# ALLEGATO N. 1

## "Fogli di Calcolo"

*Fiamma 2000 S.p.A.*
*Direttore Tecnico*

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*Fiamma 2000 S.p.A.*
*Il Gestore*
*Ing. Benito Camardella*

# Case description: Rilascio intempestivo da PSV

## Model: Liquefied Gas Vapour Release

**version: 5.09 (01/09/2010)**
**Reference: Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Use which representative step | First 20% average (flammable) |
| Type of release | Release through hole in vessel |
| *Pipeline length (m)* | |
| *Pipeline diameter (mm)* | |
| Hole diameter (mm) | 55,7 |
| Hole rounding | User defined |
| Discharge coefficient (-) | 0,8 |
| Initial temperature in equipment (°C) | 20 |
| Pressure inside vessel determination | Use actual pressure |
| Initial (absolute) pressure in vessel (bar) | 8,3 |
| Vessel volume (m3) | 5000 |
| Vessel type | Horizontal cylinder |
| Length cylinder (m) | 57 |
| Filling degree (%) | 50 |
| Type of calculation | Calculate until specified time |
| Time t after start release (s) | 1 |
| Results | |
| Initial mass in vessel (kg) | 1,2918E06 |
| Mass flow rate at time t (kg/s) | 4,3941 |
| Total mass released at time t (kg) | 4,4161 |
| *Time needed to empty vessel (s)* | |
| Pressure at time t (bar) | 8,3567 |
| Temperature at time t (°C) | 20 |
| Filling degree at time t (%) | 50 |
| Density gas at time t (kg/m3) | 15,119 |
| Maximum mass flow rate (kg/s) | 4,3941 |
| Representative release rate (kg/s) | 4,3941 |
| Representative outflow duration (s) | 1 |
| Representative temperature (°C) | 20 |
| Representative pressure (bar) | 8,3568 |
| Representative density (kg/m3) | 15,119 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 11.49.09*

# Foglio di Calcolo n° 1

# Case description: Rilascio intempestivo da PSV

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (01/09/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Vertical Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 4,39 |
| Duration of the release (s) | 900 |
| Initial liquid mass fraction (%) | 0 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,056 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 0 |
| Y-coordinate of release (m) | 15 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 900 |
| Concentration averaging time (s) | 900 |
| Results | |
| Explosive mass at time t (kg) | 0 |
| Height to LEL at time t (m) | 0 |
| Length of cloud (between LEL) at time t (m) | 0 |
| Width of cloud (between LEL) at time t (m) | 0 |
| Offset between release location and LEL at time t (m) | 0,001 |
| Maximum explosive mass (kg) | 0 |
| ...at time tmem (s) | 990 |
| Start time where 95% of maximum of explosive mass is reached (s) | 0 |
| Time where explosive mass starts decreasing below 95% of max (s) | 990 |
| Length of cloud (between LEL) at time tmem (m) | -0,97773 |
| Width of cloud (between LEL) at time tmem (m) | 0 |
| Offset between release location and LEL at time tmem (m) | 0,001 |
| Maximum area of explosive cloud (m2) | 0 |
| ...at time tmac (s) | 900 |
| Explosive mass at time tmac (kg) | 0 |
| Length of cloud (between LEL) at time tmac (m) | 6,2284 |
| Width of cloud (between LEL) at time tmac (m) | 0 |
| Offset between release location and LEL at time tmac (m) | 0,97773 |
| Offset between release centre and cloud centre at time tmac (m) | 4,0919 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0,04733 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 12 45.28*

# Foglio di Calcolo n° 1 Bis

# Case description: Rilascio intempestivo da PSV

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (01/09/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

**Parameters**

| | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Vertical Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 4,39 |
| Duration of the release (s) | 900 |
| Initial liquid mass fraction (%) | 0 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,056 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 0 |
| Y-coordinate of release (m) | 15 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 900 |
| Concentration averaging time (s) | 900 |

| | |
|---|---|
| Results | |
| Explosive mass at time t (kg) | 0 |
| Height to LEL at time t (m) | 0 |
| Length of cloud (between LEL) at time t (m) | 0 |
| Width of cloud (between LEL) at time t (m) | 0 |
| Offset between release location and LEL at time t (m) | 0,001 |
| Maximum explosive mass (kg) | 0 |
| ...at time tmem (s) | 990 |
| Start time where 95% of maximum of explosive mass is reached (s) | 0 |
| Time where explosive mass starts decreasing below 95% of max (s) | 990 |
| Length of cloud (between LEL) at time tmem (m) | -0,97773 |
| Width of cloud (between LEL) at time tmem (m) | 0 |
| Offset between release location and LEL at time tmem (m) | 0,001 |
| Maximum area of explosive cloud (m2) | 0 |
| ...at time tmac (s) | 900 |
| Explosive mass at time tmac (kg) | 0 |
| Length of cloud (between LEL) at time tmac (m) | 4,4456 |
| Width of cloud (between LEL) at time tmac (m) | 0 |
| Offset between release location and LEL at time tmac (m) | 0,97773 |
| Offset between release centre and cloud centre at time tmac (m) | 3,2006 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0 |

