the unadjusted material and labor costs per hour and per window are the same. The material cost per window is calculated by subtracting the labor cost per window from the total cost per window:

$$\$295.00 - \$48.70 = \$246.30$$

The production rate converted to sq meters per hour and adjusted for an hour per shift for radiation control measures is:

$$1 \text{ window/hr} \times 17 \text{ ft}^2\text{/window} \times .0929 \text{ m}^2/\text{ft}^2 \times 7/8 \text{ adj} = 1.38 \text{ m}^2\text{/hr}$$

The per-sq-meter labor and material costs are found by dividing the hourly costs by this production rate:

$$\text{Labor: } \frac{\$48.70/\text{hr}}{1.38 \text{ m}^2\text{/hr}} = \$35.29/\text{m}^2$$

$$\text{Material: } \frac{\$246.30}{1.38 \text{ m}^2\text{/hr}} = \$180.65/\text{m}^2$$

The total cost per sq meter for window replacement is the sum of these two figures:

$$\$35.29/\text{m}^2 + \$180.65/\text{m}^2 = \$215.94/\text{m}^2$$

The preceding calculations are summarized in Table A.3.5.7.1. The rate of the whole operation is, as usual, set at the rate of the most costly step--in this case, replacement. Therefore, 1.38 ÷ 1.73 = 0.80 removal crews would be used for each replacement crew.

TABLE A.3.5.7.1. Summary of Data for Removal and Replacement of Windows

Procedure	Rate (m^2/hr)	Cost (1982 $/$m^2$)			
		Total	Labor	Equipment	Materials
Removal	1.73	13.86	11.21	2.65	--
Replacement	1.38	215.94	35.29	--	180.65
Total	1.38	229.80	46.50	2.65	180.65

To verify that these cost and rate estimates are representative, three glass installation businesses were contacted. Ray's Glass in Seattle, Washington quoted a price of $83.30 (in 1985 dollars) for double glazed glass measuring three by six feet, the closest size to that used here as representative. With a standard metal awning frame and casement, the cost would be $245.34. The time for second story removal and replacement would be about 1.5 hours. At $34 per hour per worker, this comes to $102 for labor. The total cost is, therefore, $347.34. Converted to 1982 dollars using the Consumer Price Index, this amount is equal to about $312. For comparison, the Means-based cost estimate, without the one-hour-per-shift adjustment, is $298.

Another glass installation company, NGC, in Seattle, Washington estimated the total cost of removal and replacement of a three-by-six-foot double glazed window along with the casement at about $300 in 1985 dollars. Adjusted for inflation, this is roughly equivalent to $268.

In addition, a representative of Elan Construction in Seattle, Washington, when asked about cost estimates for window removal and replacement, said that they used Means as an aid in cost estimating. While stressing that variation in particular circumstances resulted in a wide dispersion of window replacement costs, the company has found that Means is generally reasonable and reliable.

Information from these businesses generally seems to confirm the estimates derived from Means' Building Construction Cost Data 1982.

A.3.6 Interior Wood/Plaster Walls

Many of the operations on interior walls are similar or identical, with respect to costs and rates, to analogous operations on other wall or floor surfaces. Where this is the case, reference is made to the section in which development of cost and rate estimates is discussed. While costs and rates for a particular operation on different surfaces may be the same, decontamination efficiencies in general will not be.

A.3.6.1 Vacuum

See Section A.3.2.4.

A.3.6.2 Wash and Scrub

See Section A.3.2.2.

A.3.6.3 Strippable Coating

See Section A.3.2.9.

A.3.6.4 Foam

See Section A.3.2.8.

A.3.6.5 Fixative

See Section A.3.2.3.

A.3.6.6 Remove and Replace

The information for removal and replacement of interior painted wood, plaster walls comes from Means' Building Construction Cost Data 1982. This operation involves four separate steps: removal, replacement, tape and finishing, and painting.

According to this source (p. 371), removal requires one foreman at $22.25 per hour and two building laborers at $19.40 per hour each. The total hourly labor cost is $61.05. The rate given for this procedure is 520 sq feet per day, which converts to 5.28 sq meters per hour. Dividing the labor cost by the rate yields a labor cost of $11.56 per sq meter.

