UNIVERSITY OF HOUSTON
ORAL HISTORY OF HOUSTON PROJECT

Interview with: Dr. Tom Stock
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CC: This is an interview with Dr. Tom Stock on August 1, 2006, at the University of Texas School of Public Health in Houston, Texas. Dr. Stock, first I'd like to ask you if you would tell us what your position at the University ofTexas is.

TS: Sure. I am an associate professor of Environmental Science at University of Texas School of Public Health which is part of the University of Texas Health Science Center here in Houston.

CC: And what specifically do you work on?

TS: Well, I guess my area within the division I am in which is the Division of Environmental and Occupational Health Sciences, my major area of expertise is air quality and that is both indoor and outdoor air quality. And I also like to characterize my expertise as exposure assessment because I am interested in exposure to air pollutants and that involves not just traditional monitoring of the outdoor air but indoor air and actual personal exposure so we actually clip monitors on subjects and measure what they are actually breathing in the air they are breathing zone. So, I am an exposure assessor, you could say. But from a air quality point of view.

CC: And do you find a big difference between the outdoor and the indoor?

TS: Oh, yes. Of course, it depends on what pollutants you are measuring and I have measured a lot of different pollutants. Most recently, we have been using what is called a passive monitor for measuring what is called air toxics and a subset of air toxics called

volatile organic compounds. And we have done a lot of work with those. We have validated their use at low level concentrations. They originally were designed to be used for workplace monitoring at much higher concentrations but we did a lot of work. Chamber evaluations and followups to use them at much lower concentrations. We have a nice tool now for looking at these things. And since they are passing very light badges that require no power, you can clip them on people so you can get their actual personal concentrations. You can put them inside people's homes if they don't object. Again, no noise, no nothing. You can see what the concentrations are inside their homes and you can deploy them outside anywhere you want basically. And for those compounds, the volatile organic compounds, most of them are at higher concentrations typically indoors than outdoors. In spite of all the controversy and hullaballoo and concern about the levels of air toxics outdoors, there are still consistently, for most compounds, not all, for most compounds, typically higher levels indoors than outdoors. And that is a message that the public still hasn't gotten, I think.

CC: What specific compounds?

TS: That are high indoors than outdoors? Well, again, these volatile organic compounds - one example is toluene. It is called an aromatic compound. It is produced from gasoline or automotive emissions, industrial emissions, refinery emissions - those kinds of things. And because it is used in a lot of consumer products, there are many sources of it. It is used in paints, etc. People store paints inside their homes. People store gasoline, for instance, in attached garages like I do even though I should know better, and the vapors can infiltrate inside the home. So, there are many different sources. So typically, toluene is quite a bit higher indoors than outdoors. But it is not necessarily

true . . . and that doesn't mean that we can't worry about significant outdoor sources and maybe you want to ask me specific questions about that but, you know, one of the controversial compounds we hear a lot about in Houston nowadays is 1,3-butadiene and we know that there are significant outdoor sources, industrial sources in certain areas of east Houston, for instance, and also automobiles are a significant source. Unfortunately, we don't know that much about indoor concentrations and what happens when outdoor butadiene infiltrates into the indoors because we haven't developed good like passive monitoring methods for butadiene. The badges I was talking about do not do a good job on butadiene, so reliable for toluene and benzene and the xylenes, tetrachlorethylene and things like that but not so good for butadiene. So, we have to develop better methods to really assess butadiene. But my gut feeling is that the outdoor sources are going to play a huge role in people's exposure. So, we cannot not neglect the impact of outdoor sources. They are still very important. And, of course, people who are more exposed to significant outdoor sources like where there is high traffic density or very close to, say, petrochemical facilities, their exposure is compounded by that, plus what they would get ordinarily from the indoor sources. So, you know, you can never ignore the outdoor sources because they are not under someone's control. Indoor sources theoretically are under individual people's control and one important indoor source for many of these things would be cigarette smoking. So, environmental tobacco smoke, for instance, is a source of lots of these organics as well as many other pollutants like particulate matter, carbon monoxide. You can go on and on. Many carcinogens. And certainly active smokers have complete control over their own exposure and they have a lot to do with other people in the household, what their exposure would be to environmental tobacco

smoke or second-hand smoke. So that, I think, involves a lot of educational effort to try to reduce those levels. But where smoking does occur, that is a huge contributor to most of these indoor pollutants.

