Controlled Operational Emergency Shut Down Procedures

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Abstract

Controlled Operational Emergency Shut-Down (COESD) Procedures are used by pipeline main control centre operators to be prepared in case of an emergency situation. The procedures contain the particular operational measures for each location of the entire pipeline system to be initiated via remote control facilities (e.g. SCADA system or control system). Hopefully the operator will never need to execute these procedures on his job. However, the COESD-Procedures are a good training tool for the control room operators and it is the ideal support and decision basis to initiate the proper operation sequences in a case of emergency in a timely manner.

ILF Consulting Engineers prepared these COESD-Procedures already for various pipeline systems. As an initial preparation step, the theoretical oil spill quantities are calculated for each section (based on the total drain down volume of the isolated block valve sections). The calculated results are graphically presented together with the pipeline elevation profile within the COSES-Section plan. Based on the COESD-Section plan and the available remote control devices (e.g. block valve stations, pump stations, relief tanks) the optimum measures have been defined within the COESD-Procedures to further minimize the potential oil spill quantity during an emergency situation. These COESD-Section plans and COESD-Procedures have been integrated within sophisticated GIS-systems to provide easy, quick and straightforward access to these procedures for the main control center operators.

1. Overview Emergency Intervention Procedures

The COESD-Procedures forms the first part of an overall emergency intervention procedure plan which is mandatory for every oil pipeline. The COESD-Procedure contains mainly remote controlled operational actions. (The second part is the Oil Spill Emergency Response Plan – which is not the subject/focus of this document).

The following diagram “Figure 1: Overall Emergency Intervention Procedure Plan” provides an overview for the organizational implementation of the COESD-Procedures.

The release of the COESD-Procedures shall have priority over the release of the Oil Spill Emergency Response Plan; however both plans may be released simultaneously with the perquisite that this will not delay the COESD.
2. Criteria for triggering a Pipeline Shutdown

In principle there are two options for the shutdown of an oil pipeline:

- Normal (operational) Shutdown
- Emergency Shutdown

2.1. Normal Shutdown

A normal shutdown is to be applied upon the detection of:

- Operational instructions or
- Failure or faults on safety equipment

2.2. Controlled Operational Emergency Shutdown (COESD)

A COESD has to be applied upon the detection of:
• leaks or
• suspected leaks or
• in case of danger (including the threat of danger and/or damage)

It has to be noted, that Emergency shutdowns usually cause higher operational load variations, sub-sequent operational faults and longer downtimes and thus higher costs than normal stops. Therefore, it is recommended that the management develop clear-cut operating instructions which enable the responsible operator to correctly decide if an emergency shutdown is required and/or justified.

3. Identifying or suspecting a leak along the pipeline ROW

A leak can be identified visually by human beings on any location along the ROW or in its surroundings, or by the activation/alarm of the safety equipment in the control centres.

The main possibilities that exist to identify and locate a leak are roughly described in the following sub-chapters. It is neither the intention nor the focus of this document to describe the technical details for state of the art leak detection systems. For detailed information it is recommended to refer to the operating manuals and instructions of the relevant equipment which are available at the pipeline control centre. These documents describe the Leak Detection System display, detailing the process information it provides to the operator.

3.1.Leaks identified by the company’s own staff

Companies own personnel inform the ACC, who then implement all further measures as appropriate in accordance with the Overall Emergency Intervention Procedure Plan. As the company’s own staff is familiar with the pipeline system and it’s potential risks, a reliable and clear localization (e.g. identifying the pipeline marker or significant pipeline crossings of the infected area can be expected by the control room operator).

3.2. Leak identified by people external to the company

A person external to the company informs the ACC or a public emergency call centre. Within this scenario the control room operator has to verify if the reported problem is related to the pipeline system and he needs to cross-check the reported localization which suits with the land-registry database of the effected area for the pipeline system)

3.3. Pipeline Specific SCADA Application – Leak Detection System

This concerns the identification of an actual or a suspected leak facilitated by the pipeline control centre facilities, as indicated on the leak detection system (LDS) display or other monitoring system.
A LDS Software package facilitates and integrates various leak detection monitoring methods in order to identify different kinds of leaks (small, middle or large scale leaks; slowly or rapidly developed leaks) for several operational scenarios (steady state, transient or shut-in conditions). The results of the various algorithms are also compared with each other in order to validate a single alarm and to exclude false alarms. However, it is important that all other systems such as the pipeline dynamic model, that present additional relevant information, are closely monitored and analyzed by the control centre operator in order to confirm any leak alarms.