Replacement (p. 219) requires two carpenters at $24.35 per hour each. The total hourly cost is found by multiplying one-eighth the daily rate by the cost per unit:

$$1800\ ft^2/day \div 8\ hr/day \times \$0.37/ft^2 = \$83.25/hr$$

Subtracting the labor cost gives the material cost:

$$\$83.25/hr - (2 \times \$24.35/hr) = \$34.55/hr$$

At 1800 sq feet per day, the cost of materials is

$$\frac{\$34.55/hr}{(1800\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2)} = \$1.65/m^2$$

The adjusted rate is

$$1800\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 18\ m^2/hr$$

Dividing this into the hourly labor cost gives labor as $2.66 per sq meter. The total cost per sq meter is the sum of labor and material:

$$\$2.66/m^2 + \$1.65/m^2 = \$4.31/m^2$$

The taping and finishing crew is again two carpenters. The total cost per hour is

$$2000\ ft^2/day \div 8\ hr/day \times \$0.21/ft^2 = 52.50/hr$$

Subtracting the labor cost gives the hourly material cost:

$$\$52.50/hr - (2 \times \$24.35/hr) = \$3.80/hr$$

This converts to

$$\frac{\$3.80/hr}{(2000\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2)} = \$0.16/m^2$$

The adjusted rate is

$$2000\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 20\ m^2/hr$$

Dividing this into the hourly labor cost yields

$$\$48.70/hr \div 20\ m^2/hr = \$2.40/m^2$$

Adding the labor and materials cost gives the total cost:

$$\$2.40/m^2 + \$0.16/m^2 = \$2.56/m^2$$

According to Means (p. 232), an ordinary painter has an hourly billing cost of $22.55 and a daily production of 490 sq feet. The total hourly cost is

$$490\ ft^2/hr \div 8\ hr/day \times \$0.45/hr = \$27.56/hr$$

Subtracting the labor cost gives the hourly material cost:

$$\$27.56/hr - \$22.55/hr = \$5.01/hr$$

This converts to

$$\frac{\$5.01/hr}{490\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2} = \$0.88/m^2$$

The adjusted hourly coverage rate is

$$490\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 4.98\ m^2/hr$$

Dividing this into the hourly labor cost gives the labor cost as

$$\$22.55/hr \div 4.98\ m^2/hr = \$4.53/m^2$$

Adding labor and material costs gives the total cost per sq meter:

$$\$4.53/m^2 + \$0.88/m^2 = \$5.41/m^2$$

Table A.3.6.6.1 summarizes the foregoing and shows the totals. Note that for a rate of 5.28 sq meters per hour, 5.28 ÷ 18 = 0.29 replacement crews, 5.28 ÷ 20 = 0.26 taping and finishing crews, and 5.28 ÷ 4.98 = 1.06 painting crews would be required.

A.3.7 Interior Concrete Walls

See Section A.3.6.

TABLE A.3.6.6.1. Summary of Data for Removal and Replacement of Painted Wood, Plaster Walls

Procedure	Rate (m^2/hr)	Cost ($1982 $/$m^2$)			
		Total	Labor	Equipment	Material
Removal	5.28	11.58	11.56	--	--
Replacement	18.00	4.31	2.66	--	1.65
Taping and finishing	20.00	2.56	2.40	--	0.16
Painting	4.98	5.41	4.53	--	0.88
Total	5.28	23.84	21.15	--	2.69

A.3.7.1 Vacuum

See Section A.3.2.4.

A.3.7.2 Wash and Scrub

See Section A.3.2.2.

A.3.7.3 Strippable Coating

See Section A.3.2.9.

A.3.7.4 Foam

See Section A.3.2.8.

A.3.7.5 Fixative

See Section A.3.2.3.

A.3.7.6 Scarify

See Section A.3.12.5. Means lists a lower cost for wall grinders, making the total hourly equipment cost $7.42. More important, however, is the rate, which sources at Concrete Coring Company said would be lower for walls than for floors. Using a base rate of 50 sq feet per hour, the adjusted rate comes to 4 sq meters per hour. The total cost per sq meter is $22.68, of which $20.85 is for labor and $1.83 is for equipment.

A.3.7.7 High-Pressure Water

See Section A.3.2.6.

A.3.7.8 Hydroblast

See Section A.3.2.5.

A.3.7.9 Remove and Replace

The source for information regarding costs, rates, and inputs for removal and replacement of interior concrete walls is Means' Building Construction Cost Data 1982. Removal (p. 371) requires one foreman at $22.25 per hour and four building laborers at $19.40 per hour each. The total hourly labor cost comes to $99.85. Equipment is a 250 cfm air compressor with air tools and accessories, costing $18.00 per hour.

