Problem definition. Emergency aircraft evacuation refers to emergency evacuation from an aircraft that may take place on the ground, in water, or mid-flight. There are standard evacuation procedures and special evacuation equipment but their application still does not guarantee safe leaving of the cabin without any injuries for all passengers and crewmembers. Therefore, problem of elimination of all possible harm for people onboard in emergency situation needs to be resolved with new improvements preventing mentioned risks. Thus, the task of implementation of new methods of emergency evacuation is evidently actual.

Analysis of last investigations and publications. Emergency evacuations of commercial passenger aircrafts often lead to passengers and crew injuries of different level of harm. Such problems rise due to several safety deficiencies represented in the evacuation process realization. These deficiencies are often associated with communications, exit operation and passenger preparedness for evacuation that may be complicated because of the presence of fire and smoke.

As it is represented in the United States’ National Transportation Safety Board report during a 16 months study period all the commercial airplanes’ evacuations that took place in different airports in the USA were recorded [1]. For this survey total amount of studied emergency cases leading to evacuation procedures taken is equal to 46. The events leading to the emergency evacuation in all studied cases are shown in Table 1.

Table 1 Distribution of the events leading to the emergency evacuation [1]

<table>
<thead>
<tr>
<th>Event</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine fire / suspected engine fire</td>
<td>18 (including 15 cases with engine fire presence)</td>
</tr>
<tr>
<td>Cargo smoke / cargo fire indication</td>
<td>8</td>
</tr>
<tr>
<td>Smoke inside the cabin</td>
<td>4</td>
</tr>
<tr>
<td>Gear failure</td>
<td>4</td>
</tr>
<tr>
<td>Smoke in the cockpit</td>
<td>3</td>
</tr>
<tr>
<td>Overran runway</td>
<td>3</td>
</tr>
<tr>
<td>Bomb threat</td>
<td>2</td>
</tr>
<tr>
<td>Landed short of runway</td>
<td>1</td>
</tr>
<tr>
<td>Lavatory smoke warning</td>
<td>1</td>
</tr>
<tr>
<td>Baggage cart collision</td>
<td>1</td>
</tr>
<tr>
<td>Auxiliary power unit torch</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total number of events</strong></td>
<td><strong>46</strong></td>
</tr>
</tbody>
</table>

As for accident or evacuation related injuries they occurred in 18 (39.13%) of the evaluated cases. 232 (8.15%) of the 2846 occupants onboard were injured with minor, serious and fatal outcome. On Figure 1 the representation of injuries according to their heaviness is shown.

Results represented in Table 2 show quantities of injuries evaluated for crewmembers and pas-

![Fig. 1. Percentage of crewmembers and passengers who sustained serious (including fatal outcomes) or minor injuries [1]](image-url)
sengers including people injured at accident and evacuation period altogether.

As it may be clearly seen from the analysis of data achieved by the investigators big enough amount of people who are to take evacuation actions are injured. It means that there will be serious difficulties in their transportation to the exit sites causing delays in the cabin evacuation. Therefore, emergency evacuation has to be enhanced to ensure safety and survivability of passengers and crewmembers.

**Emphasizing of the general problem parts that were not resolved before.**

Different steps were followed to improve the emergency evacuation of an airplane. These actions include enhancement of the safety regulations directed on making stricter conditions regarding the emergency evacuation provision. Different companies also try to find new techniques and create new equipment that might improve the evacuation.

However, in practical implementation this enhancement did not influence on changing of the design of the ways of transportation of passengers and crewmembers to the emergency exits. One of the methods that can improve evacuation safety is dedicated to application of moving walkways installed on the floor of the cabin aisles.

**The aim of the article.** The primary aim of the represented work is in the assessment of the possibility of the moving walkways usage for large passenger aircrafts according to safety conditions established for maximum time allowed for evacuation.

**Exposition of the main material.** Moving walkways installed on the floor of the cabin aisles have to transport passengers and crewmembers to emergency doors. The transportation process may be realized according to three following principles.