CC: Well, you were taking about the indoor pollutants. Would you find them higher over in the Ship Channel area?

TS: Actually not. It gets to be a little bit of a complicated question and if you are considering . . . let's say the indoor levels, the indoor sources are about the same no matter where you would live because people use similar products, that is not absolutely true of every product, for instance, but by and large, they are somewhat similar. So then, the next thing you have to consider is the ventilation of the indoor environment and we actually did a little pilot study and it wasn't to study this question, it was just to test out our badges. But we happened to perform it at the end of October and I can't remember the exact year. A few years ago. More than a few, I guess. And that is the time of year when things aren't the worst as far as heat and use of air conditioning but, you know, still moderately warm. So, we had a test group over in Pasadena, Texas- 5 homes and about 2 subjects I each home - and we had 5 other comparison or control homes you might say in southwest Houston. And most of those folks were recruited from faculty and students here at the School of Public Health. And there was a pretty big, as you might imagine, socioeconomic difference between the two groups. So actually, people in southwest Houston, our group, they all had central air-conditioning and they did not hesitate to use it during this 3 day period in late October when, you know, I'd say the temperatures were maybe mid 80s or high 80s perhaps the peak. So, they would use it all the time. On the other hand, I think 4 out of the 5 homes in Pasadena, even though they had window AC

units, they didn't use the AC because it takes a higher level of discomfort -- this is my theory anyhow -- for people who have to really watch their expenses with regard to utilities, it takes a higher level of discomfort for them to start using the air conditioning as it does for people who had more substantial means. So, as a result, they actually have more fresh air. They had fresh air ventilation. They opened their windows. One house actually had a huge fan that just brought in a lot of fresh air to try to cool things off. And as a result of that, their indoor environment looked more like the outdoors while the people in southwest Houston, their indoor air was more isolated from the outdoor air. So, if you understand that these indoor sources can contribute and build up higher levels indoors then, in fact, what we observed is what you'd expect - the people in southwest Houston had typically higher indoor levels of many of these pollutants than these people in Pasadena. So, again, kind of a little bit opposite of what most people would expect because the main determinant for a lot of these compounds is indoor sources, not outdoor sources. But once again, that doesn't mean we can ignore significant outdoor sources. But you really have to think it through and do these kind of detailed studies, doing personal monitoring to really sort out those major determinants of people's exposure. It is not necessarily what you might think of a priority.

CC: And you have been working on these pollutants for a long time and I know you were part of the mayor's task force.

TS: Yes.

CC: What capacity did you work on this?

TS: Well, I was just a member of the task force and attended all the meetings where we made decisions, some important decisions about reviewing chemicals and how to

prioritize the risk. I mean, that took a lot of discussions to try to determine that. So, I think it was important to bring in a broad perspective of expertise that was represented on the committee to really come to a consensus about how you should prioritize the relative risk. And I think that was one of the most successful things. I mean, I have to give credit to Steven Linder and the people who worked with him. I mean, they spent an enormous amount of time actually implement what we all agreed what should be done and that is really the tough part. And I also performed, I think, a pretty detailed review of, I don't know if it was the first draft, maybe the second draft but the ultimate draft, I guess, of the report and I think I was able to contribute some wording and improvements to that report. So, you now, I was just one of many representing different levels of expertise and different types of expertise that were brought together in this effort and I think what was really amazing is that we had such a consensus from a variety of people there.

CC: How did you go about determining which toxins to focus on? Pollutants?

