnut size	Pea size
Stove size		Buckwheat size

7. What is Semi-anthracite Coal?

A coal that has a ratio of fixed carbon of not less than five times the volatile (gas) content.

8. What are the grades of semi-anthracite coal sold by dealers?

Egg size	Chestnut size	Pea size
Stove size		Buckwheat size

9. What is Semi-Bituminous (low volatile) coal?

A coal that has a ratio of fixed carbon of not less than $2\frac{1}{2}$ times the volatile (gas) content.

10. What are the grades of low volatile coal sold by dealers?

Lump size	Stove size
Egg size	Small nut size

11. What is Semi-Bituminous (medium volatile) coal?

A coal that has a ratio of fixed carbon of not less than two times the volatile (gas) content.

12. What are the grades of medium volatile coal sold by dealers?

Lump size	Stove size	Nut size
Egg size		Pea size

13. What is Bituminous (high volatile) coal?

A coal that has a ratio of fixed carbon of not less than one time the volatile (gas) content.

14. What are the grades of High Volatile Coal sold by dealers?

Lump size	Stove size	Small nut size
Egg size		Nut size

15. What is meant by "mixture"?

The term "mixture" means a combination of two or more kinds of fuel in some definite proportions or stated amounts of each kind.

The proportions of each kind of fuel in this mixture is extremely important to the buyer of this fuel and definite knowledge of the exact proportions should be determined before attempting to successfully burn the mixture in any equipment. Fuels vary widely in chemical content, physical characteristics and combustion and because of this fact mixtures are not always practical; for example, let us consider for a moment, the mixing of some anthracite and high volatile (Bituminous) coal. The anthracite volatile (gas) content is for example - say - 5% which means the smoke produced would be very small. Let us say the high volatile coal contains 35% volatile (gas content) and produces much smoke. Now let us mix them on a 50-50 basis. We have an average then of 20% or a reasonably low volatile mixture of fuel. Mother Nature, however, never intended that we should juggle her contents in that manner because the element of combustion enters the picture and destroys the theoretical value of the mixture. When the mixed fuel is burned, the anthracite simply burns off in its natural manner without smoke, while the high volatile, which is not changed in its physical characteristics any by the mixing process, burns in its natural manner creating the smoke.

Records do indicate that so-called mixtures are occasionally offered for sale not as combustion aids or as deception of fuels, but to simply provide a fuel down to a price, because certain persons desire to purchase their fuels down to a price rather than up to a quality.

It can be readily noticed, therefore, that it becomes extremely important that the individual fuel consumer be thoroughly acquainted with and understand the mixture problem.

16. What is meant by a "Blend"?

The term "Blend" applied to coal fuel means a combination of two or more sizes and slack, of the same kind of fuel.

17. What is "Mine Run" coal?

Mine Run is coal exactly as it comes from the mine which contains all sizes of coal including slack, the quantities of each size or slack not being determined. When buying "Mine Run" coal dealers cannot guarantee and the purchaser should not request or expect the dealer from whom he is purchasing the fuel that the said coal purchase contains any definite percentage of Lump or Coarse coal.

18. What is "Forked Coal"?

The term "Forked" means that the coal has been loaded into the delivery vehicle by a "fork" which removes a portion of the fine coal and slack. Forked or Rescreened coal is desirable in small burners and heating plants with small fire boxes as it allows free admission and passage of air.

19. What is "Rescreened" coal?

The term "Rescreened" is used to indicate that the coal has been passed over a screen in loading which removes a large portion of the fine coal and slack.

20. What is "Car Run" coal?

The term "Car Run" is applied to mean sized coal, that is either lump, egg, nut, etc., which has not been rescreened or forked at the dealer's yard.

21. What is "Washed" coal?

The term "Washed" indicates that a percentage of the non-conbustible (that is material in the coal that will not burn) has been removed by some recognized process of water flotation whereby such impurities as slate or rock, sink while the clean coal remains. Processes of this nature generally tend to reduce the ash.

22. What is "Dry or Air-cleaned" coal?

This means that a percentage of the impurities in coal are removed by a method of air instead of water flotation.

23. Coal dust at times of delivery.

Coal dust is a source of air pollution and may be avoided if the purchaser at the time of ordering his coal will specify "wet at the yard" or "wet at the house". In this case the coal will be dampened or treated before it leaves the dealer's yard or is delivered to the consumer.

24. Keep your records.

Study and become acquainted with your fuel problem. Complaints of fuel in many instances are result of poor judgment of the consumer and lack of any understanding of firing methods of high and low volatile coal. Commence your study with your coal delivery ticket. See that it has plainly marked thereon the gross, tare and net weight and just as important the kind of coal and the size and insist upon all this evidence being legible. Later, if you choose to call upon the City Smoke Department for assistance in your fuel conbustion problems to which every Chicago citizen is entitled to do without cost, there will be a record of fuel consumed, also, it may be discovered that certain grades of coal give better results in a particular equipment, thus creating better fuel satisfaction, less complaints, greater economy and reduction in the air pollution, by fuel conbustion.