The rate given by Means is 100 cubic feet per day. Assuming an average wall thickness of eight inches, the rate converts to

$$100\ ft^3/day \div 8\ hr/day \times 1.5\ ft^2/ft^3 \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 1.52\ m^2/hr$$

Dividing the rate into the hourly costs gives $65.51 per sq meter for labor, $11.81 per sq meter for equipment, and the total is $77.32 per sq meter.

The labor specified for replacement (p. 82) includes two foremen at $27.85 each per hour and eight skilled workers at $25.00 per hour each. The total hourly labor cost is $255.70. The equipment specified includes 0.125 80-ton cranes and power tools for an hourly cost of $14.93.

The listed rate is 9.6 cubic yards per day. For eight-inch thick walls this converts to 3.95 sq meters per hour.

The hourly material cost is found by multiplying the hourly rate by the listed unit total cost and subtracting the other costs:

$$9.6\ yd^3/day \div 8\ hr/day \times \$340/yd^3 = \$408/hr$$

$$\$408.00/hr - (\$255.70/hr + \$14.93/hr) = \$137.37/hr$$

The cost of material per sq meter, assuming an average wall thickness of eight inches, is $34.77.

Dividing other input costs by the hourly coverage rate gives $64.72 per sq meter for labor and $3.79 per sq meter for equipment. The total cost per sq meter is $103.27.

Table A.3.7.9.1 summarizes the foregoing information. Normalizing the total rate to that of the more costly procedure, replacement, requires 3.95 ÷ 1.52 = 2.60 removal crews for each replacement crew.

TABLE A.3.7.9.1. Summary of Data for Removal and Replacement of Interior Concrete Walls

Procedure	Rate (m^2/hr)	Cost (1982 $/$m^2$)			
		Total	Labor	Equipment	Material
Removal	1.52	77.32	65.51	11.81	--
Replacement	3.95	103.27	64.72	3.79	34.77
Total	3.95	180.59	130.23	15.60	34.77

A.3.8 Interior Glass

Operations on interior glass are, in most cases, the same as on the adjacent interior wall surface. For a description of how the glass surface decontamination methods are selected, see Section A.3.5.

A.3.8.1 Water Wash

See Section A.3.2.1.

A.3.8.2 Wash and Scrub

See Section A.3.2.2.

A.3.8.3 Fixative

See Section A.3.2.3.

A.3.8.4 Vacuum

See Section A.3.2.4.

A.3.8.5 Foam

See Section A.3.2.8.

A.3.8.6 Strippable Coating

See Section A.3.2.9.

A.3.8.7 Remove and Replace

See Section A.3.5.7.

A.3.9 Carpeted Floors

See Section A.3.10.

A.3.9.1 Vacuum

See Sections A.3.2.4 and A.3.10.1.

A.3.9.2 Foam

See Section A.3.2.8.

A.3.9.3 Fixative

See Section A.3.2.3.

A.3.9.4 Remove and Replace

The primary source of information for removal and replacement of carpet comes from Means' Building Construction Cost Data 1982. The general range of these figures was confirmed by information from and conversation with sources at Deluxe Carpet Company of Kent, Washington, and Long's Installations of Bellevue, Washington.

According to Means (p. 370), carpet removal requires one building laborer at $19.40 per hour. The rate given is 100 sq yards per day. With adjustments this implies a rate of

$$100\ yd^2/day \div 8\ hr/day \times 0.836\ m^2/yd^2 \times 7/8\ adj = 9\ m^2/hr$$

Dividing this figure into the hourly cost gives $2.12 per sq meter.

According to the same source (p. 227), the total cost of carpet installation covers a range of from $7.80 per sq yard for 15-ounce polypropylene carpet to $29.00 per sq yard for 42-ounce sponge-backed wool carpet. The difference is due to different material costs. Here we assume a material cost of $11.70 per sq yard, or

$$\$11.70/yd^2 \times 1.196\ m^2/yd^2 = \$14.00/m^2$$

The rate for installation, with adjustments, is

$$40\ yd^2/day \div 8\ hr/day \times 0.836\ m^2/yd^2 \times 7/8\ adj = 3.7\ m^2/hr$$

Dividing this rate into the hourly cost for the one floor tile layer required for carpet installation gives the labor cost per sq meter:

$$\$22.55/hr \div 3.7\ m^2/hr = \$6.09/m^2$$

Adding the labor and material cost gives the total cost:

$$\$6.09/m^2 + \$14.00/m^2 = \$20.09/m^2$$

The results of the preceding calculations are presented in Table A.3.9.4.1. Also shown are the totals for the entire operation. Note that 3.7 ÷ 9 = 0.41 removal crews per replacement crew would be used in making up a single removal and replacement crew with a production rate of 3.7 sq meters per hour.