TS: Well, I think we went in understanding that the emphasis was going to be on what is called air toxics and maybe we have to step back and define that term a little bit, too, because sometimes that is not clear to everyone. That is not a regulatory term- air toxics. It is a more general term. There is a term used in EPA regulations called hazardous air pollutants that is clearly defined from a regulatory point of view. And as a matter of fact, there is a list of 188 or 189 - they change a little bit - so-called hazardous air pollutants defined now in the Clean Air Act but people tend to use this term "air toxics" to represent a more general group that typically would include the hazardous air pollutants plus maybe other compounds that didn't make a list but still are of concern because of their human health effects. And a lot of these effects are chronic health effects and one of the

biggest concerns is carcinogenesis. So, many of these compounds don't even have human data. They have estimates of their carcinogenic risk to humans through animal studies. But, you know, if you have a sufficient amount of animal data and repeated assessments in different species, it increases your confidence that it is a pretty good estimate of its potential with humans. So, various agencies provided good estimates from the toxicological data. This reflects the expertise of various toxicologists working on this which I am not but I trust them and I have read a lot of the methodology - how they do it - and I think it is sound, but there are a group of EPA scientists that have published values representing carcinogenic and noncarcinogenic risk and that is in a database called IRIS which I think stands for the Integrated Risk Information System. And so, it is EPA system, IRIS, and you can look that up on the EPA website. IRIS. So, there are values there that people generally accept as the best estimates we can come up with. As I said, there are both carcinogenic risk estimates as well as noncarcinogenic estimates of risk. Other values are available from other sources and I think our group also heavily used the California Department of Health risk values which sometimes differed from EPA's values. And I believe the philosophy, and maybe you asked Dr. Linder this, but I think the philosophy was to use the lowest value that was available from the multiple sources, just from a protective point-of-view. In other words, the maximum estimate of impact from a given concentration.

CC: Why California?

TS: Oh, well, California, you know, tends to get involved in environmental health and other general environmental issues a little bit before the rest of the country. That has been their tradition and everybody, I think, has heard about the much more strict

emissions on automotive emissions that California has had for many, many years, and EPA nationally tends to try to play catch up to the California standards. And in many other areas of environmental health and environmental concerns, I think they have led the nation in taking steps to reduce environmental hazards. So, it is not surprising to me at least that there would be a set of values _____ developed by California that, in some cases, would be a load restrictor in a health sense compared to the EPA standards. Not surprising to me.

CC: O.K., to go back before the study, when the Chronicle did their big expose . . .

TS: Yes, that is a good word. That was January 2005.

CC: Correct. I understand you did some personal monitoring.

TS: See, that is where things go wrong. That is not correct actually. My involvement was, and I mentioned to you about these passive samplers and I can certainly show you later if you want to see what one looks like . . . a tiny, very lightweight plastic badge basically. Dina Cappiello, who was the writer on that series, knew about our badges and she thought they were an interesting tool which I agree with - I think they are an interesting tool - and she actually came up with the idea as part of the series in addition . . . I think the most important thing is her investigation of measurements that were already available from the state environmental agency - the Texas Commission on Environmental Quality. That was, I think, the main thrust of the article. But she thought it would be an interesting demonstration more or less to be able to actually do an independent monitoring effort. So, what she did was ask if they could use our badges and we would analyze them and we said yes because it takes a certain expertise and experience to be able to analyze these things to a low enough level to get good results. You can't send

them to any old commercial laboratory and expect those kinds of results. So, I thought this was a good public service chance, opportunity, so I agreed that they could use those. It was their study. It wasn't our study. It was not an official study. But what was done as part of that series, the study was actually placing the badges outside the homes of volunteers. There was no personal exposure done in that study, all right? So, only the badges were clipped outside the home and I can't remember how many different homes but, you know, she looked at areas besides Houston, too, but Houston had the most interesting result, you might say. So, you know, it was not a representative study - she did ask for volunteers, but, you know, it was an opportunity to investigate the concentrations, the outdoor air concentrations that people would be exposed to in their neighborhoods as opposed to values that were typically monitored at a central ambient monitoring site such as the city or state operate. I mean, what they measure at those sites is true for that area, that particular site, but the question is how representative is that concentration in the neighborhoods where people live. And that has been part of our research activities actually in the last 3 years, kind of looking at that very question. So, we have done a lot of monitoring in neighborhoods and again, Dina knew that we were doing that kind of thing and had already been evaluating the possibility of doing that so that was another reason why she decided to employ the badges that way. So, it was, in my opinion, more or less a demonstration and maybe a way to attract people's attention that yes, it is not just this theoretical thing that is being measured at a state regulatory site but something that represents a concentration that people are actually breathing outside their homes but it was not a personal measurement and it did not involve indoor air quality at all. So, this was entirely an outdoor air quality issue.