A. Evacuation plan improvement. When the airplane stops and emergency evacuation is needed, the following systematic scheme has to be realized.

1. All seat belts are disassembled automatically or manually using special switch controlled by crew, or each passenger can disassemble his/her own (and others’) seat belt manually.
2. Exit doors open automatically or manually (all together or each by itself) by crewmembers or passengers.
3. Slides open automatically (or manually by crewmembers or passengers) with the opening of the exit doors.
4. Moving walkways corresponding to the opened doors and slides are activated automatically (or manually by crewmembers or passengers) transporting passengers to the nearest open exit.
5. Passengers and crewmembers jump on the evacuation slides and slide down to the ground or water surface.
6. Passengers and crewmembers move away from the airplane to avoid any possible fire or explosion.

7. Passengers and crewmembers contact the rescue teams asking for help in any possible way, especially if the landing was not taking place on the territory of the airport.

**B. Increase of effectiveness of safety actions.** Application of moving walkways in represented step-by-step procedure will give such advantages as:

a) easy support to be provided by crewmembers or other passengers for children, old people, disabled and injured ones; they may sit on the moving walkway to be transported to the exit, slide and finally to the ground;

b) passengers are led to the exits in case of lack of visibility, for example, in case of smoke presence;

c) passengers are distributed to the several exits; it decreases the crowd in aisles and doors;

d) passengers and crewmembers may walk on the moving walkway faster than its speed and bypass the passengers who cannot move faster;

e) malfunction of the moving walkway does not affect the ability of the passenger to reach emergency exits marching through the aisle;

f) if being provided with extra in-flight power supply these moving walkways may be used in non-emergency conditions for transportation inside the cabin, for example, during the catering period, etc.

C. Minimization of the evacuation time value. Evacuation procedures are to provide safe leaving of the cabin for all people onboard within the period before fire or explosion initiation.

In the represented work the assessment of the maximum evacuation time for large passenger airplane was done. Initial data for the calculation were collected in the following way.

1. Assessment of the limiting time value. Federal Aviation Administration (FAA) requires that an airliner should be capable of being evacuated within 90 seconds in the dark and with half the exits blocked \( t_{lt} = 90 \text{ s} \). Use of only half of the exits simulates the potential for failed evacuation devices or exits blocked due to fire or structural damage [2]. Ninety seconds value is established as the maximum evacuation time because tests have shown that the post-crash fire conditions conducive to flashover are unlikely to occur within the mentioned time span.

2. Assessment of the limiting walkway speed value. In European Standards EN 115 they establish the limiting speed value for moving walks to be equal to 0.75 m/s [3]. Taking into account the design of the walkway and seats providing perpendicular entry from seats to the moving walkway (see Figure 2c) half of that speed is used in our calculations \( v_{max} = 0.375 \text{ m/s} \).

3. Assessment of the number of people to be evacuated. Calculations are done on the basis of Airbus A330-200 design layout (see Figure 2). Selected airplane is represented on the market with
for current level of safety systems development may be taken equal to \( t_{\text{slider}} = 6 \) s.

The value of the time \( t_d \) may be evaluated with the following equation:

\[
t_d = \frac{1}{v_{\text{nw}}} l_{\text{exit}} \tag{2}
\]

where the maximum distance to the nearest open door \( l_{\text{exit}} = 30 \) m is achieved in the case when all four opened exits are located in the front end of the cabin.

For taken initial data the calculation results are as following:

\[
t_d = 80 \text{ s}; \quad t_{\text{ev}} = 86 \text{ s}. \tag{3}
\]

As it may be seen result of the calculation satisfies FAA requirement established for emergency evacuation:

\[
t_{\text{ev}} < \frac{1}{v_{\text{nw}}} l_{\text{exit}} \tag{4}
\]

Conclusions and proposals. The aim of the moving walkways application in the aircraft is to ensure the safe evacuation of all passengers in the shortest time possible. The calculations done above show that the emergency evacuation using moving walkways in the passenger aircraft takes less time than the one required by FAA. In advance the application of the method proposed brings extra advantages decrease level of injury risk for the passengers and crewmembers.

