United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EPA-450/3-87-010b
January 1989

Air

EPA

Chromium Emissions from Comfort Cooling Towers -- Background Information for Promulgated Standards

Final
EIS

EPA-450/3-87-010b

Chromium Emissions from Comfort Cooling Towers — Background Information for Promulgated Standards

Emissions Standards Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711
January 1989

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ENVIRONMENTAL PROTECTION AGENCY

Background Information and Final Environmental Impact Statement for Chromium Emissions From Comfort Cooling Towers

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Research Triangle Park, N.C. 27711

1/4/90
(Date)

1. The final rule will eliminate hexavalent chromium emissions from existing and new comfort cooling towers by prohibiting the use of hexavalent chromium in these towers. Under Section 6 of the Toxic Substances Control Act, EPA is authorized to impose regulatory controls if the Agency finds that there is a reasonable basis to conclude that the manufacture, processing, distribution in commerce, use, or disposal of a chemical substance presents or will present an unreasonable risk of injury to human health or the environment.

2. Copies of this document have been sent to the following Federal Departments: Labor, Health and Human Services, Defense, Transportation, Agriculture, Commerce, Interior, and Energy; the National Science Foundation; the Council on Environmental Quality; members of the State and Territorial Air Pollution Program Administrators; the Association of Local Air Pollution Control Officials; EPA Regional Administrators; and other interested parties.

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4. Copies of this document may be obtained from:

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TABLE 2-1 LIST OF COMMENTERS ON PROPOSED RULE TO PROHIBIT THE USE OF HEXAVALENT CHROMIUM CHEMICALS IN COMFORT COOLING TOWERS..... 2-2

1.0 SUMMARY

On March 29, 1988, the Environmental Protection Agency (EPA) proposed a rule to prohibit the use of hexavalent chromium (Cr^{+6})-based water treatment chemicals in comfort cooling towers (CCT's) and the distribution in commerce of these chemicals for use in CCT's. The proposed rule was issued under the authority of Section 6 of the Toxic Substances Control Act (TSCA). The rule affects users of CCT's including hospitals, hotels, educational facilities, office buildings, and retail shopping malls. Persons who distribute in commerce water treatment chemicals containing Cr^{+6} would be affected also.

Public comments were requested on the proposal in the Federal Register. There were 27 letters submitted concerning the rule. Sixteen letters were from water treatment chemical companies, two from CCT users, four from industry trade groups, three from water treatment consultants, one from a publicly owned treatment works, and one from an environmental group. In addition, five speakers presented comments at the public hearing. Two of the speakers were from one water treatment company, two were water treatment consultants, and one was from a company that manufactures sodium dichromate and other chromium chemicals.

The comments submitted, along with responses to these comments, are summarized in this document. The summary of comments and responses serves as the basis for the revisions made to the rule between proposal and promulgation.

1.1 SUMMARY OF CHANGES SINCE PROPOSAL

In response to public comments and as a result of EPA reevaluation, the nationwide cost impact and risks have been reanalyzed, and several changes have been made in the proposed rule. The changes in the rule involve (1) revising the labeling, recordkeeping and reporting

requirements; (2) clarifying the prohibitions on use and distribution of Cr^{+6}; and (3) adding and revising definitions.

A statement was added to the final rule to clarify that the use of Cr^{+6}-based water treatment chemicals in industrial cooling towers (ICT's) and closed cooling water systems, and the distribution in commerce of the chemicals for use in these facilities, are not prohibited. Minor changes were made to the warning label requirement to indicate that CCT's are towers that are open water recirculation devices and to clarify that inhalation of Cr^{+6} air emissions increases the risk of lung cancer.

Two changes were made to the recordkeeping and reporting requirements of the final rule. First, the requirement that records be maintained by water treatment chemical distributors of shipments of nonchromate chemicals to CCT's has been deleted. Second, the reporting requirement by distributors that provide only nonchromate water treatment chemicals also has been deleted. The EPA has reevaluated the need for these records and reports and has determined that enforcement of the rule would be adequately accomplished by other provisions.

Definitions have been included in the rule for the new terms "cooling system," "closed cooling water system," and "chilled water loop"; and the definition of "water treatment chemicals" has been revised. The new and revised definitions clarify that the labeling, recordkeeping, and reporting requirements apply to cooling systems rather than to cooling towers. The definition of "water treatment chemicals" has been revised by deleting the word "biocides." This change has been made because biocides are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Definitions also were added for the terms "distributor" and "Cr^{+6} chemicals" to clarify the intent of the rule.

The statement of applicability of this rule was revised slightly. This change is of an editorial nature to clarify the original intent of the rule, to account for changes in the recordkeeping and reporting requirements, and to improve compliance monitoring efficiency.

1.2 SUMMARY OF IMPACTS OF PROMULGATED ACTION

1.2.1 Alternatives to Promulgated Action

Regulatory control alternatives considered during development of the rule are discussed in Chapter 6 of the background information document (BID) (EPA-450/3-87-010a) for the proposed rule. These alternatives reflect different levels of emission control, and they remain unchanged from proposal.

1.2.2 Environmental and Health Impacts of Promulgated Action

Under the final rule, baseline Cr^{+6} emissions from about 37,500 CCT's will be reduced from about 33 megagrams per year (Mg/yr) (34 tons per year [tons/yr]) to zero. This emission reduction is based on a best-estimate emission factor rather than the range used in Chapter 4 of the proposal BID. A range of emission factors was used at proposal because of the uncertainty associated with the factors for Cr^{+6} emissions from CCT's. Since proposal, additional test data have been obtained which, in combination with the original data, were used to develop the best estimate emission factor.

The best estimate of the emissions for CCT's was used to reanalyze the risk to public health from Cr^{+6}. The revised risk estimates indicate that the nationwide annual incidence of lung cancer attributable to Cr^{+6} emissions from 37,500 CCT's is estimated to be about 20 cases per year. The revised maximum individual risk is estimated to be 2×10^{-4}. The final rule will reduce these risks to zero.

Water and solid waste impacts are unchanged from those presented in Chapter 9 of the proposal BID. Therefore, with the changes in the emissions and risk estimates noted in this section, the analysis of the environmental impact in the proposal BID becomes the final Environmental Impact Statement for the promulgated rule.

1.2.3 Energy and Economic Impacts of Promulgated Action

The rule would have only negligible impacts on energy consumption from increased power requirements for automated control systems. This remains unchanged from proposal.

The cost impacts of the proposed rule are presented in Chapter 7 of the proposal BID. Since proposal, the automatic control equipment and chemical treatment program costs have been revised. The average automatic

control equipment cost has increased from $500 to $1,400. The cost difference between chromate and nonchromate programs has increased from $60/million pounds (M lb) of blowdown to $85/M lb of blowdown. Based on these changes, the annual cost of compliance per CCT ranges from $300 to $1,600 and the total annual nationwide cost is projected to be about $20 million. At proposal, the total annual nationwide cost was estimated to be $9.4 million.

The economic impacts of the proposed rule are presented in Chapter 8 of the proposal BID. These impacts have been revised based on the new costs discussed above. However, the increased cost is not expected to have a significant economic impact on owners or tenants of affected properties. The average impact on rental rates for the smallest towers is estimated to be less than $0.45 per square meter ($m^2$) ($0.04 per square foot [ft^2]), or less than 1 percent if all costs were passed on in the form of increased rental rates. This is an increase from $0.12/$m^2$ ($0.01/$ft^2$) at proposal. The impact on rental rates decreases as tower size increases.

1.2.4 Other Considerations

1.2.4.1 Irreversible and Irretrievable Commitment of Resources. Other than the negligible amount of fuels required for power generation for the control systems, there is no apparent irreversible or irretrievable commitment of resources associated with this rule.

1.2.4.2 Environmental and Energy Impacts of Delayed Action. Delay in implementing the rule would result in a delay in emission reduction of Cr^{+6} from CCT's and delay in realization of other estimated impacts.

1.2.4.3 Urban and Community Impacts. The rule will have a positive impact on urban areas and communities because of decreased Cr^{+6} emissions. There should be no decrease in employment in urban areas and communities because the revised economic analysis indicates that the rule would not have a significant economic impact on owners or tenants of affected properties.

2. SUMMARY OF PUBLIC COMMENTS

A total of 27 letters commenting on the proposed rule and the proposal BID for the prohibition of Cr^{+6} chemicals in CCT's were received. In addition, five speakers commented on the proposed rule at the public hearing. Comments from the public hearing on the proposed rule were recorded, and a transcript was placed in the project docket. One letter was also received clarifying information presented at the public hearing. A list of those who submitted comments in writing and of those who presented comments at the public hearing is given in Table 2-1. The docket number assigned to their correspondence and to the public hearing transcript (docket number OPTS-61012, category IV) also is given for each commenter listed on the table.

For the purpose of orderly presentation, the comments have been categorized under the following topics:

1. Water Treatment Program Performance;
2. Health Effects/Risk;
3. Regulatory Approach;
4. Recordkeeping and Reporting Requirements;
5. Economic and Cost Impact;
6. Selection of the Source Category;
7. Monitoring and Control;
8. Legal Considerations; and
9. Miscellaneous.

The comments, the issues they address, and EPA's responses are discussed in the following sections of this chapter.

TABLE 2-1. LIST OF COMMENTERS ON PROPOSED RULE TO PROHIBIT THE USE OF HEXAVALENT CHROMIUM CHEMICALS IN COMFORT COOLING TOWERS

Docket item No.[a]	Commenter and affiliation
IV-D-9	Mr. Victor A. Denslow Chemical Regulations Services 4151 Woodland Avenue Western Springs, Illinois 60558
IV-D-10	Mr. Ed Carlyle, Jr. Pretreatment Inspector City of Bossier City Post Office Box 5337 Bossier City, Louisiana 71171-5337
IV-D-11	Ms. Elaine Zack Regulatory Specialist Mogul Division of the Dexter Corporation Post Office Box 200 Chagrin Falls, Ohio 44022
IV-D-12	Mr. John T. Brophy Quad-City Chemicals Company 2328 Eastern Avenue Davenport, Iowa 52803
IV-D-13	Mr. William J. Ward, P.E. William J. Ward & Associates Post Office Box 14681 Lenexa, Kansas 66215
IV-D-14	Mr. Vincent J. Saputo Globe Environmental Corp. 21 Business Park Drive Branford, Connecticut 06405
IV-D-15	Mr. Wesley C. Geen Geen Industries, Inc. Post Office Box 333 Itasca, Illinois 60143
IV-D-16	Mr. Richard J. Nagle President Betz Entec, Inc. 508 Prudential Road Horsham, Pennsylvania 19044

(continued)

TABLE 2-1. (continued)

Docket item No.	Commenter and affiliation
IV-D-17	Mr. Jeff Girard President Girard Chemical Company 992 Stuart Road Bartlett, Illinois 60103
IV-D-18	Mr. Shaun L. Helmhout Senior Registration Specialist Buckman Laboratories International, Inc. Post Office Box 8305 1256 North McLean Boulevard Memphis, Tennessee 38108-0305
IV-D-19	Ms. Cindy Matthews Vice President Guardian-IPCO, Inc. Post Office Box 43067 6606 Cahaba Valley Road Birmingham, Alabama 35243
IV-D-20	Mr. Walter A. Weas, Sr. President Weas Engineering, Inc. Post Office Box 816 Carmel, Indiana 46032
IV-D-21	Mr. Daniel H. Brown General Manager Chem-Serv 2955 West Clarendon Phoenix, Arizona 85017
IV-D-22	Mr. Ronald C. Bond President Bonco Manufacturing Corp. Post Office Box 521 Jefferson, Georgia 30549
IV-D-23	Mr. Larry T. Chewning General Manager Southeastern Laboratories, Inc. Post Office Box 1715 Goldsboro, North Carolina 27533-1715

(continued)

TABLE 2-1. (continued)

Docket item No.	Commenter and affiliation
IV-D-24	Mr. Thomas M. Laronge Chairman, Government and Intersociety Committee National Association of Corrosion Engineers Post Office Box 218340 Houston, Texas 77218
IV-D-25	Mr. Kenneth L. Zacharias Associate Director, Industry Affairs National Paint and Coatings Association 1500 Rhode Island Avenue, N.W. Washington, D.C. 20005
IV-D-26	Ms. Karen Florini Attorney Environmental Defense Fund 1616 P Street N.W. Washington, D.C. 20036
IV-D-27	Mr. Richard A. Hoffmann, P.E. Hoffman & Feige, Inc. 223 Katonah Avenue Katonah, New York 10536
IV-D-28	Dr. Ross E. Jones Corporate Toxicologist Occidential Chemical Corporation Post Office Box 728 360 Rainbow Boulevard South Niagara Falls, New York 14302
IV-D-29	Mr. John P. Herrmann Chief, Environmental Services Office Lyndon B. Johnson Space Center Houston, Texas 77058
IV-D-30	Mr. Brent W. Chettle, P.E. 18845 Kilfinan Street Northridge, California 91326

(continued)

TABLE 2-1. (continued)

Docket item No.	Commenter and affiliation
IV-D-31	Mr. R. L. Hagerman Research Associate, Regulatory Compliance The Dow Chemical Company 1803 Building Midland, Michigan 48674
IV-D-32	Mr. Greg D. Sefton Communications Manager Mitco Water Laboratories, Inc. Post Office Box 1435 Winter Haven, Florida 33882-1435
IV-D-33	Mr. Norman A. Alston President Cooling Tower Institute, Inc. Post Office Box 73383 Houston, Texas, 77273
IV-D-34	Mr. Louis J. Koenig, Jr. Technical Director O'Brien Industries, Inc. 2686 Lisbon Road Cleveland, Ohio 44104
IV-D-35	Mr. Thomas M. Laronge Chairman, Government and Intersociety Committee National Association of Corrosion Engineers Post Office Box 218340 Houston, Texas 77218
IV-F-1	Transcript of Public Hearing on Proposed Rule for the Prohibition of Hexavalent Chromium Chemicals in Comfort Cooling Towers. Speakers were: Dr. Charles Smith, Mitco Water Laboratories, Inc. Mr. Greg D. Sefton, Mitco Water Laboratories, Inc. Dr. Ross E. Jones, Occidental Chemical Corporation Mr. Carl T. Murphy, Apollo Beach, Florida Mr. Mark Crissman, West Palm Beach, Florida

[a]The docket number for this project is OPTS-61012. Dockets are on file at EPA Headquarters in Washington, D.C., and at the Office of Air Quality Planning and Standards in Durham, North Carolina.

2.1 WATER TREATMENT PROGRAM PERFORMANCE

2.1.1 Comment

Four commenters (IV-D-13, -14, -15, and -17) believe that many technically acceptable alternatives to Cr^{+6}-based water treatment chemicals are available. Three of the commenters (IV-D-14, -15, and -17) indicated that successful nonchromate treatment programs contain various combinations of phosphates, phosphonates, molybdate, zinc, azoles, and polymers. One commenter (IV-D-14) recommends, for example, that ice skating rinks using chromate with calcium chloride switch to calcium chloride and zinc. Another commenter (IV-D-13) says that acceptable alternatives have been proven; however, these substitutes generally are somewhat more expensive than chromate and may require more precise controls than chromates to achieve equal corrosion protection.

Response. No response necessary.

2.1.2 Comment

Three commenters (IV-D-24, -27, and -29) indicated that chromate programs offer the best corrosion protection available. One commenter (IV-D-24) indicated that there is no known single substitute for Cr^{+6} that can provide similar corrosion inhibiting properties, or that is as easy to control, as forgiving to upsets, and as cost effective. The commenter believes that stating in the proposal BID and the preamble that nonchromate substitutes exist appears certain to prejudice and/or mislead purchasers in selection, purchasing, and utilization practices of the "misnomered" nonchromate substitutes.

Response. Many nonchromate water treatment programs exist that can be used as alternatives, or substitutes, for chromate programs. These alternative programs are completely separate and self-contained; a nonchromate chemical cannot simply be substituted for chromate in an existing chromate program. Although most nonchromate programs can be used in any CCT, the water quality parameters and types of airborne contaminants in each system should be evaluated prior to a switch in treatment programs to determine the site-specific application strategy. The evaluation will indicate the level of inhibitor or product that should be maintained in the recirculating water, the amount of acid that should be added (if any), the number of cycles of concentration that can be

tolerated, the types and amounts of biocides that should be used, and the type of additional control equipment that should be installed.

Typically, nonchromate programs are more difficult to control and cost more than chromate programs. However, when properly controlled and maintained, their effectiveness has been clearly demonstrated under a wide range of conditions. In the proposal BID, the results achieved in CCT's used at a research center in Virginia were presented. In the 3 to 4 months after switching to a phosphate-based treatment program, acceptable corrosion rates as measured on carbon steel coupons were about 2 mils per year (mils/yr). In subsequent months, even lower rates were achieved as the CCT operators became more familiar with the program and the monitoring and control procedures. In this case, the operators believe that the nonchromate program performance is similar to that of the previously used 5- to 10-parts per million (ppm) chromate program. At other sites, CCT operators also indicated that acceptable corrosion rates were being achieved with nonchromate programs. The makeup water used in most of these CCT's was good quality water.[1] Even in poor quality makeup water (soft water or water that contains high chloride, hardness, and alkalinity levels), acceptable corrosion rates (<2 mils/yr) have been achieved with nonchromate programs (see responses to Comments 2.1.6 and 2.1.7).

2.1.3 Comment

Two commenters (IV-D-27 and IV-D-29) questioned whether EPA had adequately considered the impact on existing, older CCT systems of switching from Cr^{+6}-based water treatments to nonchromate treatments. One commenter (IV-D-29) believes that in an existing system being treated with a chromate program, the "protective coating" within piping and equipment would be disrupted during the transition from "proven" chromate treatments to "nonproven" nonchromate treatments. This disruption would lead to increased fouling and to pinhole leakage at least until the replacement inhibitor becomes stabilized. Thus, according to the commenter, existing towers, especially older systems, converted to "nonproven" inhibitors could experience significant downtime and disruptions.

