# Development of Regulations Concerning Asbestos-Containing Aggregate for Road Surfacing

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In the late 1970s, the Pacific Southwest Region of the Forest Service, U.S. Department of Agriculture, embarked on a program to estimate the extent of public exposure to airborne asbestos particles from aggregate used for road surfacing and, if necessary, to restrict public exposure to this material. Asbestos emissions were measured during the operation of quarries producing asbestos-containing aggregate and the use of roads surfaced with asbestos-containing aggregate. On the basis of the results, abatement measures were adopted for aggregate-surfaced roads, native-surfaced roads, and off-highway-vehicle areas that contain asbestos. In 1991, the State of California enacted a regulation prohibiting the use of asbestos-containing serpentinite aggregate for road surfacing if the asbestos content should be greater than 5 percent. The Pacific Southwest Region of the Forest Service now follows the state regulation in its management of the use of asbestos-containing aggregate for road surfacing. The costs and benefits to the Pacific Southwest Region of this 5 percent limit are unknown, but probably small.

In the late 1970s the engineering staff of the Pacific Southwest Regional Office (Region 5) of the Forest Service, U.S. Department of Agriculture, embarked on a program to determine the potential for public exposure to airborne asbestos particles (longer than 5 micrometers) from aggregate surfacing on Forest Service roads. Region 5 lands are contained mostly within the boundaries of the State of California. Forest Service geologists determined that asbestos within Region 5 occurs principally in serpentinite and peridotite rock units, which are distributed primarily within the following geomorphic provinces of California: the Coast Ranges, Klamath Mountains, and the northern Sierra Nevada (*1*,*2*). Eight National Forests are located within these provinces. Occasionally, these forests used serpentinite and peridotite for aggregate road surfacing. In these forests were

1. Eight quarries mining serpentinite or peridotite;
2. An estimated 1660 km (1,030 mi) of road constructed in serpentinite or peridotite areas; and
3. An estimated 450 km (280 mi) of road surfaced with serpentinite or peridotite aggregate.

Additionally, these forests often purchased asbestos-containing aggregate from commercial quarries outside the forest boundaries.

To make a preliminary estimate of the extent of asbestos exposure to the public, the Regional Office engineering staff studied rock-crushing and road-building operations using serpentinite. The study was done in 1979 in the Six Rivers National Forest, which is in the northern Coast Ranges Geomorphic Province of California (*2*). The results of the study, which used standard Occupational Safety and Health Administration (OSHA) air-sampling methods, were that exposures were within the OSHA permissible exposure level (PEL) in effect at that time (2 fibers/cc, time-weighted average over an 8-hr period) (*3*).

After a period of its own investigation, the Environmental Protection Agency (EPA) concluded in May 1981 that "Local, State, and Federal agencies responsible for road maintenance in the limited areas where asbestos emissions occur are in the best position to assess local conditions and implement the most appropriate control measures" (*4*).

## AIRBORNE ASBESTOS EXPOSURE STUDY

Because of this decision by EPA not to pursue regulation of airborne asbestos emissions from aggregate-surfaced roads, Region 5 of the Forest Service decided to test worst-case public exposure along with worker exposure. Although no public PEL existed at that time (or exists now), it was decided that action would be taken to limit public exposure in locations where measured exposure approaches OSHA PELs for workers. Therefore, in 1981, the Regional Office retained the Radian Corporation of Salt Lake City, Utah, to measure asbestos levels in bulk rock samples from quarries and to measure airborne asbestos levels in operating quarries and along aggregate-surfaced roads in northern California (*5*). These quarries and roads were considered to be worst case with respect to expected levels of airborne asbestos generated, based on previous bulk sample testing and on the judgment of geologists working for the national forests.

Bulk rock samples were taken from the quarry sites, and airborne dust samples were taken both from the quarry sites and from roads surfaced with aggregate from these quarries. The airborne sampling was done using a procedure recommended by the National Institute of Occupational Safety and Health (NIOSH) (*5*). This procedure included pumping air for various periods of time at a rate of 2.0 liters/min through membrane filters with an 0.8-micrometer pore size. Pumps were placed in the cabs of earth-moving equipment at the quarries, beside roads surfaced with gravel from the quarries, and inside a vehicle traveling along these roads. Dust along the roads was generated in two ways: (*a*) vehicles repeatedly

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passing a stationary sampling pump beside the road, and (*b*) a vehicle followed by a car with open windows, allowing air to be sampled by a pump inside the car.

