
Draft

**LINDE UTILITY TUNNEL-RELATED
TBD ISSUES**

Contract No. 200-2009-28555

Prepared by

Stephen L. Ostrow, PhD

S. Cohen & Associates
1608 Spring Hill Road, Suite 400
Vienna, VA 22182

Saliant, Inc.
5579 Catholic Church Road
Jefferson, Maryland 21755

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Project Manager: _____ John Stiver, CHP	Technical Contributor: Nicole Briggs
	Reviewer: John Mauro, PhD, CHP

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ABBREVIATIONS AND ACRONYMS

ABRWH	Advisory Board on Radiation and Worker Health
AEC	Atomic Energy Commission
FUSRAP	Formerly Utilized Sites Remedial Action Program
LAPC	Linde Air Products Company
NIOSH	National Institute for Occupational Safety and Health
SC&A	S. Cohen & Associates
SEC	Special Exposure Cohort
SRDB	Site Research Database
TBD	Technical Basis Document
USACE	U.S. Army Corps of Engineers
wd	work day
WG	Work Group

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1.0 INTRODUCTION

The Advisory Board on Radiation and Worker Health (ABRWH) Linde Work Group (WG) held a meeting in Cincinnati, Ohio, on January 30, 2012, to consider technical basis document (TBD)-related issues identified in the course of considering Linde Special Exposure Cohort (SEC) Petitions 00107 and 00154. The first issue is to determine when different segments of the tunnels were built (“timeline”), and the second issue was to determine appropriate tunnel occupancy factors. The WG requested that SC&A conduct its own investigations into these issues and report back to the WG for further consideration. In the course of its investigations, SC&A examined documents, plot plans, and worker statements, and consulted with the National Institute for Occupational Safety and Health (NIOSH) for certain clarifications.

2.0 UTILITY TUNNEL TIMELINE

The utility tunnel complex consists of different segments constructed at different times, with sections still existing at the site. A continuing issue, which was identified during deliberations concerning SEC Petitions 00107 and 00154, concerns the segment construction timeline. This issue was explored by SC&A as one of the action items arising from the August 15, 2011, Linde WG meeting in Cincinnati; SC&A’s conclusions are documented in its report of October 11, 2011 (SC&A 2011a), followed by a memo on October 17, 2011 (SC&A 2011b), which factored into the assessment affidavits from two former Linde workers received by SC&A subsequent to issuing SC&A 2011a. At its January 30, 2012, meeting, the Linde WG requested that SC&A re-examine the timeline.

NIOSH articulates its position on the tunnel timeline in the Linde TBD (NIOSH 2011). Section 2.3.5 describes the utility tunnel complex:

