PRTR Estimation Manual

20. Adhesive Tape Manufacturing Industry

January 2001

Japan Adhesive Tapes Makers' Association

Contents

Introduction

The Law concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management (PRTR Law) to promote the businesses' voluntary improvements in the management of specific chemical substances was promulgated on July 1999, and the industries and the chemical substances requiring notification were designated by Cabinet Order on March 2000.

In the article 5 of the Law, it is stipulated that "Businesses Handling Class Ⅰ Designated Chemical Substances shall estimate and report the amount released and transferred related to their business activities during the preceding fiscal year, prescribed by the Competent Ministerial Order related to the quantity of Class Ⅰ Designated Chemical Substances."

From April 2001 the estimation of releases and transfers, and after April 2001 the reporting of their data is required.

From the result of the questionnaire for needs conducted by Ministry of Economy, Trade and Industry, working groups (WG) were established and manuals by industries are being prepared

A WG of 8 companies from Japan Adhesive Tapes Makers' Association which consists of 20 makers producing adhesive tapes was established to make up a manual to be used in common. This "Manual for Estimating Releases and Transfers for Manufacturing Process of Adhesive Tape Manufacturing Industry" is compiled through the discussions in the committee.

Meanwhile, the coating process is focused on in the manufacturing process of adhesive tapes.

1. Outline of manufacturing process of adhesive tapes

1.1. Outline

In the adhesive tape manufacturing process, adhesive mass, backside treatment agent, and primer, etc. are manufactured or purchased, then a tape base material is coated using these materials, with a solvent being removed by drying, and then wound around in a roll form. The coated roll is further cut in a desired width and then packed.

For the release to the environment, release to air (vaporization) of the Class I Designated Chemical Substances (or PRTR chemicals) in the solvent component contained in backside treatment agent, primer, adhesive mass, etc., release to water bodies in wastewater of the solvent components mixture from the solvent recovering system, and transfer in waste solution, etc. occurring in the coating process should be estimated..

The transfer of the PRTR chemicals other than the solvents (liquid, solid) used for the base material, backside treatment agent, primer, and adhesive mass, etc. also occurred from the process such as coating, rewinding, and cutting.

1.2. Examples of PRTR chemicals

PRTR chemicals potentially used in the manufacturing process of adhesive tapes are listed below for reference.

Component	Cabinet Order No.	Name of substance
Component of Solvent	227	Toluene
	63	Xylene
	145	Dichloromethane (Methylene chloride)
	112	Tetrachloromethane
	299	Benzene
Component of Raw Materials Other Than Solvents	25	Antimony and its compounds
	69	Chromium(VI) compounds
	230	Lead and its compounds
	176	Organic tin compounds
	243	Barium and its water-soluble compounds
	60	Cadmium and its compounds
	3	Acrylic acid
	6	Methyl acrylate
	4	Ethyl acrylate
	320	Methyl methacrylate
	269	Di-n-octyl phthalate
	270	Di-n-butyl phthalate
	272	Bis(2-ethylhexyl) phthalate

2. Procedures and examples of estimating releases and transfers of solvent components in the adhesive tapes manufacturing process

2.1. Flow diagram of solvent components

The flow of the adhesive tape manufacturing process for the solvent component is shown in the attached Fig. 1.

When the primer, backside treatment agent, and adhesive mass of the solvent type are coated on the tape base material, the PRTR chemicals in the solvents are transferred as waste in waste solution, and released to air by drying. And, the solvent is not considered to be contained in the adhesive tape.

The solvent removed by drying is mostly released to air as local exhaust gas and tank vent gas, but is considered partly released to water bodies if a solvent recovering system is placed.

2.2. Calculation sheets for releases and transfers of solvent components

A calculation sheet for solvent components in the adhesive tapes manufacturing process is shown in attached table 1.

2.3. Calculation procedures

The procedure for estimating the quantities of the solvent component released and transferred in the adhesive tape manufacturing processes is carried out as in the following way.

2.3.1. Calculation of the handling amount of solvents in the adhesive mass

The used quantity (F) is shown in the following formula.