**Other information**

| | |
|---|---|
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 12.48.24*

# Foglio di Calcolo n° 1 Ter

# Case description: Rottura braccio di carico in discarica

## Model: Liquid release

**version: 5.08 (29/07/2010)**
**Reference: Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4**

| **Parameters** | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Use which representative step | First 20% average (flammable) |
| Type of release | Release from vessel through (a hole in) pipe |
| Pipeline length (m) | 40 |
| Pipeline diameter (mm) | 150 |
| Hole diameter (mm) | 50 |
| Hole rounding | User defined |
| Discharge coefficient (-) | 0,8 |
| Vessel type | Horizontal cylinder |
| Vessel volume (m3) | 300 |
| Length cylinder (m) | 26 |
| Filling degree (%) | 80 |
| Overpressure above liquid (assuming closed system) (bar) | 0 |
| Height leak above tank bottom (m) | 0 |
| Initial temperature in vessel (°C) | 20 |
| Type of calculation | Calculate until specified time |
| Time t after start release (s) | 1 |
| | |
| Results | |
| Initial mass in vessel (kg) | 1,204E05 |
| Mass flow rate at time t (kg/s) | 5,8032 |
| Total mass released at time t (kg) | 5,8323 |
| *Time needed to empty vessel (s)* | |
| Filling degree at time t (%) | 79,996 |
| Height of liquid at time t (m) | 2,859 |
| Maximum mass flow rate (kg/s) | 5,8034 |
| Representative release rate (kg/s) | 5,8034 |
| Representative outflow duration (s) | 1 |
| Representative pressure (bar) | 1,0151 |
| | |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 29/07/2010 16.59.34*

# Foglio di Calcolo n° 2

# Case description: Rottura manichetta flessibile in discarica lato ATB

## Model: Liquefied Gas Vapour Release

**version: 5.09 (29/07/2010)**
**Reference: Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Use which representative step | First 20% average (flammable) |
| Type of release | Release from vessel through (a hole in) pipe |
| Pipeline length (m) | 4 |
| Pipeline diameter (mm) | 50 |
| Hole diameter (mm) | 37,5 |
| Hole rounding | User defined |
| Discharge coefficient (-) | 0,8 |
| Initial temperature in equipment (°C) | 20 |
| Pressure inside vessel determination | Use actual pressure |
| Initial (absolute) pressure in vessel (bar) | 8 |
| Vessel volume (m3) | 300 |
| Vessel type | Horizontal cylinder |
| Length cylinder (m) | 26 |
| Filling degree (%) | 80 |
| Type of calculation | Calculate until specified time |
| Time t after start release (s) | 1 |
| Results | |
| Initial mass in vessel (kg) | 1,2127E05 |
| Mass flow rate at time t (kg/s) | 1,348 |
| Total mass released at time t (kg) | 1,3548 |
| *Time needed to empty vessel (s)* | |
| Pressure at time t (bar) | 8,3565 |
| Temperature at time t (°C) | 19,998 |
| Filling degree at time t (%) | 79,999 |
| Density gas at time t (kg/m3) | 15,118 |
| Maximum mass flow rate (kg/s) | 1,3481 |
| Representative release rate (kg/s) | 1,348 |
| Representative outflow duration (s) | 1 |
| Representative temperature (°C) | 20 |
| Representative pressure (bar) | 8,3568 |
| Representative density (kg/m3) | 15,119 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 29/07/2010 17.09.48*

# Foglio di Calcolo n° 3

# Case description: Rottura manichetta flessibile in discarica lato impianto

## Model: Liquefied Gas Vapour Release

**version: 5.09 (29/07/2010)**
**Reference: Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Use which representative step | First 20% average (flammable) |
| Type of release | Release from vessel through (a hole in) pipe |
| Pipeline length (m) | 40 |
| Pipeline diameter (mm) | 75 |
| Hole diameter (mm) | 37,5 |
| Hole rounding | User defined |
| Discharge coefficient (-) | 0,8 |
| Initial temperature in equipment (°C) | 20 |
| Pressure inside vessel determination | Use actual pressure |
| Initial (absolute) pressure in vessel (bar) | 8,2 |
| Vessel volume (m3) | 300 |
| Vessel type | Horizontal cylinder |
| Length cylinder (m) | 26 |
| Filling degree (%) | 0,8 |
| Type of calculation | Calculate until specified time |
| Time t after start release (s) | 1 |
| Results | |
| Initial mass in vessel (kg) | 5619 |
| Mass flow rate at time t (kg/s) | 1,8543 |
| Total mass released at time t (kg) | 1,8683 |
| *Time needed to empty vessel (s)* | |
| Pressure at time t (bar) | 8,3112 |
| Temperature at time t (°C) | 19,793 |
| Filling degree at time t (%) | 0,79876 |
| Density gas at time t (kg/m3) | 15,047 |
| Maximum mass flow rate (kg/s) | 1,8638 |
| Representative release rate (kg/s) | 1,8629 |
| Representative outflow duration (s) | 1 |
| Representative temperature (°C) | 19,979 |
| Representative pressure (bar) | 8,3522 |
| Representative density (kg/m3) | 15,112 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 29/07/2010 17.20.45*