One commenter (IV-D-27) believes that no nonchromate program can operate successfully in CCT's that are corroded, but are still operative, or that contain deposits. In addition, the commenter indicated that it is

essentially impossible to clean a corroded system. The commenter believes the issue of corroded systems must be addressed because many building owners inherit a CCT system that has been neglected. The commenter also believes that the carbon steel piping rather than the condenser tubes is the most critical component in many CCT systems because underdeposit corrosion is found in piping between the condenser and the CCT. In the CCT's the commenter has observed, the condenser tubes have been properly maintained in all cases. The commenter has examined samples of corroded carbon steel pipe from CCT systems in New York City that used chromate treatment programs and has found an average corrosion rate of about 7 to 10 mils/yr. For systems using molybdate treatment programs, the commenter has observed corrosion rates of 7 to 30 mils/yr. To illustrate the severity of the corrosion rate with molybdate treatment programs, the commenter indicated that pipes in some systems had operated satisfactorily on chromates but had failed because of underdeposit corrosion within only 1 to 2 years after switching to molybdate treatment. The commenter believes that these rates are the norm and that the corrosion rates presented in Table 3-1 of the proposal BID are for ideal, clean samples, which rarely exist in actual CCT systems.

Response. The EPA has investigated the impact of switching CCT's to nonchromate treatments. According to water treatment chemical distributors, the majority of CCT's, including older systems, using chromate programs are not corroded and can be easily switched to nonchromate programs. Switching a clean, chromate-based CCT system to a nonchromate program can be accomplished by switching the inhibitor feed and allowing the chemicals in the new program to repair defects in the chromate film as they develop. However, if a system is heavily corroded, it may be necessary to clean the system before a nonchromate program can be implemented successfully. In many cases, on-line cleaning is successful. On-line cleaning often is performed with chelating agents such as sodium or ammonium salts of ethylenediamine tetraacetic acid (EDTA).[2,3] Various combinations of phosphates, phosphonates, polymeric dispersants, and synthetic detergents also have been used for on-line cleaning. For example, a program containing molybdate and a polymeric diol has been developed that cleans existing corrosion and prevents its recurrence.[4]

For some heavily corroded systems, on-line cleaning may not be adequate. In these cases of severe corrosion, it may be necessary to shut down the system to perform a stronger cleaning effort. Chelating agents and other chemicals at elevated temperatures or dilute acid solutions are often used in these cases. According to a cleaning contractor, the procedure typically takes 1 to 3 days. After the recirculation water is discharged or blown down to remove the cleaning chemicals, the system should be repassivated with high levels of the inhibitor product. The high levels should be maintained for up to 2 days depending on the type of treatment, the temperature, and the level of product maintained in the CCT. After the system is repassivated, it should be heavily blown down again until the maintenance inhibitor level is reached. At this time, the pH also should be adjusted to the maintenance level.[2,3]

The CCT system is susceptible to fouling during cleaning and to high corrosion rates during both the cleaning and repassivation procedures, but the problems are minimized by proper execution of the procedures. Fouling is controlled by monitoring the suspended solids levels, adjusting the concentration of cleaning chemicals, and adjusting the blowdown. The amount of corrosion is minimized by including various inhibitors and other additives in the cleaning solution. During the repassivation phase, the system is protected by the high concentration of inhibitor product.

Evidence that switching clean systems to nonchromates does not cause downtime and disruptions was provided for CCT's used at a research center in Virgina. As described in the proposal BID, EPA evaluated available corrosion results during the 3 to 4 month period after the CCT's were switched from chromate to phosphate treatment programs. These data indicated that no leaks developed in the CCT systems and that acceptable carbon steel corrosion rates of about 2 mils/yr were achieved.[1]

Evidence that many corroded systems can be cleaned without downtime as nonchromate treatment programs are implemented is provided by the experiences at a refinery in Kansas and by a tire manufacturer in the southeastern U.S. The refinery tower (an ICT) was extremely corroded when the decision was made to switch to a phosphate treatment program. Excessive corrosion rates were not observed while cleaning chemicals were circulated along with the new nonchromate inhibitor formulation.

Corrosion rates on carbon steel coupons averaged 1 mil/yr in the 5 months following the switch. There has been no pitting or underdeposit corrosion in the piping in the 10 years since the switch.[5] The tire manufacturer in the southeastern U.S. had been using an all-organic program with soft, naturally corrosive makeup water in an industrial tower. High average corrosion rates of 5.75 mils/yr and pitting of 12 mils/yr were observed on carbon steel coupons, and heavy deposition of both corrosion products and iron phosphate was occurring. Upon switching to a molybdate program with a diol dispersant, the blowdown began to show evidence of deposit removal. Corrosion coupons examined over the first 6 months after switching indicated that the average corrosion rate had been reduced to 0.32 mil/yr with no pitting. In addition, pipe plugging was eliminated, there was no evidence of iron oxide or iron phosphate deposits anywhere in the system, and there was no indication of underdeposit corrosion or high corrosion in the piping.[4]

Evidence that even heavily corroded systems can be cleaned with only a minimum of downtime was provided by a CCT user in New York City. The CCT user contracted with a cleaning company to clean a heavily corroded CCT system with 20 chillers on 6 floors. A scheduled shutdown of 3 days was necessary for the cleaning procedure. No leaks developed in the system during this time.[6]

In summary, the results of these cleaning efforts show that it is possible to clean corroded systems and subsequently control corrosion and deposition with nonchromate programs, even in CCT's using poor quality water. Additional information about the performance of various treatment programs under poor quality water conditions is provided in the responses to Comments 2.1.6 and 2.1.7.

The commenter has misunderstood the purpose of Table 3-1 of the proposal BID. The corrosion rates in the table do not refer to average corrosion rates achievable under specific conditions as suggested by the commenter. The purpose of the table is to indicate how various rates are perceived by the corrosion and water treatment industry as a whole. For example, a carbon steel corrosion rate of 7 mils/yr would be considered moderate by most industry representatives, even though in specific applications it might be the best rate that can be achieved. Therefore,

EPA believes the rates presented in the table are appropriate for the intended purpose.

2.1.4 Comment

One commenter (IV-D-27) stated that no CCT system can remain free of airborne dirt because it is introduced into the system, coating the inner pipe surfaces, during the construction of the building and is always being generated by other construction surrounding the building. The commenter also indicated that unless the inner pipe surfaces are kept clean from dirt deposits, underdeposit corrosion is inevitable.

Response. The commenter is correct that airborne dirt near a CCT will be drawn into the system and, if uncontrolled, may deposit and lead to underdeposit corrosion. Typically, water treatment distributors successfully combat this problem by including dispersants in their water treatment programs. However, one water treatment distributor agreed with the commenter that under typical operating procedures, suspended solids cause deposition and underdeposit corrosion in some CCT systems in New York City. According to the distributor, part of the problem is that the airborne dirt levels in New York City are especially high, and the water is soft. In soft water applications, the CCT's operate at high cycles of concentration, which is defined as the ratio of the concentration of either the dissolved solids or the conductivity of the recirculation water to that in the makeup water. High cycles of concentration (i.e., 10 to 15) are necessary in New York City to achieve concentrations of calcium compounds in the recirculation water that are high enough to result in water that tends to be scale-forming rather than corrosive. Scale-forming water is important for successful operation of most nonchromate treatment programs. In New York City, operating with high cycles of concentration also produces especially high concentrations of suspended solids in the CCT system. The distributor indicated that CCT's in other cities such as Hartford, Connecticut, and Boston, Massachusetts, also use soft water and operate with high cycles of concentration, but these CCT's do not have problems with deposition and underdeposit corrosion when operated properly.[7]

In responding to the comment, EPA also obtained information indicating that deposition could, in part, be attributed to slow flow or

stagnant water conditions, especially in CCT systems used in some new multistory buildings. The new systems consist of a CCT on the roof and one or more chillers per floor. When space cooling is not needed by a particular chiller, it is turned off and water flow is stopped. This reduces energy costs, but increases the opportunity for deposition of suspended solids. Typically, CCT's also are shut off for several hours each night.

In cases where control of deposition and underdeposit corrosion is inadequate with an existing nonchromate treatment program, several options are available to bring the system under control. First, another treatment program with different dispersants may be more effective. Second, slow flow or stagnant areas of the CCT system should be eliminated. This may require that circulation be maintained (at least periodically) through all chillers. A third option, typically recommended by water treatment distributors, is to reduce the operating cycles of concentration. Because this option results in recirculating water that tends to be less scale-forming (or more corrosive) a treatment program with higher levels or additional types of corrosion inhibitors may be necessary. In the event that the operators do not want to use these options or they are unsuccessful, a fourth option would be to install a sidestream filter to remove suspended solids.

2.1.5 Comment

One commenter (IV-D-27) believes that the use of corrosion coupons to evaluate the effectiveness of a treatment program is misleading because they only measure the corrosivity of the water, not the actual under-deposit corrosion rate.

Response. The commenter is correct that coupons can only measure the effectiveness of a treatment program at creating and/or maintaining a protective film or barrier in a particular type of water. However, as indicated in the response to Comment 2.1.4, deposition should not be a problem in a properly maintained CCT system. If deposition is occurring, the program is not performing well, and adjustments should be made or the treatment program should be replaced.

Although pitting or underdeposit corrosion in tubes can be measured with an Eddy current test when the system is shut down, there is no way to

measure underdeposit corrosion in piping without removing the pipe from the system. Consequently, a preventive program based on the potential for deposition is the best approach to dealing with corrosion. (See the response to Comment 2.1.4 for a discussion of such programs.)

2.1.6 Comment

One commenter (IV-D-27) stated that EPA did not address the impact of differences in water conditions on the performance of corrosion inhibitor systems and that the proposal BID did not mention scale-forming or corrosive waters. If a scale-forming water is used in the CCT, corrosion problems are minimal. However, when soft, corrosive waters (such as those in the New York City metropolitan area) are present, the commenter believes that the results of corrosion tests would be different than the results with scale-forming water. The commenter believes that corrosive waters similar to those in New York City exist in the northwestern U.S.

Response. To respond to the comment, EPA obtained additional information about the performance of nonchromate treatment programs in CCT's using soft water from eight water treatment chemical distributors. Case history performance data provided by four of the distributors indicate that acceptable corrosion rates (0.3 to 2.5 mils/yr) can be achieved with nonchromate treatment programs in soft water applications. These corrosion rates are within the range of corrosion rates achieved with nonchromate programs in scale-forming water and are also comparable to corrosion rates achieved with chromate programs. Much of the performance data are for programs used in ICT systems. The information from ICT's is applicable to CCT's because both types of cooling towers use carbon steel distribution pipes, and the primary concern of the commenter is with corrosion of the carbon steel pipes in CCT systems. Four other water treatment chemical distributors did not provide data but they did confirm the effectiveness of nonchromate programs. The data and information obtained from all eight distributors are discussed below and in docket item IV-B-4 (docket items referenced in this BID are in docket number OPTS-61012).

Performance data were provided for a CCT in the northeastern U.S. that uses soft makeup water. The total hardness in the makeup water was 28 ppm, the alkalinity was 20 ppm, and the total dissolved solids (TDS)

level was 155 ppm. This tower operated with about six cycles of concentration. The treatment program was a molybdate/organophosphate blend that the water treatment chemical distributor claims can be used effectively even in water with zero hardness. Mild steel and copper corrosion rates as measured with coupons were about 0.9 mil/yr and 0.2 mil/yr, respectively. The distributor providing this service considers treatment programs successful if they achieve carbon steel corrosion rates of less than 3 mils/yr.

At an ICT using makeup water with a total hardness of 15 ppm, carbon steel corrosion rates of less than 1.5 mils/yr were achieved. The treatment program, supplied by another water treatment chemical distributor, consisted of a molybdate/orthophosphate/azole formulation that was fed at a rate to yield a molybdate residual of 4 to 6 ppm. A nonionic dispersant also was added, and deposition was insignificant.

Results of laboratory corrosion studies of various nonchromate formulations in low ionic strength water were provided by one water treatment chemical distributor. The total hardness of the tested water was 96 ppm, the alkalinity was 72 ppm, the conductivity was 269 micromhos (μmhos), and the Langelier Saturation Index (LSI) was 0. The LSI indicates the corrosion or scale-forming tendencies of water; positive LSI values indicate that the water tends to be scale forming, and negative LSI values indicate that the water tends to be corrosive. Corrosion rates of 2.0 mils/yr without pitting were achieved in the laboratory with high phosphate and molybdate/orthophosphate/azole formulations. The distributor considers treatment programs to be successful if corrosion rates of less than 3.0 mils/yr are achieved.

Another successful application of a nonchromate program was for an ICT using soft water; the makeup and recirculating water contained total hardness levels of less than 2 ppm and 14 ppm, respectively. The treatment program, supplied by the third water treatment chemical distributor, consisted of orthophosphate and polyphosphate for mild steel protection and tolyltriazole for admiralty brass protection. Mild steel corrosion rates as measured by untreated coupons ranged from 2.2 mils/yr to 2.7 mils/yr. Corrosion rates on pretreated coupons ranged from 0.7 mil/yr to 1.6 mils/yr. Pretreated coupons are chemically passivated similar to

the way the metal surfaces in the cooling system are passivated. This distributor believes that actual system corrosion rates are represented more accurately with pretreated coupons than with untreated coupons.

An ICT system at a tire manufacturing plant in the southeastern U.S. using makeup water that contains low hardness and low alkalinity was able to achieve very low corrosion rates with a nonchromate program. Actual hardness and alkalinity values were not available, but an average corrosion rate of 0.32 mil/yr with no pitting was achieved with a molybdate and polymeric diol treatment program supplied by a fourth water treatment chemical distributor. In addition, there was no deposition or underdeposit corrosion in the system piping. This corrosion rate is as good as or better than results obtained with chromate treatment programs.

Four water treatment chemical distributors indicated that nonchromate treatment programs provide acceptable results when soft makeup water is used, but they did not present case history information. One distributor indicated that if the hardness in the recirculating water is less than about 50 ppm, average corrosion rates of 1 to 2 mils/yr with no pitting can be achieved only with zinc programs. A second distributor indicated that average corrosion rates of 2 to 3 mils/yr without pitting are achieved with molybdate treatment programs in CCT's that use makeup water with calcium hardness levels as low as 14 to 20 ppm and alkalinity of 6 to 9 ppm. These CCT's operate with 10 to 15 cycles of concentration so that the recirculating water has a positive LSI. A third distributor indicated that "excellent" results are obtained in CCT's in Greenville, South Carolina, where the water has total hardness levels of only 2 to 3 ppm. The fourth distributor believes that average corrosion rates of less than 2 mils/yr can be obtained with treatment programs based on various combinations of zinc, phosphonate, orthophosphate, and molybdate when soft makeup water (e.g., total hardness of about 18 ppm and total alkalinity of about 10 ppm) is used. The distributor recommends that the system be operated with 10 or more cycles of concentration to obtain a positive LSI and more than 100 ppm of calcium hardness. In addition, the pH should be maintained above 7.5, which may require the addition of caustic soda.

In summary, the case history performance data and other information obtained from the water treatment chemical distributors show that many nonchromate treatment programs in soft water applications can achieve acceptable carbon steel corrosion rates of less than 2 mils/yr. Several programs can achieve corrosion rates of less than 1.5 mils/yr. These corrosion rates are comparable with corrosion rates achieved in scale-forming water, and the lowest corrosion rates are similar to the rates achieved with chromate programs.

2.1.7 Comment

One commenter (IV-F-1 [Smith]) indicated that no nonchromate program can successfully control corrosion when the water has high chloride, hardness, and alkalinity levels (e.g., along the coast of Florida), especially when operators provide poor daily maintenance. Typically, acid must be added to reduce the alkalinity and control scale. However, acid addition increases the corrosivity of the water. In addition, for waters that also have high levels of chlorides, it is imperative that a tight inhibitor film is formed and maintained to withstand low pH excursions or high chloride excursions because the presence of chloride ions increases the corrosivity of the water.

When contacted for clarification, the commenter recommended that the sodium chloride concentration in recirculating water be limited to about 600 ppm. According to the commenter, CCT's able to operate at about 5 cycles of concentration without exceeding this level are using good to moderate quality water. Based on the original comment, the lowest corrosion rates that the commenter has been able to achieve with nonchromate programs in such water are 2 to 4 mils/yr with some molybdate/dispersant programs. Zinc, all-organic, and molybdate programs without dispersants or only low levels of molybdate achieved corrosion rates of 4 to 15 mils/yr. Because many of the commenter's customers specify that treatment programs must limit mild steel corrosion to less than 2 mils/yr, the programs described above would be unacceptable to them. According to the commenter, many water supplies in Florida contain 200 to 400 ppm NaCl, and some have higher levels. For CCT's using this water, higher than recommended chloride levels would need to be maintained in the CCT for it to operate at 5 cycles of concentration. The commenter indicated that

higher chloride levels would result in higher corrosion rates than those presented above. The commenter also indicated that the CCT could operate successfully at lower cycles of concentration so as not to exceed the maximum recommended chloride concentration, but this would require more makeup water and higher cost (see Comment 2.5.2 for additional discussion of the cost impact).

The commenter also indicated that new programs tested in the laboratory have achieved corrosion rates of 1 to 3 mils/yr (with no pitting) in water containing 500 to 1,000 ppm NaCl. In a more recent contact, the commenter indicated that corrosion rates of 1 to 4 mils/yr (with no pitting) have been achieved with the new program in the field. The commenter believes that the field results were not as good as the laboratory results because the treatment programs may not have been controlled as well in the field. Another commenter (IV-F-1 [Crissman]) described the severe scaling and underdeposit corrosion problems that occurred in two systems using nonchromate treatment programs in poor quality Florida water.

Response. To respond to these comments, additional information about the performance of nonchromate water treatment programs for CCT's in areas where the makeup water has high chloride, hardness, and alkalinity levels was requested from water treatment companies and other contacts. The information provided by five water treatment companies indicates that nonchromate treatment programs that provide adequate control of corrosion in CCT's using such water are available. Corrosion rates, as measured with carbon steel coupons, at two CCT's and two ICT's using makeup water similar to water in Florida ranged from less than 1 mil/yr to 1.33 mils/yr. In addition, results of laboratory studies provided by two water treatment companies indicate that corrosion rates of less than 2 mils/yr can be achieved in such water. These data and information are discussed below and in docket item IV-B-2.