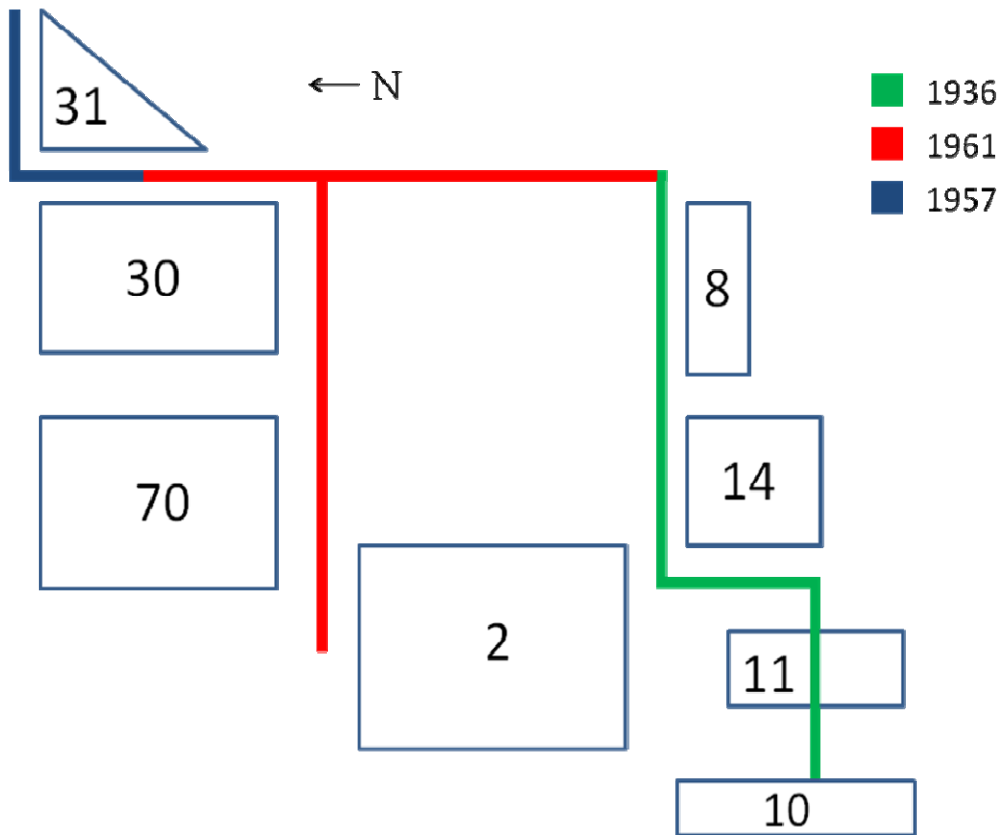
The Linde site had a system of utility tunnels, constructed at different times, to carry steam, electricity, water, telephone lines, and other utilities from one part of the plant to another (LAPC ca. 1937 [1936], 1957, 1961; Coutts 2005).

Documentary evidence shows that the first tunnel section was built in 1937 and ran from the powerhouse (Building 8) past the Tonawanda Laboratory (Building 14, also called the Proving Laboratory) to Building 10... Another section of tunnel was constructed in 1957 near Buildings 57, 58, and 31 in the northeastern area of the Ceramics Plant, and an extensive addition to the tunnel system was done in 1961 when the 1937 and 1957 tunnels were linked by new tunnels that ran between Buildings 30 and 31 and then branched south to Building 8 and west past Buildings 70, 2, and 2A. The 1957 and 1961 tunnel sections ran through areas of soil that were contaminated by radium-bearing ore and were subject to radon infiltration from this source.

Following the Linde WG’s directions, SC&A personnel met on February 2, 2012, to perform a detailed review of full-sized plot plans (LAPC 1936, 1957, and 1961) and other documents; SC&A confirmed with NIOSH prior to the meeting that these were the same (and only set) of drawings that NIOSH had as well. SC&A had previously examined these drawings and included reduced-sized versions in its October 11, 2011, report (SC&A 2011a). As discussed in that

SC&A report, and included therein as a figure, one of the former workers interviewed by SC&A at the May 2010 Niagara Falls ABRWH meeting had supplied a schematic plot plan of the site that he had annotated with the locations of all the utility tunnels. Using the three large plot plans and the annotated schematic, SC&A put together its own schematic drawing of the Linde facility (Figure 1), with the tunnels labeled according to what SC&A believes are their dates of construction. This drawing represents a simplification and consolidation of the tunnel construction assumptions used by NIOSH and presented by SC&A in its October 2011 report (SC&A 2011a).

Figure 1. Utility tunnel schematic and dates of construction



SC&A also considered worker statements, taken by NIOSH during interviews, regarding the tunnels, which provided valuable but somewhat inconsistent information; these statements were considered previously (SC&A 2011a), but are re-examined here. **[Worker 6]**, who was the **[redacted]** at Linde, stated that the east-west tunnel that went from the Powerhouse (Building 8) to Buildings 1, 2, and 10 was built before 1953 (Murray 2010b). This description matches what appears in the 1936 plot plan (LAPC 1936) and the green portion of Figure 1 in this report. The worker statement continues to describe the north-south tunnel, which was built after 1956, that traversed the whole length of the facility to Buildings 30 and 31, and also had a branch that ran west to Building 70. This description matches the 1957 and 1961 drawings (LAPC 1957 and 1961) and the blue and red portions of Figure 1.

