BY BRIAN KROMER

Smoke Stack Theory and the Stationary Model

Infleksion set to release inaugural stationary emission sources study

Smoke Stack Theory

Facilities = Geographic Concentrations

- ALL facilities regulated for any one of 189 Hazardous Air Pollutants under the Clean Air Act of 1990
- Each facility will be ranked against the quantity or pollutant produced into a permitted class

Stacks = Air Emissions Concentrations

- Not all facilities have stacks
- Stacks represent the combination of processes and exhaust streams

Points = Equipment Concentrations

- Points are the origin of the pollutant and the physical entity producer
- Points can be a boiler, turbine, chemical process, internal combustion engine, etc.

Figure 1. Infleksion Smoke Stack Theory.

Through most of more than 20 years of involvement in emissions issues, I have wondered if there was a way to inventory America's smoke stacks to identify exactly what generated the types of "smoke" upon which government interest has focused since the 1990 Clean Air Act became law. In this presentation, I will introduce a new way to view stationary emission sources in relationship to time, geography and technology. I've called this new view Smoke Stack Theory.

Smoke Stack Theory is the result of my long-term dream of creating a list locating every single engine, generator, boiler, turbine, compressor, pump, crusher or driven piece of stationary equipment in the United States. Beyond that, I dreamt of building a database tool that could manipulate and interpret that data. That endeavor has proven so successful that it led me to form Infleksion, a company dedicated to providing an extremely flexible and useful user interface encouraging exploration and manipulation of that data and allows the insights thus gained to be easily presented and shared.

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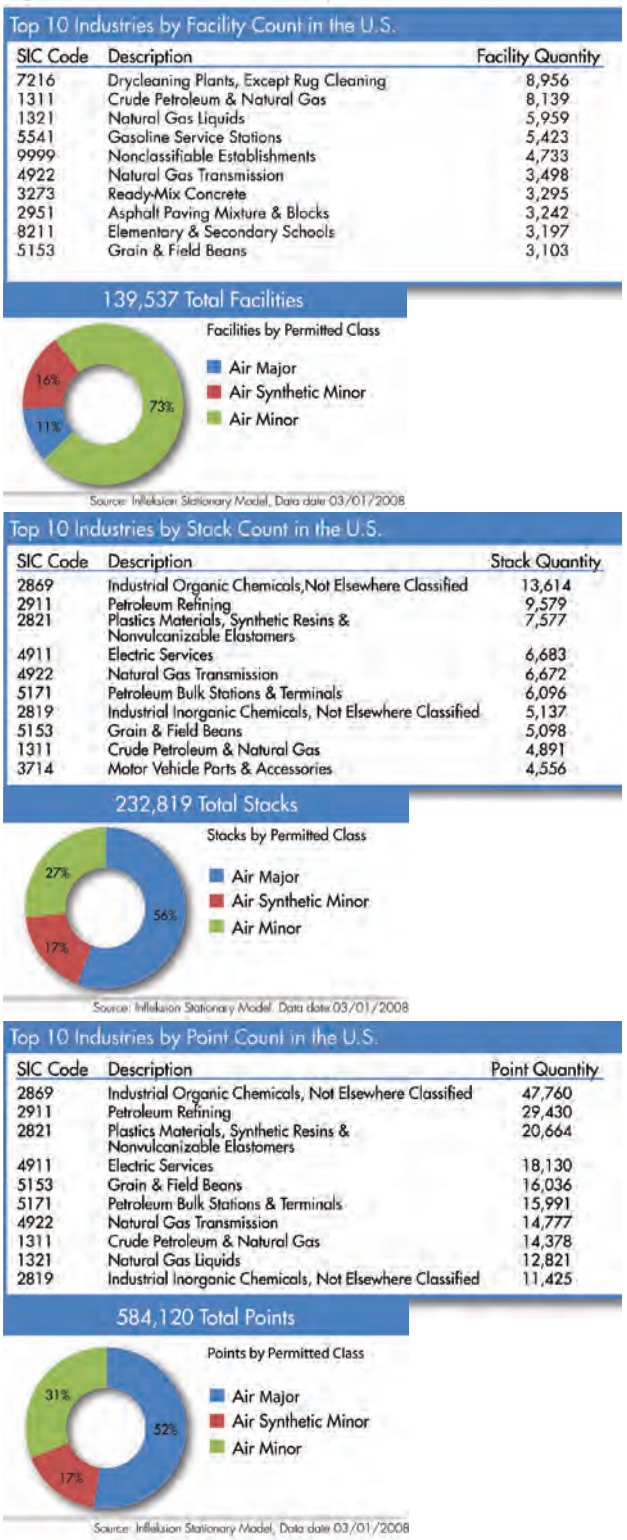
Figure 1 represents an oversimplification of what the Clean Air Act and its Amendments have become 18 years after its original passage. The United States Environmental Protection Agency (EPA) mandates minimum National Emission Standards for Hazardous Air Pollutants (NESHAPs) from an original list of 189 hazardous pollutants for any discharge to the atmosphere within the territorial boundaries of the United States. This minimum standard then promulgates through the various state and territorial entities (53 in total) at no less than the federally mandated minimum standard. Some states have long taken a more comprehensive approach in viewing the role of the environment and pollution, and state entities such as the California Air Resources Board (CARB) have often adopted standards much more stringent than the federally mandated minimum.