Case history performance data were provided by four water treatment companies on corrosion rates achieved at cooling towers that use water with high chloride, hardness, and alkalinity levels similar to those cited by the commenter. According to one company, corrosion is successfully controlled with a nonchromate program in a CCT in Phoenix, Arizona, that

uses makeup water similar to that cited by the commenter. The makeup water has a total hardness level of about 176 to 192 ppm (60 percent calcium hardness, 40 percent magnesium hardness), a chloride concentration of about 132 to 148 ppm (equivalent to about 218 to 244 ppm NaCl), and a pH of 7.8. The recirculation water has a total hardness of about 620 to 680 ppm and a chloride level of 480 to 556 ppm (about 790 to 920 ppm NaCl). Based on these levels, the CCT operates with about 3.7 cycles of concentration. Sulfuric acid is added to the recirculating water to reduce the pH to about 7.0. Blowdown and chemical feed are controlled automatically by a conductivity sensor, and acid feed is controlled automatically by a pH sensor. This CCT has used an orthophosphate-based treatment program with dispersants for several years. Corrosion rates as measured with carbon steel coupons average 1 to 1.33 mils/yr with no pitting. In addition, there has been no problem with deposition or underdeposit corrosion in the system piping.

An ICT at a refinery in Kansas also uses water similar to that cited by the commenter. The recirculating water has chloride levels of 400 to 800 ppm (660 to 1,320 ppm as NaCl) and total hardness levels of 1,000 to 1,500 ppm (calcium hardness accounts for about 40 percent of the total hardness). A phosphate program has been used for the past 10 years. The average corrosion rates as measured with carbon steel coupons have been less than 1 mil/yr, and there have been no problems with deposition or underdeposit corrosion in the system piping.

One of the case studies cited at proposal was for the CCT at a shopping mall in Virginia. As noted in the proposal BID, the TDS level in the makeup water for this CCT is significantly higher in the summer than during the rest of the year. During the summer of 1986, the TDS level was as high as 2,500 ppm; in other years, the summer average has been about 700 to 800 ppm. During the rest of the year, the TDS level is typically 300 ppm. Most of the additional dissolved solids in summer are NaCl from seawater that enters the reservoir when the river flow is low. According to one water treatment chemical distributor, corrosion rates measured on carbon steel coupons average about 0.5 mil/yr during the summer. In addition, operators indicated that the condenser tubes have been found to be clean when checked each winter, and no problems with deposition or

underdeposit corrosion in the system piping have been detected. A phosphonate-based treatment program is used in this CCT.

An ICT at an ethylene production plant uses recirculating water with a total hardness of 390 ppm, chloride concentration of 400 ppm (660 ppm as NaCl), and a total alkalinity of 200 ppm. Carbon steel corrosion rates of less than 1 mil/yr were measured in 60°C (140°F) return water, and no fouling occurred in the plant heat exchangers. Because many dissolved solids are less soluble at higher temperatures, the worst fouling would be expected to occur in the heat exchangers. The absence of deposition in the heat exchangers suggests that the pipes are also clean. Corrosion is controlled at this ICT using a zinc, inorganic phosphate, and organic phosphate corrosion inhibitor program.

Two water treatment companies provided the results of laboratory corrosion studies that evaluated water treatment programs under conditions similar to those cited by the commenter. In one study, water circulating through the test equipment had a total hardness of 400 ppm, a chloride concentration of 412 ppm (824 ppm as NaCl), and an alkalinity level of 20 ppm. Average carbon steel corrosion rates of 0.9 and 1.2 mils/yr were achieved using a high phosphate inhibitor at pH levels of about 7 to 8. Average carbon steel corrosion rates of 1.1 and 1.2 mils/yr were achieved using a molybdate/orthophosphate/azole blend at pH levels of about 7 to 8, and no pitting was observed. The other study was conducted to evaluate the same zinc, inorganic phosphate, and organic phosphate blend used in the ICT at the ethylene production plant described above. The recirculating water used in the laboratory had a total hardness of 1,350 ppm, a chloride content of 600 ppm (990 ppm as NaCl), and an alkalinity level of 50 ppm. The corrosion rate achieved under these conditions was 1.4 mils/yr, which is slightly worse than the 1 mil/yr achieved in the ICT under better conditions. These similar results are in contrast with the commenter's belief that corrosion rates achieved in the field would be worse than those in the laboratory.

Two additional water treatment chemical distributors did not provide site-specific data but indicated that their nonchromate treatment programs can control corrosion in CCT's using water with high chloride, hardness, and alkalinity levels. One distributor indicated that CCT's using makeup

water with 200 to 400 ppm NaCl are easily treated with nonchromates even if the water also contains high hardness and alkalinity levels. This distributor also claims that nonchromate programs can be used successfully in systems containing much higher NaCl levels (e.g., even in brackish water that contains 20,000 to 40,000 ppm NaCl). The other distributor stated that acceptable results (unspecified corrosion rates, but <5 mils/yr) can be achieved with molybdate or all-organic programs. However, if hardness levels are high, it may be necessary to add acid to reduce alkalinity and to increase the level of dispersants to control deposition.

To achieve acceptable results with nonchromates, the system must be properly monitored, controlled, and maintained. Although operators may not maintain and control system parameters properly, as suggested by the commenter, it would not be because adequate programs or information about proper procedures are unavailable. As shown above, the case history performance data and other information obtained from the water treatment companies show that acceptable corrosion rates of less than 2 mils/yr can be achieved in CCT's and ICT's that use water with high chloride, hardness, and alkalinity levels. These corrosion rates are comparable with corrosion rates achieved in average water and are only slightly higher than some of the rates reported by the commenter for chromate programs.

2.1.8 Comment

One commenter (IV-D-27) noted that nonchromate programs do not control microbiologically influenced corrosion (MIC) in corroded or deposit-laden systems that use corrosive water. The commenter has measured corrosion rates of 80 to 100+ mils/yr in carbon steel piping for CCT's in New York City that were treated with molybdate and that also suffered from MIC. These rates are not observed in CCT's treated with chromates, and the commenter believes that the micro-organisms responsible for MIC are controlled by the inherent toxicity of the chromates.

Response. Corrosion inhibitors are not designed to kill the micro-organisms responsible for MIC; this is accomplished with biocides. Because chromium is toxic, however, it may have some incidental biocidal properties. Therefore, greater amounts of biocides may be required when a

system is switched to a nonchromate program. Regardless of the corrosion inhibitor, MIC may occur if deposition is not controlled adequately because biocides cannot penetrate the deposit to kill the microorganisms. As indicated in the response to Comment 2.1.4, steps to control deposition of suspended solids, such as modifying the water flow or installation of sidestream filters are available and easily implemented. However, as described in the response to Comment 2.1.3, if a system is already heavily corroded, it will need to be cleaned before switching to nonchromates. In summary, EPA believes that MIC can be controlled adequately in clean CCT systems by nonchromate treatment programs with good control of deposition and appropriate supplemental biocide programs.

2.1.9 Comment

One commenter (IV-F-1 [Sefton]) has performed research that shows that chromates seem to inhibit algae growth, and many cooling tower operators have found that they need little or no biocide with a chromate program. Also, the commenter believes that old habits may be hard to break and that many operators will not add sufficient biocide with nonchromate treatment programs.

Response. Chromium compounds are sold for use as corrosion inhibitors, not as biocides. However, because of the toxic properties of chromium, chromate treatment programs may have some incidental biocidal properties. Consequently, CCT operators may need to add greater amounts of biocides when they switch to nonchromate treatment programs. Typically, water treatment distributors recommend the amount of biocide necessary with any type of treatment program. The recommended biocide treatment should be incorporated into the CCT operators routine operation and maintenance of the CCT. Installation of equipment to add biocides automatically to the system would simplify the operators' work load. However, the operators would still need to monitor the system periodically (visually and/or chemically) to determine that biological growth is under control.

2.2 HEALTH EFFECTS/RISKS

2.2.1 Comment

Two commenters (IV-D-9 and IV-D-30) believe that the results of chromium toxicity studies are not adequate to prove that the highly soluble Cr^{+6} in water treatment chemicals is carcinogenic. Both commenters indicated that many studies show only slightly soluble or insoluble Cr^{+6} to be carcinogenic and that the carcinogenicity of soluble Cr^{+6} shown in some studies may be overstated or the result of other factors.

One commenter (IV-F-1 [Jones]) cited results of animal inhalation studies that show that only calcium chromate produced a carcinogenic response. Other Cr^{+6} compounds noted to be positive when implanted intrabronchially or intratracheally include sodium bichromate, zinc potassium chromate, zinc chromate, and strontium chromate. In one study cited by the commenter, 20 Cr^{+6}-containing compounds were administered intrabronchially as pellets, and only the sparingly soluble materials produced a carcinogenic response. The components that produced bronchial carcinomas included strontium chromate, calcium chromate, and to a lesser extent, zinc chromate.

Response. The 1984 Health Assessment Document for Chromium (HAD) (EPA 600/8-83-014F) describes both positive as well as negative studies on soluble chromates.[8-10] The experimental protocols used in these negative studies were inadequate, and, thus, the negative findings are not adequate to discount or negate the positive carcinogenic effect observed for soluble chromates in the Steinhoff study. Also, since the time the HAD was published, additional scientific evidence has demonstrated the carcinogenic activity of soluble Cr^{+6} in exposed animals. Furthermore, although human exposure data are insufficient to identify the specific compounds involved in the etiology of lung cancer, recent studies have also shown epidemiological evidence associating exposure to soluble Cr^{+6} with an increased cancer risk.[11-17]

2.2.2 Comment

One of the commenters (IV-D-9) indicated that EPA's position on the carcinogenicity of Cr^{+6} conflicts with that in the 1985 National Institute of Occupational Safety and Health (NIOSH) Pocket Guide for Chemical

Hazards, which states that on the basis of current evidence, all Cr^{+6} is carcinogenic except for sodium, potassium, hydrogen, and lithium monochromates and dichromates. Furthermore, this commenter indicated that the Agency for Toxic Substance and Disease Registry (ATSDR) concluded that sodium dichromate was only a weak carcinogen under the test conditions in the Steinhoff study.

Response. The EPA acknowledges that there are varying degrees of scientific support associating an increased cancer risk with exposure for the many chromium compounds. When EPA evaluated the scientific data, the authors of the HAD took the position that it would be prudent to consider all Cr^{+6} compounds to be carcinogenic given the available data as well as the uncertainties in the data. The EPA's Science Advisory Board (a group of nationally known scientists external to EPA and who give scientific advice to EPA) stated that it "agrees with the position stated in the draft document that Cr(VI) should be classified in Group 1 ('The chemical . . . is carcinogenic to humans') of the criteria adopted by the International Agency for Research on Cancer." Hexavalent chromium compounds also are assigned a "high" hazard ranking for the purposes of reportable quantity adjustments under the Comprehensive Environmental Response, Compensation, and Liability Act. This ranking is based on a potency factor of 389 $(mg/kg/day)^{-1}$, determined from the Mancuso epidemiological data, and a weight-of-evidence Group A classification.[18]

A representative from NIOSH testified before the Occupational Safety and Health Administration (OSHA) on August 1, 1988, on OSHA's proposed rule on air contaminants that, based on evidence published since 1975, NIOSH recommends that OSHA should consider all Cr^{+6} compounds as occupational carcinogens.[19,20]

The ATSDR document referenced by the commenter on chromium was still in draft form. The EPA has commented to ATSDR that EPA and NIOSH (according to the NIOSH testimony) consider all Cr^{+6} compounds to be carcinogenic and that ATSDR should consider changing its conclusions in the draft document. As of the time of this comment response, the document is still in draft form.

2.2.3 Comment.

One commenter (IV-D-30) indicated that the International Agency for Research on Cancer (IARC) concluded that the carcinogenic effect in the Steinhoff study was weak.[8] This commenter notes that EPA cites the Steinhoff et al., report as the basis for its position but fails to report other animal studies that have shown negative results with respect to the causation of lung cancer.[21-23] Considering the weight of these other studies, the commenter says it is quite possible that the Steinhoff et al., method of applying the chromate dosages actually "duplicated more the functional mechanism of the sparingly soluble salts, than it did to prove the carcinogenicity of the water soluble compounds." The commenter notes that the carcinogenic effect was weak; all tumors developed at the end of the lifetime study, and none was the cause of death.

Response. The EPA agrees that the IARC monograph is a valuable resource material. The EPA has referenced IARC monograph Volume 23, 1980 in the HAD on chromium (1984). The HAD, however, contains studies on Cr^{+6} that were not referenced by the IARC working group in their evaluation of the carcinogenic effects of chromium compounds in 1980.[8,9,23] The Steinhoff et al., study was not cited by IARC in the 1980 (Volume 23) monograph.

Regarding the method of applying dosages, although it would be desirable to exactly mimic the human exposure route via an inhalation study, the intratracheal instillation method of exposure used by Steinhoff is relevant to the human exposure route in that it is in the respiratory tract and is useful in the qualitative assessment of carcinogenicity. Despite the fact that the tumors did not kill the test animals, the test substance did result in a positive carcinogenic response in this study.

2.2.4 Comment

One commenter (IV-D-9) believes that the carcinogenic effects observed in the Steinhoff tests may not be transferable to humans because the intratracheal administration of treatment method used in that study does not reproduce the human exposure route of inhalation.

Response. Although experiments that actually duplicate the human route of exposure are preferable over those that do not, EPA believes that positive results achieved by different routes of exposure should not be

discounted. As stated in the response to Comment 2.2.3, the intratracheal instillation method of exposure is relevant to the inhalation pathway. It is difficult to design experiments that exactly duplicate the human exposure scenario with animal models due to numerous factors such as dosimetric differences in the respiratory tract between rodents and humans. The EPA determined the Steinhoff study to be an acceptable protocol and useful in the qualitative assessment of carcinogenicity. Other studies were used in the overall weight of evidence conclusion that all Cr^{+6} compounds should be considered carcinogenic. These include epidemiology studies, animal studies, and in vitro studies (including mutagenicity studies). These are summarized in the HAD.

2.2.5 Comment

One commenter (IV-D-30) cited epidemiological studies of chrome plater and chromium production workers exposed to a mixture of chromates that showed no higher mortality for these workers than for the general population.[16,24] Furthermore, the commenter indicated that most of the epidemiological studies, including the Mancuso study, did not consider the effects of cigarette smoking, radon, or other occupational exposure factors that are known to affect the incidence of lung cancer. The commenter also quoted the following IARC conclusions on chromium carcinogenicity that were reported in the IARC Monographs, Volume 23, 1980:

> There is sufficient evidence for the carcinogenicity of calcium chromate and some relative insoluble chromium [VI] compounds (sintered calcium chromate, lead chromate, strontium chromate, sintered chromium trioxide, and zinc chromate) in rats. There is limited evidence for the carcinogenicity of lead chromate [VI] oxide and cobalt-chromium alloy in rats. The data were inadequate for the evaluation of the carcinogenicity of other chromium [VI] compounds and of chromium [III]) compounds. There is sufficient evidence of respiratory carcinogenicity in men occupationally exposed during chromate production. Data on lung cancer risk in other chromium-associated occupations and for cancer at other sites are insufficient. The epidemiological data do not allow an evaluation of the relative contributions to carcinogenic risk of metallic chromium, chromium [III], and chromium [VI] or of soluble versus insoluble chromium compounds.

In addition, the commenter quoted the following conclusion from IARC's Environmental Carcinogens Selected Methods of Analysis (1986):

The epidemiological data do not permit an evaluation of the effects of Cr[III] versus Cr[VI] or the role of solubility, nor can the ultimate carcinogenic form of Cr or a dose-response relationship be determined from these studies. There is no definite evidence that Cr caused cancers other than in lung, although excesses of cancers of the esophagus, stomach, pancreas, maxillary sinus, and prostate have been reported in some studies (IARC, 1980; Sheffet et al., 1982).

Response. The overall mortality ratio was actually less than 1 (0.92) in the Hayes et al., study.[24] (A standardized mortality ratio is calculated by dividing the observed number of deaths by the number expected.) This observation is consistent, however, with what is known as the "healthy worker" effect. That is, workers will tend to be healthier than the general population by virtue of being in the work force and thus will have lower overall age-adjusted mortality rates. This does not negate a specific effect such as an elevated risk for lung cancer.

According to the epidemiological criteria, the strength of the association between chromium exposure and lung cancer is strong and that it is unlikely that confounding would have played a significant role in the results that have been observed. There is a consistency of results found by different investigators in different countries, a dose-response and high lung cancer mortality ratios observed in several studies, and a specificity of tumor site (lung). With regard to smoking per se as a confounding factor, assumptions and modifications were made in the dose-response assessment in the chromium HAD (1984) that demonstrated that smoking as a confounder would not have significantly affected the dose response assessment. (Refer to the HAD for more detailed information in this matter.) Radon exposure is not known to be present in chromate production or other industrial settings where chromium compounds have been studied epidemiologically.

The EPA agrees that alone, the epidemiological data do not allow a firm conclusion to be drawn regarding the association between one oxidation state or soluble versus insoluble compounds and the causation of lung cancer among workers. The EPA's conclusions about the carcinogenicity of Cr^{+6} compounds are based on the weight of evidence from epidemiological studies plus long term animal studies and short-term bioassays.

2.2.6 Comment

One commenter (IV-D-30) believes that the following statement in the preamble concerning estimation of the Cr^{+6} potency factor from the results of the Mancuso study is incorrect: "Although there is the possibility of a slight underestimation of exposure prior to 1949, which would decrease somewhat the potency factor, there are other factors that may have resulted in an increased potency estimate." The commenter believes that underestimating exposure in an epidemiological study will result in a perceived increase in apparent potency, not a decrease. The commenter also notes that this study involved exposure to a mixture of insoluble, slightly soluble, and soluble chromates and, thus, it cannot be used to calculate the risk of exposure to soluble Cr^{+6} (the water treatment variety) alone.