# Foglio di Calcolo n° 4

# Case description: Rottura manichetta flessibile in caricazione lato ATB

## Model: Liquefied Gas Vapour Release

**version: 5.09 (29/07/2010)**
**Reference: Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Use which representative step | First 20% average (flammable) |
| Type of release | Release from vessel through (a hole in) pipe |
| Pipeline length (m) | 4 |
| Pipeline diameter (mm) | 50 |
| Hole diameter (mm) | 50 |
| Hole rounding | User defined |
| Discharge coefficient (-) | 0,8 |
| Initial temperature in equipment (°C) | 20 |
| Pressure inside vessel determination | Use actual pressure |
| Initial (absolute) pressure in vessel (bar) | 8,3 |
| Vessel volume (m3) | 1666 |
| Vessel type | Horizontal cylinder |
| Length cylinder (m) | 60 |
| Filling degree (%) | 80 |
| Type of calculation | Calculate until specified time |
| Time t after start release (s) | 1 |
| Results | |
| Initial mass in vessel (kg) | 6,7365E05 |
| Mass flow rate at time t (kg/s) | 3,0216 |
| Total mass released at time t (kg) | 3,0368 |
| *Time needed to empty vessel (s)* | |
| Pressure at time t (bar) | 8,3567 |
| Temperature at time t (°C) | 19,999 |
| Filling degree at time t (%) | 80 |
| Density gas at time t (kg/m3) | 15,119 |
| Maximum mass flow rate (kg/s) | 3,0217 |
| Representative release rate (kg/s) | 3,0217 |
| Representative outflow duration (s) | 1 |
| Representative temperature (°C) | 20 |
| Representative pressure (bar) | 8,3568 |
| Representative density (kg/m3) | 15,119 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 29/07/2010 18.06.13*

# Foglio di Calcolo n° 3 Bis

# Case description: Rottura manichetta flessibile in caricazione lato impianto

## Model: Liquefied Gas Vapour Release

**version: 5.09 (29/07/2010)**
**Reference: Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Use which representative step | First 20% average (flammable) |
| Type of release | Release from vessel through (a hole in) pipe |
| Pipeline length (m) | 100 |
| Pipeline diameter (mm) | 75 |
| Hole diameter (mm) | 50 |
| Hole rounding | User defined |
| Discharge coefficient (-) | 0,8 |
| Initial temperature in equipment (°C) | 20 |
| Pressure inside vessel determination | Use actual pressure |
| Initial (absolute) pressure in vessel (bar) | 8,3 |
| Vessel volume (m3) | 1666 |
| Vessel type | Horizontal cylinder |
| Length cylinder (m) | 60 |
| Filling degree (%) | 80 |
| Type of calculation | Calculate until specified time |
| Time t after start release (s) | 1 |
| Results | |
| Initial mass in vessel (kg) | 6,7365E05 |
| Mass flow rate at time t (kg/s) | 2,4318 |
| Total mass released at time t (kg) | 2,4439 |
| *Time needed to empty vessel (s)* | |
| Pressure at time t (bar) | 8,3567 |
| Temperature at time t (°C) | 20 |
| Filling degree at time t (%) | 80 |
| Density gas at time t (kg/m3) | 15,119 |
| Maximum mass flow rate (kg/s) | 2,4318 |
| Representative release rate (kg/s) | 2,4318 |
| Representative outflow duration (s) | 1 |
| Representative temperature (°C) | 20 |
| Representative pressure (bar) | 8,3568 |
| Representative density (kg/m3) | 15,119 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 29/07/2010 18.16.56*

# Foglio di Calcolo n° 4 Bis

# Case description: Rottura catastrofica pompa Sala pompe attuale

## Model: Liquid release

**version: 5.08 (29/07/2010)**
**Reference: Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4**

| **Parameters** | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Use which representative step | First 20% average (flammable) |
| Type of release | Release from vessel through (a hole in) pipe |
| Pipeline length (m) | 15 |
| Pipeline diameter (mm) | 150 |
| Hole diameter (mm) | 50 |
| Hole rounding | User defined |
| Discharge coefficient (-) | 0,8 |
| Vessel type | Horizontal cylinder |
| Vessel volume (m3) | 300 |
| Length cylinder (m) | 30 |
| Filling degree (%) | 80 |
| Overpressure above liquid (assuming closed system) (bar) | 0 |
| Height leak above tank bottom (m) | 0 |
| Initial temperature in vessel (°C) | 20 |
| Type of calculation | Calculate until specified time |
| Time t after start release (s) | 1 |
| Results | |
| Initial mass in vessel (kg) | 1,204E05 |
| Mass flow rate at time t (kg/s) | 5,6577 |
| Total mass released at time t (kg) | 5,686 |
| *Time needed to empty vessel (s)* | |
| Filling degree at time t (%) | 79,996 |
| Height of liquid at time t (m) | 2,6615 |
| Maximum mass flow rate (kg/s) | 5,6578 |
| Representative release rate (kg/s) | 5,6578 |
| Representative outflow duration (s) | 1 |
| Representative pressure (bar) | 1,0151 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 29/07/2010 18.45.19*