25. Chimney and Furnace Charts.

One of the interesting exhibits available and one that every homeowner is extremely anxious to study consists of an artist's colored drawing showing the proper and improper chimney construction and furnace conditions. It is pointed out that chimney tops below the gable of a house or surrounding buildings prevents clear proper furnace draft, joists extending into the chimney, loose cleanout door fittings, refuse accumulated, in chimney or pipes, pipes extending too far into the chimney, cap covers on top of chimney, improper flue lining, all of these things reduce efficiency of equipment. Also leaking pipe joints, loose valves, downward slanting pipes, loose or warped doors, warped or burned out grates of which samples are available in exhibit for observation. All of these defective equipment faults are pointed out as reducing fuel satisfaction and creation of fuel complaints resulting in the dealer

being criticized for fuel delivered. The consumer is shown that regardless of the best equipment being installed or the proper fuel and the best methods of firing be followed if the common defaults above pointed out are present, the best fuel-burning results cannot be obtained. Among the items every coal consumer is requested to follow are:

1. Clean and carefully check every part of your furnace at least once a year.

2. Clean the chimney before starting fall fires.

3. Examine drafts and dampers for proper fitting and operation.

4. Test all pipes and connections to see if air tight or rusted.

5. Always keep the ash pit under the grate cleaned.

6. That emission of smoke through a hot-air register is dangerous to life and property and indicates a cracked fire-pot.

HOW TO FIRE HIGH and LOW VOLATILE COALS

Intense public interest is shown in the scene-in-action or actual moving scene of how both the high and low volatile coals are fired.

The question is often asked of a coal consumer "Does a fire burn upward or downward"? Few people realize that the proper method of starting a fire is to first place the coal in the firebox over a bed of at least 3 inches or more of ashes, then place the kindling and lastly the paper on top. The simple explanation quickly conveys the principle involved to the interested observer when it is pointed out that the first disintegration of coal commences at about 500 degrees F. at which time the gases are first thrown off and that the paper and kindly provide sufficient heat and temperature to not only ignite the coal but consume the smoke and gases which must pass through the flame. Likewise instructions are given in refueling of the high volatile coals by carefully instructing that the hot coals should be pushed over to one side of the firebox and then place the fresh green coals on the opposite side from the hot coals. Thus the green coal is soon ignited from on top, burning downward to the base and at all times providing a sufficiently hot flame to consume all smoke and gases thrown off. The above term is called side bank, or alternate method.

Particular attention is called to the necessity of avoiding a mixing of the hot coals with the ashes, lest clinkers will be created. Another important instruction point is the fact that the rate of combustion (the speed with which the fire burns) is easily controlled by the thickness of the bed of ashes permitted on the top of the grate, allowing in the spring and the fall, when little heat is required, a thickness of approximately ten inches, and in winter, or cold weather, about four to six inches, when more heat is required.

The necessity of keeping ashes in the ash pit cleaned out is visually impressed by burned out and warped grates that are on display, which not only allows the loss of fuel through the burned-out sections, but the admission of cold air through the holes that will appear in the fire bed. Again, the considerable grate-replacement, expense, is pointed out to the observer.

For the low volatile (Semi-Bituminous) coals, instructions are given

depending upon the type of equipment used. For the upright type of boiler, the conical method is advocated and displayed by a Scene-in-Action moving Firing Chart showing how to properly fire the Pocahontas Type Coals whereby the coal is shown piled in a cone shape in the center of the fire box, permitting the larger chunks of coal to roll down to the base of the cone, thus insuring ample air. In refueling under this method of firing, advice is given to use care and carefully break open the cone with a bar, avoiding any stirring or mixing of the coals and ashes, and then gently pile in the fresh coal in the center of the firebox and rebuild the cone.

For the rectangular firebox type of boiler, the low volatile (Semi-Bituminous) coals should be burned by gently pushing the hot coals to the rear of the firebox and piling the fresh green coals just inside the firebox door. Care should be exercised at all times not to allow too thin an ash bed or mixing of the hot coals and the ashes. Punching of the fire with a slice bar, piling in green coals on top of hot coals, are particularly pointed out to be an operation detrimental to proper method of firing and a creator of smoke and air pollution.

Draft and damper controls are visualized by action displays showing the necessity for entrance of oxygen over the coal fire in the high volatile Bituminous coals.