TABLE A.3.9.4.1. Summary of Data for Removal and Replacement of Carpet

Procedure	Rate (m^2/hr)	Cost (1982 $/$m^2$)			
		Total	Labor	Equipment	Material
Removal	9	2.12	2.12	--	--
Replacement	3.7	20.09	6.09	--	14.00
Total	3.7	22.21	8.21	--	14.00

A.3.9.5 Steam Clean

Data for steam cleaning carpets comes from Means' Building Construction Cost Data 1982 (p. 227). Two sets of costs and rates are given. The one with the slower rate and higher cost is used here. The total cost per hour can be found with the following calculations:

$$3250\ ft^2/day \div 8\ hr/day \times \$0.06/ft^2 = \$24.38/hr$$

The specified labor is one building laborer at $19.40 per hour. Subtracting the labor cost from the total cost gives the equipment cost:

$$\$24.38/hr - \$19.40/hr = \$4.98/hr$$

With adjustments, the hourly rate is

$$3250\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 33\ m^2/hr$$

Dividing this into the hourly input costs yields costs on a dollars-per-sq-meter basis:

$$\text{Labor: } \frac{\$19.40/hr}{33\ m^2/hr} = \$0.59/m^2$$

$$\text{Equipment: } \frac{\$4.98/hr}{33\ m^2/hr} = \$0.15/m^2$$

The total cost is the sum of the input costs, $0.74 per sq meter.

A.3.9.6 Shampoo

Carpet shampooing involves applying the shampoo with a power brush device and vacuuming when the resulting foam has dried. Northwest Janitorial Systems of Mercer Island, Washington, estimates the cost of this operation at from $0.10 to $0.20 per sq foot. A lower, but overlapping, range was provided by American Building Maintenance of Seattle, Washington, with their estimate of $0.05 to $0.11 per sq foot. This source added that the hourly production rate was about 370 sq feet and that labor comprised 60 percent of their cost.

Based on these figures and an assumed cost of $16.00 per hour each for two cleaning workers, this operation is estimated to have a rate of 40 sq meters per hour and a total cost of $1.25 per sq meter. Labor costs $0.80 per sq meter, and equipment costs come to $0.45 per sq meter.

A.3.10 Linoleum Floors

This surface is intended to be representative of resilient floor coverings in general, including linoleum, asphalt tile, and vinyl. Many of the operations on this surface are similar or identical to operations on other interior floor surfaces and, in some cases, operations on wall surfaces.

A.3.10.1 Vacuum

Janitorial cleaning and painting sources indicated that the rates of operations on floors are not much different from the rates on walls. Therefore, the cost of this operation is taken to be the same as vacuuming painted wood exterior walls. See Section A.3.2.4.

A.3.10.2 Wash and Scrub

See Section A.3.2.2.

A.3.10.3 Strippable Coating

See Section A.3.2.9.

A.3.10.4 Foam

See Section A.3.2.8.

A.3.10.5 Fixative

See Section A.3.2.3.

A.3.10.6 Remove and Replace

In instances of severe contamination, removal and replacement of linoleum floor covering may be indicated. Data for this operation come primarily from Means' Building Construction Cost Data 1982. The general range of these costs is supported by information from and discussion with sources at commercial floor covering businesses, including the Deluxe Carpet Company of Kent, Washington, and Long's Installations of Bellevue, Washington.

The crew specified for linoleum removal (p. 371) includes one foreman at $22.25 per hour and four building laborers at $19.40 per hour each. The total hourly labor cost comes to $99.85. Equipment is just those hand tools supplied by the workers themselves.

The rate, listed as 2500 sq feet per day, after adjustments is

$$2500\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 25\ m^2/hr$$

Dividing the hourly labor cost by the number of sq meters per hour gives the labor cost as $4.00 per sq meter.

According to Means (p. 228), labor for replacement of the linoleum flooring is one floor tile layer at $22.55 per hour.

Material costs range from about $0.50 per sq foot for asphalt tile on concrete underlayment to over $5.50 per sq foot for vinyl tile. Here we use a cost of about $0.60 per sq foot or $6.36 per sq meter.