# Case description: Rottura catastrofica pompa della Nuova Sala pompe

## Model: Liquid release

**version: 5.08 (29/07/2010)**
**Reference: Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4Yellow Book, CPR-14E, 3rd edition 1997, Paragraph 2.5.4**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Use which representative step | First 20% average (flammable) |
| Type of release | Release from vessel through (a hole in) pipe |
| Pipeline length (m) | 15 |
| Pipeline diameter (mm) | 250 |
| Hole diameter (mm) | 50 |
| Hole rounding | User defined |
| Discharge coefficient (-) | 0,8 |
| Vessel type | Horizontal cylinder |
| Vessel volume (m3) | 1666 |
| Length cylinder (m) | 60 |
| Filling degree (%) | 80 |
| Overpressure above liquid (assuming closed system) (bar) | 0 |
| Height leak above tank bottom (m) | 0 |
| Initial temperature in vessel (°C) | 20 |
| Type of calculation | Calculate until specified time |
| Time t after start release (s) | 1 |
| Results | |
| Initial mass in vessel (kg) | 6,6865E05 |
| Mass flow rate at time t (kg/s) | 7,3464 |
| Total mass released at time t (kg) | 7,3832 |
| *Time needed to empty vessel (s)* | |
| Filling degree at time t (%) | 79,999 |
| Height of liquid at time t (m) | 4,4352 |
| Maximum mass flow rate (kg/s) | 7,3465 |
| Representative release rate (kg/s) | 7,3465 |
| Representative outflow duration (s) | 1 |
| Representative pressure (bar) | 1,0151 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 29/07/2010 18.53.16*

# Foglio di Calcolo n° 5 Bis

# Case description: Rottura braccio di carico in fase di caricazione PT 1, 2 e 3

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (02/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

**Parameters**

| Inputs | |
|---|---|
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 10,6 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |

| Results | |
|---|---|
| Explosive mass at time t (kg) | 112,94 |
| Height to LEL at time t (m) | 2,4 |
| Length of cloud (between LEL) at time t (m) | 17,339 |
| Width of cloud (between LEL) at time t (m) | 57,863 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 131,63 |
| ...at time tmem (s) | 24,75 |
| Start time where 95% of maximum of explosive mass is reached (s) | 22,985 |
| Time where explosive mass starts decreasing below 95% of max (s) | 25,153 |
| Length of cloud (between LEL) at time tmem (m) | 37,585 |
| Width of cloud (between LEL) at time tmem (m) | 69,697 |
| Offset between release location and LEL at time tmem (m) | 1 |
| Maximum area of explosive cloud (m2) | 1795,7 |
| ...at time tmac (s) | 24,75 |
| Explosive mass at time tmac (kg) | 131,63 |
| Length of cloud (between LEL) at time tmac (m) | 37,585 |
| Width of cloud (between LEL) at time tmac (m) | 69,697 |
| Offset between release location and LEL at time tmac (m) | 1 |
| Offset between release centre and cloud centre at time tmac (m) | 19,792 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0,04733 |

| **Other information** | |
|---|---|
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 02/08/2010 16.13.26*

# Foglio di Calcolo n° 6

# Case description: Rottura braccio di carico in fase di caricazione PT 1, 2 e 3

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (02/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 10,6 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Results | |
| Explosive mass at time t (kg) | 86,423 |
| Height to LEL at time t (m) | 2,6 |
| Length of cloud (between LEL) at time t (m) | 28,477 |
| Width of cloud (between LEL) at time t (m) | 24,507 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 92,223 |
| ...at time tmem (s) | 21,45 |
| Start time where 95% of maximum of explosive mass is reached (s) | 20,138 |
| Time where explosive mass starts decreasing below 95% of max (s) | 21,544 |
| Length of cloud (between LEL) at time tmem (m) | 44,169 |
| Width of cloud (between LEL) at time tmem (m) | 27,794 |
| Offset between release location and LEL at time tmem (m) | 1 |
| Maximum area of explosive cloud (m2) | 863,74 |
| ...at time tmac (s) | 21,45 |
| Explosive mass at time tmac (kg) | 92,223 |
| Length of cloud (between LEL) at time tmac (m) | 44,169 |
| Width of cloud (between LEL) at time tmac (m) | 27,794 |
| Offset between release location and LEL at time tmac (m) | 1 |
| Offset between release centre and cloud centre at time tmac (m) | 23,085 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 02/08/2010 16.37.16*

# Foglio di Calcolo n° 7

# Case description: Rottura braccio di carico in fase di caricazione PT 1, 2 e 3

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (03/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 10,6 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 58 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| | |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 16812 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,9048E06 |
| ...at distance (m) | 1,11 |
| Maximum distance to threshold concentration (m) | 37,419 |
| | |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\L.Monacelli at 03/08/2010 16.51.56*

# Foglio di Calcolo n° 8

# Case description: Rottura braccio di carico in fase di caricazione PT 1, 2 e 3

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (03/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| **Parameters** | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 10,6 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 31 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| | |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 3288,6 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,9048E06 |
| ...at distance (m) | 1,1481 |
| Maximum distance to threshold concentration (m) | 52,131 |
| | |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programm\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\L.Monacelli at 03/08/2010 16.54.09*

