Many of the current research programs do not meet these criteria. For example, biomedical research on the carcinogenity of synthetic fuels mixtures is primarily sponsored by the DOE and conducted through its national laboratories, which are viewed by some groups as proponents of synthetic fuel development.

5.0 WHAT ARE THE ENVIRONMENTAL RISKS OF AN ACCELERATED SYNFUELS COMMERCIALIZATION PROGRAM?

Although the technology for producing liquid fuels from coal was first demonstrated by Germany during the 1920's, coal liquefaction is still in an early state of development in this country; no commercial-scale plants exist or are under construction in the Us. A "crash" or "accelerated" commercialization program to reduce dependence on foreign oil will involve substantial technical, economic, and environmental risks.

Indirect coal liquefaction is closer to commercialization than direct processes. However, rapid deployment of indirect processes will require the use of currently commercial gasifiers such as Lurgi and Koppers-Totzek. More advanced technologies such as the Texaco coal gasifier and the pressurized Shell-Koppers and Winkler gasifiers are not yet in advanced pilot plant stages and need to go through the commercial module demonstration stage before commercialization.

Figure 5-1 illustrates the time required for the development of a commercial plant for two direct processes, EDS and H-Coal, under a "normal" development schedule as projected by the licensing firm (developers). Development is estimated to take 17 years for the

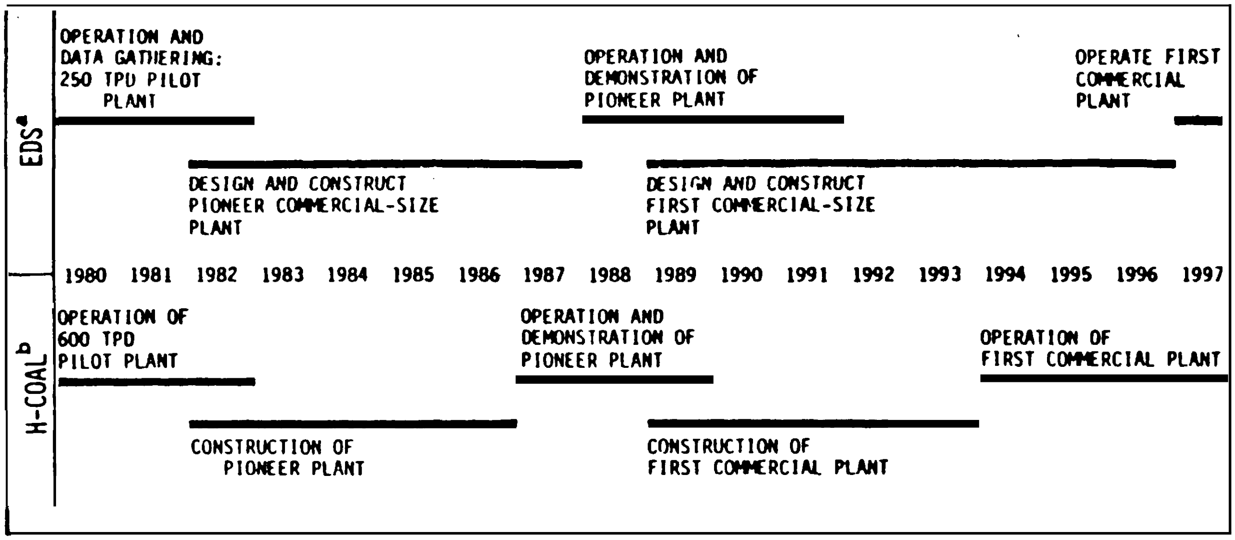

Figure 5-1: Time schedule for two direct coal liquefaction processes.

a Green 1980.

b Based on two years operation before construction of next unit, design and construction five-year time estimate from Rogers and Hill 1979.

Exxon Donor Solvent (EDS) process and *14* years for the H-Coal process. The EDS estimate includes 7 years for design and construction following operation of both a 250 tpd pilot plant and a pioneer commercial size unit. In contrast, it is estimated that the H-Coal process will require only a 5-year construction period; all design presumably takes place while gathering data from operating units. These estimates have assumed that the permitting process goes on concurrently with design. Because designing requires several years, it is the primary determinant in project schedules. However, if permitting is not concurrent, then an increase equivalent to permitting time for each step would be added to the timetables.

If coal synfuels are commercialized rapidly, it would require: (1) deploying indirect processes now utilizing Lurgi or Kopper-Totzek gasification and/or (2) by-passing some of the scale-up steps in the development of the newer gasification or direct process technologies. Both approaches, and especially the latter, may be unwise for technical and economic reasons. In addition, accelerated commercialization programs will contribute to increased environmental risks for four reasons:

- Technical risks from by-passing development steps;
- Difficulty in monitoring and detecting impacts;
- Regulatory lags; and
- Added impacts from rapid construction.