The rate is given as 540 sq feet per day. With adjustments, this is equivalent to

$$540\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 5.48\ m^2/hr$$

Dividing this figure into the hourly labor cost yields a labor cost of $4.11 per sq meter. Adding the material cost brings the total to $10.47 per sq meter.

The foregoing is summarized in Table A.3.10.6.1, and the combined totals for the entire operation are presented. Note that 5.48 ÷ 25 = 0.22 removal crews would be used for each replacement crew.

TABLE A.3.10.6.1. Summary of Data for Removal and Replacement of Linoleum Floors

Procedure	Rate (m^2/hr)	Cost (1982 $/$m^2$)			
		Total	Labor	Equipment	Materials
Removal	25	4.00	4.00	--	
Replacement	5.48	10.47	4.11	--	6.36
Total	5.48	14.47	8.11	--	6.36

A.3.11 Wood Floors

See Section A.3.10.

A.3.11.1 Vacuum

See Sections A.3.2.4 and A.3.10.1.

A.3.11.2 Wash and Scrub

See Section A.3.2.2.

A.3.11.3 Strippable Coating

See Section A.3.2.9.

A.3.11.4 Foam

See Section A.3.2.8.

A.3.11.5 Sand

This operation involves sanding and refinishing the wood floor. Data come from Means' Building Construction Cost Data 1982 (p. 231). For our purposes, we use the maximum refinishing cost.

The labor required is one carpenter at $24.35 per hour. The total hourly cost is equal to the rate times the cost per sq foot:

$$130\ ft^2/day \div 8\ hr/day \times \$1.99/ft^2 = \$32.34/hr$$

Material cost can be found by subtracting the labor cost:

$$\$32.34/hr - \$24.35/hr = \$7.99/hr$$

This can be converted to cost per sq meter by the following:

$$\$7.99/hr \div 16.25\ ft^2/hr \div 0.0929\ m^2/ft^2 = \$5.29/m^2$$

The adjusted rate for this operation is

$$130\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 1.32\ m^2/hr$$

Using this rate, the cost of labor per sq meter can be found:

$$\$24.35/hr \div 1.32\ m^2/hr = \$18.45/m^2$$

Adding the labor and material costs gives the total cost:

$$\$18.45/m^2 + \$5.29/m^2 = \$23.74/m^2$$

A.3.11.6 Fixative

See Section A.3.2.3.

A.3.11.7 Remove and Replace

This operation has three distinct steps for which costs are calculated separately. They are removal, replacement, and finishing. The source for this operation is Means' Building Construction Cost Data 1982.

The removal crew specified (p. 371) includes one foreman at $22.25 per hour and four building laborers at $19.40 per hour each. The total labor cost comes to $99.85 per hour. The only equipment indicated would be small hand tools supplied by the workers themselves.

The adjusted rate is

$$1300\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 13.2\ m^2/hr$$

Dividing the hourly labor cost by the rate gives the labor (and total) cost as $7.50 per sq meter.

For replacing a wood floor, Means advises a crew of one carpenter at $24.35 per hour. The total hourly cost is

$$170\ ft^2/day \div 8\ hr/day \times 3.37/ft^2 = \$71.61/hr$$

Subtracting the labor cost gives the hourly material cost:

$$\$71.61/hr - \$24.35/hr = \$47.26/hr$$

Converting this directly to cost per sq meter is done as follows:

$$\frac{\$47.26/hr}{170\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2} = \$23.94/m^2$$

The adjusted rate is

$$170\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ adj = 1.73\ m^2/hr$$

Dividing this figure into the hourly labor cost gives

$$\$24.35/hr \div 1.73\ m^2/hr = \$14.08/m^2$$

Adding labor and material cost yields total cost:

$$\$14.08/m^2 + \$23.94/m^2 = \$38.02/m^2$$

For finishing a new floor, Means (p. 231) specifies the total cost as $0.99 per sq foot and the daily production rate as 295 sq feet. From these figures the total hourly cost is easily calculated:

$$295\ ft^2/day \div 8\ hr/day \times \$0.99/ft^2 = \$36.50/hr$$

The labor required is one carpenter at $24.35 per hour. Subtracting the hourly labor cost from the hourly total cost gives

$$\$36.50/hr - \$24.35/hr = \$12.15/hr$$

for materials. This can be converted to a cost per sq meter with the following calculations:

$$\frac{\$12.15/hr}{295\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2} = \$3.55/m^2$$