# Foglio di Calcolo n° 9

# Case description: Rottura braccio di carico in fase di caricazione PT 1, 2 e 3

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (03/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 10,6 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 36 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| **Results** | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 38222 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,9048E06 |
| ...at distance (m) | 1,11 |
| Maximum distance to threshold concentration (m) | 31,01 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\L.Monacelli at 03/08/2010 16.46.10*

# Case description: Rottura braccio di carico in fase di caricazione PT 1, 2 e 3

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (03/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 10.6 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 24 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 21990 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,9048E06 |
| ...at distance (m) | 1,1481 |
| Maximum distance to threshold concentration (m) | 32,73 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\L.Monacelli at 03/08/2010 16.47.55*

# Case description: Rottura braccio di carico in fase di caricazione PT 4, 5 e 6

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (04/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 20,9 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0,5 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Results | |
| Explosive mass at time t (kg) | 216,01 |
| Height to LEL at time t (m) | 2,8 |
| Length of cloud (between LEL) at time t (m) | 19,019 |
| Width of cloud (between LEL) at time t (m) | 72,904 |
| Offset between release location and LEL at time t (m) | 6,0635 |
| Maximum explosive mass (kg) | 317,28 |
| ...at time tmem (s) | 24,75 |
| Start time where 95% of maximum of explosive mass is reached (s) | 24,16 |
| Time where explosive mass starts decreasing below 95% of max (s) | 25,457 |
| Length of cloud (between LEL) at time tmem (m) | 44,783 |
| Width of cloud (between LEL) at time tmem (m) | 94,668 |
| Offset between release location and LEL at time tmem (m) | 6,4997 |
| Maximum area of explosive cloud (m2) | 3111,6 |
| ...at time tmac (s) | 27,225 |
| Explosive mass at time tmac (kg) | 261,73 |
| Length of cloud (between LEL) at time tmac (m) | 48,925 |
| Width of cloud (between LEL) at time tmac (m) | 87,826 |
| Offset between release location and LEL at time tmac (m) | 6,5354 |
| Offset between release centre and cloud centre at time tmac (m) | 30,998 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0,04733 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 04/08/2010 19.17.06*

# Foglio di Calcolo n° 6 Bis

# Case description: Rottura braccio di carico in fase di caricazione PT 4, 5 e 6

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (04/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 20,9 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Results | |
| Explosive mass at time t (kg) | 201,49 |
| Height to LEL at time t (m) | 3,2 |
| Length of cloud (between LEL) at time t (m) | 41,788 |
| Width of cloud (between LEL) at time t (m) | 33,528 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 246,19 |
| ...at time tmem (s) | 21,45 |
| Start time where 95% of maximum of explosive mass is reached (s) | 20,996 |
| Time where explosive mass starts decreasing below 95% of max (s) | 21,622 |
| Length of cloud (between LEL) at time tmem (m) | 49,577 |
| Width of cloud (between LEL) at time tmem (m) | 42,913 |
| Offset between release location and LEL at time tmem (m) | 3,3837 |
| Maximum area of explosive cloud (m2) | 1432 |
| ...at time tmac (s) | 21,45 |
| Explosive mass at time tmac (kg) | 246,19 |
| Length of cloud (between LEL) at time tmac (m) | 49,577 |
| Width of cloud (between LEL) at time tmac (m) | 42,913 |
| Offset between release location and LEL at time tmac (m) | 3,3837 |
| Offset between release centre and cloud centre at time tmac (m) | 28,172 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 04/08/2010 19.22.10*

# Foglio di Calcolo n° 7 Bis

# Case description: Rottura braccio di carico in fase di caricazione PT 4, 5 e 6

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (04/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 20,9 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0,5 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 75 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 14774 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,9048E06 |
| ...at distance (m) | 7,2226 |
| Maximum distance to threshold concentration (m) | 55,073 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 04/08/2010 19.34.32*

# Foglio di Calcolo n° 8 Bis

# Case description: Rottura braccio di carico in fase di caricazione PT 4, 5 e 6

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (04/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| **Parameters** | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 20,9 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 36 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 1754 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,9048E06 |
| ...at distance (m) | 1,1481 |
| Maximum distance to threshold concentration (m) | 68,08 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 04/08/2010 19.38.58*

# Foglio di Calcolo n° 9 Bis

# Case description: Rottura braccio di carico in fase di caricazione PT 4, 5 e 6

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (04/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 20,9 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0,5 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 45 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 35978 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,9048E06 |
| ...at distance (m) | 7,2226 |
| Maximum distance to threshold concentration (m) | 30,01 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 04/08/2010 19.43.15*

# Case description: Rottura braccio di carico in fase di caricazione PT 4, 5 e 6

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (04/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| **Parameters** | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 20,9 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 28 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| | |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 9775,8 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,9048E06 |
| ...at distance (m) | 1,1481 |
| Maximum distance to threshold concentration (m) | 44,38 |
| | |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 04/08/2010 19.47.04*