Each of these factors is briefly discussed below.

5.1 RISKS DUE TO TECHNICAL UNCERTAINTIES

The technical uncertainties in commercial plant performance have typically resulted in requirements for a bench-scale, pilot plant, pioneer plant, and commercial-scale plant development sequence. In the case of direct processes (see Section 2), this scale-up sequence is required primarily because of the inability to predict the flow of coal solids, semisolids, and entrained solids in a liquefaction plant. Thus, they must be tested for phases in a scale-up to commercial size. Any increase in the frequency of upsets or accidents (see Section 2.2) due to accelerated development programs could cause a major increase in air emissions and occupational health and safety risks. In the case of air emissions, neither the controlled combuster nor the vent/flare systems are designed with sulfur or particulate removal systems; therefore, upsets from plugging, reactor malfunctioning, and other events can lead to major increases in emissions of some pollutants. These technical problems can also increase risks of leaks, explosions, and other plant accidents. Further, if units are improperly designed, risks in a complex plant are not simply additive. For example, a poorly designed section that plugs can result in other sections of a facility being shut down. These shut-downs result in temperature changes that can cause stress in valves and fittings, further contributing to leaks or other failures.

Water quality impacts are also of concern with accelerated development because wastewater treatment designs are just emerging. Materials balances and performance data based on preliminary designs are not available. The wastewater treatment systems have not been tested against actual plant conditions, since existing small pilot plants now send waste streams to adjacent refineries. Performance data from wastewater treatment systems being designed for pioneer plants need to be evaluated prior to full-scale commercialization. Because of this uncertainty and the Potential for failure in the wastewater treatment system, for example due to poisoning of biotreaters, the water quality risks would be increased under an accelerated schedule.

Generally, strong economic incentives exist for adequate design and testing in order to achieve a high level of plant operation capacity. Thus, developers are typically wary of a rapid development schedule for economic reasons. However, as discussed in Section 4.2, the environmental costs can sometimes be much larger than the economic costs if a plant does not perform properly. For example, fugitive emissions of toxic hydrocarbons may represent a substantial health risk, but they may only represent a small economic cost in terms of lost product. For this reason, accelerated development programs should include rigorous environmental monitoring programs.

5.2 DIFFICULTIES IN MONITORING

As discussed in Section 4.1, several of the potential environmental impacts associated with coal synfuels will be difficult to monitor and detect. This problem will exist even under a “normal” development pace (such as that illustrated in Figure 5-l), and it will be exacerbated by rapid commercialization programs. Rapid commercialization would limit data development and interpretation from monitoring programs. For example, the latency of skin cancer can be 5 to 10 or more years after exposure, with other cancers having an even longer latency. Rapid commercialization programs would increase the risks that environmental hazards would be overlooked during the first years of pilot or pioneer plant operation.

A “normal” development schedule, such as described in Section 5.0, can resolve a range of existing health uncertainties as summarized in Table 5-1. Pilot plant operation provides time for screening the range of products for bacterial mutagenicity, laboratory carcinogenicity tests, and toxicology studies. The

TABLE 5-1: HEALTH RISKS POTENTIALLY RESOLVED DURING A NORMAL DEVELOPMENT SCHEDULE

Plant Stage	Time Duration (years)	Uncertainties Potentially Resolved: Emissions/ Effluents/Products	Uncertainties Potentially Resolved: Health Risk
Pilot plant operation	**1-4**	**Product composition**	Bacterial mutagenicity Short-term laboratory carcinogenicity
Constructing pioneer plant	3-8	None	None
Demonstration of pioneer plant	8-14	**Composition of discharge streams (preliminary)**	**Initial worker accident risk** assessed **potential public exposure determined**
Construction of first commercial plant	12-15	None	None
Commercial plant operation	15-30	**Composition of discharge streams**	Levels of public ex**posure confirmed (commercial)**
		Quantity of discharges	**Longer term worker and and accident risks informed**
Long term operation and retirement	30-55	Quantity of discharges; leaks; hazards assessment	**Worker accident risk confirmed** **Actual public health risk informed**
Decommissioning	55-	None	Public and occupational health risk more conclusively informed

demonstration (pioneer) plant phase provides for an evaluation of the composition of discharge streams, for determination of potential public exposure to chemicals, and an initial evaluation of occupational accident and exposure risks. A normal development sequence can provide for some determination of all but the long term risks, such as those due to cancer, prior to the operation of a commercial plant.