CC: And these were mostly used in the neighborhoods in the Ship Channel and ___ ?

TS: Yes, it was mostly around Manchester, that area, in Houston and as I said, she looked at 3 different other areas - Freeport, and I can't remember where else. Perhaps it was Port Arthur, I think, was one and I can't remember the third.

CC: They were all around industry?

TS: Yes, that was the idea - to look at the potential impact of nearby industry, yes, exactly.

CC: Am I assuming you found the levels very high?

TS: Well, not necessarily but, I mean, the highest, I guess, levels were certainly found in the Manchester area because . . . I don't know if you've ever been to Manchester but it is an amazing area. It is essentially completely surrounded by sources - both industrial and what we call mobile sources; in other words, high density traffic areas, too. So, I've never really seen any other area quite like it. You know, it is a fairly small neighborhood but it really is surrounded by lots and lots of industrial sources, mainly industrial sources. And the monitoring really picked up on that. I guess the most interesting one and I have to back up now and say, remember, I said that our badges don't do a very good job on butadiene? That is true but they do actually pick it up. The problem is that it disappears in the badge. It decays off of it. But sometimes if the levels are high enough and we analyze the badges quickly enough, we do see it. And we did see it in Dina's samples, from a street that was very, very close to some suspected sources that have been confirmed since then, a complex . . . Texas Petrochemicals and Goodyear were probably the two plants that produced butadiene and they have entered into some agreements with

the City since then to reduce the emissions of butadiene. But people living on, I think it was Gober Street, it was southeast - not the typical prevailing wind direction but it was rather stagnant wind conditions during that sampling period and the thing is that they were the closest in proximity to those sources. So, you know, I think it was like 3 different homes on Gober Street all showed somewhat elevated levels of butadiene. So, that was probably, to most people, the most interesting result of all.

CC: Hypothetically, let's say a family has been living on that particular street for 10 years. What is the relationship to their health?

TS: Well, you know, it is always impossible to say about an individual. We talk about risks and that is usually like on a population basis or I guess when you talk about an individual, it is a probability argument then and if you say . . . I don't remember what relative risk of cancer that those concentrations would correspond to but if you say it is 10 in 1 million, well, that is a probability of 10 in 1 million to those people or if you actually had 1 million people that were exposed to those concentrations, then you'd say there is a good chance that 10 people would have premature mortality due to a lifetime exposure to that. But, you know, we have a lot of assumptions here and we don't know whether people on that street have had a lifetime exposure. Some people, you know, may have just moved there and only lived there for a few years. Some people may have lived there for a few years, then moved elsewhere.

CC: So, 10 years isn't a good . . .

TS: Well, I wasn't quite through. And the other problem is, again, remember, the indoor environment. People spend 90% of their time indoors so actually, an outdoor level doesn't necessarily represent their exposure. So, their total exposure could be more

or less. From what I had told you earlier, for many compounds, the total exposure probably will be higher than what the ambient level will be. I am not certain about butadiene. Again, parking back to what I had said earlier, we don't have reliable methods, say, these passive devices, that we can do good indoor measurements so we don't have a really good feeling right now. Hopefully, that will be remedied in the near future about what the corresponding levels of butadiene are. Now, we know that smoking can contribute. So, ifthere was indoor smoking, undoubtedly, the levels would be higher. But outside of smoking, there may not be any important indoor sources. So, the exposures would be equivalent to the outdoor measurements when they are outdoors around the homes and whatever infiltrates from the outdoors into the indoors during the rest of the, say, 90% of the time when they are indoors. And we really don't know how well butadiene necessarily infiltrates from the outdoors to the indoors. All that is still kind of a research question. So, I never like to say that the risk numbers represent the absolute risk. I like to use these risk numbers in a relative way and I think that is the way that the mayor's task force did it because you can still trust that intrinsically, if a compound has a higher risk, then it is of more concern potentially than a compound of lower risk. So, if you are concerned about people's overall exposures to toxic air pollutants, then we need to start prioritizing and working to put more effort into reducing those chemicals that have high risk numbers than those that have a lower risk number. No matter what the actual risk will be, the order of priority ought to be the same. So, that is the whole idea there.