# Foglio di Calcolo n° 11 Bis

# Case description: Rottura pompa Sala Pompe e Compressori attuale

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (01/09/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| **Parameters** | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 5,66 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 100 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Results | |
| Explosive mass at time t (kg) | 58,56 |
| Height to LEL at time t (m) | 5,5 |
| Length of cloud (between LEL) at time t (m) | 14,666 |
| Width of cloud (between LEL) at time t (m) | 47,282 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 58,56 |
| ...at time tmem (s) | 19,8 |
| Start time where 95% of maximum of explosive mass is reached (s) | 14,121 |
| Time where explosive mass starts decreasing below 95% of max (s) | 20,303 |
| Length of cloud (between LEL) at time tmem (m) | 14,666 |
| Width of cloud (between LEL) at time tmem (m) | 47,282 |
| Offset between release location and LEL at time tmem (m) | 1 |
| Maximum area of explosive cloud (m2) | 854,97 |
| ...at time tmac (s) | 24,75 |
| Explosive mass at time tmac (kg) | 29,262 |
| Length of cloud (between LEL) at time tmac (m) | 34,245 |
| Width of cloud (between LEL) at time tmac (m) | 36,503 |
| Offset between release location and LEL at time tmac (m) | 1 |
| Offset between release centre and cloud centre at time tmac (m) | 18,122 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0,04733 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 16.13.55*

# Case description: Rottura pompa Sala Pompe e Compressori attuale

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (01/09/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| Parameters | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 5,66 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 100 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Results | |
| Explosive mass at time t (kg) | 30,207 |
| Height to LEL at time t (m) | 3,6 |
| Length of cloud (between LEL) at time t (m) | 22,345 |
| Width of cloud (between LEL) at time t (m) | 14,626 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 30,207 |
| ...at time tmem (s) | 11 |
| Start time where 95% of maximum of explosive mass is reached (s) | 8,4248 |
| Time where explosive mass starts decreasing below 95% of max (s) | 20 |
| Length of cloud (between LEL) at time tmem (m) | 22,345 |
| Width of cloud (between LEL) at time tmem (m) | 14,626 |
| Offset between release location and LEL at time tmem (m) | 1 |
| Maximum area of explosive cloud (m2) | 238,18 |
| ...at time tmac (s) | 20 |
| Explosive mass at time tmac (kg) | 30,207 |
| Length of cloud (between LEL) at time tmac (m) | 22,345 |
| Width of cloud (between LEL) at time tmac (m) | 14,626 |
| Offset between release location and LEL at time tmac (m) | 1 |
| Offset between release centre and cloud centre at time tmac (m) | 12,172 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 16.16.40*

# Case description: Rottura pompa Sala Pompe e Compressori attuale

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (01/09/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 5,66 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 1,4996E05 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 3,462E05 |
| ...at distance (m) | 1,1 |
| Maximum distance to threshold concentration (m) | 17,015 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 16.22.38*

# Case description: Rottura pompa Sala Pompe e Compressori attuale

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (01/09/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 5,66 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| | |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 1,1735E05 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 4,2751E05 |
| ...at distance (m) | 1,1 |
| Maximum distance to threshold concentration (m) | 36,047 |
| | |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programm\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 16.23.27*

# Case description: Rottura pompa Sala Pompe e Compressori attuale

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (01/09/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 5,66 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| | |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 1,4996E05 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 3,462E05 |
| ...at distance (m) | 1,1 |
| Maximum distance to threshold concentration (m) | 15,666 |
| | |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 16.19.26*

# Case description: Rottura pompa Sala Pompe e Compressori attuale

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (01/09/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 5,66 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| | |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 1,1735E05 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 4,2751E05 |
| ...at distance (m) | 1,1 |
| Maximum distance to threshold concentration (m) | 23,345 |
| | |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programm\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 01/09/2010 16.20.55*

# Case description: Rottura Pompa Booster

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 1,52 |
| Duration of the release (s) | 30 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 100 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Results | |
| Explosive mass at time t (kg) | 19,875 |
| Height to LEL at time t (m) | 1,6 |
| Length of cloud (between LEL) at time t (m) | 10,609 |
| Width of cloud (between LEL) at time t (m) | 31,589 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 20,116 |
| ...at time tmem (s) | 29,7 |
| Start time where 95% of maximum of explosive mass is reached (s) | 18,761 |
| Time where explosive mass starts decreasing below 95% of max (s) | 34,687 |
| Length of cloud (between LEL) at time tmem (m) | 8,7552 |
| Width of cloud (between LEL) at time tmem (m) | 31,724 |
| Offset between release location and LEL at time tmem (m) | 1 |
| Maximum area of explosive cloud (m2) | 379,31 |
| ...at time tmac (s) | 34,65 |
| Explosive mass at time tmac (kg) | 19,397 |
| Length of cloud (between LEL) at time tmac (m) | 13,323 |
| Width of cloud (between LEL) at time tmac (m) | 42,15 |
| Offset between release location and LEL at time tmac (m) | 3,7131 |
| Offset between release centre and cloud centre at time tmac (m) | 10,375 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0.04733 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 9.55.58*