## STUDY RESULTS

Bulk samples contained <0.01 to 20 percent chrysotile asbestos, by volume. Air samples from quarry operations contained 0.09 to 0.10 fiber/cc (8-hr time-weighted average for fibers longer than 5 micrometers). Air samples from roads contained <0.01 fiber/cc to 0.27 fiber/cc. Therefore, all samples were within the 2-fiber/cc OSHA PEL. The airborne sample results obtained from the five quarries are shown in Tables 1 to 5.

## FOREST SERVICE AIRBORNE ASBESTOS ABATEMENT MEASURES

Although at the time of the study the OSHA PEL was 2 fibers/cc, a stricter PEL of 0.1 fiber/cc had been recommended since 1976 by NIOSH and OSHA (*3*). In anticipation of the adoption of a stricter PEL [in 1986, a PEL of 0.2 fiber/cc was adopted by OSHA (*3*)], a Forest Service decision was made to abate public exposure to asbestos from aggregate-surfaced roads, native-surfaced roads, and off-highway-vehicle areas. Abatement measures included

1. Paving (typically with asphalt concrete);
2. Applying surface treatments, such as chip seals;
3. Covering with asbestos-free aggregate;
4. Applying dust palliatives, such as lignin sulfonate and magnesium chloride;
5. Controlling traffic; and
6. Restricting use during dry periods.

Many miles of existing aggregate-surfaced roads with the highest asbestos levels were paved with asphalt concrete. Forest Service-owned quarries discontinued the production of asbestos-containing aggregate for road surfacing. No restrictions were placed on the use of asbestos-containing riprap or on asbestos-containing aggregate for other than surfacing applications (for example, road base and aggregate in asphalt concrete). Public exposure to asbestos from aggregate-surfaced roads in Region 5 has decreased, although no airborne asbestos exposure data exist to determine the amount.

**TABLE 1 Airborne Sample Results from Quarry 1**

| SAMPLE NUMBER | SAMPLING TIME | SAMPLE LOCATION | CONCENTRATION (FIBERS/CC) |
|---|---|---|---|
| 01 | 0909-1144 | INSIDE CAR | 0.27 |
| 02 | 0955-1400 | SIDE OF ROAD | <0.01 |
| 03 | 1026-1400 | SIDE OF ROAD | <0.01 |
| 04 | 1058-1436 | SIDE OF ROAD | 0.03 |
| 05 | 1114-1447 | SIDE OF ROAD | 0.03 |
| 07 | 1127-1500 | SIDE OF ROAD | 0.01 |
| 08 | 1148-1513 | SIDE OF ROAD | 0.03 |
| 09 | 1335-1527 | INSIDE CAR | 0.12 |
| 10 | 1055-1202 | INSIDE CAR | 0.03 |

NOTE: The location of the quarry is 41°20′ N, 122°31′ W, Shasta-Trinity National Forest, Klamath Mountains Province. The samples were generated from vehicle use on a road with aggregate from Quarry #1. A bulk sample from the quarry contained 5-10 percent chrysotile asbestos.

**TABLE 2 Airborne Sample Results from Quarry 2**

| SAMPLE NUMBER | SAMPLING TIME | SAMPLE LOCATION | CONCENTRATION (FIBERS/CC) |
|---|---|---|---|
| 11 | 1147-1455 | SIDE OF ROAD | <0.01 |
| 12 | 1125-1443 | QUARRY | <0.01 |
| 13 | 1139-1449 | QUARRY, STOCKPILE | <0.01 |

NOTE: The location of the quarry is 41°53′ N, 124°04′ W, Six Rivers National Forest, Klamath Mountains Province. The samples were generated from quarry operations and from vehicle use on a road with aggregate from that quarry. A bulk sample from the quarry contained 5-10 percent chrysotile asbestos.

**TABLE 3 Airborne Sample Results from Quarry 3**

| SAMPLE NUMBER | SAMPLING TIME | SAMPLE LOCATION | CONCENTRATION (FIBERS/CC) |
|---|---|---|---|
| 14 | 1020-1200 | QUARRY, LOADER | 0.09 |
| 15 | 1130-1420 | SIDE OF ROAD | 0.04 |
| 16 | 1037-1353 | QUARRY, ROAD | 0.03 |
| 17 | 1121-1411 | SIDE OF ROAD | 0.03 |
| 18 | 1300-1348 | QUARRY, LOADER | 0.10 |

NOTE: The location of the quarry is 41°45′ N, 123°52′ W, Six Rivers National Forest, Klamath Mountains Province. The samples were generated from quarry operations and from vehicle use on a road with aggregate from that quarry. A bulk sample from the quarry contained 1-2 percent chrysotile asbestos.