The model identifies three key concepts. Facilities refer to geographical concentrations of emission sources. Stacks refer to concentrations derived from the cumulative emissions from processes and exhaust streams. Points represent a physical entity (boiler, turbine, chemical process, internal combustion engine and so on) that generates a pollutant.

In order to benefit from the evolution of the Clean Air Act and the EPA's interpretation and enforcement of it, the permitting process itself and the role of each individual state authority, we must understand the logic of the lingo those entities use. Facilities have a compliance obligation independent of (but strongly related to) the status of the equipment within them. This represents a fundamental difference from traditional mobile equipment markets. Unlike an automobile, the manufacturer of stationary equipment does not hold the compliance obligation. That obligation must be met by the facility.

Indeed, facilities have a relationship to the regulatory tide and the general public, and geography plays a very strong role in defining that relationship. Proximity to 8-Hour Ozone Areas, Nonattainment Areas or national parks dictate increased levels of mandated compliance technology. Facilities cannot necessarily move, and the surrounding air quality must be considered dynamic. That is, once a pollutant has been released into the atmosphere, its concentration can affect a site by how it is distributed once it is in the environment. This is one reason why the EPA focuses on ozone, as it is a precursor to other greenhouse gas concentrations.

The main point is that there will always be a facility, there may only sometimes be a stack and there are always points inside the facility. Again, stacks are concentrations of singular



Top 10 Industries by Facility Count in the U.S.

SIC Code	Description	Facility Quantity
7216	Drycleaning Plants, Except Rug Cleaning	8,956
1311	Crude Petroleum & Natural Gas	8,139
1321	Natural Gas Liquids	5,959
5541	Gasoline Service Stations	5,423
9999	Nonclassifiable Establishments	4,733
4922	Natural Gas Transmission	3,498
3273	Ready-Mix Concrete	3,295
2951	Asphalt Paving Mixture & Blocks	3,242
8211	Elementary & Secondary Schools	3,197
5153	Grain & Field Beans	3,103

Top 10 Industries by Stack Count in the U.S.

SIC Code	Description	Stack Quantity
2869	Industrial Organic Chemicals,Not Elsewhere Classified	13,614
2911	Petroleum Refining	9,579
2821	Plastics Materials, Synthetic Resins & Nonvulcanizable Elastomers	7,577
4911	Electric Services	6,683
4922	Natural Gas Transmission	6,672
5171	Petroleum Bulk Stations & Terminals	6,096
2819	Industrial Inorganic Chemicals, Not Elsewhere Classified	5,137
5153	Grain & Field Beans	5,098
1311	Crude Petroleum & Natural Gas	4,891
3714	Motor Vehicle Parts & Accessories	4,556

Top 10 Industries by Point Count in the U.S.

SIC Code	Description	Point Quantity
2869	Industrial Organic Chemicals, Not Elsewhere Classified	47,760
2911	Petroleum Refining	29,430
2821	Plastics Materials, Synthetic Resins & Nonvulcanizable Elastomers	20,664
4911	Electric Services	18,130
5153	Grain & Field Beans	16,036
5171	Petroleum Bulk Stations & Terminals	15,991
4922	Natural Gas Transmission	14,777
1311	Crude Petroleum & Natural Gas	14,378
1321	Natural Gas Liquids	12,821
2819	Industrial Inorganic Chemicals, Not Elsewhere Classified	11,425

Figure 2. Infleksion Stationary Model.

or multiple exhaust, and process streams and points are what produce the physical criteria pollutant that is being tracked. Simply put, points index equipment and can be classified by their type — internal combustion engine, gas turbine, boiler, chemical process and so on.

Figure 2 shows a summary of what I have called the Stationary Model. The Stationary Model can aggregate and report at a prime mover level such as boiler, turbine, internal combustion engine and so on. It truly is a comprehensive geospatial index of the stationary infrastructure and facility inventory for the United States. It is a model because it provides a spatial reference against which to view and evaluate multiple variables in the areas of time, geography, technology and compliance of stationary markets. Furthermore, it is a model because it is software that provides the user a real and dynamic relationship to the stationary emissions sources in the United States.

In Figure 2 you see a summary view illustrating why Smoke Stack Theory might be more than just theory. Note the distinct appearance of the dry-cleaning industry as the largest concentration of monitored industries when viewing only the number of facilities. But also note the changing industry composition as we shift our attention to stacks and points — dry cleaning disappears altogether, because although we need dry-cleaning establishments to be as handy as gasoline service stations, and they are centrally located in relationship to major populations, they do not truly generate a major quantity of emissions.