HOW TO READ SMOKE:

Large, framed, Ringlemann charts are available, showing the correct method of reading the smoke density of any stack. This is further visualized by working model of a photo-electric cell smoke indicator, mounted on what represents the breeching of a power plant furnace. This motorized exhibit registers the various densities of smoke in accordance with the Ringlemann charts, giving a bell signal warning when 60% dense, or #3 smoke, is reached, which is the violating point under the present Chicago Smoke Ordinance. Available also is a working motorized model of a smoke recorder that grades samples of smoke drawn from a stack or breeching where it enters one glass bulb where the solids are removed. Thence, it is drawn to a second glass bulb where the moisture is removed by the action of sulphuric acid. It is then blown against a chart, where its density is recorded by the Ringlemann method for each hour and minute of the day.

THE DUST GROUP:

Interesting, indeed, are the facts presented concerning air pollution, by samples of fly-ash obtained from combustion of coal over grates and also powdered coal, which is solid fuel burned in suspension. These are offered for observation and represent actual samples.

The volume of the samples are identical, but their specific gravity or atomical weights vary widely due to the minuteness of the fly-ash resulting from the coal burned in suspension. Samples of washer water showing carbon deposits, together with fly-ash and the automatic separation of the carbon and fly-ash to the bottom of the jars while the tar floats to the top, offer visual facts of costs to merchants and individuals of Chicago totalling $30,000,000.00 annually.

Charts show the tests taken of the dust fall in Chicago during 1926 which year the record indicates there fell to every square mile in the city the huge total of 326 tons. In 1932 this record had been reduced to 230 tons per square mile. And in 1934 the amount of dust fall shows a further drop to 146 tons per square mile.

Miniature models of cyclone dust collectors used for collection of smoke solids, or manufactured processes show the progress of eliminating the solids

from fuel and other productive sources.

Nature has a convincing and natural manner of conveying needed lessons to the human mind. Actual human lungs of two male persons 45 years of age are on display one a man who lived and died in the country; the other a city dweller, which is convincing beyond conception of the necessity of eliminating dust from the air and obtaining better fuel conbustion from the coal that is consumed. These human lungs must be seen to appreciate the smoke problem of the city of Chicago. Dirt and dust from the air we breathe is visualized before the eyes of visitors by the small micrometer which through a small vacuum suction pump tests the number of particles of dust in the vary air the visitor is breathing or from their clothing. Enlarged pictures show a grain of dust increased to 100 and 800 times greater than its original size. Also a human hair is shown with dust particles attached. A working firebox or stack-testing apparatus is offered that shows how the solids from smoke stacks or breechings are obtained by combustion engineers.

A working model of a smoke washer is available with circulating water runni perpendicularly over baffle plates to collect the smoke solid blown from a horizontal level through the baffle plates.

Miniature railroad trains, each weighing 75 pounds run around a 60-foot circular track that is suspended two feet from the ceiling. On each flat car of the train is mounted a statistical card of the fuel-changing conditions, also cards indicating the volume and density of smoke of the various coal-consuming groups using the 22 million tons of solid fuel burned in Chicago during 1933.

A coal tree, 40" x 48", electrified and set in glass, presents an interesting study of the endless chain of by-products obtainable from coal.

A glass framed diagramatic artist's drawing, 48" x 72", depicts the modern locomotive roundhouse. This drawing traces by colors the present system of washing the solids from engine smoke before it is emitted to the atmosphere as washed smoke.

A hand operated miniature stoker is accessible for all to study and operate. This miniature stoker fills a demonstrating niche of importance, pointing out the fact to observers that the Domestic (homes and apartments) Group is now the first producer of smoke and the consumer of approximately half of Chicago's annual coal consumption, and serving the purpose of conveying to the coal consumer the fact that a better understanding of fuel conbustion problems must be obtained to reduce this tremendous volume of smoke. While the stoker is not a guarantee against smoke or air pollution, it is pointed out as serving a very great need by feeding coal to the furnaces at the proper rate and at the correct intervals of time with the proper air, thus creating correct conbustion and a saving of fuel to the owner and reducing air pollution.

Our exhibit continually directs attention to the fact that both the high and low volatile coals can be easily fired without producing smoke if simple rules and methods are followed. The Railroad Group stands forth as a shining example of effort well planned and executed. Moving action scenes of locomotive fireboxes with and without sealed arches are shown to indicate the proper mixing of gases, the loss of fuel, the creation and elimination of smoke.

An actual steam jet forms a counter display with explanatory descriptive reading material setting forth its principle of firebox turbulence and mixture of gases to aid in obtaining proper and complete conbustion. The point in mind is to convey the necessary adjuncts to obtain proper conbustion, which are:

1. Mixture of air and gases
2. Sufficient Oxygen - Clean fresh air
3. Sufficient Time
4. Sufficient Temperature

Thus we recall in a moment the word - MATT, - mixture, air, time, and temperature.