$F = (F1 \times f1i) + F2$

F1 … used quantity such as purchased adhesive mass,

f1i … solvent content in adhesive mass,

F2 …quantity of solvent used at the time of manufacturing adhesive mass

When the solvent is recycled, the quantity subtracted by the quantity recycled becomes the quantity used.

2.3.2. Calculation of transfers of solvents in waste adhesive mass

The solvent quantity (D) contained in the waste adhesive mass is expressed in the following formula.

D = D1 x d1i

D1 … generated quantity of the waste adhesive mass, etc.

d1i … solvent content in waste adhesive mass, etc.

2.3.3. Calculation of releases of solvents to water bodies from solvent recovery process

The quantity of solvent released (W) to water bodies is expressed in the following formula.

W = W1 x w1i

W1 … wastewater quantity, w1i …concentration of solvent in wastewater

Concentration is obtained from the saturation solubility (water solubility of toluene is 0.58kg / m^3), or obtained from the actual measurement.

If a wastewater treatment equipment is used, W* = W1 x w1i x (1-removal rate).

As to the removal rate, refer to Table 3, “Removal efficiency and decomposition rate in wastewater treatment device”.

2.3.4. Calculation of releases of solvents to the air

The quantity (A) of the solvent component released to the air is expressed in the following formula.

(1) In the case without solvent recovering system or solvent combustion equipment

A = F - D

(2) In the case with a solvent recovering system

A = F - D - W

(3) In the case with a solvent combustion equipment

A = F - D - N

A … the quantity of the solvent component released to air,

F … the quantity of the solvent component handled

D … the quantity of solvent in the waste adhesive mass, etc.

W … the quantity of solvent released to water bodies,

N … the quantity of solvent removed by combustion

The quantity recovered (recycling quantity) is the total quantity treated by the recovery system multiplied by the recovering efficiency. The quantity removed by

combustion (N) is the total quantity treated by the combustion equipment multiplied by the combustion efficiency.

N = N1 x n1i

N1 … combustion introduction quantity, n1i … combustion efficiency

2.4. Examples of calculation

2.4.1. Calculation example 1

Outline of the facility

Process: Adhesive tape manufacturing process

Solvent recovery system: None

Solvent combustion equipment: None

Quantity of adhesive mass purchased: 100,000kg / year

Quantity of solvent purchased: None

Solid content of adhesive mass: 30 % (solvent component 70 %)

Waste solution: 2,000kg / year (solvent component 70 %)

(Quantity of a solvent handled) = 100,000 x 0.7 = 70,000kg

(Quantity transferred in waste solution) = 2,000 x 0.7 = 1,400kg

Hence, the quantity released to air is 70,000 - 1,400 = 68,600kg.

2.4.2. Calculation example 2

Outline of facility

Process: Adhesive tape manufacturing process

Solvent recovery system: Used (recovering efficiency about 90 %)

Solvent combustion equipment: None

Quantity of adhesive mass purchased: None

Quantity of solvent handled: 8,364kg / year (no stock change)

Quantity of solvent used: 70,000kg / year

Waste solution: 2,000kg / year (solvent component :70 %)

(Quantity transferred in waste solution) = 2,000 x 0.7 = 1,400kg

Quantity of solvent recycled = 70,000 - 8,364 = 61,636kg

If the recovery system is used, there is release to water bodies. If it operates for 200 days with the wastewater quantity of $1m^3$ / day using saturation solubility (for example, water solubility of toluene is 0.58kg / m^3),

(Quantity kg released to bodies of waters) = 0.58 x 1 x 200 = 116kg

(Quantity released to air) = 8,364 - (1,400 + 116) = 6,848kg

* Total quantity treated by the recovery system= 70,000-1,400 = 68,600kg

Since the quantity recovered (recycled quantity) is 61,636kg, the recovery rate is about 90 %.