The adjusted rate is

$$295\ ft^2/day \div 8\ hr/day \times 0.0929\ m^2/ft^2 \times 7/8\ \ adj = 3\ m^2/hr$$

Dividing the hourly labor cost by this figure gives the labor cost in dollars per sq meter:

$$\$24.35/hr \div 3\ m^2/hr = \$8.12/m^2$$

Adding the labor and equipment costs yields the total cost:

$$\$8.12/m^2 + \$3.55/m^2 = \$11.67/m^2$$

The foregoing calculations are summarized in Table A.3.11.7.1. In addition, the costs for the entire combined operation are presented. The rate for the whole operation is set equal to that of the most costly procedure, following the convention used in this report. Consequently, 1.73 ÷ 13.2 = 0.13 removal crews and 1.73 ÷ 3.00 = 0.58 finishing crews would be combined with one replacement crew to form one crew for the entire operation.

TABLE A.3.11.7.1. Summary of Data for Removal and Replacement of Wood Floors

Procedure	Rate (m^2/hr)	Cost (1982 $/$m^2$)			
		Total	Labor	Equipment	Material
Removal	13.2	7.50	7.50	--	--
Replacement	1.73	38.02	14.08	--	23.94
Finish	3.00	11.67	8.12	--	3.55
Total	1.73	57.19	29.70	--	27.49

A.3.12 Concrete Floors

See Section A.3.10.

A.3.12.1 Vacuum

See Sections A.3.2.4 and A.3.10.1.

A.3.12.2 Wash and Scrub

See Section A.3.2.2.

A.3.12.3 Strippable Coating

See Section A.3.2.9.

A.3.12.4 Foam

See Section A.3.2.8.

A.3.12.5 Scarify

In this report, scarification refers to any of a variety of methods to remove the surface of concrete floors, pavement, or walls. Information from three sources is combined to develop the cost and rate estimates of this

operation. Two of these sources are associated with Concrete Coring Company. Their input specifications are combined with labor and equipment costs from Means' Building Construction Cost Data 1982.

Concrete Coring Company performs a wide range of jobs on concrete, including drilling, coring, flat sawing, flame cutting, grooving, and grinding. This company also has experience in working in radiation contaminated environments and in using remote-controlled equipment. According to a source in this company, the most effective means for treating concrete subjected to low contamination is with high-pressure water. For higher levels of contamination, the alternatives for surface treatment include grinding and saw cutting with chipping. The grinding procedure uses a rotating abrasive disk to grind away the surface. Water is used as a coolant and a dust suppressant. The other procedure has two basic steps. The first step is to cut grooves in the surface. In the second step, the high portions between the grooves are chipped away by hand. For both operations there are machines of various sizes, operating speeds, and operating costs. In general, grinding floors, roads, and other ground-cover surfaces is faster, easier, and less costly than grinding walls, ceilings, or sloped and irregular surfaces.

Based on input descriptions from Concrete Coring Company, costs are determined using data from Means, as shown in Table A.3.12.5.1.

TABLE A.3.12.5.1. Cost Data for Scarifying Concrete Surfaces

Labor	Cost (1982 $/hr)
1 Small-equipment operator @ $23.70/hr	23.70
2 Building laborers @ $19.40/hr	38.80
1 Foreman @ $22.25/hr	22.25
Total labor	84.75
Equipment	
1 Grinder	1.82
1 Wet vacuum	1.00
1 Pickup truck	5.42
Total equipment	8.24

To convert these hourly cost figures to a cost-per-sq-meter basis, it is necessary to estimate the production rate. Here, information is ambiguous. One source at Concrete Coring Company estimated a production rate of 2000 sq feet per day. Another source with the same company estimated a rate of 96 sq feet. The primary reason for this wide discrepancy is that the first source provided a rate estimate for normal operating conditions, while the second source adjusted the coverage rate to what it would be under severely contaminated conditions. The rate used here is between these two

rates--800 sq feet per day. Converted to sq meters per hour and adjusted for one hour per shift lost to personnel and equipment decontamination, this comes to 8.1 sq meters per hour.

Dividing the rate into the hourly costs gives $10.43 per sq meter for labor and $1.01 per sq meter for equipment. The total is $11.44 per sq meter.

A.3.12.6 Resurface

This operation involves laying a thin layer of concrete over the existing concrete floor. The information for this operation comes from Means' Building Construction Cost Data 1982 (p. 83).