# Case description: Rottura Pompa Booster

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 1,52 |
| Duration of the release (s) | 30 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 100 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Results | |
| Explosive mass at time t (kg) | 5,808 |
| Height to LEL at time t (m) | 1,6 |
| Length of cloud (between LEL) at time t (m) | 9,5612 |
| Width of cloud (between LEL) at time t (m) | 7,9636 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 5,808 |
| ...at time tmem (s) | 29,7 |
| Start time where 95% of maximum of explosive mass is reached (s) | 5,8076 |
| Time where explosive mass starts decreasing below 95% of max (s) | 30 |
| Length of cloud (between LEL) at time tmem (m) | 9,5612 |
| Width of cloud (between LEL) at time tmem (m) | 7,9636 |
| Offset between release location and LEL at time tmem (m) | 1 |
| Maximum area of explosive cloud (m2) | 59,154 |
| ...at time tmac (s) | 30 |
| Explosive mass at time tmac (kg) | 5,808 |
| Length of cloud (between LEL) at time tmac (m) | 9,5612 |
| Width of cloud (between LEL) at time tmac (m) | 7,9636 |
| Offset between release location and LEL at time tmac (m) | 1 |
| Offset between release centre and cloud centre at time tmac (m) | 5,7806 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 10.06.49*

# Case description: Rottura Pompa Booster

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

**Parameters**

| Inputs | |
|---|---|
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 1,52 |
| Duration of the release (s) | 30 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 45 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |

| Results | |
|---|---|
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 18543 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,6771E06 |
| ...at distance (m) | 1,1 |
| Maximum distance to threshold concentration (m) | 22,106 |

| **Other information** | |
|---|---|
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 10.14.50*

# Case description: Rottura Pompa Booster

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 1,52 |
| Duration of the release (s) | 30 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 30 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | No |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 41337 |
| Maximum distance to threshold concentration (m) | 18,449 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 10.20.17*

# Case description: Rottura Pompa Booster

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 1,52 |
| Duration of the release (s) | 30 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 37 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 66584 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 1,6771E06 |
| ...at distance (m) | 1,1 |
| Maximum distance to threshold concentration (m) | 17,932 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 10.24.20*

# Foglio di Calcolo n° 22

# Case description: Rottura Pompa Booster

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 1,52 |
| Duration of the release (s) | 30 |
| Initial liquid mass fraction (%) | 100 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 30 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | No |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 41337 |
| Maximum distance to threshold concentration (m) | 10,561 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 10.27.50*

# Case description: Rottura pompa nuova Sala Pompe

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| **Parameters** | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 7,35 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 100 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |
| Results | |
| Explosive mass at time t (kg) | 67,232 |
| Height to LEL at time t (m) | 5,5 |
| Length of cloud (between LEL) at time t (m) | 16,695 |
| Width of cloud (between LEL) at time t (m) | 45,339 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 81,106 |
| ...at time tmem (s) | 23,1 |
| Start time where 95% of maximum of explosive mass is reached (s) | 21,576 |
| Time where explosive mass starts decreasing below 95% of max (s) | 23,397 |
| Length of cloud (between LEL) at time tmem (m) | 32,884 |
| Width of cloud (between LEL) at time tmem (m) | 56,751 |
| Offset between release location and LEL at time tmem (m) | 1 |
| Maximum area of explosive cloud (m2) | 1214,7 |
| ...at time tmac (s) | 23,1 |
| Explosive mass at time tmac (kg) | 81,106 |
| Length of cloud (between LEL) at time tmac (m) | 32,884 |
| Width of cloud (between LEL) at time tmac (m) | 56,751 |
| Offset between release location and LEL at time tmac (m) | 1 |
| Offset between release centre and cloud centre at time tmac (m) | 17,442 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0,04733 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 12.41.04*

# Foglio di Calcolo n° 12 Bis

# Case description: Rottura pompa nuova Sala Pompe

## Model: Dense Gas Dispersion: Explosive mass

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

**Parameters**

| | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 7,35 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 100 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 20 |
| Concentration averaging time (s) | 20 |

| | |
|---|---|
| Results | |
| Explosive mass at time t (kg) | 42,711 |
| Height to LEL at time t (m) | 3,9 |
| Length of cloud (between LEL) at time t (m) | 26,4 |
| Width of cloud (between LEL) at time t (m) | 16,364 |
| Offset between release location and LEL at time t (m) | 1 |
| Maximum explosive mass (kg) | 42,711 |
| ...at time tmem (s) | 11,55 |
| Start time where 95% of maximum of explosive mass is reached (s) | 9,3363 |
| Time where explosive mass starts decreasing below 95% of max (s) | 20 |
| Length of cloud (between LEL) at time tmem (m) | 26,4 |
| Width of cloud (between LEL) at time tmem (m) | 16,364 |
| Offset between release location and LEL at time tmem (m) | 1 |
| Maximum area of explosive cloud (m2) | 314,95 |
| ...at time tmac (s) | 20 |
| Explosive mass at time tmac (kg) | 42,711 |
| Length of cloud (between LEL) at time tmac (m) | 26,4 |
| Width of cloud (between LEL) at time tmac (m) | 16,364 |
| Offset between release location and LEL at time tmac (m) | 1 |
| Offset between release centre and cloud centre at time tmac (m) | 14,2 |
| Inverse Monin-Obukhov length (1/L) used (1/m) | 0 |

| | |
|---|---|
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 12.45.15*

# Foglio di Calcolo n° 13 Bis

# Case description: Rottura pompa nuova Sala Pompe

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 7,35 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 47 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 18170 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 3,4585E05 |
| ...at distance (m) | 1,1 |
| Maximum distance to threshold concentration (m) | 36,806 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 17.02.34*