2.4.3. Calculation example 3

Outline of the facility

Process: Adhesive tape manufacturing process

Solvent recovery system: None

Solvent combustion equipment: Used (combustion efficiency 90 %)

Quantity of adhesive mass purchased: 50,000kg / year

Quantity of solvent purchased: 35,000kg

Solid content of adhesive mass: 30 % (solvent component 70 %)

Waste solution: 2,000kg / year (solvent component 70 %)

(Quantity of the solvent in the adhesive mass purchased)

= 50,000 x 0.7 = 35,000kg

(Quantity of the solvent handled) = 35,000 + 35,000 = 70,000kg

(Transferred quantity contained in waste adhesive mass)

= 2,000 x 0.7 = 1,400kg

Total quantity treated by the combustion equipment is 70,000 - 1,400

= 68,600kg, and if the combustion efficiency is 90 %,

(Quantity of solvent removed by combustion) = 68,600 x 0.9 = 61,740kg

(Quantity kg released to air) = 70,000 - (1,400 + 61,740) = 6,860kg.

2.4.4. Summary of calculation examples

In Table 4 the results of the above calculation examples are summarized.

Figure 1 Flow of adhesive tape manufacturing process (solvent component)

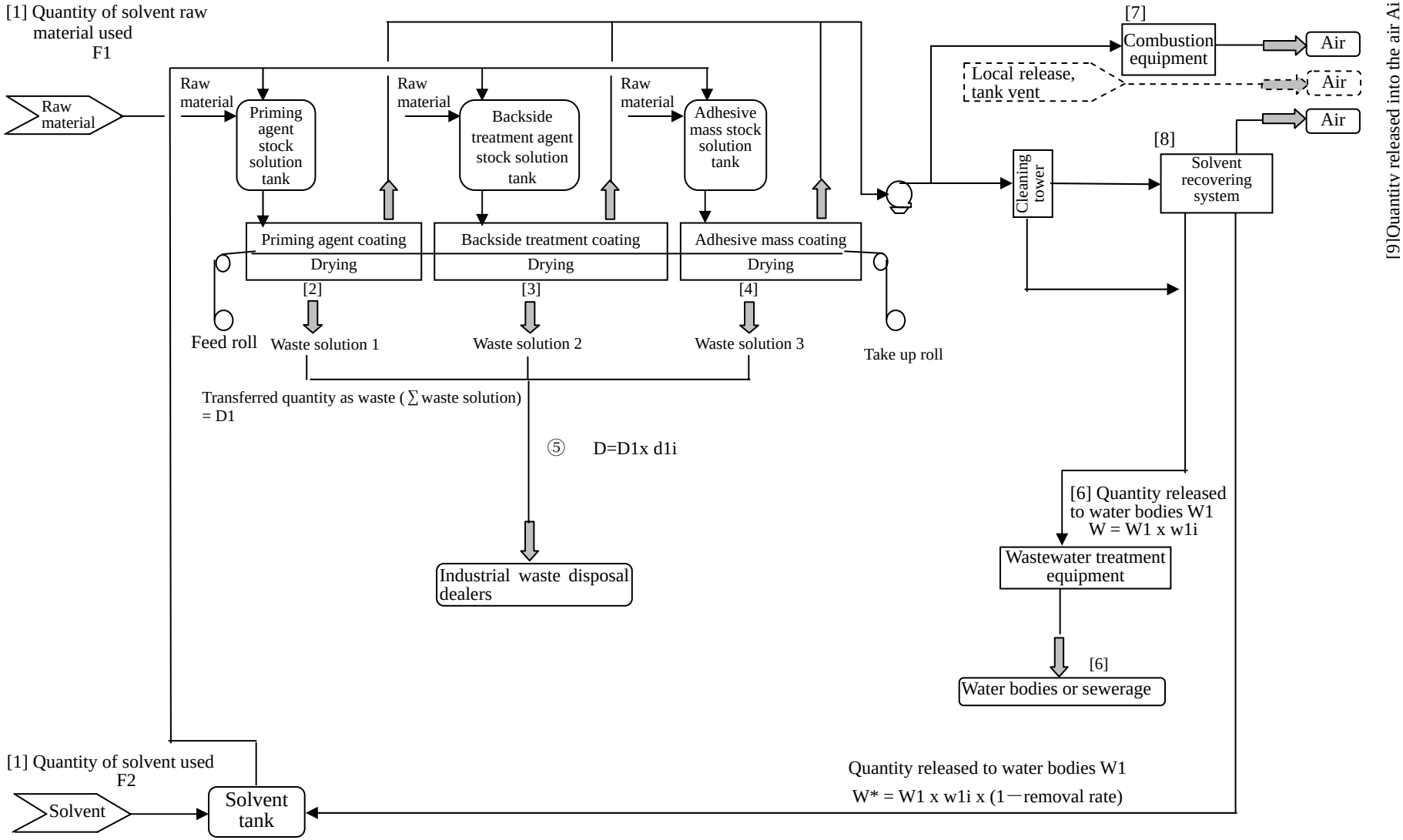

Table. 1 Calculation sheet for the quantities released and transferred in adhesive mass manufacturing processes (solvent component)

Unit: kg

		Quantity of Class I Designated Chemical Substances handled	Waste solution				Quantity released to water bodies	Quantity of solvent removed by combustion	Quantity of solvent recovered	Quantity of solvent released to air
Symbol		F	D				W	N	K	A
Process No.		[1]	[2]	[3]	[4]	[5] [5]=[2]+[3]+[4]	[6]	[7]	[8]	[9]
Solvent	(Calculation method)	F = (F1 x f1i) + F2				D = D1 x d1i	Calculate from saturation solubility or found value W = W1 x w1i	Total quantity treated by the combustion equipment x combustion efficiency (%)	Total quantity treated by the recovery system x recovering efficiency (%)	
	Calculation example 1	70,000	–	–	–	1,400	–	–	–	68,600
	Calculation example 2	8,364	–	–	–	1,400	116	–	61,636	6,848
	Calculation example 3	70,000	–	–	–	1,400	–	61,740	–	6,860