**TABLE 4 Airborne Sample Results from Quarry 4**

| SAMPLE NUMBER | SAMPLING TIME | SAMPLE LOCATION | CONCENTRATION (FIBERS/CC) |
|---|---|---|---|
| 19 | 1013-1216 | QUARRY | 0.04 |
| 20 | 1020-1218 | QUARRY | 0.11 |
| 21 | 1036-1327 | QUARRY | 0.06 |
| 22 | 1130-1503 | SIDE OF ROAD | <0.01 |
| 24 | 1139-1516 | SIDE OF ROAD | 0.01 |
| 25 | 1218-1403 | QUARRY | 0.20 |
| 29 | 1320-1438 | QUARRY | 0.13 |
| 31 | 1405-1616 | QUARRY | 0.10 |

NOTE: The location of the quarry is 41°54′ N, 123°02′ W, Klamath National Forest, Klamath Mountains Province. The samples were generated from quarry operations and from vehicle use on a road with aggregate from that quarry. A bulk sample from the quarry contained 5-10 percent chrysotile asbestos.

**TABLE 5 Airborne Sample Results from Quarry 5**

| SAMPLE NUMBER | SAMPLING TIME | SAMPLE LOCATION | CONCENTRATION (FIBERS/CC) |
|---|---|---|---|
| 69 | 1110-1406 | QUARRY | <0.01 |
| 71 | 1129-1415 | SIDE OF ROAD | <0.01 |
| 81 | 1141-1428 | SIDE OF ROAD | <0.01 |
| 82 | 1148-1435 | SIDE OF ROAD | <0.01 |
| 83 | 1159-1437 | SIDE OF ROAD | <0.01 |
| 84 | 1208-1440 | SIDE OF ROAD | <0.01 |
| 85 | 1216-1445 | SIDE OF ROAD | <0.01 |

NOTE: The location of the quarry is 40°03′ N, 121°10′ W, Plumas National Forest, Sierra Nevada Province. The samples were generated from quarry operations and from vehicle use on a road with aggregate from that quarry. A bulk sample from the quarry contained no asbestos.

## STATE OF CALIFORNIA REGULATIONS

In 1989, the State of California Air Resources Board began the first phase of a three-phase plan to regulate asbestos generated from rock containing the mineral serpentine:

*Phase 1*: Regulation of asbestos-containing serpentinite rock used for aggregate in road surfacing;

*Phase 2*: Regulation of serpentinite quarries, mines and construction activities in areas of serpentinite rock, and off-road-vehicle activity in areas of serpentinite rock;

*Phase 3*: Further evaluation of existing roads surfaced with serpentinite aggregate to determine whether more stringent retroactive measures are needed (for example, paving).

Forest Service Region 5 engineers participated in hearings that were held for the Phase 1 part of the plan. These hearings resulted in the May 1990 State of California regulation entitled "Asbestos Airborne Toxic Control Measure, Asbestos-Containing Serpentine," which was signed into law in 1991 (*6*). This law prohibits the use of serpentinite aggregate surfacing for roads if it has an asbestos content greater than 5 percent. The law also provides for a test method for determining the asbestos content of aggregate sampled from quarry stockpiles or from roads. Phases 2 and 3 are planned for completion later.

Region 5 of the Forest Service follows the state law and now allows the use of serpentinite (or any other rock type) aggregate for road surfacing as long as the rock has an asbestos content of 5 percent or less.

## CONCLUSIONS

The costs of adhering to the 5 percent limit are unknown, but probably low. Few rock sources in the Pacific Southwest Region contain asbestos percentages greater than 5 percent. Also, alternative sources with no asbestos, or less than 5 percent asbestos, are usually available for a modestly increased cost. Finally, in recent years, the number of miles of aggregate surfacing placed on National Forest roads has substantially decreased, because of causes such as reduced timber production.

The benefits of adhering to the 5 percent limit are also unknown, but probably low. On the basis of the Pacific Southwest Region's air sampling study discussed in this paper, public exposure to airborne asbestos particles from aggregate-surfaced roads has been historically quite low. Specifically, testing was on worst-case roads, generating the maximum exposure to dust for the conditions. Also, calculated exposures were based on the assumption that the road user travels continuously in a vehicle with open windows, directly behind another vehicle. Despite these conservative assumptions, only one test exceeded the permissible exposure limit, based on current OSHA PELs.

## REFERENCES

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