The labor designated includes one building laborer at $19.40 per hour and two cement finishers at $23.00 per hour each. The total hourly labor cost is $65.40. For equipment, two gas-powered cement finishing machines are specified for a total hourly charge of $6.85. The material cost comes to $8.88 per hour.

The coverage rate is 590 sq feet per day. With adjustments, this comes to 6 sq meters per hour. Dividing this into the hourly input costs yields:

Labor: $10.90/$m^2$

Equipment: $1.14/$m^2$

Materials: $1.30/$m^2$

Total: $13.34/$m^2$

A.3.12.7 High-Pressure Water

See Section A.3.2.6.

A.3.12.8 Hydroblast

See Section A.3.2.5.

A.3.12.9 Scarify and Resurface

This operation involves scarification as described in Section A.3.12.5, followed by resurfacing as described in Section A.3.12.6. This information is summarized in Table A.3.12.9.1. Note that 6 ÷ 8.1 = 0.74 scarification crews would be used for each resurfacing crew.

TABLE A.3.12.9.1. Summary of Data for Scarification and Resurfacing of Concrete Floors

Procedure	Rate (m^2/hr)	Cost (1982 $/$m^2$)			
		Total	Labor	Equipment	Materials
Scarification	8.1	11.44	10.43	1.01	--
Resurfacing	6	13.34	10.90	1.14	1.30
Total	6	24.78	21.33	2.15	1.30

A.3.12.10 Fixative

See Section A.3.2.3.

A.3.13 Remove Structure

In the most severe cases it may be necessary to remove entire structures rather than attempt extensive decontamination operations. While structure removal may be preceded by an operation such as application of a fixative, subsequent decontamination operations on any of the structure surfaces are precluded.

A.3.13.1 Wooden Structures

The primary information source for this operation is Means' Building Construction Costs Data 1982 (p. 25). Data are for the demolition of small or single wood buildings. The reported figures include an allowance for hauling away of materials; no salvage is assumed. Since hauling costs are estimated separately in this report, they must be deleted from the Means data. Excluding the two heavy-truck drivers and the two dump trucks, the specified labor requirements are one outside foreman at $22.25 per hour, one equipment operator at $24.95 per hour, and two building laborers at $19.40 per hour each. The total hourly labor cost is $86.00. The only equipment specified is a front-end loader at $72.46 per hour.

The production rate is given at 14,100 cubic feet per day. However, we wish to express the coverage rate in terms of exterior wall area. This conversion can be accomplished using the dimensions of the representative single-family home described in Appendix E. The floor area of this structure is 1600 sq feet and the overall wall height per story is 10 feet. This gives a total building volume of 16,000 cubic feet. Factor h is the ratio of exterior wall area to projected roof area and factor k is the ratio of floor area to projected roof area. Dividing h by k:

$$h/k = 1.46/1.40 = 1.04$$

gives the ratio of exterior wall area to floor area. Therefore, the exterior wall area is:

$$1600 \text{ ft}^2 \times 1.04 = 1669 \text{ ft}^2.$$

Dividing the exterior wall area by the building volume:

$$1{,}669 \text{ ft}^2 \div 16{,}000 \text{ ft}^3 = .104 \text{ ft}^2/\text{ft}^3$$

gives the ratio of exterior wall area to building volume. Thus, the daily production rate can be expressed as:

$$14{,}100 \text{ ft}^3/\text{day} \times .104 \text{ ft}^2/\text{ft}^3 = 1{,}470 \text{ ft}^2/\text{day}.$$

This converts to:

$$1{,}470 \text{ ft}^2/\text{day} \div 8 \text{ hr/day} \times .0929 \text{ m}^2/\text{ft}^2 \times 7/8 \text{ adj} = 14.9 \text{ m}^2/\text{hr}.$$

Dividing the hourly labor cost by the production rate yields the labor cost in terms of sq meters of exterior wall area.

$$\$86.00/\text{hr} \div 14.9 \text{ m}^2/\text{hr} = \$5.76/\text{m}^2$$

Similarly, the equipment cost is:

$$\$72.46/\text{hr} \div 14.9 \text{ m}^2/\text{hr} = \$4.86/\text{m}^2.$$

The total cost per sq meter of exterior wall area is:

$$\$5.76/\text{m}^2 + \$4.86/\text{m}^2 = \$10.62/\text{m}^2.$$

For comparison, a number of building demolition companies were contacted for information about this operation. Each source was asked to provide estimates regarding costs, rates, and inputs for the removal of a 1600 sq foot single-family home with a second story.