Reporting is required: The total value for each facility of business is reported with two significant figures.

Table 3. Removal efficiency and decomposition rate of exhaust water treatment device (Source: Material by Prof. URANO, Yokohama National University)

Treatment device	Substance to be treated			
	Suspended inorganic compounds[b)]	Suspended organic compounds	Soluble inorganic compounds[c)]	Soluble organic compounds
General precipitation	0.4 (0)	0.2 (0)	0 (0)	0 (0)
Coagulating sedimentation	0.8 (0)	0.7 (0)	0 (0)	0 (0)
Microbial decomposing[a)]	0.7 (0)	0.7 (0.3)	0 (0)	0.6 (0.4)
Membrane filter	1.0 (0)	1.0 (0)	0 (0)	0 (0)
Activated carbon absorber	0.1 (0)	0.1 (0)	0.2 (0)	0.8 (0)

a) These are the values obtained for rather persistent substances when they are treated by devices using aerobic microbes such as those to which activated sludge method, submerged biofilter method, biological contact aeration method, and rotary disc method are adopted.

Indicated values in ( ) are decomposition rates. The difference between the removal efficiency and the decomposition rate becomes equal to the quantity of waste.

b) “Suspended” (inorganic or organic compound) means that the subject substance exists in the form of particles in effluent. Values are adopted for rather persistent substances.

Indicated values in ( ) are decomposition rates. The difference between the removal efficiency and the decomposition rate becomes equal to the quantity of waste.

c) “Soluble” (inorganic or organic compound) means that the subject substance is dissolved in effluent. Values are adopted for rather persistent substances.

Indicated values in ( ) are decomposition rates. The difference between the removal efficiency and the decomposition rate becomes equal to the quantity of waste.

The table above may be used to obtain a rough value, when regarding to the exhaust water treatment device, no data on the removal efficiency and the decomposition rate are available from an actual measurement or from the information of literatures for the subject PRTR chemicals.