4. Localization of a leak within the COESD-Section Plan

In practice, it must be expected when a leak is identified, that its precise location may not become known in parallel. For example, if a person external to the company reported a leak on the telephone and a member of the pipeline staff asked about its location, this informant would refer to the neighbouring villages, roads, rivers or railways and would not normally be in a position to cite the pipeline kilometre or to refer to the valve stations.

Even in the event that a leak is firstly detected in the control centre, being derived from the display of a leak detection system or other monitoring system, it will not always be possible to sufficiently define the leak position immediately.

This is especially the case if the volume/mass balance method reports a difference in quantity and no other leak detection system alarms at the same time. Provided that this is not a false alarm (e.g. an instrumentation failure, faults in transmitting or evaluating the measured values) the leak may be at any point within the total length of the line section in between the two metering devices.

Therefore, when drafting a Controlled Operational Emergency Shutdown Procedure the possible uncertainty about the location of an existing leak must be taken into account.

The COESD Section Plan (refer to Figure 2 “Example for a COESD Section Plan”) provides an overview to identify the proper COESD Procedure. The COESD Section Plan divides a pipeline system into main sections (called A section). These main sections extend between the pump stations, pigging / relief stations and receiving terminals.

The first number (x) after the letter A is also used for all other subsections (B, C and D) used in this plan and allows the overall ranging concerning the localization of each individual section.

The Ax sections are further subdivided into Ax.y sections, in sections between geodetic high points and other points of technical interest, e.g.: pigging stations.

Furthermore each Ax section is subdivided into Bx.y sections, which isolate a block or check valve between the next upstream and downstream block or check valves.
The first number (x) of the Bx.y sections is always in line with the overall Ax section and inform so on the localization, while the second number y inform on the sequence.

Figure 2 “Example for a COESD Section Plan”

Furthermore each Bx section is subdivided into Cx.y sections, which isolate pipeline sections between the next upstream and downstream block or check valves.

The first number (x) of the Cx.y sections is always in line with the overall Ax section and inform so on the localization, while the second number y inform on the sequence.

The Dx.z sections are based on hydraulic criteria and on the possibility for “artificial” draining, using existing mechanical connections, into mobile storage equipment or using mobile pumps for transfer around closed block valves to the neighbor section.
The second number \( z \) of a \( \text{D}_x.z \) section is in line with the sequence number \( y \) of the superior \( \text{C}_x.y \) section.

Furthermore the theoretical oil spill quantities are shown on the section plan. These quantities are based on the total drain down volume of the isolated block valve sections, which would be valid in case no COESD-Procedure is carried out in time or at all to minimize these quantities. For each elevation point the maximum possible spill quantity for the affected section was calculated.

The A-Sections are subdivided and classified into B, C and D-Sections, refer to Figure 2 “Example for a COESD Section Plan”. The dedicated COESD Procedures should be carried out as quick as possible directly by the Control Centre Operator, refer to Figure 3 “Example for a COESD Procedure”.

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<table>
<thead>
<tr>
<th><strong>COESD-Section</strong>:</th>
<th><strong>GC14 – GB15</strong></th>
<th><strong>COESD-Code</strong>:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From:</strong></td>
<td>GC14</td>
<td>C4.8</td>
</tr>
<tr>
<td><strong>To:</strong></td>
<td>GB15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>km 590.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td>km 599.45</td>
<td></td>
</tr>
<tr>
<td><strong>Worst Case Spillage Quantity</strong></td>
<td>5500 m³</td>
<td></td>
</tr>
</tbody>
</table>

**COESD-Procedure:**

1. a) Stop all pumps of PSG2

1. b) Close block valves GB12

1. c) If
   - the pressure at block valve GB12 decreases below 77.9 bar or
   - the pressure at block valve GB15 decreases below 32.8 bar or
   - the pressure gradient between the block valves GB15, GB16 and GB17 reverses
     stop all pumps of PSG2 and close block valves GB12 and GB15

1. d) Decrease set-point (PC) at the inlet of PT1 down to the minimum (PCL 7 bar) and continue pumping with PT1 with the max flow rate possible, until the pumps suction pressure reaches the minimum of 2.5 bar

2. Close block valve GB15

3. Monitor pressure development within section C4.8 (notice possible effect of check valves GC13 and GC14)
The classification enables the responsible operator, depending on the level of information available, to identify the pipeline sections of interest, while automatically ensuring that the optimum operating parameters possible are maintained. The section of interest shall be always the smallest section available (within the section plan) depending whether the endangered location is known very precisely or if it is uncertain, e.g. of a number of +/- kilometres.