Response. In the 1984 HAD for chromium (page 7-105), it is clearly stated that risk may be overestimated because there is the possibility that the use of 1949 hygiene data may result in some degree of underestimation of worker's exposures. Note the following excerpt taken from page 7-105 of the HAD.

> Thus, a cancer risk estimate based on total chromium exposure will underestimate the risk due to hexavalent chromium alone. In the Bourne and Yee (1950) study, the ratio of trivalent (Cr III) to hexavalent (Cr VI) chromium in the airborne dust in the plant's nine major departments ranged from 1 to 3, except in the case of two departments, where the ratios were 6 for the lime and ash operation and as high as 52 for the ore preparation operation. Therefore, the ratio of trivalent and hexavalent chromium in the plant did not exceed 52, seems unlikely to exceed 6, and may be smaller. Thus, the underestimation of the risk from hexavalent chromium when the Mancuso (1975) data on exposures to total chromium are used is unlikely to be more than sevenfold, if the ratio is assumed to be 6. There are two other factors, however, that may result in an overestimation of the risk: (1) there is a possibility that the use of 1949 hygiene data may result in some degree of underestimation of worker's exposures, and (2) the risk presented in this report may be somewhat overestimated because of the implicit assumption that the smoking habits of chromate workers were similar to those of the general white male population. It is difficult to determine how much the risk has been overestimated in this regard. However, it seems reasonable to assume that the risk is not overestimated by more than 4 times on the assumption that 80 percent of the chromium workers and 50 percent of the control population smoked cigarettes, and that the exposure may be underestimated by a factor of 2.

The above assumption about the smoking incidence may overestimate the risk because it is highly probable that the smoking incidence was greater in the chromate industry population than in the general population. Overall, EPA's Human Health Assessment Group believes that the extent of risk underestimation and overestimation was approximately equal. Furthermore, pulmonary chromium levels were elevated in autopsied samples of exposed workers who had died from lung cancer 15 to 195 months after their chromium exposure, implicating chromium as an etiological agent in the cause of death.

The EPA prefers to use epidemiological data to derive potency estimates rather than animal data. Although there are uncertainties in the exposure assumptions made, EPA believes in the absence of better information, the assumptions described above are reasonable.

2.2.7 Comment

One commenter (IV-D-28) believes that a threshold concept for Cr^{+6} carcinogenicity is scientifically valid. This belief is based on many individual findings published or presented recently that together have resulted in a postulated mechanism for cancer induction. These findings indicated that only soluble and slightly soluble forms of Cr^{+6} can potentially enter cells, that the body has several defense mechanisms against Cr^{+6}, and that Cr^{+6} must be reduced close to the deoxyribonucleic acid (DNA) to produce DNA adducts capable of producing gene mutations.

The commenter indicated that the body defenses against Cr^{+6} begin at inhalation. Particle size determines the amount of Cr^{+6} that is available to the lungs. Various studies have shown that about 5 to 20 percent reaches the lungs and that the rest is cleared and swallowed. Gastric juices efficiently reduce Cr^{+6} to trivalent chromium (Cr^{+3}), and secretions in the lung have the capacity to reduce some of the Cr^{+6} that enters. Secondary defense is played by the pulmonary alveolar macrophages, which physically reduce Cr^{+6} by engulfing it and by enzymatically reducing it to Cr^{+3}. In addition, up to 2 milligrams (mg) of Cr^{+6} absorbed by the blood can be reduced to Cr^{+3} by plasma. Any Cr^{+6} that enters a cell can be reduced by electron donors in the mitochondria and by enzymes in the microsomes, cytosol, and other cellular organelles.

The commenter also suggested that if the Cr^{+6} gets past these defenses, it may reach the DNA. Several theories have been suggested to explain how the Cr^{+6} interacts with DNA. Although the mechanism is unclear, it is known that the Cr^{+6} must be reduced either close to the DNA or after it is incorporated into DNA because Cr^{+3} is detected in DNA and has been shown to be active with DNA. Once a DNA adduct is produced, the last line of defense is the DNA repair process by various enzymes. In humans, this defense is good. However, if not repaired, the modified DNA molecule would have the potential to produce mutations. A mutation produced during reproduction of the cell would then have the potential to be cancerous. Although the reduction capacity of the body cannot be precisely quantified, the commenter estimated that it is approximately 100 times or more than that needed for low-level workplace exposures.

Response. The EPA agrees with the commenter that the body has some defense mechanisms to protect against toxic effects of exposure to chromium compounds. These mechanisms include: (1) clearing and swallowing large particles containing Cr^{+6} reduces the amount of chromium available to the lung; (2) effective conversion of Cr^{+6} to Cr^{+3} by the gastric juice, lung secretions, blood, and intracellular organelles (cytosol, mitochondria, and microsomes); and (3) physical reduction of Cr^{+6} by pulmonary alveolar macrophages that engulf it. However, wide intraspecies and interspecies variations and a host of other factors generally affect pharmacokinetics and metabolism of the chromium compounds. In spite of all these protective mechanisms, Cr^{+6} can reach target molecules and induce the carcinogenic process at some dose levels as seen in human and experimental animals.

The commenter mentioned that only the soluble and slightly soluble forms of Cr^{+6} can enter the cell and that the insoluble forms cannot. In contrast, EPA believes that even the insoluble compounds can be made bioavailable because body organ systems have a capacity to disintegrate and dissolve insoluble chromium compounds and thereby enter the cell.

The genotoxicity of chromium and its compounds has been studied extensively. The chromium compounds have been evaluated in 315 short-term tests. Hexavalent chromium has produced positive responses in most of the test systems used to investigate its potential for mutagenicity. To

express the positive mutagenic response, Cr^{+6} must enter the cell nucleus in order to interact with DNA and produce a DNA adduct or DNA damage.

Hexavalent chromium compounds have been classified as human carcinogens based on human epidemiologic studies supported by experimental animal studies and in vitro tests with submammalian test systems. However, for practical and statistical reasons, cancer risk associated with the low level exposure cannot be measured directly either by animal experiments or by epidemiologic studies. Therefore, EPA must depend on the current understanding of the mechanism of carcinogenesis. At the present time, the dominant view of the carcinogenesis process involves the concept that most cancer-causing agents also cause irreversible damage to DNA. This position is reflected by the fact that a very large proportion of agents, including Cr^{+6}, that cause cancer are also mutagenic. There is reason to expect that the carcinogenic response, which is initiated by a mutagenic event, is of a nonthreshold nature and thus can be associated with the linear nonthreshold dose-response relationship. Therefore, the hypothesis that was developed by the commenter cannot be considered adequate to establish the existence of a threshold when mutagenic responses are noted to occur.

2.2.8 Comment

One commenter (IV-D-28) cited recent reviews of the epidemiological data that indicate chromate-induced lung cancers are the result of the alkaline process used before 1961 in the production of sodium bichromate and chromic acid or in certain chromate pigment manufacturing operations. Since 1961, process changes have been implemented, industrial hygiene practices have been improved, and the workplace exposure limit has been set at 0.05 milligrams per cubic meter (mg/m^3) in the United States. Because studies of epidemiological data obtained in the last 25 years have not noted an increased incidence of lung tumors, the commenter believes that the current workplace exposure limit is a safe level.

Response. It is unlikely that cancer epidemiologic studies of chromate manufacturing workers employed since 1961 would have a sufficient length-of-followup to detect a statistically significant excess risk of lung cancer. Furthermore, epidemiologic studies of chromium-exposed

workers who did not experience an "alkaline process" (e.g., chrome platers) still found those workers to have an excess risk of lung cancer.

2.2.9 Comment

One commenter (IV-D-30) believes that the scientific basis for inferring human carcinogenicity from mutagenicity in rats and bacteria is weak and that the EPA proposal fails to indicate that studies have shown an extraordinary number of common food products contain natural chemical compounds that also have been shown to be carcinogens and mutagens.[25] Based on these studies, the commenter concluded that an individual is exposed to a much greater risk from food than from cooling tower drift. Furthermore, the commenter indicated that studies have shown that workers exposed continuously to relatively high levels of chromate can experience severe ulceration of the skin and nasal mucosa but that none of the lesions has been shown to become cancerous.[26]

Response. The evidence is strong showing an association between exposure to chromium compounds and lung cancer. This conclusion is based on numerous epidemiological studies with workers and is supported by multiple positive animal studies and mutagenicity tests as summarized in the HAD. The EPA agrees that there are naturally occurring carcinogens, as well as man-made, and that some of these can be found in food. The EPA in this rulemaking is concluding that exposure to CCT drift is significant enough to warrant regulation under TSCA Section 6. Whether the risk is greater than or less than risks from other sources, such as food intake does not enter into this decision.

Exposure to some chromium compounds at high enough concentrations can result in dermatitis and effects on the respiratory tract in addition to lung cancer. The fact that skin and nasal mucosal effects have generally not become cancerous does not preclude one from getting lung cancer or alter conclusions from the many studies that show the association between chromium exposure and lung cancer.

2.2.10 Comment

One commenter (IV-D-29) believes that EPA has seriously overstated the potential risk of Cr^{+6} emissions from CCT's. The commenter (IV-D-29) has taken air samples near cooling towers using chromate treatments and analyzed them for Cr^{+6}. None of the samples contained detectable

concentrations of Cr^{+6}, and concentrations were well below the OSHA exposure standard of 0.5 mg/m^3 and the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) of 0.05 mg/m^3. Swipe and soil samples also were taken at random locations near the cooling tower, and no indication of fallout of Cr^{+6} particulates was indicated. The soil samples contained 9.6 to 32.5 micrograms of total chromium per gram of soil (μg/g) but contained less than 0.1 μg/g of Cr^{+6}/g soil. Swipe samples showed 0.0050 to 0.235 milligrams (mg) of total chromium per filter and a maximum of 0.0055 mg Cr^{+6}/filter.

Response. The fact that the monitored values are below occupational standards does not mean that there is no significant health risk. The EPA's concern is with all members of the general population, including sensitive subgroups, who may be continuously exposed to toxic air pollutants 24 hours per day, 7 days per week over a lifetime. In comparison, OSHA's standards are designed to protect "healthy" workers from exposures of 8 to 10 hours per day, for 5 days per week. The EPA's estimates of exposure were based on dispersion modeling and assumptions regarding emission rates, meteorology and population. The maximum annual average concentration of Cr^{+6} estimated from a large model CCT was 0.0055 $\mu g/m^3$. It is possible that the impact from the cooling tower mentioned by the commenter is below the limit of detection for the monitoring method used. There are several technical problems commonly encountered in monitoring Cr^{+6} in the ambient air (and in soil) including conversion of Cr^{+6} to Cr^{+3} in the sampling equipment and with the detection limit being too high for the various methods in use. The concentrations reported by the commenter are not inconsistent with estimates developed by EPA using dispersion modeling techniques. For a more detailed discussion of how the risk estimates were developed, the commenter should refer to Appendix B of the proposal BID.

2.2.11 Comment

One commenter (IV-D-30) indicates that EPA has overestimated the effects from exposure to other hazards such as asbestos, arsenic, dioxins, and methylene chloride by a factor of 10 or more in the past. Consequently, the commenter believes that risk from Cr^{+6} could be overestimated by at least a factor of 10. Application of this overestimation factor to

the risk of exposure to Cr^{+6} emissions from CCT's would result in a more "realistic" number of lung cancer incidences (0.4 to 11.2 cases per year). The commenter concludes by saying that in either case, the number of cancer cases attributable to exposure to chromate in cooling tower drift is very small compared to the nearly 150,000 cases of lung cancer annually--80 to 90 percent of which are thought to be caused by cigarette smoking.

Response. The EPA notes in Appendix B of the proposal BID that there are uncertainties in the risk analysis which could result in either an underestimate or overestimate of the risk from CCT's. There are uncertainties in all elements of any risk assessment including the potency estimate, the estimates of exposure, the emissions estimates and all the assumptions used in each step of the process. Some of the uncertainties in assumptions used may tend to overestimate risk, while others used may underestimate risk. The basis for the commenter's conclusion that EPA overestimates risk by a factor of 10 is unclear. The EPA believes the estimates presented are reasonable given the uncertainties in the available information and the technical "tools" available to conduct the risk assessment. The fact that exposures to other toxicants in one's environment may result in a greater risk than from Cr^{+6} emissions from CCT's does not negate the findings of this analysis or the need for this regulation.

2.2.12 Comment

One commenter (IV-D-24) believes that prohibition of Cr^{+6}-based water treatment chemicals may create a potential health hazard from proliferation of biological organisms that far outweighs the risk from Cr^{+6}. The commenter believes that chromate programs effectively control many potential health risks from biological organisms, but that the same results may not be achievable with nonchromate programs.

Response. Upon reviewing a significant amount of scientific literature, the only harmful biological organisms that appear to be associated with cooling tower emissions are *Legionella pneumophila*, bacteria responsible for what is commonly referred to as Legionnaire's Disease. These bacteria are found in many water sources including surface water supplies. Several biocides (e.g., chlorine and quaternary ammonium

salts) are sold as part of regular treatment programs for controlling these organisms. Chromium compounds are sold for use as corrison inhibitors, not as biocides. However, because of the toxic properties of chromium there may be some incidental biocidal properties. If readily available biocidal treatment agents are used at concentrations recommended by the manufacturer, growth of biological organisms such as Legionella pneumophila is expected to be minimal and increased outbreaks of disease are not expected to occur as a result of this rulemaking.

2.2.13 Comment

One commenter (IV-F-1 [Sefton]) believes that the proposed rule may cause health hazards to increase as greater amounts of biocides such as isothiazolin or 2,2-dibromo-3-nitrilo propionamide (DBNPA) are emitted from CCT's. Even with additional biocides, the commenter believes that biological growth is nourished by many of the alternative programs and that harmful organisms such as Legionella pneumophila are being propagated and dispersed.

Response. Since the majority of CCT owners in the United States already use alternative treatment programs, EPA does not believe that because of this regulation health hazards will increase significantly by the increased use of biocides (which are currently regulated by EPA's Office of Pesticide Programs). Scientists from the Center for Communicable Disease Control have indicated that there should not be any increase in outbreaks from Legionella pneumophila if cooling towers have been treated properly with a biocidal regimen.

2.2.14 Comment

One commenter (IC-F-1 [Sefton]) believes that health risks could increase for some elderly residents of condominiums in Florida if they are without air conditioning while failed CCT system components are replaced. The commenter believes that piping and other components in CCT systems using water containing high chloride, hardness, and alkalinity could fail after switching to nonchromate treatment programs and that repairs would require extended downtime (see Comment 2.1.7).

Response. As indicated in the response to Comment 2.1.7, acceptable corrosion rates are achieved with several nonchromate treatment programs in CCT's using the poor quality water cited by the commenter. Therefore,

properly operated and maintained CCT's are not expected to experience an interruption in air conditioning service to replace corroded components.

2.3 REGULATORY APPROACH

2.3.1 Comment

Two commenters (IV-D-25 and IV-D-31) indicated that proposal of a rule under Section 6 of TSCA triggers automatic export notification requirements under TSCA Section 12(b) for the regulated chemical. One of the commenters (IV-D-31) also indicated that EPA's interpretation of the TSCA requirements is that they apply to chemicals subject to the triggering regulations rather than to such chemicals in restricted uses. Consequently, under the proposed rule, export notices would be required for any substance or mixture containing Cr^{+6}, regardless of its nature or intended use. Both commenters believe that the rule should be changed to limit the circumstances that would require export notifications. One commenter (IV-D-31) believes EPA should either restrict the category of chemicals covered by the proposed rule or specify the category of chemicals in the rule for which export notice is required. The other commenter (IV-D-25) requested that the final rule specifically exempt paint and coatings manufacturers, or their pigment suppliers, from the export notification requirements because they would be unduly burdened by these requirements.

Response. Section 12(b) of TSCA requires that any person who exports or intends to export to a foreign country a chemical substance or mixture for which a rule has been proposed or promulgated under Section 5 or 6 must notify EPA of such exportation or intent to export. The Administrator is then required to furnish notice of the rule to the government of the country receiving the export. Because the chemical substance subject to this rule is Cr^{+6}, the commenter is correct in noting that export notices would be required for any substance containing Cr^{+6}, not just for Cr^{+6}-based water treatment chemicals. It is not clear that this requirement could be narrowed, as a practical matter, because of the inability to determine the possible end use of the material at the time of export.

The EPA anticipates that the burden of the export notification requirements will be minimal and has incorporated this into the overall estimated cost for industry to comply with the labeling, reporting, and

recordkeeping requirements (see response to Comment 2.5.8). Companies are required only to provide notification the first time they export or intend to export to each country in a calendar year. The notification consists of the company's name and address, chemical name, TSCA section that triggered the notification (Section 6 in this case), countries that are the receivers, and the export date or intended export date.

2.3.2 Comment

One commenter (IV-D-31) believes that EPA should narrow the scope of application of the proposed rule. In the preamble to the proposed rule, EPA stated that the intent of the rule is to regulate the use of Cr^{+6} in CCT's by controlling the use of Cr^{+6}, usually in the form of sodium dichromate. Thus, the rule would apply to any compound containing chromium in an oxidation state of six, regardless of the nature of the substance or its uses. The commenter concluded that EPA did not intend to include such substances as lead chromate (a yellow pigment widely used for highway markings) in the scope of the rule. The commenter suggested that the scope of the rule should, therefore, be narrowed to include only those substances that may reasonably be used in CCT's. Even if EPA does not narrow the scope of application of the rule, as a matter of policy, the rule should contain a list of the chemicals covered by the rule. This would enable those persons who are potentially subject to the rule to verify their status and, thus, would provide a higher level of compliance.