CC: Do you know of any personal studies or any studies that have been done actually in the Houston area to show whether there has been any link to health regarding the increase of pollutants in the air in Houston?

TS: Well, again, that is a big question. With regards, say, to toxic air pollutants, no. There will be a study starting shortly that I am going to be involved in with a colleague from the school, Dr. Maria Mirandi, called the Heat study funded by EPA region 6 and the Texas Commission on Environmental Quality and we are going to be looking at indoor, outdoor and personal exposures to these toxic air pollutants in and around the Manchester area, comparing it with a group in Aldine which is similar sociodemographic characteristics but not industrially exposed whatsoever and we are going to be administering a health-related questionnaire. So, to some extent, we may get some health-related impact but we are not going to be looking at, say, cancer rates, etc. Now, with regard to other pollutants and other health effects, yes, I have been involved in some studies in the past. There was an important study that was done way, way back. As a matter of fact, it was the first study that I was involved in when I carne here in the early 1980s and it was called the Houston Asthma Study. It had an interesting origin. Monies were directed to the School of Public Health by a congressional mandate basically and the reason for that was local concern that a lot of the regulations up to that time were being set on the basis of health effects data obtained in southern California and there was some concern among the local leaders that maybe the photochemical mix and the health threat was different in Houston than it would be in southern California. So, they wanted to establish a health effects study on ozone primarily to compare the result. So, I was involved in that study. It went on for several years and, you know, we had publications

coming out of that. Unfortunately, it wasn't a clear-cut result of all that. I mean, there certainly seemed to be effects of ozone but when all the pollutants that were necessary to add in to the analysis were added, actually it reduced the study period from 6 months to 4 months. It was mainly because of the particles. They were delayed in getting the equipment set up to measure that. And so, when all that data was analyzed over a shorter study period, even though ozone appeared to trend towards increasing asthma attacks, it was not statistically significant. So, you know, people debate these things all the time. But the trend was there and without the particles, it was statistically significant. So anyhow, there was a study on the ozone. There was also a corresponding study on runners, joggers, that occurred at the same time and once again, we had a little bit of a complication that the people running at high ozone levels tended to have lower, what is called pulmonary function tests, and that is what is expected from exposure to some pollutants - it is a decrease in pulmonary function or the ability of the lungs to really work properly. But when the impact of exposure to elevated humidity and temperature were taken into account, then once again, the statistical significance of that change went away, see? So if you really believe in statistics, you can't say that we really showed it, although the tendency was there, O.K.? So, that was one study. Now, much more recently, we did a study . . . we, the principal investigator was George Delclose who is the Division Director of the Environmental and Occupational Health Sciences Division here- a number of us collaborated including some investigators from Baylor. We did a study of middle school kids in Aldine and the emphasis was on exposure to a certain class of air toxics - not the volatile organic compounds but what is called oxygenated air toxics or aldehydes and ketones primarily because very little was known about what health

effects they could incite. And the results were not positive with regard to effects of the primary pollutants, these oxygenated air toxics, but a couple of other pollutants that we measured and sort of estimated the exposure - ozone and particles, particulate matter because we knew those were important pollutants- at least the latest analysis that we did suggests that ozone does have a statistically significant impact on the increase of asthma among these group of asthmatics, middle school asthmatics. So, we do have, for the first time now, I think, a reliable, very positive result based on ozone in Houston. And that has been a criticism in the past, you know, because there have been lots of studies nationally on the impact of ozone and other pollutants on asthma but it had never been really shown conclusively here in Houston and I think we now have those results to show.

CC: You mentioned particulate matter. Are you talking about diesel particulate matter?