Since each source included the cost of hauling, it is helpful for the purposes of comparison to adjust the Means figures to include these costs. Hauling would, according to Means, raise the costs as calculated above by 70 percent. Without hauling included, the cost of structure removal is equivalent to $1648 for the removal of the representative single-family home; with hauling the cost comes to $2802. This is equal to about $1.75 per sq foot of floor area. In addition, the job would take about nine hours, excluding the one hour per shift adjustment.

Most companies emphasized the difficulty of providing estimates of representative information owing to the considerable variability between specific jobs. Consequently, they were reluctant to provide such information. This variability is reflected in the divergence of cost and rate data supplied by the different companies. Important factors affecting costs and rates of building demolition include the type of material with which the structure is built, the number of stories, ease of access to the structure, and so forth. Dollar amounts from these sources are in 1985 dollars.

Atlas Building Wreckers in Seattle, Washington estimated that demolition of the representative structure would cost $1000 to $1500. This is equivalent to less than one dollar per sq foot. With two to three workers plus a backloader and a special dump truck, the job would take about one day to complete.

The representative for Cleveland Wrecking Company in Los Angeles, California stated that his company is exceptionally large in an industry that is composed almost entirely of small firms. As a result, Cleveland Wrecking is subject to legal regulations on some types of jobs to which other companies are not subject. According to the representative, a consequence is that Cleveland Wrecking frequently has higher costs, particularly for labor, than other firms.

For demolishing the representative structure, the estimated cost given was $3.00 per sq foot or $4800 for the job. The job would involve about six workers, a front-end loader and three dump trucks. In addition, this source stated that total labor costs, inclusive of benefits would be about $30 per hour per worker. When this information is combined with the projected job length of one week, an inconsistency in the information becomes apparent. The total wage bill for six workers for one week at $30 per hour comes to $7200, considerably more than the estimated total job cost. When compared with information from other sources, it appears that the length of the job, the number of workers, and the hourly labor cost are all somewhat higher.

Janutsky Statewide Construction in Seattle, Washington indicated that demolition of the representative structure would cost about $3500 to $4000. This is equivalent to about $2.20 to $2.50 per sq foot. This source mentioned that structures that are more difficult to remove would cost about $3.00 per

sq foot. This source declined to provide information regarding crew size or wage rates. The job length was estimated to take between one day and one week.

A representative for Pacific Wrecking in Seattle, Washington estimated that demolition of the representative structure would cost somewhere between $1.50 to $2.00 per sq foot. This job would take about one day using a front-end loader, two dump trucks, and four or five workers.

In addition, this source mentioned that $3.00 per sq foot served as a standard against which the costs of other jobs could be compared. This figure represents an above-average cost for removal of a small wood frame building. For a four-story steel frame commercial building the removal cost would be about $2.50 to $3.00 per sq foot according to this source. For taller buildings the cost could get as high as $5.00 to $6.00 per sq foot.

The information from these sources falls around the estimates generated from Means data for costs as well as rates. This suggests that the estimates based on the Means data are reasonably representative.

A.3.13.2 Brick and Concrete Structures

The difference in materials and dimensions between buildings with exterior wood walls and those with masonry has significant effect on costs and rates. The basic data source is Means' Building Construction Cost Data 1982 (p. 25). The cost data for large masonry buildings are used. Again, as in removal of wood structures, the Means information has to be purged of costs, personnel, and equipment used for hauling.

Labor includes one outside foreman at $22.25 per hour, two medium equipment operators at $24.95 per hour each, one oiler at $21.45 per hour, and two building laborers at $19.40 per hour each. The total hourly labor cost comes to $132.40.

The equipment required includes one 25-ton hydraulic crane at $50.58 per hour and one front-end loader at $72.46 per hour. The total hourly equipment cost is $123.04.

The production rate is listed as 19,300 cubic feet per day, but it is necessary to convert this figure so that it can be expressed in terms of exterior wall area. Using information from Appendix E, the total building volume of the representative commercial structure can be estimated by multiplying the floor area (10,818 sq feet) by the height per story (12 feet). This gives a volume of 129,800 cubic feet. The exterior wall area is 7370 sq feet, so that the ratio of exterior wall area to building volume is:

$$7370\ ft^2 : 129{,}800\ ft^3 = 0.0568\ ft^2/ft^3.$$