Response. Section 6 of TSCA states that when use of a chemical substance presents an unreasonable risk to human health, a rule may be promulgated under Section 6 that protects against the risk by prohibiting the distribution in commerce of such substance for a particular use and/or by prohibiting any manner or method of commercial use of such substance. The EPA has determined that inhalation of Cr^{+6} emitted from CCT's presents an unreasonable risk to human health. The proposed rule was developed to protect against this risk and specifically prohibits only the distribution in commerce of Cr^{+6}-based water treatment chemicals for use in CCT's and the use of these chemicals in CCT's. These requirements were stated clearly in section 249.68(c) of the proposed rule (the "Applicability" section). With the exception of export notification requirements for any

Cr^{+6} chemical, substances containing Cr^{+6} for other uses are not covered by the rule. (Discussion of the export notification requirements is included in the response to Comment 2.3.1). Consequently, EPA believes there is no need to identify specific Cr^{+6} chemicals covered by the rule.

2.3.3 Comment

One commenter (IV-D-29) recommended that the final rule be phased in over a longer period than 120 days. The commenter stated that if EPA were to identify a target year in which such a ban were to be in place, plans could be made to replace critical equipment and begin conversion to alternative chemicals in existing towers. All new towers could be designed to not use chromates. At a minimum, the commenter recommended that the rule contain a variance provision that would allow facilities sufficient time to make any necessary regulatory arrangements and to perform any required engineering modifications. For example, the commenter operates a blowdown pretreatment facility to comply with the discharge requirements of the local POTW. Any significant change in the current operating procedure (e.g., a change in effluent composition) would impact that agreement, and the commenter believes all required arrangements for the new conditions with the POTW could not be completed within 120 days. In addition, if the current pretreatment system must be modified (e.g., for reduction of phosphates), the commenter also believes that the required design and engineering work could not be accomplished within 120 days.

Response. The prohibition on the use of Cr^{+6}-based water treatment chemicals in CCT's becomes effective 135 days after the date of publication of the final rule. The EPA believes this allows sufficient time for CCT owners and operators to exhaust supplies of Cr^{+6}-based water treatment chemicals and complete the transition to the use of a nonchromate program. Furthermore, the commenter and others aware of EPA's proposed rule could begin the transition long before publication of the final rule. The EPA also is not aware of POTW's that impose restrictions on phosphate discharges, but several POTW's have indicated that they do not impose restrictions.[27-29]

2.3.4 Comment

One commenter (IV-D-34) believes that the effective date of the regulation is August 1, 1989, and noted that this date is during the middle of the cooling season. The commenter suggested that a more realistic effective date would be the end of the cooling season such as December 1, 1989. At this time of year, the vast majority of cooling towers will be emptied for the winter anyway. In contrast, another commenter (IV-D-33) is concerned that the effective date of the regulation will occur during the winter. The commenter notes that many small CCT owner or operators who do not have information on the pending restrictions would be faced with a 6-month or more supply of Cr^{+6}-based water treatment chemicals that would have to be disposed of as regulated materials. The commenter suggested that owners/operators be allowed to use Cr^{+6} materials on hand at the effective date, but that no additional Cr^{+6} materials could be purchased.

Response. The first commenter implies that it will be necessary to shut down CCT's for cleaning in order to convert to nonchromate systems. However, in properly maintained systems, the existing chromate program is designed to prevent development of conditions that would require downtime for cleaning, such as significant scaling or corrosion. Therefore, EPA believes that the time of year that the regulation becomes effective is not a concern. (See the response to Comment 2.1.3 for more information on cleaning of CCT systems.)

The concern that owners/operators will be left with unusable stockpiles of Cr^{+6} chemicals is not justified. The relevant trade associations, publications and, most importantly, vendors of water treatment chemicals are aware of the restrictions posed by the rule and the effective date of the rule. In fact, vendors began making CCT users aware of the upcoming prohibition of Cr^{+6} in CCT's as soon as the rule was proposed in the Federal Register. No reputable vendor would sell a customer a large stockpile of Cr^{+6} chemicals in the face of the pending restrictions, and trade associations and publications will have extensive opportunity to educate CCT users about the rule. Allowing CCT owners/operators to use up existing supplies of Cr^{+6} chemicals as suggested by the commenter could significantly delay the environmental benefits of the

rule if large quantities of Cr^{+6} have been stockpiled, intentionally or otherwise. For these reasons, no change to the effective date of the rule has been made.

2.3.5 Comment

Two commenters (IV-D-24 and IV-D-27) believe that high-efficiency drift eliminators (HEDE's) present a viable and technologically sound alternative to prohibiting the use of chromates in CCT's and that the use of HEDE's would alleviate health risks and make corrosion protection economical and practical. One commenter (IV-D-27) recommended that the proposed rule be revised to include the option of installing HEDE's.

Response. The EPA considered the use of HEDE's as a regulatory alternative during development of the rule. Drift eliminator manufacturers indicate that HEDE's can remove up to 80 to 90 percent of the drift discharged from lower efficiency drift eliminators (LEDE's). Emission tests sponsored by EPA show that this range is an upper bound to the effectiveness of HEDE's over LEDE's.

The lower effectiveness of HEDE's (approximately 85 percent) compared to a nonchromate alternative (100 percent emission reduction) is only one reason why the use of HEDE's is not the preferred alternative. The nationwide costs of using HEDE's are estimated to be about $25 million compared to $20 million for the nonchromate alternative. This difference is due to the fact that HEDE's are not used widely in CCT's at present, and the industry would incur significant capital costs to install them. Also, the cost to develop a nationwide certification program for HEDE efficiency and perform annual inspections would be approximately $14.4 million or 60 percent of the nationwide costs of HEDE's. Because of the large number of CCT's using chromates relative to the number of water treatment vendors, the enforcement burden would be much greater for the HEDE alternative than for the nonchromate alternative.

Because of the costs to retrofit, difficulties in implementation, and the smaller emission reduction potential, EPA has concluded that the use of HEDE's is not a feasible control alternative. Therefore, the final rule does not allow the option of installing HEDE's to reduce Cr^{+6} emissions from CCT's.

2.3.6 Comment

One commenter (IV-F-1 [Jones]) believes that EPA does not have the authority under TSCA to prohibit the use of Cr^{+6} compounds in CCT's because: (1) TSCA requires that action be taken under other authorities unless it is in the public interest to protect against risk under TSCA, and a court decision (SED, Inc., v. City of Dayton, 519.F. Supp. 979, 989-90 [S.D. Ohio, 1981]) has upheld this TSCA requirement; (2) there is clear authority under the Clean Air Act (CAA) to protect against the risk of Cr^{+6} air emissions, the only media in which Cr^{+6} poses a risk; and (3) the justifications for using TSCA rather than the CAA do not meet the "public interest" criterion set forth in Section 6(c) of TSCA (i.e., the incremental benefit for EPA's enforcement office is not sufficient to show that regulating under TSCA is less costly and more efficient than regulating Cr^{+6} emissions under the CAA). The commenter states that prohibiting the use of a substance is a drastic measure, only to be taken as a last resort when other authorities under which regulations could be developed would not be adequate to address the risk from the substance. The CCT regulation addresses only air emissions of Cr^{+6}, and EPA has already taken steps under the CAA towards regulating air emissions of Cr^{+6}. Also, EPA has stated that recordkeeping under the CAA would be adequate. Consequently, the commenter believes that regulations should be developed under the CAA to protect against the risk posed by Cr^{+6} emissions, possibly by setting a zero emission standard as EPA suggested in the notice of the proposed TSCA rule.

Response. The EPA disagrees that its finding fails to satisfy the "public interest" criterion in Section 6(c) of TSCA. The decision to regulate Cr^{+6} under TSCA rather than the CAA is a decision which is wholly left to the discretion of the Administrator. After considering the factors in section 6(c), EPA believes that the decision to use TSCA in this rulemaking is a reasonable one and that adequate rationale for that decision is presented in the Federal Register notice of the proposed rule (53 FR 10206).

The decision cited by the commenter (SED, Inc., v. City of Dayton) involves the issue of whether the TSCA PCB regulations preempt (under TSCA Section 18) State laws that are promulgated to control PCB's. The issue

in that case is unrelated to the question of the relationship of TSCA to other Federal laws administered by EPA. Although the Court in SED discusses TSCA Section 9, it did not reach a decision which would be controlling in the present rulemaking. Section 9(b) of TSCA explicitly states how the Administrator must resolve issues involving the relationship of TSCA to other EPA statutes. As stated previously, EPA has determined under TSCA Section 9(b) that it is in the public interest to use TSCA to protect against the risks from the use of Cr^{+6} in CCT's.

In conclusion, EPA has reviewed the options for limiting exposure to Cr^{+6} emissions from CCT's and has concluded that the reduction in risk to the public and enforcement of the rule for this substance cannot be satisfactorily accomplished in any way other than by prohibiting the use of Cr^{+6}-based water treatment chemicals in CCT's and the distribution in commerce of these chemicals for use in CCT's.

2.3.7 Comment

One commenter (IV-F-1 [Sefton]) believes that the benefits of chromate far outweigh its environmental problems and that the probable consequences of the proposed rule are severe. Consequently, the commenter believes that a more reasonable regulatory approach and one that would be more beneficial to the public than the proposed rule would focus on education of vendors, users, and cooling system design engineers. The commenter suggested several aspects of this approach. First, an allowable threshold level of Cr^{+6} could be determined. Second, using probable and realistic human intake values, average distances from CCT's where Cr^{+6} concentrations exceed the allowable threshold could be determined. If the concentrations within areas frequented by people are too close to the threshold to protect human health, installation of HEDE's could be required. This requirement would have the added advantage of minimizing airborne dissemination of Legionella pneumophila, possibly by an amount similar to the 85 percent by which health risks from chromium would be reduced. Labels could be required on cooling water products indicating that prolonged breathing of cooling tower mist containing the product could increase the risk of lung cancer. Finally, maintenance people could be "cautioned" to wear a dust mask when working in or around a cooling tower containing chromium.

Response. The EPA evaluated two regulatory alternatives: (1) prohibition of the use of Cr^{+6}, and (2) installation of HEDE's. Prohibition of Cr^{+6} use was selected as the regulatory approach because it is the most protective of public health and the costs are reasonable. Furthermore, as described in the proposal BID, effective alternative water treatment programs are readily available and are already in use at 75 to 90 percent of CCT's.

The EPA disagrees with the commenter's assertion that the benefits of chromate far outweigh its environmental problems. As discussed at proposal, EPA believes that continued use of Cr^{+6}-based water treatment chemicals in CCT's presents an unreasonable risk of injury to human health. Hexavalent chromium has been determined to be a potent human carcinogen and, as indicated in the response to Comment 2.2.7, the carcinogenic response is of a nonthreshold nature. The average annual exposure to Cr^{+6} emissions from CCT's is estimated to be about 140 mg/person (3.1×10^{-4} lb/person), and the annual incidence of lung cancer is estimated to be about 20 cases based on EPA's "best-estimate" emission factor. (See docket item IV-B-5 for a detailed discussion of the rationale and basis for the best estimate emission factor.) Additionally, the available information indicates that a lower (and, in most cases, much lower) public health risk results from exposure to chemicals used in alternative water treatment programs.

The EPA also believes that the benefits provided by chromate can be achieved with nonchromate treatment programs at reasonable cost. As described in the proposal BID and in the responses to Comments 2.1.6 and 2.1.7, acceptable corrosion rates can be achieved with nonchromate treatment programs. As indicated in the response to Comment 2.5.1, the cost of prohibiting Cr^{+6} use in CCT's has been reestimated since proposal to be about $20 million and is distributed among 37,500 CCT's. The EPA believes this cost is reasonable.

Compared to a rule prohibiting the use of Cr^{+6}-based water treatment chemicals in CCT's, a rule based on HEDE's would be less effective and would require retrofit of a large number of CCT's at greater expense. Furthermore, there is no evidence that dissemination of *Legionella pneumophila* would be reduced by HEDE's. Thus, EPA has concluded that a

prohibition of use of Cr^{+6}-based water treatment chemicals is appropriate because substitutes are available and prohibition costs are reasonable.

2.3.8 Comment

One commenter (IV-D-26) strongly supports the use of TSCA to minimize the health risks of Cr^{+6} emissions because (1) adequate substitutes for chromate are available, (2) it is the most effective means of eliminating human exposure, (3) it avoids cross-media transfer of risks, and (4) it minimizes EPA's burden of enforcement. In addition, the commenter believes that full enforcement of the rule is an extremely cost-effective way of advancing environmental protection objectives and urges EPA to devote adequate resources to ensure compliance with the rule.

Response. The EPA agrees with the commenter's assessment of the rule and the need for adequate enforcement to ensure its effectiveness. The enforcement burden of about 1,800 person-hours per year will involve checking the shipment records at an estimated 200 water treatment chemical distributors, spot-checking a portion of CCT facilities to determine compliance with the rule, and processing export notifications. The TSCA provides EPA with adequate enforcement authority, including the authority to impose fines for noncompliance, and EPA plans to provide resources for enforcement of the rule after it becomes effective.

2.3.9 Comment

One commenter (IV-D-24) believes that the use of chromates requires regulation but prohibition is unwarranted. The commenter (IV-D-35) later clarified this comment by indicating that regulation should be at the point of use or disposal rather than at the point of shipment for use.

Response. This rule does regulate Cr^{+6}-based water treatment chemicals at the point of use by prohibiting its use in CCT's. Distribution in commerce of Cr^{+6}-based water treatment chemical for use in CCT's also is prohibited because enforcement of the rule can more easily be accomplished by inspecting the shipment records of 200 water treatment chemical distributors than by inspecting 37,500 CCT's. These are the least burdensome requirements to protect against the risk to human health from Cr^{+6} emissions from CCT's.

2.3.10 Comment

One commenter (IV-D-9) recommended that regulatory decisions on chromium be directed toward specific compounds, not to Cr^{+6} in general, and that more studies on commercially important compounds be made using treatment methods (and solutions) that reproduce human exposure routes. The proposed rule should be postponed until there is sufficient evidence to support the need for a regulation on sodium dichromate.

Response. The Administrator has determined that the use of Cr^{+6}-based water treatment chemicals in CCT's poses an unreasonable risk to human health. Because of the potential adverse health effects associated with Cr^{+6} exposure, EPA initiated a review to determine the risks to public health from exposure to chromium in the ambient air. As part of this review, a comprehensive HAD was prepared that summarizes the scientific literature on health effects of chromium and emphasizes the inhalation route of exposure. The HAD was reviewed at a public meeting of the Environmental Health Committee of EPA's Science Advisory Board on November 1, 1983. The Science Advisory Board concurred with the major findings of the HAD including the finding that there is sufficient evidence from the combined human and animal data to consider all Cr^{+6} compounds (including sodium dichromate, the most commonly used chromium compound for corrosion inhibition) to be carcinogenic, in humans. Therefore, EPA believes that there is no compelling reason to postpone a regulation to limit emissions of Cr^{+6} from CCT's.

2.3.11 Comment

One commenter (IV-D-11) indicated that the proposed rule does not clearly describe how products for use in CCT's should be distinguished from products for use in ICT's. To make the distinction, the commenter believes that all products formulated with Cr^{+6} should be distinctly labeled as prohibited for use in CCT's.

Response. The proposed rule stated that persons who distribute in commerce Cr^{+6}-based water treatment chemicals shall affix a label or keep an existing label affixed. The label has been revised slightly to clarify that CCT's are open water recirculation devices. The label is required to read as follows:

Warning: This product contains hexavalent chromium. Inhalation of hexavalent chromium air emissions increases the risk of lung cancer. Federal law prohibits use of this substance in comfort cooling towers, which are towers that are open water recirculation devices and that are dedicated exclusively to, and are an integral part of, heating, ventilation, and air conditioning or refrigeration systems.

Since proposal, the definition of water treatment chemicals has been revised and definitions have been included in the rule for several additional terms. These new and revised definitions clarify that the labeling requirement applies to shipments of Cr^{+6}-based water treatment chemicals for use in cooling systems, not just in cooling towers.

2.4 RECORDKEEPING AND REPORTING REQUIREMENTS

2.4.1 Comment

Nine commenters (IV-D-11, -13, -16, -18, -19, -20, -21, -22, and -23) indicated that the requirement to retain records on all CCT customers and all water treatment chemicals used in CCT's, as well as on ICT customers using chromate water treatment, would create a significant burden on water treatment chemical distributors. Two commenters (IV-D-19 and IV-D-22) believe that requiring records on nonchromium products (especially from distributors that sell no chromium products) will not help in enforcement of the rule. One of these commenters (IV-D-22) also believes that EPA enforcement personnel can do a better job if they are not burdened with all the extraneous paperwork on nonchromate use. Another commenter (IV-D-21) believes that regulation of all chemicals used in water treatment would be a tremendous burden because of the extra paperwork; the commenter questioned why shipping records must be provided for nonhealth hazard chemicals.

Response. Since proposal, EPA has reevaluated the need for records of shipments of nonchromate treatment chemicals for use in CCT's and has decided not to require maintenance of these records. It was determined that enforcement of the rule would be accomplished by other provisions and that requiring recordkeeping of nonchromate shipments would be unnecessary. In the final rule, recordkeeping of shipments of Cr^{+6}-based water treatment chemicals is required. The EPA also revised the definition of water treatment chemicals and included definitions for several additional

terms to clarify that the recordkeeping applies to shipments of Cr^{+6}-based water treatment chemicals for use in cooling systems, not just for use in ICT's. The net result of these changes is that the cost burden to industry for recordkeeping will be lower than projected at proposal. See the response to Comment 2.5.8 for the revised estimate of the recordkeeping burden.

The recordkeeping provisions described above are required so that enforcement personnel may check records to determine compliance with the rule by the water treatment chemical distributors. The recordkeeping also will aid in determining sites where Cr^{+6}-based water treatment chemicals are being used in cooling systems. This will enable EPA to target and prioritize. Industrial cooling towers and closed cooling water systems in which these chemicals are used likely to be colocated with CCT's. Therefore, these will be locations at which inspection activities are focused. Existing records kept by water treatment chemical distributors are expected to meet the recordkeeping requirements of this rule with only slight modifications.

2.4.2 Comment

One commenter (IV-D-11) represents a water treatment chemical distributor that does not maintain telephone numbers, contact names, or type of cooling tower in its billing records. Therefore, this information is not available at the distributor headquarters. The commenter indicated that to comply with the rule, the distributor would have to change its billing system, which would be an unnecessary burden because the information could be obtained, as needed, on a specific account under review.