TS: Well, not really. In the study that I just mentioned, it was not differentiated. Basically, this is just particulate matter of a certain size. It is called PM 2.5. And it means particles that are less than an aerodynamic diameter of 2.5 microns. So, there is an EPA standard based on PM 2.5. There is also one based on PM 10 but most people now are concerned about the smaller particles with regards to the chronic health effects. So, the PM 2.5 might come partially from diesel - diesel has very small particles, but it can also come from many other sources other than, you know, like tailpipe emissions, industrial sources, etc. So, yes, we can't claim that any effect was due to diesel -just fine particulate matter basically.

CC: I do believe in the study, didn't you all look at the . . .

TS: Actually, I mean to say that, too, and I forgot - that the original intent was air toxics but in our deliberations on the mayor's task force, we decided we could not ignore three pollutants, I guess, basically. One was ozone because of what was known about the serious health impact of ozone nationally and presumably in Houston because we have some of the highest levels of ozone and then two types of particulate matter - one would be just general PM 2.5, as I mentioned before since that is a regulated pollutant by EPA, and then specifically diesel particulates. Now, they are not usually exclusive, as I said. One is characterized in it by source from diesel engines. The other is characterized in it by size, PM 2.5. But they are not unique. They are not mutually exclusive whatsoever. But there are different ways to estimate levels of the two different types of particulate. And so, I think it was important for us to provide those risk estimates as available. It surprised many of us that the diesel particulates pose such a high risk relative to all the others.

CC: In the study, you also found that chromium 6 was one of the elements.

TS: Yes. Chromium 6 is another toxic air pollutant. It is part of the heavy metals. It is not surprising there are a number of heavy metals that have some serious health effects -lead and mercury, things like that. It is just always a question of how high the levels are in a given area and in certain census tracts apparently, there are significant, probably industrial sources that contribute to somewhat elevated levels and that then kicked up the chromium to be a relatively high risk.

CC: Did you all do your own testing for emissions during this test?

TS: No, this is all a paper study, really. So, we just used all available data that was out there but, you know, it wasn't that simple. So, for instance, part of what we looked at

was the actual monitoring result from the Texas Commission of Environmental Quality. But that took apparently a huge effort to just get that total database and get it in a form where it could be analyzed. That was not easy to get all that historical data.

CC: Is this from the study done in Texas 2000?

TS: No. The Texas 2000 study was aimed towards looking at sources of pollutants that might give rise to, say, high ozone levels. And they made some very important discoveries about levels of precursors being given off by industry - much higher levels than what were estimated from the emissions inventories, you know, especially things like butylene and propylene, and those can be very highly reactive in forming ozone. So, that was the real contribution of the Texas 2000 data and that was only a very brief period, very intensive monitoring. But what I am talking about is data that we went back and got . . . and I think we took just one or two key years, and I can't remember what that was. It might have been in the year 2003, but where we had some complete monitoring data from all the sites that are monitoring in the Houston area and then used those estimates plus from many other compounds that are not routinely monitored, we went back and got emissions estimate and that is from something called the Toxic Release Inventory that requires industries to release their best estimates of emissions every year. So, if we didn't have concentrations, then we had to use the emissions estimates. So, you know, we did the best we could based on the data available.

CC: To go back and talking about the heat study, would this also have anything to do with the study that Dr. Hamilton is doing at Baylor?

TS: I am not familiar with that study. You will have to tell me more about it. But no, I mean, she is not involved in the heat study. I know that.

CC: Do you personally or professionally believe that the industry is the major problem with the emissions in the Houston area?

TS: I would say that I think there is a lot more progress that needs to be made with regard to refining the accuracy of the emissions estimate from industrial sources, let's put it that way. We probably have a better handle on the mobile sources; in other words, from automotive emissions in general because we know emissions factors from the testing of various model cars and that is nationally available and then it is just the question of estimating traffic density of different roads and that is not really proprietary information so you can get that. But I think a lot of times in large industrial complexes, there is sometimes a question about the accuracy of the emissions. Sometimes, I am not saying it is necessary an intentional fall of the industry. I think it is just a very difficult thing to do because some of the industries, they have a zillion potential sources of what they call fugitive emissions - they have to try to estimate emissions from individual valves and they may only get somebody to review whether they are leaking or not every 2 years or 3 years. So, you know, it may be a question of resources but given all that, I think, and what the Texas 2000 study showed, I think there is a lot of room for improvement for estimating the emissions from industrial sources for sure.