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However, one statement made by another worker, [Worker 1] (Murray 2010c), where he is paraphrased as saying “the tunnels were in place before he started working there in 1953,” appears to contradict this information. It is not clear, however, if [Worker 1] is referring to all of the tunnels or simply a portion. A subsequent affidavit by [Worker 1], quoted by SC&A in SC&A 2011b, states:

In all of that time frame the Utility Tunnels from Building #10 to Junction box located north of the road way between Building #39 & Building #58 where an exit and entrance ladder existed and was in existence to the best of my knowledge and experience. In fact the tunnel had to be there in order for utilities such as Electricity, Steam, condensate, water, air pressure, telephone lines to supply these utilities to the Ceramics Plant Buildings 30, 31, 37, 38, & 39.

It is noted that the worker uses the phrase “the tunnel had to be there,” rather than a formulation like “I personally saw it there.” Hence, his assertion appears to be a supposition, not a personal observation. In fact, as will be discussed later, an alternative theory to a tunnel supplying utilities is supplied by the presence of an aboveground trestle carrying utilities.

SC&A reviewed each of the full-size drawings closely, paying particular attention to their fine details and notes. The oldest drawing, from 1936, clearly shows that some utility tunnels were in place in the southwest corner of the facility near Building 14 (Tonawanda Laboratory) and Buildings 2, 8, 10, and 11, well before the AEC operational period at Linde.

SC&A then examined the 1957 drawing, which shows only the southeast corner of the facility. This plan presents all of the details of the tunnel section around Buildings 30 and 31. It was not readily apparent if this map represents a drawing of the tunnel section that was already in place in 1957, or if it represents construction plans for a tunnel section that was going to be built and, therefore, did not yet exist as of the date of the drawing (March 20, 1957). There are, however, some notations on the drawing that indicate that it is most likely a construction plan. Appearing throughout the drawing, there are notes describing “existing storm sewer,” “existing water lines,” and “existing sanitary sewers,” as well as descriptions and locations of “new” sanitary sewer lines, water pipes, etc. On this drawing, any pipes, lines, or small buildings (such as the “smoking shed”) that cross the location of the tunnel schematic are labeled as “to be removed,” which further indicates that, as of 1957, this tunnel had not yet been constructed. The 1957 drawing confirms the existence of trestles (notes “existing trestles” to the west of Building 31), which SC&A assumes were used to supply utilities to the buildings at this part of the facility prior to the construction of the tunnels.

SC&A then examined the third drawing, dated February 1, 1961, which shows the majority of the Linde facility and the entire tunnel complex. This drawing clearly labels portions of the tunnel that already existed, such as the L-shaped tunnel around Buildings 30 and 31, and clearly indicates the “new” tunnel portions connecting the 1936 and 1957 tunnels. This plan also expands on the use of the trestles, as presented here from Note #5 of LAPC 1961:

The portion of the trestle from Bldgs. 30 and 31 South to the dogleg, between tracks #3 and #4, shall be maintained until the tunnel is in service. At junction

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Box #6, east to Bldg. 31, west to Bldg 30 and when the trestle crosses the tunnel running west from junction box 7, the lines on the trestle shall have to be supported during construction period. When the tunnel is completed and the lines installed therein this portion of the trestle can be removed.

Following review of the available drawings, SC&A created Figure 1, which shows schematically its view of when different portions of the utility tunnel complex were constructed. SC&A contacted NIOSH (Chris Crawford) for clarification during its review session. He stated that when NIOSH requested Linde utility tunnel maps from Praxair (the current operator of the Linde site), they specifically sent “construction drawings.” He also drew SC&A’s attention to a memo (already known to SC&A) from Shaw Environmental (Coutts 2005) under an Army Corps of Engineers FUSRAP (Formerly Utilized Sites Remedial Action Program) contract, which discusses the utility tunnels. The following is an excerpt from that memo, which mentions the dates of construction:

The 97-inch tunnel between Junction Boxes #6 and #7 and the 80-inch tunnel between #7 and #9 were constructed in 1961. The nearby building Building 31 tunnel set was constructed 4 years earlier and removed during remedial action in EA-M and EA-E due to fixed interior contamination.