When the substance is treated by two kinds of treatment devices connected in series, calculate the overall removal efficiency R by using the removal efficiency of the first device R1 and that of the second device R2 as shown below.

$$R = R1 + (1-R1) \times R2 = R1 + R2 - R1 \times R2$$

When three kinds of treatment devices connected in series, calculate the overall removal efficiency R by using the following formula in the same way.

$$R = R1 + R2 + R3 - R1 \times R2 - R1 \times R3 - R2 \times R3 + R1 \times R2 \times R3$$

Table 4. Summary of calculation

Amount of adhesive mass 100,000kg/y (solid content 30%)

Unit: kg

Case	1 without recovery system	2 with recovery system	3 with incinerator	
Adhesive purchased	100,000		50,000	
Adhesive manufactured		100,000	50,000	
1) Solvent handled	70,000	8,364	70,000	
Solvent used	70,000	70,000	70,000	Handled + recovered and used
2) Transfer as waste	1,400	1,400	1,400	2,000 x 0.7
Vaporized solvent	68,600	68,600	68,600	
Capture rate at recovery entrance (%)		90		
Captured amount		61,740		
Recovery rate (%)		99.83		
Amount of solvent recovered		61,636		
Recovery → Vapor absorb/desorb water		1,000		m^3
3) Recovery → exhausted into waste water		116		0.58 kg/ m^3
Capture rate at incinerator entrance (%)			90.45	
Captured amount			62,049	
Incineration rate (%)			99.5	
4) Incinerated amount			61,738	99.50%
5) Release to air	68,600	6,848	6,862	=1)-2)-3)-4)

In case of the incinerator, the capture rate is a problem.

3. Procedures and examples of estimating releases and transfers of solid components in the manufacturing process of adhesive tapes

The solid component is a sum of raw materials except solvent component released to air.

3.1. Flow diagram of solid components

The flow of the adhesive tape manufacturing process for the solid component is shown in Fig. 2.

As for the solid component, losses including the base material occurring in the process of coating primer, backside treatment agent, and adhesives on the tape base material and the losses occurring in the finishing/cutting process thereafter are transferred as waste.

If a thermal disposal equipment is owned, burnt ash is waste.

3.2. Calculation sheets for solid components of releases and transfers

A calculation sheet for solid component of the manufacturing process for adhesive tapes is shown in attached table 2.

3.3. Procedure of calculations

The procedure for estimating the quantities released and transferred other than solvent component in the adhesive tape manufacturing process is carried out in the following way.

3.3.1. Calculation of the handling amount of PRTR chemicals in adhesive tapes

The quantity handled (F) is expressed in the following formula.

$F = F1 \times f1j$

F1 … quantity of the adhesive tape handled,

f1j … content in the adhesives, etc.

When recycling is performed, the quantity subtracted by the quantity recycled is the quantity handled.

3.3.2. Calculation of the amount shipped out as products

Calculation is made by multiplying the quantity of the PRTR chemicals handled by the total yield of the product.

The yield is based on the actual value of the product.

The quantity shipped out as product (P) is expressed by the following formula.

$P = F \times p1j$

F … quantity handled,

p1j … product yield

3.3.3. Calculation of transfers as waste

The quantity of waste generated (D) is expressed by the following formula.

D = D1 + D2 = F (1-p1j)

D1 … waste handed over to waste disposal dealers

D2 …the quantity of Class I Substances in the burned ash generated in the thermal disposal.