CC: There seems to be a very big disparity between different groups on what the emissions are. Is this because of the way the emission controls are taken?

TS: Well, yes, part of the problem is there is no . . . I mean, way back when, when I first started looking at emissions, I thought, well, these are based on measurements; you know, people actually measure what is coming out of stacks. Not true. I mean, that happens once in a while. It is not an easy thing to do to put a measuring device on a

stack. There are methods but it happens very rarely. Almost all the time, these are just based on emission estimates, calculations based on through put of precursor chemicals and what the chemical engineers understand about a process and then they figure out what should go out. And then, there are, as I say, periodic measurements like of these fugitive emissions and mobile - many minor sources, say, of leaking valves and things like that, leaking pipes. So, probably with the limited manpower that they devote to it, they are probably doing the best they can. That doesn't mean that they couldn't devote more manpower. There is certainly some improved technologies that have come along recently. You have maybe heard ofthe Hawk camera? Have you heard about that?

CC: No.

TS: This is an infrared camera that is now being used and industry actually is starting to buy these units and use them themselves and it is a way of detecting leaks. The vapors coming out, if you take a picture with this . . . and I forget, there is a more formal name for the camera . . . this is one brand name, the Hawk, I know . . . if you photograph this, it will look like a smoke plume basically and it is just the volatilization of organics coming off of a given source. So, I have seen some examples of this fly over flight, say, over in the east part of town where they have been able to really observe unsuspected sources of major releases of VOCs. And also like barges coming up the Ship Channel, you could see the same kind of thing. So, this ought to help, I think, considerably in improving the emissions estimates so they can see those things and address them. Not just, say, increase their estimates but improve the control on those unsuspected sources so we reduce the levels. That would help a lot, I think.

CC: Well, we all know the plants were built many, many years ago.

TS: Yes.

CC: And obviously, the equipment is old.

TS: That's right. We have had no new refineries in I don't know how many years, right? So that is one of the big problems. Absolutely. Old infrastructure in the industry.

CC: And this would increase the leakage?

TS: Absolutely. Sure. That would be true of any industry. Anything I could think of.

CC: So, modernization would help, of course.

TS: Absolutely.

CC: Besides the benzene and the butadiene, what other chemicals would you mark down as a major health problem? Other than the particulates.

TS: Well, again, I think we did a pretty decent job on the mayor's task force and in response to that, I would just go down the list. We had several tables there. Table 1, I think, is the highest priority of pollutants and then table 2 is whatever we called the next category. And I think that probably represents the very best, most recent estimates of probably the chemical pollutants that we most have to worry about. We work out way down those lists and try to do something about doing better controls over ambient emissions of those chemicals, I think, will improve the health risk of . . . lower the health risk of Houston's population. I think that is a good plan of action right there that you have in front of you. I can't think of a better . . . I mean, since we spent all that time taking a look at that. Now, you know, it is true it is sometimes difficult to . . . it is like apples and oranges when you compare risk, say, from ozone, or particles to benzene because they are different endpoints. You know, like benzene is not an acute hazard. Most of our concern has to do with chronic exposure and maybe the increase in cancer

risk of our long, long lifetime. Well, how do you compare that with ozone levels that once they exceed a certain level, will increase the number of asthma attacks and the number of asthmatic admissions to hospitals, decrement in lung function? I don't know how to compare those exactly. And we discussed that problem in the Committee and there was no way to really equate the two in the same units but we still felt that because of all these other serious health impacts, that they had to be included in a top priority classification. You can't really necessarily enumerate them quite the same way.

Tape #2

CC: We were discussing the health effects and how is it difficult to compare . . .

TS: Compare with different endpoints. It is really hard to try to make a list and say which is worse - ozone or benzene or butadiene, something like that. So, I think we need to just consider all those as high risk pollutants and do our best efforts to lower concentrations of all the pollutants that are listed in the list there, in the highest category.

CC: Well, I would assume that if benzene is known to cause cancer over a 20 year exposure and yet, there is a chemical that will keep you from breathing, you won't live long enough to get cancer.