SC&A concludes from its latest review of the utility tunnels that the evidence supports the assumption that the only tunnel section that was in place before 1957 was the 1936 portion, represented by the green lines in Figure 1. The evidence leading to this conclusion includes the testimony by former Linde worker, [Worker 6], the construction notes on the 1957 and 1961 drawings (LAPC 1957 and 1961), the existence of the trestles to supply utilities to Buildings 30 and 31, Praxair’s description of the maps as “construction drawings,” and the notes in the Shaw Environmental memo (Coutts 2005).

3.0 TUNNEL OCCUPANCY FACTORS

In order to reconstruct doses at different time periods for Linde personnel who might have been exposed to radiation while in the utility tunnels, NIOSH made certain assumptions about personnel occupancy factors. The Linde TBD (NIOSH 2011) presents the assumption in several places; for example, Section 2.3.5 states:

The utility tunnels would have been routinely accessed by inspectors and maintenance personnel throughout the site history. There is only limited information on the number of hours a worker might have worked in these tunnels but, according to USACE (2002b), approximately 2 months a year are currently needed for annual maintenance (sump pumps replacement, condensate pump repair, lighting repairs, etc.). The report also provides an estimate of effort required for tunnel inspection each year. This estimate is supported by worker interviews (Murray 2010a, 2010b, and 2010c). There were stairwells from the tunnel up to Buildings 2, 8, 14, and 30 (Building 30’s access was by means of a

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ladder at Junction Box 6), but it was not general practice for employees to use them to get from one building to the other, and the practice was not condoned by the company (Murray 2010c). However as a favorable to claimant assumption, it is assumed that all other personnel may have used the tunnels for transit. A transit occupancy time of 10 minutes per workday (wd) is assumed.

TBD Section 6.4 states the assumptions more succinctly, dividing the personnel into two classes:

It is assumed that trade workers and laborers worked in these tunnels doing maintenance for 8 hr/wd (2 months of the year) and for the other 10 months, a transit time of 10 min/wd using the tunnels to get between buildings. For all other workers, only the transit time of 10 min/wd should be applied year-round.

SC&A examined USACE 2002b cited in the TBD quotation above, which is a report prepared for the U.S. Army Corps of Engineers under the FUSRAP program, assessing the dose from surface contamination within the Linde utility tunnels. Section 2.2, “Tunnel Access,” provides information on activities carried out within the tunnels and associated occupancy times:

The tunnel is frequently accessed for inspections and maintenance activity. Two workers spend approximately 24 hours per month inspecting the entire tunnel for repairs and to support the annual steam line startup each winter. If repairs are identified, maintenance is scheduled based on the critical nature of the repair. Light to moderate maintenance activities may include sump pump replacement, condensate pump repair, lighting repairs, etc. These types of repairs usually occur on a monthly cycle and involve approximately four workers, one day each month.

Approximately two months each year are necessary for annual maintenance activities that are more time consuming and complex. These scheduled activities include intrusive work such as concrete drilling to repair or hang brackets and concrete chiseling to repair the tunnel walls. It is estimated that four workers will spend an average of 60 days in the tunnel performing such heavy maintenance activity. Praxair staff also indicated plans for a large-scale structural repair project to improve the overall condition of the tunnel and to preserve the structural integrity of the network. The project may also include isolating and closing some older sections. The structural repair project is estimated to require seven months to complete and will involve at least four workers. Based upon the contamination information and discussion with Praxair staff, it was decided to limit the time period in that section to 30 days.

NIOSH relies on this information to support its assumption of 2-months per year exposure to tunnel workers. However, as the TBD itself notes, the Army Corps of Engineers estimate was based on then (2002) *current* practices and not on historical practices that Linde workers may have engaged in; the latter may have entailed more than 2 months per year exposure.