Although a range of short-term screening tests can be used to evaluate the hazards of intermediate process streams, discharges, and products, some hazard will remain that can only be evaluated with detailed occupational and public health studies. As indicated above, these studies are likely to identify risk (for some skin cancers) within as few as about 5 years. As indicated in the examples in Table 5-2 some cancers show up sooner than five years, such as those induced by chemical therapy or ionizing radiation. However, cancers initiated by occupational exposures to various chemicals, such as detection of elevated rates of lung and kidney cancer from exposure to chemicals in coal tar, typically require 10 to 20 or more years to be detected. Because the latency period of cancer is dependent on the organ, dose, and susceptibility of the population, no clear pattern emerges to dictate how effective a monitoring program can be over the short term. Apparently many of the risks can be determined within 5 to 10 years of the operation of a pioneer plant, but the degree of risk for many soft tissue cancers can only be determined after up to 30 or more years of commercial plant operation.

TABLE 5-2: TYPICAL LATENCY PERIODS IN CANCER DETECTION

Latency Period (years)	Cause	Cancer (site)
(o. 2 to 0.3)	Chemical therapy	Lymphoma (lymph glands)
2 to 15	Ionizing radiation	Leukemia (blood)
5 to 10	PNAS	Skin cancer
lo-	Mustard gas	Lung cancer
10 to 15	Vinyl chloride	Liver cancer
10 to 30	Smoking	Lung cancer
10 to 30	Ionizing radiation	Breast cancer
20 to 40	Coal tar	Lung and kidney cancer
35 to 50	Asbestos	Mesothelioma (chest or stomach lining)
up to 60	Burns	Skin cancer

Source: Compiled from National Cancer Institute 1981; Braunstein, Copenhaver and Pfuderer 1978; NIOSH 1977.

5.3 REGULATORY LAG

A closely related problem is regulatory lags that would occur during an accelerated development schedule. As indicated in Section 2.0, emission and discharge standards do not exist for coal liquefaction plants. EPA and DOE are developing "Pollution Control Guidance Documents" (PCGD's) which will serve as guidelines for evaluating plant designs in the near future. Final standards will be an on-going process as more is learned from each new pilot or pioneer commercial plant. If a synfuels commercialization program is accelerated by building the next generation of plants before fully evaluating the previous one, or by simply by-passing steps in the normal scale of sequence, then some types of environmental regulations (such as emission standards) would always lag behind ongoing design and construction. Experience with the nuclear power industry has shown the problems of attempting to redesign components of a very complex system in response to environmental/safety concerns while the project is under construction. Accelerated development increases environmental risks because each generation of plants would not be guided by environmental regulations informed by the prior generation, and any modifications or retrofits needed to correct past deficiencies would often be very expensive.

5.4 IMPACTS FROM RAPID CONSTRUCTION

Accelerated development of synfuels could also aggravate the socioeconomic and environmental problems associated with "boom and bust" population cycles in small communities. These problems include:

- Inadequate municipal services (water supply, police and fire protection, etc.);
- Insufficient housing;
- Water quality and ecological effects (e.g., inadequate sewage treatment capacity); and
- Inadequate streets, roads, and highways.

Although these growth management problems will exist for any large construction project in rural areas, they will be increased by an accelerated synfuels program because of the number of plants required, the lack of means to coordinate plant schedules, and the probability that many facilities will be located in clusters in single or multicounty regions in the eastern U.S. (for example, see Enoch 1980). As an example, Figure 5-2 shows the number of workers included in synfuel plant construction in a 30-mile radius of Owensboro, Kentucky, if plans developed in 1980 should be implemented.