Response. As noted in the response to Comment 2.4.1, the requirement that distributors maintain records of shipments of all water treatment chemicals for use in CCT's has been deleted. The final rule requires only that shipment records of Cr^{+6}-based water treatment chemicals for use in cooling systems be maintained. Existing records kept by affected water treatment chemical distributors can be modified slightly to include the information required by the rule for shipments of Cr^{+6}-based water treatment chemicals. The requirements are the minimum necessary to ensure effective compliance with the rule.

2.4.3 Comment

One commenter (IV-D-18) questioned EPA's authority under TSCA to require shipping records and records on chemicals that are not controlled by TSCA. Three other commenters (IV-D-19, -20, and -23) believe that EPA does not have the authority to require such records. Two commenters (IV-D-18 and IV-D-23) noted that TSCA Section 6(a) provides EPA with the authority to further regulate the use of a chemical determined to cause an unreasonable risk to human health or the environment. The two commenters also indicated that TSCA Section 8(a) provides EPA with the authority to require ancillary recordkeeping for Section 6(a) chemicals. However, the commenters believe that the proposed rule's recordkeeping requirements for chemicals that have not been shown to cause unreasonable hazards to human health or the environment are not covered by either TSCA section. Also, one commenter (IV-D-23) indicated that TSCA Section 8(a) is rather specific regarding the type of recordkeeping that can be required, and shipping records are not one of the types of records listed.

Response. Since proposal, EPA has reevaluated the need for records of shipments of nonchromate treatment chemicals for use in CCT's and has decided not to require maintenance of these records.

2.4.4 Comment

Seven commenters (IV-D-13, -18, -19, -20, -21, -22, and -23) were concerned that the recordkeeping requirements in the proposed rule would place an unreasonable burden on the resources of small businesses. One commenter (IV-D-13) indicated that many (if not most) water treatment chemical distributors are small businesses without the computers or manpower to comply with the proposed recordkeeping requirements.

Response. There may be water treatment chemical distributors that are small businesses. However, EPA does not believe that the resources of small businesses will be unduly burdened by compliance with the recordkeeping requirements of the rule, especially since the final rule requires that only records of Cr^{+6}-based water treatment chemical for use in cooling systems be maintained. Existing records kept by small water treatment chemical distributors are expected to meet the recordkeeping requirements of this rule with only slight modification. Storage capacity (either computer or paper files) is not expected to increase. In

addition, a distributor that does not need a computer now will not need to purchase one to comply with the recordkeeping requirements of the rule. The total cost to the water treatment chemical industry of labeling, recordkeeping, and reporting requirements is estimated to be about $87,000/yr. This cost is less than 1 percent of gross water treatment chemical industry sales of approximately $90 million/yr. The average cost burden that individual distributors of Cr^{+6}-based water treatment chemicals would incur as a result of the labeling, recordkeeping, reporting (includes export notification) requirements is estimated to be $435/yr over a 3-year period. Therefore, the cost of recordkeeping requirements of the rule is not expected to cause any economic hardship on small businesses.

2.4.5 Comment

One commenter (IV-D-18) indicated that maintaining all CCT records for 2 years will require time and archive space that many water treatment chemical distributors cannot afford. Another commenter (IV-D-21) believes that additional people would have to be hired to handle the extra paperwork.

Response. As noted in the response to Comment 2.4.1, the requirement for retention of records on all water treatment chemicals for use in CCT's has been deleted, and only records of Cr^{+6}-based water treatment chemicals are required to be maintained. The EPA believes that the majority of distributors already keep most, if not all, of the required information and that only slight modifications will be necessary to meet the requirements of the rule.

2.4.6 Comment

One commenter (IV-D-16) believes that the requirement to maintain records of a contact name of any CCT user to whom water treatment chemicals are shipped is unfair because water treatment chemical distributors would have to keep track of CCT owner/operator personnel changes.

Response. Under the final rule, recordkeeping requirements only apply to shipments of Cr^{+6}-based water treatment chemicals for use in cooling systems. Water treatment chemical distributors will need to retain contact names of ICT users and those CCT users with closed cooling

water systems that are receiving Cr^{+6} chemicals. The EPA believes that most companies that order water treatment chemicals identify a specific person responsible for placing that order or to whom the order should be shipped. Thus, distributors will not have to "keep track of" personnel changes but merely will need to record the name associated with an individual order.

2.4.7 Comment

One commenter (IV-D-23) indicated that because water treatment chemical distributors are required to submit annual reports under FIFRA on all biocide chemicals and reports every 5 years under TSCA on all chemicals, it seems ridiculous to have to maintain all shipping records for 2 years.

Response. The annual reports required by FIFRA only apply to the biocides used in cooling towers, and biocides are not included as part of the corrosion inhibitor formulation. Consequently, these reports will not help in enforcement of the rule. The commenter's reference to a TSCA report every 5 years is unclear because there is no such requirement in TSCA. In any case, as noted earlier, the recordkeeping requirements have been revised since proposal, and maintenance of records of shipments of nonchromate water treatment chemicals is no longer required. The recordkeeping requirements in the final rule have been limited to those that are necessary to ensure effective compliance with the rule.

2.4.8 Comment

Seven commenters (IV-D-11, -13, -16, -19, -21, -22, and -23) believe that it would be sufficient and more appropriate to maintain records only on customers still receiving Cr^{+6}-based water treatment chemicals; records indicating that these chemicals were shipped only for use in ICT's would show compliance with the prohibition of use in CCT's. As an alternative, three commenters (IV-D-11, -13, and -16) believe that information on CCT's, if necessary, should be supplied by the CCT owners/operators or by the CCT manufacturers, not by the water treatment chemical distributors.

Response. As described in the response to Comment 2.4.1, EPA has reevaluated the recordkeeping requirements and agrees with the commenters that records of Cr^{+6}-based water treatment chemicals are adequate to ensure compliance with the rule. Therefore, only records of shipments of

Cr^{+6}-based water treatment chemicals are required in the final rule. The EPA also has clarified that the recordkeeping requirement applies to shipments of Cr^{+6}-based water treatment chemicals for use in cooling systems, not just for use in ICT's.

The EPA disagrees that CCT owners, operators, or manufacturers should supply the records necessary to ensure compliance. For purposes of determining compliance with this rule's requirements, EPA has determined that the most effective approach is to require recordkeeping by persons who distribute Cr^{+6}-based water treatment chemicals in commerce. The EPA has also determined that recordkeeping by the water treatment distributors significantly reduces the overall recordkeeping, reporting, and enforcement burden of the rule because the number of distributors is much smaller than the number of CCT owners, operators, and manufacturers.

2.4.9 Comment

One commenter (IV-D-11) suggested that persons distributing Cr^{+6}-based water treatment chemicals should be required to provide each publicly owned treatment works (POTW) with records that identify cooling tower owners/operators in the POTW district that receive shipments of the chemicals.

Response. The purpose of the recordkeeping requirements is to provide information necessary for EPA to determine compliance with the prohibition of use of Cr^{+6}-based water treatment chemicals and distribution in commerce of the chemicals for use in CCT's. The commenter's suggestion would impose an additional paperwork burden on water treatment chemical distributors without contributing to the effective enforcement of the rule. Therefore, EPA does not believe that the suggested requirement is warranted, and it is not included in the final rule.

2.4.10 Comment

One commenter (IV-D-16) requested that the final rule include a statement indicating that records will be kept confidential. The commenter wants to ensure that a water treatment chemical distributor will not be able to obtain copies of a competing distributor's customer list under the Freedom of Information Act (FOIA).

Response. Any person who submits information to EPA can request that the information be treated as confidential business information (CBI) under TSCA. In any event, the only information that is required to be reported to EPA under this rule is the name, address, telephone number, and contact name for the headquarters and shipment offices and a statement related to whether the distributor distributes in commerce any Cr^{+6}-based water treatment chemicals. Records of Cr^{+6}-based water treatment chemicals are to be retained at the distributor headquarters and would not be subject to FOIA requests. These records would only be available to authorized EPA enforcement personnel.

2.4.11 Comment

Six commenters (IV-D-18, -19, -20, -21, -22, -23) were opposed to the reporting requirements of the proposed rule, particularly for nonchromate water treatments. Two commenters (IV-D-18 and IV-D-23) stated that because of the numerous reporting requirements already in place, including those under the Superfund Amendments and Reauthorization Act (SARA), OSHA, TSCA, FIFRA, and State and local laws, the drain on resources for small businesses is large. One commenter (IV-D-18) believes that completing the initial report required by the proposed rule, in addition to the proposed recordkeeping requirements, will require time and archive space these small companies cannot afford.

Response. The EPA has reevaluated the reporting requirements and has decided not to require reports by distributors that provide only nonchromate water treatment chemicals. It was determined that these reports would be unnecessary because enforcement of the rule would be accomplished by other provisions. However, in the final rule, reporting by distributors of Cr^{+6}-based water treatment chemicals is required. The required reporting is minimal and consists of identification of the distributor name, address, telephone number, and name of contact for both the headquarters and shipment office locations. The reporting requirements also have been clarified to indicate that they apply to distributors of Cr^{+6}-based water treatment chemicals for use in cooling systems. At proposal, reporting was required by distributors of water treatment chemicals for use in CCT's and by distributors of Cr^{+6}-based water treatment chemicals for use in ICT's. The clarification should not increase

the reporting burden because most distributors provide chemicals for use in both cooling towers and closed cooling water systems. As stated in the response to Comment 2.5.8, the cost of the reporting requirements averaged over the first 3 years of the rule for distributors of Cr^{+6}-based water treatment chemicals is estimated to be about $30 per company per year. Therefore, EPA believes that the reporting requirements of the final rule do not pose an undue burden on water treatment chemical distributors.

2.4.12 Comment

One commenter (IV-D-13) suggested that the reporting responsibility for Cr^{+6}-based water treatment chemicals should lie directly with the users/consumers. The commenter believes that the authority to handle this may already be in place and operational under SARA, Title III Section 302 et al.

Response. As discussed in the response to Comment 2.4.8, EPA has determined that the large number of CCT owners and operators would preclude the effective imposition of recordkeeping requirements on the user population, particularly when the objectives of the rule can be met with far less overall burden by the much smaller groups of water treatment chemical distributors. Similar reasoning applies to the imposition of reporting requirements. Furthermore, the reporting requirements under SARA apply only to releases of "reportable quantities" of hazardous substances in a 24-hour period. The reportable quantity of sodium dichromate is 454 kilograms (1,000 pounds), which is significantly more than would be emitted from any cooling tower in a 24-hour period. Consequently, the responsibility for reporting will continue to remain with the water treatment chemical distributors.

2.4.13 Comment

One commenter (IV-D-33) stated that the reporting requirements require the creation of two separate lists; one based on invoicing and the other based on end use locations. The commenter noted that in cases where materials are purchased by a company and shipped to a central location for use at separate facilities, the distributor may not know the actual end use location. The commenter recommended that this reporting be minimized to avoid adverse costs to smaller water treatment distributors.

Response. The commenter is correct that under the scenario described, the water treatment chemical distributor would be required to collect and maintain information that may not be currently maintained. However, effective enforcement of this regulation depends on the identification of end use locations of Cr^{+6}-based water treatment chemicals. The cost that would be faced by the distributor would be to redesign and print the order form to incorporate end use location. The EPA believes that this cost is reasonable and it has been incorporated into the revised estimate of industry burden which is discussed in the response to Comment 2.5.8.

2.5 ECONOMIC AND COST IMPACT

2.5.1 Comment

Two commenters (IV-D-27 and IV-F-1 [Sefton]) believe that EPA has underestimated the cost impact of the proposed rule. Based on conversations with water treatment chemical distributors, one commenter (IV-D-27) believes that the cost of technical service provided by the distributors will increase significantly with nonchromates, whereas the proposal BID indicates that the cost is not expected to increase significantly. The monitoring and control equipment necessary to use nonchromates are estimated by the commenter to cost between $5,000 and $10,000 per CCT system. Another commenter (IV-F-1 [Sefton]) sells a basic control system for over $2,500 (not including installation costs) that includes automated feed, bleed-off, and pH control equipment. If separate acid feed or mixing equipment is required, the cost would be even higher. Consequently, the commenter believes that EPA's estimate of $500 for this type of equipment is extremely low. The commenter also believes EPA's estimate of 15-year life expectancy for this equipment is optimistic because many components, such as pH probes, were found to have life spans as short as 1 year or less. To illustrate annual nonchromate treatment program costs, the commenter selected as examples four typical CCT's (150 to 350 tons) using different nonchromate treatment programs for which the annual costs were $2,160 to $4,590. These costs include the cost of the corrosion inhibitor and technical service as well as other expenses such as additional biocides for phosphate programs; however, annualized equipment costs are not included. In addition to the control equipment and chemical

treatment costs, Commenter IV-D-27 believes that additional staff would be needed to monitor the equipment, instrumentation, and CCT's.

Response. To respond to this comment, EPA obtained additional information about automatic control equipment and water treatment program costs from water treatment distributors and other contacts. The additional information provided shows that costs for both control equipment and nonchromate treatment program chemicals and technical service were underestimated in the proposal BID, but not by as much as the commenters have suggested. The revised cost estimates are summarized below and are discussed in more detail in docket item IV-B-1.

In the proposal BID, it was reported that the only necessary automatic control equipment was a blowdown controller, and the controller life was assumed to be 15 years. New information from six water treatment chemical distributors shows that a chemical feed pump and a water meter also are needed and that equipment life expectancy should be 10 years. The information also indicates that acid is added in about 25 percent of the CCT's to reduce pH and alkalinity levels. For these CCT's, a pH controller and an acid feed pump would be needed in addition to the other equipment described above. Finally, it was assumed that about 3 percent of all CCT's are in high-rise buildings that would need high-pressure feed pumps.

The revised capital costs were based on information obtained from six water treatment chemical distributors, one automatic control equipment manufacturer, and one CCT user. All of the estimated capital costs are purchase costs. Installation costs have not been included because it was assumed that installation would be performed by the building or facility maintenance personnel as part of their regular duties. The revised costs that would be incurred by a typical CCT for a blowdown controller, standard corrosion inhibitor feed pump, and water meter are about $1,100. For the 25 percent of CCT's that also add acid to reduce pH and alkalinity levels, a pH controller and an acid feed pump would cost an additional $1,150. For the 3 percent of the CCT's that would require a high-pressure pump, the capital cost would increase by $450. Based on these estimates, the average capital cost per CCT has been revised to $1,400. In addition to the initial capital costs, the new information

indicates that replacement of conductivity probes is necessary every 3 years at a cost of $100, and pH probes must be replaced every 2 years at a cost of $150. Based on these capital and replacement costs, the annualized automatic control equipment cost is about $300 per CCT.

The chemical treatment program costs reported in the proposal BID were underestimated because they were average costs for both ICT's and CCT's and because they did not include biocide costs. For nonchromate programs, the revised chemical treatment program costs were based on estimates provided by seven water treatment chemical distributors and two CCT users. For nonchromate programs, the revised chemical treatment cost is $300/million pounds (M lb) of blowdown, which is 150 percent higher than the estimate at proposal. The revised chemical treatment cost for chromate programs is $215/M lb of blowdown, which is 260 percent higher than the proposal estimate. These estimates include the cost for biocides as well as for the cost for the corrosion inhibitor formulation.

The total annual cost to switch CCT's from chromate to nonchromate treatment programs is the sum of the annual cost difference between nonchromate and chromate treatment programs, the annualized capital cost for control equipment, and the annualized cost for replacement equipment. The total annual nationwide cost is estimated to be $20 million, which is more than two times higher than the $9.4 million in the proposal BID. This new estimate is based on the worst-case assumption that all 37,500 CCT's switching from chromate to nonchromate treatment programs would need to install automatic controls. Even under this worst-case scenario, EPA believes the estimated costs are reasonable as is the revised cost-effectiveness value. Cost effectiveness was calculated using the total annual nationwide cost and a revised estimate of the annual incidence based on a best estimate of the emissions (see docket item IV-B-1). The calculated cost effectiveness of eliminating Cr^{+6}-based treatment programs is $1 million per cancer case avoided.

The economic impact of the rule has been revised based on the new costs. As indicated in the proposal BID, if it is assumed that the costs will be passed on in the form of rental rate increases, the average impact on rental rates for the smallest size towers is estimated to be less than $0.45/square meter ($m^2$) ($0.04/square foot [ft^2]). This cost would

represent a rent increase of about 0.3 percent. The impact on rental rates decreases as CCT (and building) size increases.

The costs discussed above do not include costs for additional staff to monitor the equipment, instrumentation, and CCT's as suggested by the commenter. The level of effort to monitor, control, and maintain a CCT system using a nonchromate treatment program is similar to that for a CCT using a typical chromate program. Typical activities include sampling the cooling water on a weekly or daily basis (30 minutes); analyzing the samples for the inhibitor or tracer concentration (10 to 20 minutes); visual inspection of the system daily; adjusting the automatic controls, as necessary; inspecting and cleaning the chemical feed system, cooling water pump, and conductivity sensor once a month (about 1 hour); and periodically adding biocide (and acid, if not added automatically). These activities require a level of effort of up to about 2 hours per day (h/d). Most building support staffs consist of at least two persons between whom the work can be divided. The impact on most building support staffs may be significantly less than 2 h/d because weekly checks of the water are sufficient for many automatically controlled nonchromate programs; simple analyses are available for molybdate, zinc, and phosphate; and operators of CCT's on typical chromate programs already perform some of these tasks.

2.5.2 Comment

One commenter (IV-F-1 [Sefton]) believes that the economic impact of the proposed rule on individual CCT's using poor quality makeup water that contains high chloride, hardness, and alkalinity levels would be enormous (specifically in the Florida area) and estimates that the total costs could exceed $1 billion for Florida alone. The commenter indicates that both the replacement frequency of highly corrodible components of the CCT system and the replacement of these components with more expensive corrosion-resistant components must be considered. The commenter described specific repairs and improvements that could be required and provided the costs for some of them.