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In order to try to assess potential exposures to personnel in the tunnels, SC&A examined worker statements for relevance to time spent in the tunnels; most references to occupancy time, however, were made in passing in discussions of other matters, and are anecdotal and incomplete. Several pertinent examples are presented below. **[Worker 1]**, who is quoted in Section 2.0 of this report, said in an interview conducted by NIOSH (Murray 2010c):

Every week a millwright and an electrician would do a walk-through looking for leaks and other problems, and examining sump pumps... The walk-through took about an hour. He did not do the walk-through every week.

There were stairwells from the tunnel up to Bldgs. 14, 2 and 30. But it was not general practice for employees to use them to get from one building to the other, although he did recall more than one instance in which employees used the tunnels to get from their buildings to the cafeteria during inclement weather. He stressed that this was not a normal practice, nor was the practice condoned by the company.

These quotations support that personnel used the tunnels for work purposes and also for convenience purposes, although the latter use was neither usual nor condoned.

SC&A interviewed four former Linde workers during an ABRWH meeting in Niagara Falls, New York, in May 2010; the focus was on the utility tunnel complex, which had become a topic of interest during SEC petition deliberations. The workers were given the opportunity to comment on SC&A's draft report (the discussions were not recorded verbatim, but paraphrased by SC&A) and their comments were incorporated into the final version, which was issued in May 2010 (SC&A 2010). Several quotations relevant to tunnel occupancy have been extracted from that report and are presented here:

[Worker 1]: *Another comment. It was brought to my attention that the tunnel was not generally accessible. That is a fallacy.*

[Worker 1]: *They said the tunnel was restricted and unauthorized personnel were not allowed, but they never said who was not authorized.*

[Worker 4]: *I went in there all the time.*

[Worker 2]: *It was also a good place to hide from your foremen and take a nap there.*

[Worker 2]: *Between [production] batches, people went to sleep [in the tunnel]. Anyone who worked at Linde had access to the tunnel.*

In addition, **[Worker 1]** provided a two-page statement, dated May 19, 2010 (**[Worker 1]** y 2010), presenting feature-by-feature details of the utility tunnels. The statement ends with a comment on the occupancy of the tunnels:

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The utility tunnel was used by personnel as long as I was employed, during inclement weather it was used like a subway, nice and warm etc. to get to the cafeteria and various offices for all employees. There was no policing only sign stating no Unauthorized Personnel. It never stated who were the authorized...I recall some old time chemical operators who worked for the silicone division tell me that on the midnight shift they grabbed some shuteye between batches or to hide from the foreman in the utility tunnel where access was gained by using the stairwell in Building #14. As for the two months a year, this is someone's pipe dream; some jobs alone took six to eight months to complete.

These above quotations support the assumption that personnel went into the tunnels, but, with the exception of the last, do not furnish quantitative information on durations – *some jobs alone took six to eight months to complete*, – which is considerably in excess of NIOSH's assumption of 2 months per year (on the average). His statement about some personnel sleeping in the tunnel, however, is hearsay, since he neither did it himself nor witnessed others doing it.

SC&A also examined another statement from [Worker 1], an affidavit of November 10, 2006, in which he recounts his long job history at Linde ([Worker 1] 2006). In the course of his writings, he mentions his experience with the tunnels:

Many job assignments were in the utility tunnel. On steam, condensation lines, steam traps, replacing various gaskets in steam line flanges were necessary... One large job we had was removing all the rusted steel unit strut supports and replacing it with stainless steel unit strut.

Later in his statement, he said:

Also as a [redacted] many job assignments placed me back in all the same building contaminated with radiation. One job performed every week on the preventative maintenance program, was to walk the Utility tunnel with another craftsman and inspect all steam, condensate lines, electrical conduit switch boxes, N2 lines, exhaust fans, sump pumps and look for other problems.

Again, these quotations establish that the tunnel was routinely accessed for work-related purposes, some periodic and some episodic. Occupancy times are not quantified, however.

After reviewing relevant portions of the Army Corps of Engineers report (USACE 2002b) and the worker statements, SC&A finds that the NIOSH tunnel occupancy assumptions appear reasonable, but their support is far from conclusive, since they are primarily based on the USACE report, which presents information for operations in 2002, but does not discuss historical operations in the tunnels.

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