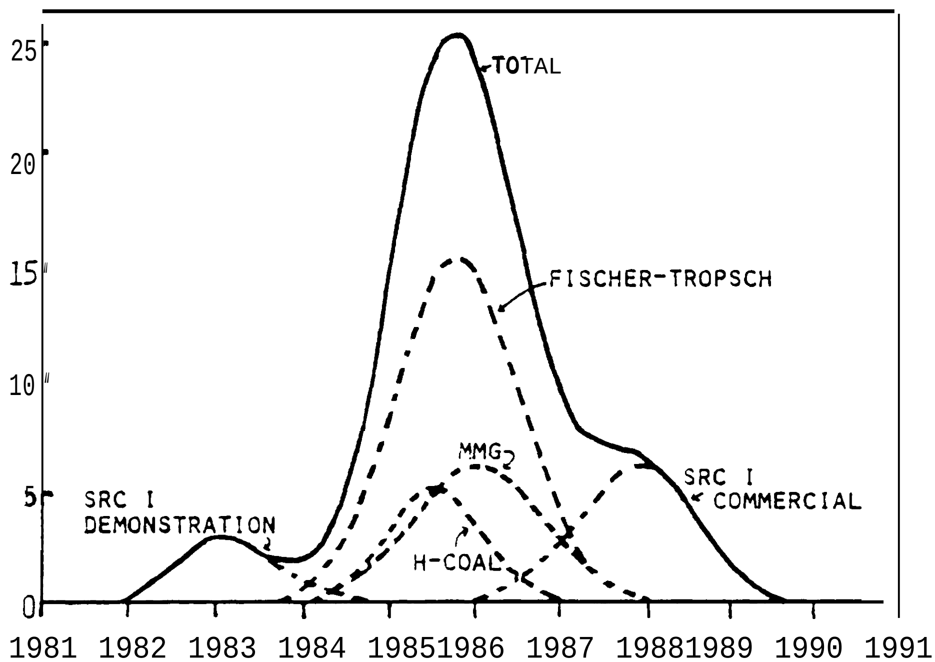

Figure 5-2: Synfuel plant construction labor requirement near Owensboro, Kentucky.

Source: Enoch 1980.

Scheduling can **play** a major role in determining the magnitude of population impacts experienced by a community. Construction of a coal synfuel plant can require a peak workforce of approximately 5,000; this can result in population increases of 15,000, including family members and secondary population growth. Figure 5-3(A) illustrates a typical workforce schedule for a coal gasification plant. Simultaneous construction of two or more plants in an area under an accelerated synfuels commercialization program will proportionately increase population and probably exponentially increase impacts. On the other hand, construction of multiple plants can be phased so that population impacts are lessened, as illustrated in Figure 5-3(B).

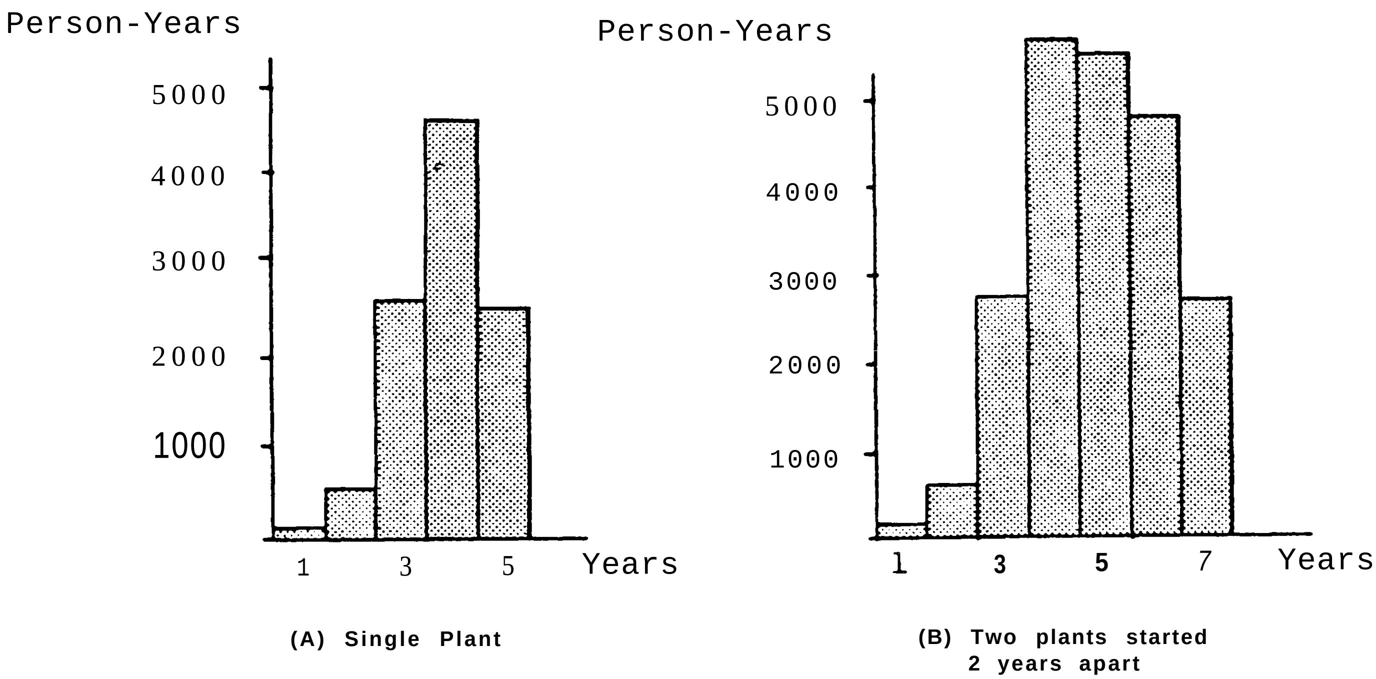

Figure 5-3: Workforce schedules for coal gasification projects. Source: White et al. 1979.