TS: Well, that is one way to look at it. Yes, I mean, the cancer tends to be a problem of older age. You certainly increase your chances as you get older and that would be true of the continuous exposure to the chemicals, too, but, you know, I mean, ozone we know . . . yes, well, we do know . . . can affect kids pretty adversely starting from a very early age. So, again, that is something you have to consider but it is still very hard, I think, to put an actual estimate, you know, one versus the other, so I'd say why bother? Why try to choose? We need to do all these, you know, _____them down.

CC: It has been suggested by citizen activists, different environmental groups as well as articles in the Chronicle that there is a very high level of cancer in those areas around Manchester. Have you seen any studies to indicate . . .

TS: No. I mean, I can't answer that. There are other people you might want to talk to about that. There is a faculty member here named Ann Coker and I think she has worked on some data with regard to cancer rates in different geographic areas of Houston and is working on some areas so you may want to talk with her and I think some of that was actually published in the Chronicle a little while ago. But that is kind of outside my area of expertise so I'd rather you talk to somebody who knows more about it.

CC: O.K. There have been an awful lot of studies done now on the fact that we have identified a lot of the pollutants. What do you suggest goes from here?

TS: Well, I mean, it is hard for me to suggest it, I guess. I think it is important for political leaders to understand this - that there is a difference, you know, among pollutants. All pollutants are not necessarily the same and that there is a priority list. Now, one thing I am encouraged about is that Mayor White, during his brief comments upon accepting this report, I noticed right then, he said we'll instantly prioritize reducing emissions of benzene because there already was an agreement about reducing butadiene emissions from the known major sources. So, he said that the next thing would be to reduce benzene. And I think that is very important because some recent data from the TCEQ indicates that there are certain areas like I remember in Galena Park, for instance, that had continuing high levels of benzene and where they were trying to identify sources but it wasn't conclusively proven, I guess. So, it sounded like the mayor was aware of that and he is going to make that a high priority to really track down those major sources

and somehow minimize it by negotiation or perhaps litigation - I am not sure how but one way or the other, try to reduce emissions of benzene. So, that is the kind of action I would hope would take place - that by educating our political leaders, the people who have the wherewithal to really get something done and also industrial leaders to see, yes, that these are the chemicals of concern - everybody make a more concerted effort to reduce the levels of these particular pollutants.

CC: So, instead of having more studies, now is time for action?

TS: Oh, I think so. I mean, that doesn't mean that we can't do more studies. We will always need more studies. But I think you can never use it as an excuse to not do anything. So, I think we have sufficient information. It is the best scientific evidence available. We pulled this from existing sources basically, just kind of put things together in a way where we have the unique Houston perspective on things and it really does, I think, represent the best estimates and I haven't heard anybody criticize it from a scientific point of view. Maybe there are people doing that, I don't know. But, you know, we have a plan of action basically and I think we should just go ahead and work on it because, again, even if our absolute estimates are off, even by factor 10, still I have much more confidence in the prioritization process and again, you know, we shouldn't stop action -- as long as we know what are the riskiest pollutants, we should get to work on reducing exposures to those.

CC: And, of course, there are a lot of industries that are outside the city limits.

TS: That is true.

CC: So, has the county signed on that you know of to . . .

TS: I don't know anything about that but I would hope that the county would also take a look at this and have some concerted activity with the city. I mean, that is a political question that I tend not to get involved in. I am one of these academics that tries to stay above it all and just concentrate on the science and kind of hope for the best. But I realize I do have an obligation to encourage these things wherever possible. It is just that I don't know the ins and outs of the politics. But I would certainly encourage all the parties involved in regional air quality and that is an important issue you raise because you can't dictate boundaries to air pollution, as you well know. So, we need everybody involved in the regional air quality issue to get on board and realize that more efforts need to be done. Hopefully, that will occur.

CC: And I look forward to seeing what you all come out with your heat study.

TS: Yes, it will be a two-year study, so don't look right away. It will be somewhat down the line and, of course, with analysis and all so maybe three years from now will be a time to look for it.

CC: I want to thank you very much for agreeing to this interview.

TS: Sure. I enjoyed it. Thank you.