If the operator gains some additional information at a later stage and knowledge of the actual leak location is improved, the operator shall immediately take the necessary corrective actions to reduce the previously selected pipeline section as appropriate.

5. Implementation of the COESD-Procedures

In the event of an alarm, the responsible operator identifies the section(s) of the pipeline in the Overview Section Plan (refer to Figure 2) in which he can already locate the leak or the potentially dangerous point on the basis of the initial information or suspicions. The section code(s) for the section(s) for which damage has been assumed shown in the Overview Section Plan refer(s) to the particular description of the measures to be taken. These measures are defined in the “Catalogue of COESD-Procedures to be Executed” (refer to Figure 3 “Example for a COESD-Procedure”). Depending on the pipeline length and its elevation profile the number of individual COESD-Procedures could easily reach 400 and more.

The individual sections of the pipeline covering the threat location, as identified on the section plan, should always be selected as short as possible; in other words, a most exact definition of the section to be considered has to be made.

Beside the code number in the COESD-Procedure heading of each section, the type of station or important hydraulic points and their location shown in total pipeline kilometers are indicated for the beginning and the end of the individual sections.

Furthermore the worst case oil spillage possible within sections B, C and D is shown in the procedure heading. This actual figure is depending on the exact location of the leak (for details refer to Figure 2 “COESD Section Plan”)

When executing the measures for the individual sections (described in the Catalogues of COESD-Procedures to be Executed), it is important to adhere strictly to the specified control sequence.

6. Example of COESD-Procedure Implementation within GIS data warehouse platform

In order to assist the pipeline operator in a timely manner especially in emergency situations, the COESD-Procedures should be easy accessible and selectable within a modern electronic database. The database tool shall provide quick access to the relevant COESD-Section Plan drawings as well as to the identified COESD-Procedures. Within an early project stage (e.g. during pipeline commissioning or line-
fill activities) this functionality can be provided already within a simple Microsoft-Office database application. However, at the final stage the database shall support also any cross-references with other geographical pipeline information (e.g. maps including pipeline markers, Right of Way pipeline corridor, land registry database, pipe book, etc.). This complex set of information can be provided to the control room operator via modern Geographical Information System (GIS) data warehouse systems. This kind of implementation is carried out by IT-Solution providers which are following the pipeline specific requirements defined by ILF. The following example screenshots (Figure 4 & 5) are derived from a former ILF project for which ms.GIS (www.msgis.com) was implementing the COESD-Procedures within a GIS data warehouse system.

Figure 5 “Example for a COESD Section Plan within a GIS data warehouse”

Figure 5 is presenting on the right hand side a map for the selected pipeline section. Within the bottom lower part of the display various filter options are available for a quick pipeline section allocation, depending on the information available to the control center operator. On the left hand side the COESD-Section Plan is provided for the selected section. The operator can access the COESD-Procedure by selecting the relevant one directly within the COESD-Section Plan. The COESD-Procedure will be presented to the operator within a separate register tab as a part of the left hand frame (refer to figure 6 for details).
CV of the author
The author Tobias Walk is original based in Munich, where he studied Electrical Engineering and Information Technology at the Technical University with special focus on Automation and Control Systems. In 1996 he received his Diploma. In 1997 he started to work as project engineer for ILF Consulting Engineers within the Oil & Gas market. He has been involved within various international pipeline projects [e.g. design of the automation concept for the East-Siberia-Pacific-Ocean (ESPO) Crude Oil Pipeline System from 2007 - ongoing; design, construction and commissioning for the Baku-Tbilisi-Ceyhan (BTC) Crude Oil Pipeline System within 2001 - 2006; design and commissioning of the automation concept and process logics for the Cadereyta Pipeline System project within 1999 – 2000; Commissioning of the SCADA and Leak Detection System for the Central German Product Pipeline System MIPRO within 1998 - 1999; tender design for the modernization of the Crude Oil Pipeline Drushba for the Czech section within 1997]. Since 2006 Tobias Walk is Deputy Head of the Department for SCADA & Automation within ILF.

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