# Foglio di Calcolo n° 14 Bis

# Case description: Rottura pompa nuova Sala Pompe

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| **Parameters** | |
|---|---|
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 7,35 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 26 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | User defined |
| Threshold concentration (mg/m3) | 18900 |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | No |
| | |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 6311,1 |
| Maximum distance to threshold concentration (m) | 55,741 |
| | |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 17.06.10*

# Foglio di Calcolo n° 15 Bis

# Case description: Rottura pompa nuova Sala Pompe

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

| | |
|---|---|
| **Parameters** | |
| Inputs | |
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 7,35 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | F (Very Stable) |
| Wind speed at 10 m height (m/s) | 2 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 30 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | No |
| Results | |
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 40928 |
| Maximum distance to threshold concentration (m) | 34,995 |
| **Other information** | |
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 17.15.39*

# Foglio di Calcolo n° 16 Bis

# Case description: Rottura pompa nuova Sala Pompe

## Model: Dense Gas Dispersion: Concentration

**version: 5.13 (05/08/2010)**
**Reference: Yellow Book 3rd edition 1997 chapter 4; Ermak, D.L. User manual for SLAB Lawrence Livermore National Laboratory, June 1990**

**Parameters**

| Inputs | |
|---|---|
| Chemical name | Propane (YAWS) |
| Type of release | Horizontal Jet release |
| *Total mass released (kg)* | |
| Mass flow rate of the source (kg/s) | 7,35 |
| Duration of the release (s) | 20 |
| Initial liquid mass fraction (%) | 93 |
| *Fixed pool surface (m2)* | |
| Diameter of expanded jet (m) | 0,05 |
| Temperature after release (°C) | 20 |
| X-coordinate of release (m) | 10 |
| Y-coordinate of release (m) | 0 |
| Z-coordinate (height) of release (m) | 0 |
| Pasquill stability class | D (Neutral) |
| Wind speed at 10 m height (m/s) | 5 |
| Roughness length description | Cultivated land |
| Time t after start release (s) | 22 |
| Concentration averaging time (s) | 20 |
| Distance from release (Xd) (m) | 10 |
| Distance perpendicular to wind direction (Yd) (m) | 0 |
| Height (Zd) (m) | 0 |
| Predefined concentration | LEL (Lower Explosion Limit) |
| *Threshold concentration (mg/m3)* | *38504* |
| Predefined wind direction | S |
| *Wind comes from (North = 0 degrees) (deg)* | *180* |
| Perform Max Conc vs Distance graph | Yes |

| Results | |
|---|---|
| Concentration at (Xd, Yd, Zd, t) (mg/m3) | 39883 |
| Maximum concentration at (Yd, Zd) (mg/m3) | 4,2675E05 |
| ...at distance (m) | 1,1 |
| Maximum distance to threshold concentration (m) | 51,772 |

| **Other information** | |
|---|---|
| Main program | Effects 8.0.1.3218 |
| Chemical database | YAWS database |
| Chemical database path | C:\Programmi\TNO\Effects 8.0\Shared data\Databases\Purple Book (1999).rdb |
| Chemical database date | 12/02/2009 |

*Effects report created by FIAMMAWKS051\l.monacelli at 05/08/2010 17.21.17*

# Foglio di Calcolo n° 17 Bis

# RIEPILOGO

| EVENTO | LEL | | 50% LEL | |
|---|---|---|---|---|
| | D-5 mt | F-2 mt | D-5 mt | F-2 mt |
| Rottura braccio carico 1-2 e 3 | 32,73 | 31,01 | 52,13 | 37,41 |
| Rottura braccio carico 4-5 e 6 | 44,38 | 30,01 | 68,08 | 55,07 |
| Rottura sala pompa e compressori attuali | 23,34 | 15,66 | 36,04 | 17,01 |
| Rottura pompa booster | 10,56 | 17,93 | 18,44 | 22,1 |
| Rottura pompa nuova sala pompe | 51,77 | 34,99 | 55,74 | 36,8 |

| EVENTO | MASSA ESPLOSIVA | |
|---|---|---|
| | D-5 kg | F-2 kg |
| Rottura braccio 1-2-3 | 92,22 | 131,63 |
| Rottura braccio 4-5-6 | 246,19 | 317,28 |
| Rottura catastrofica pompa attuale | 30,2 | 58,56 |
| Rottura catastrofica pompa booster | 5,8 | 20,11 |
| Rottura catastrofica pompa nuova | 42,71 | 81,1 |
| Scatto PSV serbatoio da 5000 mc | 0 | 0 |