However, before moving walkways implementation in the practice to ensure their safety, reliability and affectivity the on-ground experimental evacuations are to be done with the passenger aircrafts’ full-size models.

Fig. 2. Airbus A330-200 3-classes cabin design:
- a – passenger seats layout;  
- b – evacuation aisles layout;  
- c – scheme of entry from seats to the aisles

We may calculate the total time needed for evacuation \( t_{\text{ev}} \) on formula:

\[
t_{\text{ev}} = t_d + t_{\text{slider}}, \tag{1}
\]

where \( t_d \) – maximum time to reach the door for the most distantly located passenger standing on the walkway; \( t_{\text{slider}} \) – time needed for opening the evacuation exits and slides, which maximum value
ДОСЛІДЖЕННЯ ВПЛИВУ ПРЯНИХ ОВОЧІВ НА ОРГАНОЛЕПТИЧНІ, ФІЗИКО-ХІМІЧНІ ТА СТРУКТУРНО-МЕХАНІЧНІ ВЛАСТИВОСТІ ПИРОГІВ ПОНИЖЕНОЇ ЕНЕРГЕТИЧНОЇ ЦІННОСТІ

Криворук В.М., Данилюк Л.П.
Вінницький торговельно-економічний інститут
Київського національного торговельно-економічного університету

В статті досліджено вплив пряних овочів, а саме селера, петрушки та пастернаку, на органолептичні, фізико-хімічні та структурно-механічні властивості пирогів. Відображено хімічні властивості вищезазначених коренеплодів та доведено їх лікарські властивості. В ході роботи відображено два дослідження. Вони дозволили встановити оптимальну кількість використання добавок для підвищення харчової та біологічної цінності пирогів. Визначено вплив меншої та більшої кількості пряних коренеплодів на продукцію.

Ключові слова: пироги, коренеплоди, селера, петрушка, пастернак, органолептичні, фізико-хімічні та структурно-механічні властивості.

Аналіз останніх досліджень і публікацій. Проblemи оздоровчого харчування та підвищення вмісту корисних речовин у пирогах сьогодні відведено значну роль. Чимало вітчизняних та західних вчених відображали це питання у своїх працях, а саме: Сирохман І.В., Бандаева Е.Ш., Корячкина С.Я., Васильченко А.Н., Лебеденко Т.Є., Дробот В.І. Незважаючи на попередні дослідження стосовно впливу пряних коренеплодів на продукцію, вони надзвичайно багаті на життєво важливі інгредієнти, перш за все біологічно активні речовини: вітаміни, мінеральні елементи, харчові волокна, поліфенольні сполуки, органічні кислоти та інші.

Мета статті. Головною метою цієї роботи є підвищення харчової цінності та органолептичних показників коренеплідних овочів. Це овочі, в яких їстівною частиною є подовжений стрижневий корінь. До них відносяться: морква, буряк, редька, ріпа, селера, петрушка, пастернак, органолептичні, фізико-хімічні та структурно-механічні властивості.

Колосков В.Ю.
Национальный университет гражданской защиты Украины

ИСПОЛЬЗОВАНИЕ ДВИЖУЩИХСЯ ДОРОЖЕК ДЛЯ ЭКСТРЕННОЙ ЭВАКУАЦИИ ИЗ САМОЛЕТА

Аннотация
Проведен анализ уровня травматизма среди пассажиров при реализации эвакуационных мероприятий по статистике экстренных посадок пассажирских самолетов. Рассмотрены направления усовершенствования системы экстренной эвакуации после вынужденной посадки самолета. Предложено использовать движущиеся дорожки в проходах салона самолета для повышения эффективности экстренной эвакуации. Сформулированы основные принципы создания движущихся дорожек. Проведено оценивание возможности использования движущихся дорожек в больших пассажирских самолетах в соответствии с требованиями, касающимися предельного времени эвакуации пассажиров.

Ключевые слова: самолет, экстренная эвакуация, безопасность, пассажиры, движущиеся дорожки.