If we examine Figure 2 in more detail, we can also see the relationships of these facilities to the 189 Criteria Air Pollutants by their Permitted Class. The EPA ranks each facility in accordance with the quantity of any single criteria air pollutant or any combination thereof, and there are just three categories — Air Major, Air Synthetic Minor and Air Minor. The Stationary Model summary in Figure 2 clearly shows that the number of facilities in the permitted universe of the U.S. totals 139 537 with over 232 810 stacks and 584 120 point sources.

The figure further delineates the permitted class of Air Major, Air Synthetic Minor and Air Minor by its concentration of facilities, stacks and points. Here we can see the almost even relationship the Air Synthetic Minor class has across all fields, but the relationship of Air Major and Air Minor are really inversely proportional to the number of facilities represented — in other words, it takes very few Air Major facilities to find equipment, but very distinct Air Minor facilities to find equipment.

Figure 3 shows that just 11% of these facilities host over 50% of distinct emission generating equipment in the form of over 300 000 points. These points ultimately lead back to the equipment that generates the pollutant, such as the gas turbines, internal combustion engines, boilers and other equipment mentioned earlier. In the Air Major category, we find duty cycle and density of equipment on a grand scale, because an Air Major could be producing 100 tons annually of any one of the single

Permitted Class	Facilities	Stacks	Points
ALL / Entire U.S.	138,537	232,819	584,120
AIR MAJOR	11.03%	55.95%	52.54%
AIR SYNTHETIC MINOR	16.01%	17.37%	16.64%
AIR MINOR	72.96%	26.69%	30.81%

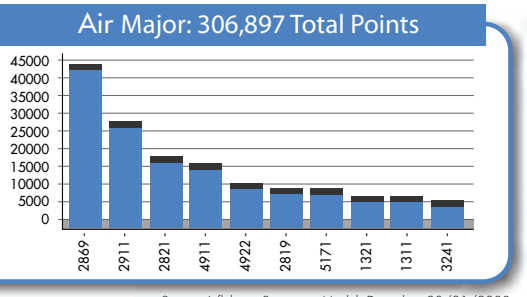
Source: Infleksion Stationary Model, Data date 03/01/2008

Figure 3. Infleksion Permitted Class Index.

Figure 4. Infleksion Air Major Equipment Concentration Index.

Top 10 Industries by Point Count in the U.S.

SIC Code	Description	Point Quantity
2869	Industrial Organic Chemicals, Not Elsewhere Classified	44,539
2911	Petroleum Refining	28,252
2821	Plastics Materials, Synthetic Resins & Nonvulcanizable Elastomers	18,428
4911	Electric Services	16,352
4922	Natural Gas Transmission	10,858
2819	Industrial Inorganic Chemicals, Not Elsewhere Classified	9,400
5171	Petroleum Bulk Stations & Terminals	9,259
1321	Natural Gas Liquids	7,276
1311	Crude Petroleum & Natural Gas	7,234
3241	Cement, Hydraulic	5,870



Source: Infleksion Stationary Model, Data date 03/01/2008

189 Criteria Air Pollutants at a minimum. This is the main reason why such a relatively small number of facilities constitute such a large percentage of the points and resulting equipment.

Figure 4 highlights the points concentration in the Air Major class to represent the top 10 industries and resulting number of points at a single four-digit Standard Industrial Classification (SIC) code level. Perhaps here the significance is more in what the data does not say than what it does say. As an example, the point source data can be imagined as a definite limit to any piece of equipment being sought. The usefulness of this data can be expanded by grouping facilities across the dataset into multiple SIC combinations representing the oil and gas industry, power generation, refining and chemical, and a host of other resolutions that point to opportunity and growth in energy markets. I plan to address those possibilities and their application and interpretation in detail at a later date. My goal here is to lay the groundwork for that by sharing the underlying model that permits such fine resolution.

If the widely published assertion that the United States generates 25% of the world's greenhouse gas emissions is accurate, then potentially these 14 000 facilities in the Air Major class representing only 11% of the U.S. total might represent 12% of the world's carbon footprint with regard to stationary point source emissions. Even if these 14 000 facilities do not constitute 12% of the total global stationary carbon imprint, they do represent over 50% of the point source concentration of stationary air emissions of the U.S. and thus constitute a target of constant compliance monitoring.

I believe the new perspective made available by Smoke Stack Theory and the Stationary Model together represent a unique common denominator applicable globally and across all markets.

Real or perceived, it is undeniable that widely held public opinion holds that human activities have a direct impact on the planet and that change is due in response. Eventually, public perception and industry realities will cross paths. I believe that Smoke Stack Theory and the Stationary Model represents a transparent model far more significant than the simple inventory I dreamt of originally.

Stationary installations are extremely sensitive to these issues because their facilities are geographically fixed. As a result, they will by their very nature face disproportionate public scrutiny by regulators and those living and working closest to them.

About the data: The data is dated March 1, 2008, and is continually updated by Infleksion's Stationary Model software application and Infleksion's Annual Study. Details about the Study and the Stationary Model software can be found at www.infleksion.com.