F … Quantity handled, p1j … product yield

3.4. Examples of calculation

Outline of the equipment

Process: Adhesive tape manufacturing process

Quantity of adhesives used: 100,000kg / year

Lead nitrate content: 2 mass %

Ratio of lead element in lead nitrate: 62.6 %

Product yield: 95%

(Quantity of lead handled) = 100,000 x 0.02 x 0.626 = 1,250kg

(Quantity shipped out as product) = 1,250 x 0.95 = 1,188kg

(Transferred quantity by being contained in waste) = 1,250-1,188

= 62kg

Fig. 2 Flow of adhesive tape manufacturing process flow <solid component>

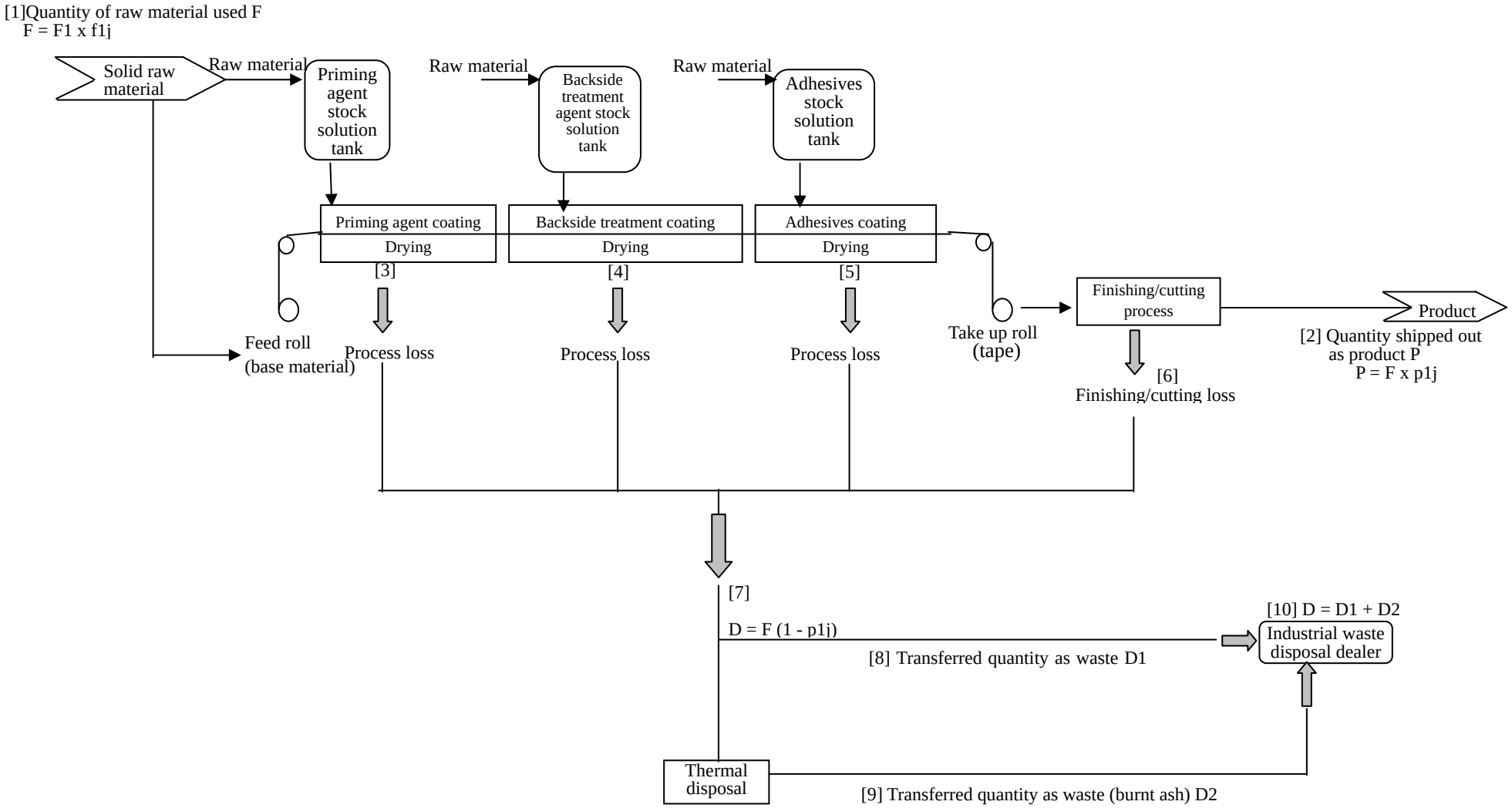

Table. 2 Calculation sheet for the quantities released and transferred in adhesives manufacturing processes <solid component>

		Quantity of Class I Designated Chemical Substances handled	Quantity shipped out as product	Process loss, cutting/roll replacement loss					Industrial waste disposal dealers		
Symbol		F	P	D					D		
Process No.		Purchase	Product	Primer coating	Back surface	Adhesive mass	Cutting	Total loss	Loss	Burnt ash	Total
		[1]	[2]	[3]	[4]	[5]	[6]	[7] [7]=[3]+[4]+[5]+[6] [7]=[1]−[2]	[8]	[9]	[10] [10]=[8]+[9]
Raw material	(Estimation method)	F = F1 x f1j	P = F x p1j p1j = product yield					D = F (1 - p1j)			D = D1 + D2
	Estimation example (lead and its compound)	1250	1188	−	−	−	−	62	62	−	62