The commenter also believes that higher operating costs are incurred by CCT's in Florida using poor quality water supplies. In many cases, more frequent cleaning of the heat transfer equipment would be necessary

to remove scale, which is produced by many of these water supplies at the effective pH levels of the inhibitors. Cleaning may be accomplished on-line with expensive and unpredictable chelating agents. Alternatively, the system could be shut down and cleaned with acid, which can cost $500 or more depending on the size of the chiller. Scale impairs the heat transfer process and, thus, also results in higher energy consumption and cost to maintain the design cooling requirement. Water costs also would increase for these CCT's. To illustrate how water costs could increase, the commenter presented the following example. If the cycles of concentration in the CCT are kept low because corrosion inhibitors that are less effective than chromate are used, water usage increases. At five cycles of concentration (typical for chromate programs), bleed off is about 0.7 gallons of water per minute (gal/min) per 100 tons of air conditioning. At two cycles, the bleed-off rate would be about 2.7 gal/min per 100 tons of air conditioning. For a 1,000-ton CCT operating at full capacity, the increase in water usage would be an additional 20 gal/min or over 28,000 gal/d. The commenter indicated that some water in Florida now costs over $5/1,000 gal, but even at $3/1,000 gal, this increased water usage would result in increased operating costs of over $2,500 per month.

Response. As indicated in the response to Comment 2.1.7, information obtained by EPA from water treatment chemical distributors and other contacts show that nonchromate programs are available that effectively control corrosion in CCT's using makeup water containing high chloride, hardness, and alkalinity levels. Consequently, EPA disagrees that more frequent replacement of system components would be required for CCT's using nonchromate chemicals with poor quality makeup water and has not considered such costs in developing the final rule. Because these programs also have been shown to control scale in high chloride/high hardness water through the addition of acid and dispersants, the commenter's claim that energy use would increase also is unsupported. However, the additional information obtained by EPA indicates that the commenter is correct in stating that increased water usage would occur for these CCT's. To determine the impact of the increased water costs and to incorporate revisions to other costs resulting from the new information,

EPA conducted a new cost analysis for CCT's using water with high chloride, hardness, and alkalinity levels such as those in Florida. The total annual cost for a hypothetical analysis of nonchromate substitution for all Florida CCT's was estimated based on the additional cost of chemicals, water, and automatic control equipment. The annual incidence also was revised based on the typical chromate concentration provided by the commenter and on the best estimate emission factor developed by EPA since proposal. The following discussion summarizes the results of this analysis, and docket item IV-B-2 further describes how the costs were estimated.

Information on the chemical cost of treating cooling water with high chloride, hardness, and alkalinity levels was solicited from several water treatment chemical distributors. Only two distributors provided chemical cost information, and this information was used to calculate the chemical cost difference between nonchromate and chromate treatment programs in Florida. These costs include the cost of the corrosion inhibitor, acid, dispersants, and biocides. An 89 percent utilization rate was assumed for the Florida CCT's, which is higher than the nationwide average rate of 46 percent. Based on information received from two water treatment chemical distributors, the Florida CCT's were assumed to operate at 3.8 cycles of concentration as opposed to 5 cycles of concentration assumed in the proposal BID. Therefore, the makeup water rate in Florida towers using the poor quality makeup water is about 9 percent higher than average. The water cost for Florida was assumed to be $3/1,000 gallons, also higher than the nationwide average. Automatic control equipment capital costs for Florida were assumed to be no different from the costs for an average CCT (see the response to Comment 2.5.1). Finally, for the purpose of this analysis, it was assumed that all chromate-using CCT's in Florida use water with high chloride, hardness, and alkalinity levels, thus overstating the cost impact.

Based on these assumptions, the total annual cost of the hypothetical analysis for approximately 1,700 chromate-using CCT's in Florida to switch to nonchromate treatment programs is estimated to be about $6.6 million, much lower than the $1 billion estimated by the commenter. The hypothetical annual incidence for this analysis was estimated to be about

3 cases/yr. This annual incidence is based on a chromate concentration of 25 ppm rather than 10 ppm as reported in the proposal BID. The higher concentration was used because the commenter indicated that the typical chromate concentration in towers using the poor quality water is greater than 20 ppm. Even under this worst-case scenario, EPA believes the estimated costs are reasonable as is the revised cost-effectiveness value of $2 million per cancer case avoided.

2.5.3 Comment

One commenter (IV-F-1 [Sefton]) believes that the proposed rule would have a significant economic impact on small businesses using CCT's with makeup water with high chloride, hardness, and alkalinity levels. To illustrate this impact, the commenter estimates that a 15-story condominium could incur high costs to repair corrosion damage or to upgrade the equipment before failure. The commenter also noted that annual operating costs for such a building could increase by $50,000 due to increased chemical costs, increased water usage, and higher energy costs (in high-scaling situations).

Response. As discussed in the response to Comment 2.5.2, EPA does not believe that CCT's using water with high chloride, hardness, and alkalinity levels will need to replace or repair equipment due to corrosion any more frequently when using nonchromate programs than when using chromate programs. However, EPA's revised cost analysis for such CCT's did show that annualized costs would be greater for them than for CCT's using good quality water. The revised total annual costs for switching from chromate to nonchromate programs for CCT's in these poor water quality areas (such as Florida) ranged from about $600 per year for the smallest model tower (27 tons) to $18,400 per year for the largest model tower (1,520 tons). These costs are higher than those for average CCT's, but the average impact on rental rates for the smallest building is estimated to be less than 1 percent. These costs and the impact on rental rates are considered reasonable.

2.5.4 Comment

One commenter (IV-D-27) believes that the cost to repipe buildings because of total system failure should be addressed because some buildings with heavily corroded CCT systems have been faced with this cost soon

after they switched to nonchromate treatment programs. For a high-rise building with an extensive piping network, this cost would overwhelm the other costs of switching to nonchromates. The commenter cited corrosion rates of 7 to 10 mils/yr under chromate programs and 7 to 30 mils/yr under nonchromate programs for systems using soft, naturally corrosive New York City municipal water.

Response. As indicated in the response to Comment 2.1.3, the majority of CCT systems using chromate treatment programs are not heavily corroded and can be easily switched to nonchromates. However, two options exist for dealing with heavily corroded systems that are switched to nonchromates. These options are (1) switching directly to nonchromate treatment programs without cleaning (noncleaning option) and (2) cleaning before or concurrent with the switch to nonchromate treatment programs (cleaning option). The EPA evaluated the total annual cost, annual incidence, and cost effectiveness of the rule for these options. The analysis was performed for all six model towers and is discussed in detail in docket item IV-B-3. However, only the results of the analysis for the largest model tower are summarized below because this model tower represents the CCT's used in high-rise buildings as described by the commenter.

The cost of both options is a function of the pipe life. The life of new pipe was estimated to be 40 years based on corrosion rates of 2 mils/yr, the assumption that most of the system consists of 2-inch diameter pipe which has a wall thickness of 154 mils, and the assumption that the pipe would need to be replaced when less than half of the original wall thickness remains. For the noncleaning option, the average pipe life was estimated to be about 4 years under chromate programs and about 1 year under nonchromate programs. This estimate is based on the above assumptions and the highest corrosion rates observed by the commenter under both programs. The highest corrosion rates were used because this pairing results in the earliest need for pipe replacement after switching to nonchromates. The average pipe life for the cleaning option was estimated to be 19 years, or 15 years longer than for the existing chromate program. This estimate is based on the above assumptions and the information presented in the response to Comment 2.1.3.

This information shows that even heavily corroded systems can be cleaned adequately and that acceptable corrosion rates of 2 mils/yr can be achieved with nonchromate treatment programs in the cleaned systems.

The total annual cost of the noncleaning option is based on the annualized pipe replacement cost for the years of life lost by switching to nonchromate treatment programs, the additional annual chemical cost for nonchromate programs, and the annualized automatic control equipment cost. Based on information from one water treatment chemical distributor, the pipe replacement cost was estimated to be $215,000. As indicated above, this cost would be incurred 3 years earlier under the noncleaning option than under the existing chromate program. Using the pipe replacement cost, the 3 years of life lost by switching to nonchromates, an assumed building life of 40 years, and an interest rate of 10 percent; the annualized pipe replacement cost of the noncleaning option was estimated to be $5,100/yr.

The annual chemical cost difference between chromate and nonchromate programs was estimated to be about $2,900/yr based on cost data from two water treatment chemical distributors for soft water applications. The cost data provided were scaled to the New York City utilization rate of 33 percent. The average annualized automatic control equipment cost is about $300/yr. This cost is the same for all towers, as described in the response to comment 2.5.1. Based on these costs, the total annual cost of the noncleaning option is estimated to be about $8,200/yr for the largest size model tower.

The total annual cost of the cleaning option is based on (1) the annualized difference between the initial cost for cleaning and the present value of the cost of continuing to use chromate in a corroded system and (2) the same increased chemical and automatic control equipment costs as for the noncleaning option. The cleaning cost was estimated to be $37,500 based on information from a cleaning company. As indicated above, the estimated pipe replacement cost of $215,000 would be incurred 15 years earlier under the existing chromate program than under the cleaning option. The present value of the annualized pipe replacement costs for these 15 years is $110,000. This cost indicates that cleaning results in a present value cost savings of about $73,000, or an annual

cost savings of about $7,800/yr, over the existing chromate program. Even when the additional chemical and automatic control equipment costs are included, the cleaning option results in an annual cost savings of about $4,700/yr.

For heavily corroded systems, the annual incidence is estimated to be three times higher than average. This annual incidence is based on a new, best estimate of the Cr^{+6} emissions and a tower utilization rate of 33 percent. The annual incidence also is based on a chromate concentration of 40 ppm which, according to the commenter and two water treatment chemical distributors, is typical for soft water applications such as those in New York City.

The total annual cost of $8,200/yr for the noncleaning option, the option with the highest cost, was used in analyzing the total annual cost of switching heavily corroded systems to nonchromate treatment programs. Based on this cost and the revised annual incidence, the best estimate of the cost effectiveness is about $1 million per cancer case avoided. The EPA believes these costs are reasonable.

In addition to the cost analysis for heavily corroded systems, EPA also evaluated the cost for clean CCT systems using soft water because the commenter claimed that corrosion rates are worse in soft water than in scale-forming water (see Comment 2.1.6). This analysis is summarized below and is presented in detail in docket item IV-B-4. As indicated in the response to Comment 2.1.6, information obtained by EPA from water treatment distributors shows that acceptable corrosion rates can be achieved with nonchromate treatment programs in CCT's using soft water. Therefore, the cost of the rule for CCT's using soft water is based on the same annual chemical and automatic control equipment cost information described above except that the provided chemical cost was scaled to the nationwide average utilization rate of 46 percent. It also was assumed that the distribution of the six model towers using soft water is the same as the nationwide distribution of the model towers. Based on these assumptions and conditions, the total annual cost of the rule ranges from about $300/yr for the smallest model tower to about $3,600 for the largest model tower. As with the analysis for heavily corroded systems, the annual incidence was revised using a typical chromate concentration of

40 ppm for soft water applications. The cost effectiveness based on these costs and revised annual incidence values is about $500,000 per cancer case avoided. The EPA believes these costs are reasonable.

2.5.5 Comment

One commenter (IV-F-1 [Sefton]) believes that the estimates in the proposal BID for the distribution of the total CCT population on a per capita basis underestimates both the number of cooling towers in warm regions of the U.S. and the economic impacts for those areas. For example, the commenter estimates that 6,250 CCT's in Florida use chromate and that the economic impacts of the proposed rule on these towers could exceed $1 billion. This estimate includes the cost to replace corroded pipes.

Response. The total CCT population was distributed on a per capita basis because this was and still is the best method available. Buildings may not need as much cooling in cool areas of the U.S., but they still use cooling towers. In cool areas, the CCT's operate at lower utilization rates or they may be smaller than those in warm regions. Consequently, EPA believes that the distribution of CCT's on a per capita basis is reasonable.

As discussed in the response to comment 2.5.1, the nationwide economic impact of the rule was revised from $9.4 million to $20 million. This analysis averages the costs for CCT's nationwide. Therefore, it overestimates the cost for CCT's with utilization rates below the average, for CCT's that operate with higher than average cycles of concentration, and for CCT's that already have automatic control equipment. On the other hand, the analysis underestimates the cost for CCT's using makeup water that is highly-scale forming and for CCT's with utilization rates above the average. The commenter is correct that Florida is one area where the cost per CCT is higher than average. However, as discussed in the response to comment 2.5.2, EPA conducted a hypothetical cost analysis for Florida and found the total annual cost to be less than $6.6 million even if all Florida CCT's were assumed to use high chloride makeup water, considerably less than the $1 billion estimated by the commenter. Consequently, EPA believes that the cost and economic impact of the final rule is estimated adequately by distribution of the CCT's on a per capita

basis. Furthermore, underestimation of the number of towers using chromate in a region also would result in underestimation of the emissions and risk. Because the cost and risk are both directly proportional to the number of towers, the cost effectiveness would be the same regardless of the number of towers.

2.5.6 Comment

One commenter (IV-F-1 [Murphy]) indicated that good corrosion protection was necessary to keep cooling towers, condenser tube bundles, tube sheets, and piping from corroding at rates that require repair or replacement in only a short time. Damage to condenser heads and tube sheets could require sandblasting and epoxy coating. The commenter provided estimated costs and downtime that would be typical to repair corrosion damage in a 500-ton system.

Response. The EPA agrees that good corrosion protection is necessary to minimize the need for repair or replacement of CCT system components. As discussed in the responses to Comments 2.1.3, 2.1.6, and 2.1.7, the effectiveness of many nonchromate programs has been demonstrated even in CCT's using poor quality makeup water. Consequently, the replacement costs and downtime cited by the commenter would not be incurred by CCT's that properly implement these nonchromate programs.

2.5.7 Comment

One commenter (IV-D-29) stated that EPA has not assessed the potential consequences of conversion to nonchromates on older CCT systems. The commenter believes that conversion to substitute chemicals will lead to pinhole leakage in the system at least until the replacement becomes stabilized. The commenter estimated that the overhead costs and lost salaries would exceed $1 million per day if his facility had to be shut down because of system failure. Another potential cost could be the loss of critical data within computer systems.

Response. The EPA has assessed the potential for corrosion during conversion of older CCT's to nonchromate treatment programs and concluded that system failure or unplanned shutdown will not occur when the conversion is properly conducted. Shutdown will not be necessary if the system is clean before the switch, as the water treatment distributors indicated is the case with most CCT's using chromates. Typical procedures that the

water treatment companies follow when converting a system are presented in the response to Comment 2.1.3. Because these procedures are well understood by water treatment chemical distributors and cleaning contractors, a CCT owner/operator should not incur overhead costs or the loss of critical data when switching to a nonchromate treatment program.

2.5.8 Comment

One commenter (IV-D-16) concluded that the estimated labeling, recordkeeping, and reporting cost of $169,900 per year would be the average cost of compliance for each of 400 water treatment chemical distributors because the alternative of $425/year seems very low. This would lead to the removal from the economy of about $68 million/year (or $204 million over 3 years) that the commenter believes would be better used by investing in expansion.

Response. The commenter's conclusion about the labeling, recordkeeping, and reporting cost to industry is incorrect. For the proposed rule, the estimated cost averaged over the first 3 years of the rule was $425 per company and $169,900 for the industry. These costs were considered reasonable because most of the required records are kept by the water treatment chemical distributors, and any additional information could be easily obtained and recorded after an initial modification is made to the existing recordkeeping format. However, the labeling, recordkeeping, and reporting burden has been reevaluated since proposal. The requirement that records be maintained of nonchromate shipments to CCT's has been deleted as described in the response to Comment 2.4.1, and the reporting requirement has been revised as described in the response to Comment 2.4.11 to exempt distributors that provide only nonchromate water treatment chemicals. In addition, the cost impact of the export notification requirements has been estimated. The labeling, recordkeeping, and reporting requirements have also been revised as described in the responses to Comments 2.3.11, 2.4.1, and 2.4.11 to clarify that they apply to distributors that ship water treatment chemicals for use in cooling systems; not just for use in cooling towers. These clarifications should not change the cost impact because most distributors providing Cr^{+6}-based water treatment chemicals for closed cooling water systems also provide the chemicals for ICT's.

At proposal, it was estimated that there are a total of about 400 water treatment chemical distributors. Since proposal, it was assumed that about 200 of the distributors provide both Cr^{+6}-based and nonchromate water treatment chemicals, and the other 200 distributors provide only nonchromate chemicals.

The 200 distributors providing Cr^{+6}-based water treatment chemicals would be affected by all of the labeling, recordkeeping, and reporting requirements. For these 200 distributors, the revised cost averaged over the first 3 years of the rule is estimated to be $435 per distributor per year. This cost comprises $30 for reporting, $225 for recordkeeping, and $180 for labeling. In addition, the cost impact of the export notification requirements accounts for a very small part of the total annual cost. It was assumed that 10 of these 200 distributors also export Cr^{+6}-based water treatment chemicals to 1 country. For these 10 distributors, the estimated cost impact of the export notification requirements averaged over the first 3 years of the rule is $50 per distributor per year. The rule would have no cost impact on the 200 distributors selling only nonchromate chemicals because they would not be affected by the labeling, recordkeeping, and reporting requirements. The estimated annual cost for the water treatment chemical industry over the first 3 years of the rule is about $87,000.

Producers of sodium dichromate and manufacturers of Cr^{+6} chemicals other than water treatment chemicals are also affected by the export notification requirements. It is assumed that 2 producers of sodium dichromate each export to 20 countries and that 20 chemical manufacturers of Cr^{+6} chemicals each export to 1 country. For the producers, the estimated cost averaged over the first 3 years of the rule is about $1,000 per company per year. The cost impact for the chemical manufacturers averaged over the first 3 years of the rule is $50 per company per year.