Interesting counter displays encased in glass show the relationship of the Lake Michigan water and the land air temperature from 1911 to 1933; also the direct influence of Lake Michigan upon the climate of Chicago. Pictures of the stockyards in 1900 - from a smoke angle - compared with 1934 are shown. A chart shows the total number of foggy and dark days in Chicago from 1911 to 1933. This is important due to the fact that the greatest number of dark and foggy days occur between October and March each year, or during the coal-consuming months and further that fog is created simply by condensation of the moisture in the air with dust particles. Maps show the smoke density of each ward in Chicago. There is also data on pneumonia, which reveal that the cases of this respiratory disease is the greatest in those wards which have the highest density of smoke, regardless of whether comparison is made with density of population per square mile, old housing conditions, or strictly Negro population; and further, that 65% of the cases of pneumonia occur during the coal-consuming months, from October to March, and during the period when the foggy and dark days are more prevalent.

METEOROLOGICAL CONDITIONS DETRIMENTAL TO CHICAGO'S SMOKE PROGRAM:

Few persons realize the importance of the meteorological conditions that exist in every city and their effect upon the general problem of air pollution. In Chicago, a city 25 miles in length and 12 miles in width, it has been developed from government records that for the smoke-forming hours, from 5:00 to 7:00 A.M., when the fires are being built up, that for the coal-consuming months, from October to March, during the years 1911 to 1933, the prevailing winds blew:

49	Months	-	From the	Northwest
40	"	-	"	" West
38	"	-	"	" Southwest
13	"	-	"	" South

These prevailing winds blew at an average velocity of 12 miles per hour and are termed "polluting winds", as they drove the smoke continually toward the heavily populated regions of the city. The "Clearing winds" from the North, Northeast, East and Southeast, blowing the smoke away from the city, prevailed only four months during the same period of time from 1911 to 1933.

All of this interesting data is set upon a background of red, blue and green colored glass, 42" x 48" and electrified.

STOKER OPERATIONS, FIRING METHODS, SMOKE GRADING, AND STATISTICAL DATA:

A continuously operated Belloptician machine, 4' x 2', containing an endless belt of pictorial slides 2¼ x 3¼", depict data and statistical figures on stokers, smoke firing methods, fuel conbustion, and smoke densities.

SELF-EXAMINATION ALBUM:

For the laymen and engineers' examination is a handy counter album containing

many ordinary questions concerning boiler operations that are generally asked at examinations for Civil Service Examinations for Engineers. The answers to the questions appear on the opposite page from the questions. By answering and grading one's self on each page, a test of an individual's personal knowledge is possible.

MOVING PICTURES:

In the center of this interesting exhibit has been placed a 2,000 pound, one-fourth inch steel boiler shell, seven feet tall and ten feet long. Inside this boiler is located a moving picture projector and these pictures are projected upon a screen located in the firebox door - a new, simple and unique method of motion picture projection.

In the atmosphere of a boiler and burning coal fires, we find this exhibit portraying the smoke problem in Chicago in its real sense, and this is realized when such pictures as the following are presented for observation:

1. The Chicago Industrial Smoke Problem
2. The Chicago Domestic Smoke Problem
3. Smoke Abatement by Chicago Railroads
4. Abating a Smoke Nuisance in Chicago
5. Special Sources of Air Pollution
6. The Three Atoms: Carbon, Oxygen and Hydrogen

All of these special pictures depict fuel combustion, smoke abatement, and lessons in firing of high and low volatile coals. Many special scenes are also shown, including the recent stockyards fire, which destroyed ten million dollars worth of property. All of these pictures are intermingled into a background of Chicago's scenic wonderland visually presents the visitor with an idea of the vast smoke and fuel combustion problem in a city and metropolitan area of over four million persons.

Literature covering the following subjects is available for free distribution:

1. Firing Method of Bituminous Coal
2. Firing Methods of Pocahontas Type Coals
3. Educational Bulletins (6 in number)
4. Up-Draft Boiler Operation Rules
5. Down-Draft Boiler Operation Rules
6. Data on Stokers
7. How to Read Smoke
8. How to Burn Garbage
9. General Resume' of Chicago Smoke Abatement Fair Exhibit Booth

Every person visiting this exhibit leaves with a better understanding of fuel economy and smoke prevention. Every coal operator, coal dealer, agent, salesman, janitor, and homeowner should grasp this opportunity to view and learn the lessons and facts here portrayed, so that there may be a closer cooperation between the fuel producer, the dealer, the consumer, and the public officials to the end that there will be fuel economy and health improvement.

---oooOOOooo---