2.6 SELECTION OF THE SOURCE CATEGORY

2.6.1 Comment

Eight commenters (IV-D-15, -17, -18, -19, -21, -22, -23, and -26) believe that EPA should regulate Cr^{+6} chemicals in CCT's, and five of the commenters (IV-D-15, -18, -21, -23, and -26) support the proposed rule

because they believe that Cr^{+6} is a health hazard that should be removed from the environment. One commenter (IV-D-15) believes that Cr^{+6} also should be banned from use in boilers and closed hot and chilled water cooling systems. This commenter also supports the proposed rule because chromate is detrimental to pump seals and valve packings, stains floors and ceilings, and is nonbiodegradable. Another commenter (IV-D-17) supports the proposed rule because users will not change to nonchromates unless forced to do so.

Response. The proposed rule was based on EPA's determination that the use of Cr^{+6}-based water treatment chemicals in CCT's presents an unreasonable risk to human health and that TSCA is the most effective means to control this risk. The final rule will effectively eliminate the use of Cr^{+6}-based water treatment chemicals in CCT's. The recordkeeping and reporting provisions, by identifying both users and distributors of Cr^{+6}-based water treatment chemicals, will allow EPA to identify potential violations by CCT operators and water treatment chemical distributors. The labeling requirements will ensure that distributors and users are aware of the hazard associated with Cr^{+6}-based water treatment chemicals and informed of the restrictions on their use.

However, EPA disagrees with the commenter that Cr^{+6}-based water treatment chemicals should be banned from boilers and other closed systems under this rule. The EPA has determined that the primary exposure pathway of concern is by inhalation of air emissions. Because airborne Cr^{+6} emissions are not expected from boilers, closed cooling water systems, and closed chilled water loops, EPA has no current plans to prohibit use of Cr^{+6} in these systems.

To clarify that the prohibitions on distribution and use do not include closed systems (or ICT's), several changes have been made to the rule. First, the following statement has been added to § 749.68(e) of the rule:

> Distribution in commerce of hexavalent chromium-based water treatment chemicals for use in, and commercial use of hexavalent chromium-based water treatment chemicals in, industrial cooling towers and in closed cooling water systems are not prohibited.

Second, several changes have been made to the definitions in § 749.68(d) of the rule. A new term, "cooling system," has been defined as any cooling tower or closed cooling water system. "Closed cooling water system" also is a new term that has been defined as any configuration of equipment in which heat is transferred by circulating water that is contained within the equipment and not discharged to the air. One type of closed cooling water system is a chilled water loop that transfers heat from air handling units or refrigeration equipment to a refrigeration machine or chiller. Finally, the definition of the existing term "water treatment chemicals" has been revised slightly to indicate that it applies to chemicals used to treat water in cooling systems, not cooling towers. The definition of the term "cooling tower" has not changed. These changes make it clear that the prohibitions against distribution and use of Cr^{+6}-based water treatment chemicals apply only to open water recirculation CCT's.

2.6.2 Comment

Two commenters (IV-D-13 and IV-D-26) urged EPA to complete the analysis of ICT's promptly because they believe that the risk of exposure to Cr^{+6} emissions also exists with those towers.

Response. As discussed in the preamble to the proposed rule, the differences between CCT's and ICT's are significant enough to warrant separate regulatory analysis. Industrial process cooling towers are different from CCT's in size, heat exchanger surface and bulk water temperature, and heat exchanger construction materials. The higher temperatures in industrial processes promote a higher corrosion rate in ICT heat exchangers than is experienced in CCT condensers. Also, the common heat exchanger construction material used in ICT systems, carbon steel, is less resistant to corrosion than the copper used in most CCT systems. The EPA is continuing to investigate ICT emissions and control options in a separate study. A determination of the regulatory requirements for ICT's will be made as expeditiously as possible.

2.6.3 Comment

One commenter (IV-D-24) indicated that CCT's should not be construed to be similar or equivalent to ICT's such as those widely used throughout major wet process industries.

Response. As noted in the response to Comment 2.6.2, EPA is aware of the differences between ICT's and CCT's. These differences are discussed in the preamble to the proposed rule for Cr^{+6}-based water treatment chemicals used in CCT's. A separate study is underway for ICT's.

2.7 MONITORING AND CONTROL

2.7.1 Comment

Two commenters (IV-D-12 and IV-D-24) indicated that Cr^{+6} is often used as a tracer in nonchromate treatments because it is easier to monitor, gives more accurate results than analyses for many nonchromates (e.g., phosphonates), and is cost effective. Consequently, one commenter (IV-D-24) requested that Cr^{+6} at least be allowed as a tracer for use with nonchromate water treatment programs. The other commenter (IV-D-12) would like to find an easier test for phosphonate or another legal tracer.

Response. The EPA believes that there is not a justifiable need to allow the use of Cr^{+6} as a tracer because acceptable alternatives exist, such as molybdate and orthophosphate. Tracers are often included in water treatment programs to aid in monitoring the level of corrosion inhibitor in the water. Periodic analysis of the concentration of phosphonate or other organic chemicals used in organic-based treatment programs is necessary to ensure that adequate levels are maintained to inhibit corrosion. Because these analyses are difficult and time-consuming, a tracer such as molybdenum for which analysis is more simplified is sometimes used. The ratio of the tracer to the corrosion inhibitor (e.g., phosphonate) is known, and fluctuations in concentration of the tracer would indicate corresponding fluctuations in concentration of the corrosion inhibitor.

Two water treatment chemical distributors have indicated that molybdate can be used as a tracer in concentrations above about 2 ppm and can be measured reliably by a simple colorimetric test.[30,31] Another distributor indicated that molybdenum concentrations as low as 1 ppm are reliably measured by a colorimeter.[32] One test kit manufacturer also has developed a new method with which concentrations even less than 1 ppm can be measured with a colorimeter. Several water treatment distributors indicated that molybdenum concentrations lower than 1 ppm could be used as a tracer, but more difficult and costly spectrophotometric analysis may be

required.[31,33,34] The distributor could perform these analyses at least monthly, if necessary, because the CCT owners/operators would not likely have the required equipment. According to one distributor, substituting molybdenum at 2 ppm as a tracer would add about 20 percent to the cost of the treatment program.[32] Another distributor estimated that using molybdenum at 1 ppm would increase the cost of the treatment program by 5 to 10 percent.[31]

Another tracer that can be used instead of Cr^{+6} or molybdate is orthophosphate. Low levels (2 to 12 ppm) are added to the system, and samples are analyzed colorimetrically for total phosphate. Any phosphate that is contained in the raw water is accounted for in the analysis. A low-level orthophosphate test kit costs about the same as chromate test kits.[35]

The EPA agrees with the commenters that the phosphonate tests are more difficult to perform and subject to more error than the tests for tracers. However, conscientious operators can get acceptable results. Furthermore, these results can be periodically confirmed by digesting a sample and testing for phosphate. Sales representatives from some water treatment distributors perform these tests on a monthly or quarterly basis. Many of the major distributors are conducting research in this area, and at least one test kit manufacturer recently developed a less time-consuming digestion kit that it believes will be easier for the CCT operators to use. In addition, a water treatment chemical distributor has developed what it believes is a simpler and more reliable test for phosphonate.[7] These developments will make it easier for CCT operators to use nonchromate treatment programs without tracers.

For the reasons discussed above, the final rule prohibits all uses of Cr^{+6} at any concentration as a tracer in nonchromate water treatment programs. The EPA believes that acceptable alternative tracers are available and that accurate tests are available (and others are under development) at a reasonable cost for tracers and for phosphonate.

2.8 LEGAL CONSIDERATIONS

2.8.1 Comment

One commenter (IV-D-9) that advises clients on warning requirements such as labels and material safety data sheets is concerned that conflicting conclusions on the carcinogenicity of Cr^{+6} and sodium dichromate among regulatory agencies could cause personal injury liability risks to increase. The commenter indicates that, in contrast to EPA's position, the 1985 NIOSH Pocket Guide to Chemical Hazards states that Cr^{+6} from sodium dichromate is noncarcinogenic. Furthermore, in a Toxicological Profile, ATSDR concluded from the Steinhoff study that sodium dichromate is only a weak carcinogen.

Response. The commenter's concerns regarding the conflicting conclusions on the carcinogenicity of Cr^{+6} among regulatory agencies are addressed in the response to Comment 2.2.2 in the Health Effects/Risk section of this document. Based on evidence published since 1975, NIOSH recommended to OSHA in 1988 that OSHA should consider all Cr^{+6} compounds as occupational hazards. The EPA has commented on the ATSDR document, which is still in draft form, and recommended that ATSDR consider changing its conclusions. The additional information provided in the response to Comment 2.2.2 and in the response to Comment 2.2.1 regarding EPA's conclusion on the carcinogenicity of Cr^{+6}, should be helpful to the commenter in developing appropriate advice for clients.

2.8.2 Comment

One commenter (IV-F-1 [Sefton]) believes that EPA's contention that building owners would not risk liability by failing to add sufficient biocide is not realistic. The commenter also believes it is likely that sufficient biocides will not be added in many cases because operators that can disregard biocides with chromate treatments may find it hard to break old habits.

Response. The EPA did not contend that building owners would not risk liability by failing to add sufficient biocide. In fact, EPA believes that failure to add recommended amounts of biocides could result in health problems and, possibly, in liability claims. Failure to add biocides also can lead to excessive growth of algae and other micro-organisms on the internal tower and heat exchanger surfaces. Such growth

can result in decreased cooling efficiency and increased corrosion, both of which cannot be tolerated in most CCT systems. Consequently, EPA believes, contrary to the commenter's opinion, that building owners will be conscientious in adding sufficient biocide in their water treatment programs.

2.9 MISCELLANEOUS

2.9.1 Comment

One commenter (IV-D-13) believes that most middle-size to large-size water treatment chemical distributors supply only small amounts of Cr^{+6}-based water treatment chemicals and that less than 5 percent of CCT's under "professional" treatment currently use chromates. The commenter believes that small water treatment chemical distributors and "do-it-yourselfers" use chromate because of its low cost, convenience, and ease of testing and control. Another commenter (IV-D-17) estimates that 25 percent of the CCT's in the commenter's area (Bartlett, Illinois) use chromates.

Response. Based on discussions with several water treatment chemical distributors, EPA believes that from 10 to 25 percent of the CCT's in the U.S. are using Cr^{+6}-based water treatment programs, although their use may be significantly different in some regions of the country.[1] The commenter's estimate appears to be lower than this range, but adding the large number of small water treatment companies may bring the commenter's estimate up to 10 percent.

2.9.2 Comment

One commenter (IV-F-1 [Sefton]) believes that corrosion-related failures of the tube sheets will increase, which will cause, among other things, the release of several hundred pounds of ozone-depleting Freon into the atmosphere per occurrence.

Response. Typically, tube sheets are constructed of carbon steel. Therefore, the commenter's conclusion is predicated on the assumption that nonchromate treatment programs cannot control corrosion in carbon steel. However, as discussed in responses to Comments 2.1.6 and 2.1.7, nonchromate treatment programs have achieved acceptable results even under poor quality water conditions. To achieve acceptable results requires proper monitoring, control, and maintenance of the treatment program and

the CCT system. As an added precaution, the CCT operator could epoxy coat the tube sheets. The CCT operators will rapidly identify and implement successful programs and, considering the cost of neglect, they also will implement proper monitoring, control, and maintenance procedures. Consequently, EPA does not believe tube sheet failures or Freon emissions will increase.

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APPENDIX A.
CALCULATION OF NATIONWIDE COST EFFECTIVENESS

In Section 2.5, the cost effectiveness is calculated by a conventional approach using a single discount, or interest, rate. Another discount approach currently being considered by EPA is a two-stage procedure that takes into consideration both the opportunity cost of the displaced resources and the consumer rate of time preference. The opportunity cost assumes the capital costs incurred by companies from government action would displace other private investments. The consumer rate of time preference assumes government action will increase operating costs of companies that will be passed through to consumers in the form of higher prices and, as a result, consumption of goods and services would be reduced. Using the two-stage approach, the estimated capital costs are annualized using the marginal rate of return on capital (interest rate). Total costs over the life of the capital equipment then are discounted to present value using a social rate of time preference (consumption rate of interest). Benefits may be estimated with the same discounting procedure. Calculations of the nationwide cost effectiveness based on the conventional discounting approach and the two-stage discounting approach are presented below. Additional information about the chemical costs, capital costs, and annual incidence per CCT are presented in Section 2.5 and in docket items IV-B-1, IV-B-2, IV-B-3, and IV-B-4.

A.1 CONVENTIONAL APPROACH WITH 10 PERCENT INTEREST RATE

Annual chemical cost difference between chromate and nonchromate programs = \$9,773,000

Annualized capital cost per CCT

$$= \frac{\$1,400 \times 0.1 \times 1.1^{10}}{1.1^{10}-1} + \frac{\$100 \times 0.1 \times 1.1^{3}}{1.1^{3} \times (1.1^{3}-1)}$$

$$+ \frac{\$150 \times 0.25 \times 0.1 \times 1.1^{2}}{1.1^{2} \times (1.1^{2}-1)}$$

$$= \$228 + \$30 + \$18$$

$$= \$276/\text{CCT}$$

Annualized nationwide capital cost = \$276/CCT x 37,580 CCT's
= \$10,372,000

Total annual cost = \$9,773,000 + \$10,372,000
= \$20,145,000

Annual benefit = 20 cases

Cost effectiveness $= \frac{\$20,145,000}{20 \text{ cases}} = \$1,000,000/\text{case}$

A.2 TWO-STAGE APPROACH WITH 7 PERCENT INTEREST RATE AND 3 PERCENT DISCOUNT RATE FOR BOTH TOTAL COSTS AND BENEFITS

Annual chemical cost difference between chromate and nonchromate programs = \$9,773,000

Annualized capital cost per CCT

$$= \frac{\$1,400 \times 0.07 \times 1.07^{10}}{1.07^{10}-1} + \frac{\$100 \times 0.07 \times 1.07^{3}}{1.07^{3} \times (1.07^{3}-1)}$$

$$+ \frac{\$150 \times 0.25 \times 0.07 \times 1.07^{2}}{1.07^{2} \times (1.07^{2}-1)}$$

$$= \$199 + \$31 + \$18$$

$$= \$248/\text{CCT}$$

Annualized nationwide capital cost = \$248/CCT x 37,580 CCT's
= \$9,320,000

Total annual cost = \$9,773,000 + \$9,320,000
= \$19,093,000

Discounted present value of total annual cost $= \frac{\$19,093,000 \times (1.03^{10}-1)}{0.03 \times 1.03^{10}}$

= \$162,867,000

Discounted present value of benefits $= \frac{20 \text{ cases} \times (1.03^{10}-1)}{0.03 \times 1.03^{10}}$

= 171 cases

Cost effectiveness $= \frac{\$162,867,000}{171 \text{ cases}} = \$952,000/\text{case}$

A.3 TWO-STAGE APPROACH WITH 7 PERCENT INTEREST RATE, 3 PERCENT DISCOUNT RATE FOR TOTAL COST, AND NO DISCOUNT FOR BENEFITS

The Office of Pesticides and Toxic Substances has suggested that a separate analysis be evaluated using discounted cost and undiscounted benefits.

Discounted present value of total annual cost = \$162,867,000

Undiscounted present value of benefits = 20 cases/yr x 10 years
= 200 cases

Cost effectiveness $= \frac{\$162,867,000}{200 \text{ cases}} = \$814,000/\text{case}$

APPENDIX B.
APPROACH TO DATA GATHERING EFFORT

To respond to comments about water treatment program performance and costs, EPA conducted a comprehensive data gathering effort. An attempt was made to obtain information from several water treatment chemical distributors, cooling tower users and equipment manufacturers for use in responding to industry comments on the proposed rule. However, often times little or no information was offered or supplied from the various contacts made. Presented below is a summary of the contacts who provided information used in responses to the public comments. The information obtained was sufficient to provide an adequate assessment and responses to industry comments. Most of the major water treatment chemical distributors, two small water treatment chemical distributors, an automatic control equipment manufacturer, a company that cleans corroded CCT systems, and a customer of the cleaning company provided some information. All of the companies were contacted by telephone, and followup letters were sent to some of the water treatment chemical distributors.

The water treatment distributors were asked for (1) typical costs of nonchromate and chromate programs, (2) case histories of nonchromate treatment program performance and cost in poor quality water applications, (3) types and costs of automatic control equipment needed for successful operation of nonchromate treatment programs, and (4) prevalence of heavily corroded systems on chromate programs and how these systems are cleaned and/or switched to nonchromate treatment programs. Based on information in the proposal BID, the distributors that were contacted represent over 75 percent of the water treatment industry.

The automatic control equipment manufacturer was asked to provide costs for typical types of equipment described by the water treatment chemical distributors. Several of the water treatment chemical distributors indicated that they used this manufacturers equipment. A company that cleans corroded CCT systems was contacted for the cost of cleaning, types of cleaning solutions, and the length of time required to clean corroded systems. To confirm that heavily corroded systems can be cleaned adequately, a customer of the cleaning company was also contacted.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-450/3-87-010b	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Chromium Emissions From Comfort Cooling Towers--Background Information for Promulgated Standards		5. REPORT DATE January 1989
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, N.C. 27711		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-02-3817
12. SPONSORING AGENCY NAME AND ADDRESS Director of Air Quality Planning and Standards, Office of Air and Radiation, U. S. Environmental Protection Agency, Research Triangle Park, N.C. 27711		13. TYPE OF REPORT AND PERIOD COVERED Final
		14. SPONSORING AGENCY CODE EPA/200/04
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

A final rule for the control of hexavalent chromium emissions from comfort cooling towers is being promulgated under authority of Section 6 of the Toxic Substances Control Act. The final rule prohibits both the use of Cr^{+6} in CCT's and the distribution in commerce of Cr^{+6} for use in CCT's. The rule would apply to existing and new CCT's. This document contains a summary of changes to the rule made since proposal, a summary of the impacts of the promulgated rule, and a summary of the public comments on the proposed rule and EPA's responses.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air pollution Pollution control Comfort cooling towers Hexavalent chromium Water treatment chemicals	Air pollution control	

18. DISTRIBUTION STATEMENT Unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 87
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE