

# Engineering Standard

SAES-L-125

30 April 2005

## Safety Instruction Sheet for Piping and Pipelines

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## Saudi Aramco DeskTop Standards

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Revised paragraphs are indicated in the right margin

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**1 Scope**

This standard specifies mandatory requirements and outlines the procedure to be followed in the preparation of Safety Instruction Sheets (SIS) for piping systems of new plants, or additions to existing plants. This standard is also to be followed for preparation of Safety Instruction Sheets for existing piping.

**2 Conflicts and Deviations**

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Consulting Services Department of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer Representative, who shall follow internal company procedure [SAEP-302](#) and forward such requests to the Manager, Consulting Services Department of Saudi Aramco, Dhahran.

**3 References**

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

- 3.1 Saudi Aramco References
  - Saudi Aramco Engineering Procedure

[SAEP-302](#)                      *Instructions for Obtaining a Waiver of a  
Mandatory Saudi Aramco Engineering  
Requirement*

#### Saudi Aramco Engineering Standards

[SAES-A-004](#)                      *General Requirements for Pressure Testing*

[SAES-L-100](#)                      *Applicable Codes and Standards for Pressure  
Piping Systems*

[SAES-L-105](#)                      *Piping Materials Specifications*

[SAES-L-150](#)                      *Pressure Testing of Plant Piping and Pipelines*

[SAES-L-310](#)                      *Design of Plant Piping*

[SAES-L-410](#)                      *Design of Pipelines*

[SAES-L-450](#)                      *Construction of On-Land and Near Shore  
Pipelines*

[SAES-L-460](#)                      *Pipeline Crossings under Roads and Railroads*

#### Saudi Aramco Forms and Data Sheets

2821-ENG                      *Safety Instruction Sheet - Critical Plant Piping*

[5645-1-ENG](#)                      *Safety Instruction Sheet for Cross Country  
Pipelines - Main Line Pipe*

[5645-2-ENG](#)                      *Safety Instruction Sheet for Cross Country  
Pipelines - Critical Piping*

[5645-3-ENG](#)                      *Safety Instruction Sheet - Terminal and Bulk Plant  
Piping*

#### Saudi Aramco Drafting Manual

### 3.2 Industry Codes and Standards

#### American Society of Mechanical Engineers

ASME B16.5                      *Pipe Flanges and Flanged Fittings*

ASME B31.3                      *Process Piping*

ASME B31.4                      *Liquid Transportation Systems for Hydrocarbons,  
Liquid Petroleum Gas, Anhydrous Ammonia  
and Alcohols*

ASME B31.8                      *Gas Transmission and Distribution Piping  
Systems*

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## 4 Definitions

Definitions in the referenced Saudi Aramco standards are applicable to this standard.

## 5 Purpose

- 5.1 The purpose of safety instruction sheets is to ensure that operating, maintenance and inspection personnel are provided with adequate information in a consistent format concerning safe operating limits, protective devices and any special safety precautions for all piping systems and pipelines.
- 5.2 Safety Instruction Sheets shall be prepared for all piping which in view of size, pressure rating and application are within the scope of Saudi Aramco Engineering Standards and general industry codes referred to therein, including:
  - a) Critical plant piping as defined in [SAES-L-100](#).
  - b) Cross country and offshore pipelines within the scope of [SAES-L-100](#), [SAES-L-310](#), [SAES-L-410](#), [SAES-L-450](#), and [SAES-L-460](#).
  - c) Terminal and bulk plant piping that is considered critical as defined in [SAES-L-100](#).
- 5.3 Safety Instruction Sheets shall reflect the as built information. They may be completed during the project design stage, however all information shall be field verified.

## 6 Preparation

Safety Instruction Sheets for Piping are prepared for new piping systems or additions/modifications to existing piping systems as follows:

- 6.1 The following Saudi Aramco Engineering Forms are available for completion of SIS. Detailed guidelines listing the key numbers to complete these forms have been prepared and are shown as attachments.
    - a) Saudi Aramco 2821-ENG, Safety Instruction Sheet - Plant Piping, see Attachment A-1. Refer to paragraph 6.2.
    - b) Saudi Aramco [5645-1-ENG](#), Safety Instruction Sheet for Cross Country Pipelines – Main line Pipe, see Attachment A-2, Section A. Refer to paragraph 6.3.
    - c) Saudi Aramco [5645-2-ENG](#), Safety Instruction Sheet for Cross Country Pipelines - Critical Piping, see Attachment A-3, Section B. Refer to paragraph 6.3.
-

- d) Saudi Aramco [5645-3-ENG](#), Safety Instruction Sheet - Terminal and Bulk Plant Piping, see Attachment A-4. Refer to paragraph 6.4.
- 6.2 Form 2821-ENG "Safety Instruction Sheet - Plant Piping" shall be prepared for plant piping which is critical because:
- a) Its failure leads to a major shutdown of the plant or a major unit in the plant,
  - b) Its failure leads to a major reduction in throughput of the plant,
  - c) Its failure leads to a major environmental impact,
  - d) High temperature [340°C (650°F) or higher],
  - e) High pressure [3,450 kPa (500 psi) or greater],
  - f) Hydrocarbon at or above its auto ignition point (450°F or above),
  - g) Fluid released could result in gas cloud and explosion,
  - h) Toxic or corrosive nature of fluid handled (as defined in SAES-B-061),
  - i) General hydrocarbon fluid lighter than diesel at ambient temperature or diesel at or above 225°F.
- 6.3 Form [5645-1-ENG](#), "Safety Instruction Sheet for Cross Country Pipelines - Main Line Piping" shall be completed for all major pipelines, trunklines and cross country pipelines, in general, carrying any fluid. Flowlines are excluded.
- In addition, Form [5645-2-ENG](#), "Safety Instruction Sheet for Cross Country Pipelines - Critical Piping" shall be filled out for the same pipelines to cover tie-in piping, scraper traps and their appurtenances, jumpovers, as well as flanges, fittings or any special components.
- Both forms ([5645-1-ENG](#) and [5645-2-ENG](#)) are to retain the same Saudi Aramco drawing number, but with different sheet numbers. For review purposes, the issuer of the forms is to attach a calculation sheet with each form. The calculation sheet shall show, in detail, the method for achieving calculated values (formulas, individual variables in the formulas with their units, specific standards requirements, etc.).
- 6.4 Form [5645-2-ENG](#) "Safety Instruction Sheet for Cross Country Pipelines - Critical Piping" shall be prepared for flowlines, trunklines, testlines, submarine pipelines and those critical components within a pipeline network, e.g., lateral ins, lateral outs, station by-passes, lateral intermediate traps, launcher/receiver barrels, fill lines, gas meter stations, etc.
- 6.5 Form [5645-3-ENG](#), Safety Instruction Sheet - Terminal and Bulk Plant Piping shall be prepared for all piping in Terminals and Bulk Plants that is considered
-

to be critical as defined in [SAES-L-100](#). A calculation sheet shall be attached to each SIS showing the method for achieving calculated values (formulas, individual variables in the formulas with their units, specific standards requirements, etc.). In addition, a diagram showing the limits of each piping section covered by the SIS is to be attached. The calculation sheet and diagram are to retain the same Saudi Aramco drawing number as the SIS sheet, but with sheet numbers 002 and 003, respectively.

## 7 Approval

Safety Instruction Sheets are considered as Key Engineering Drawings. Therefore, they are to be handled per Section V (Handling Engineering Drawings), Volume I (Instructions and Procedures for Engineering Drawings) of Saudi Aramco Drafting Manual.

In general, the Project Manager is responsible for the preparation, approval and issue of the Safety Instruction Sheets on new construction projects. When piping is installed or modified outside a new construction project scope, the Facility Engineering Division Head is responsible for SIS preparation and approval.

Copies of the Safety Instruction Sheets and the applicable design data sheets may be submitted to the Manager, Consulting Services Department for review and concurrence by his designated representative(s) where CSD expertise is required. Revised Safety Instruction Sheets shall be issued where necessary as a result of this review.

## 8 Control

Safety Instruction Sheets shall be assigned Saudi Aramco drawing numbers and shall become a part of the Project Photostat Book, Section A, and Project Inspection Record Books. These SI Sheets shall be submitted to the proponent as per SAEP-122.

### Revision Summary

30 April 2005

Revised the "Next Planned Update". Reaffirmed the contents of the document and reissued with editorial changes.

## Attachment A-1: Completion of SA Form 2821-ENG, Critical Plant Piping

Complete this form as required in paragraph 6.2 of this standard.

A blank form with key numbers is included at the end of this attachment, and an electronic file in Excel format is also available in the Forms & Data Sheets section of Saudi Aramco Desktop Standards.

### LINE IDENTIFICATION (ENTRIES 1-6)

1	Show line designation and specification: e.g., P- 28-3A1, P-102-3CS9P, etc.
2 & 3	Indicate where line starts and ends, e.g., Furnace F-201 to Column C-221, Acid pumps G-21A/B to Reactor D-21.
4	Give specific data on fluid; e.g., Reduced Crude with Acid, Vapor, etc.
5	Show applicable Industry Code and year, e.g., ASME B31.3, '90.
6	Pertinent pipe isometrics, P & ID's, Line Designation Table, or other reference drawings.

### EQUIPMENT DATA (Entries 7-22)

7	Enter nominal pipe size - in inches
8	Enter pipe outside diameter – in inches
9	Enter pipe wall thickness – in inches
10	Indicate material specification, e.g., A-106, API 5L, etc.
11	Indicate material grade, e.g., Gr.B, X-42, etc.
12	Enter basic allowable stress at design temperature (from Table A1, ASME B.31.3)
13	Indicate welded (SAW) or seamless (SMLS).
14	Indicate weld joint quality factor ( $E_j$ ), obtained from Table 302.3.4 of ASME B31.3.
15	Enter flange rating according to ASME B16.5.
16	Indicate if the flanges are raised face (RF), ring joint (RJ), or flat face (FF), etc.
17	Indicate material specification, e.g., A-105, A-350, etc.
18	Indicate material grade, e.g., LF-2, etc.
19	Indicate fitting rating, i.e., Sch. 40, 3000 lb., etc.
20	Indicate material specification and grade, e.g., A-105, A-234, API 5L, etc.
21	Indicate material grade, e.g., WPB, X-42, etc.
22	Indicate any specific remarks regarding material. Include precautions necessary during operation of tests, such as need to blind off expansion joints during hydrostatic tests because they will not withstand the test pressure.

**OPERATING LIMITS (Entries 23-33)**

23	Enter the design pressure, which should be consistent with <a href="#">SAES-L-310</a> .
24	Enter the design temperature, which should be consistent with <a href="#">SAES-L-310</a> .
25	Indicate the limiting item, e.g., pipe wall, flanges, process limitations, or any other limiting factors.
26	Enter the actual test pressure when the line was new (i.e., immediately after construction). The test pressure shall be in accordance with <a href="#">SAES-L-150</a> and should be consistent with the hydrostatic test diagram and <a href="#">SAES-A-004</a> .
27	Show the limiting item of the test pressure, such as flanges, pipe wall thickness, vessel, exchanger, etc.
28	Equipment safety valve setting not greater than that shown under key number 23.
29	Calculated required minimum wall thickness ( $T_m$ ) at which the pipe can withstand an internal pressure equal to the internal design pressure without exceeding the allowable stress based on ASME B31.3.
30	Indicate the Required Corrosion Allowance ( $T_{ca}$ ). If not required, enter N/R.
31	This is the sum of line 29 and 30. This is the Required Minimum Thickness per ASME B31.3 ( $T_m + T_{ca}$ ).
32	If the minimum pipe thickness for mechanical strength (per Table I in <a href="#">SAES-L-310</a> ) is greater than the calculated required minimum thickness listed on line 29, enter that minimum pipe thickness. Otherwise, leave it blank. Refer to <a href="#">SAES-L-310</a> or the Piping Specialist in Consulting Services Department for further explanation.
33	Remarks pertaining to any item or calculation above. Indicate any items or hazards which require consideration by Operations, Inspection or Maintenance.



Saudi Aramco 2821 ENG (12/2001)

SAUDI ARABIAN OIL COMPANY						
SAFETY INSTRUCTION SHEET - CRITICAL PLANT PIPING						
PMT						
CERT	1					
ENGG	1					
DESCRIPTION	1					
JOB/NO	1					
DATE	1					
REV. NO.	1					
DISCIPLINE ENGINEER	1					
DATE	1					
PROJECT ENGINEER	1					
DATE	1					
CERTIFIED	1					
DATE	1					
CONSTRUCTION AGENCY	1					
DATE	1					
OPERATIONS	1					
DATE	1					
EDS VERIFICATION CONTROL NUMBER	1					
BY:	1					
DATE:	1					
REVISION CERTIFICATION	1					
THIS INDICATES THAT REV. NO. _____ OF THIS DRAWING IS COVERED, FOR ALL APPROVAL/CERTIFICATION REQUIREMENTS, BY DRAWING COMPLETION CERTIFICATE (DCC) NO. _____	1					
<b>SAUDI ARABIAN OIL COMPANY</b>						
<b>SAFETY INSTRUCTION SHEET - CRITICAL PLANT PIPING</b>						
1	LINE NUMBER					
2	START					
3	END					
4	SERVICE					
5	PIPING CODE/ YEAR					
6	P&ID's OR LINE DESIGNATION TABLE					
EQUIPMENT DATA						
PIPE						
7	NOMINAL PIPE SIZE	in.	in.	in.	in.	
8	PIPE O.D.	in.	in.	in.	in.	
9	NOM. WALL THK.	in.	in.	in.	in.	
10	MATERIAL SPEC.					
11	MATERIAL GR.					
12	ALLOWABLE STRESS	PSI	PSI	PSI	PSI	
13	WELDED/ SMLS					
14	WELD JOINT EFFICIENCY					
FLANGES						
15	RATING					
16	FACING					
17	MATERIAL SPEC.					
18	MATERIAL GR.					
FITTINGS						
19	RATING					
20	MATERIAL SPEC.					
21	MATERIAL GR.					
22	REMARKS :					
23	DESIGN PRESSURE		PSIG	-	KPa	
24	DESIGN TEMPERATURE		"F		"C	
25	LIMITED BY					
26	TEST PRESSURE NEW		PSIG	-	KPa	
27	LIMITED BY					
28	SAFETY VALVE SET PRESSURE		PSIG	-	KPa	
29	$t_m$ (Pressure)	in.	in.	in.	in.	
30	Req. Corr. Allow.	in.	in.	in.	in.	
31	$t_m$ (Code)	in.	in.	in.	in.	
32	$t_m$ (Structural) <sup>(1)</sup>					
(CONTACT OPERATIONS ENGINEERING BEFORE EXCEEDING THE ABOVE LIMITS)						
33	REMARKS:					
(1) This is the Structural Minimum Thickness (i.e., for Mechanical Strength). This $T_m$ (Structural) is listed if GREATER than $T_m$ (Pressure). Refer to SAES-L-003.						
SIS FOR		DWG TYPE	PLANT NO.	INDEX	DRAWING NO.	SHT. NO.
				A	E-	1
						OF
						1
						00
		SAUDI ARABIA	JO / EWO			

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## Attachment A-2: Completion of SA Forms [5645-1-ENG](#), Cross Country Pipelines – Main Line Pipe

Complete this form as required in paragraph 6.3 of this standard.

A blank form with key numbers is included at the end of this attachment, and an electronic file in Excel format is also available in the Forms & Data Sheets section of Saudi Aramco Desktop Standards.

### GENERAL

Pipelines Department has established a comprehensive database for all of its pipelines. Refer to this database for information and data of existing pipelines. This database can be obtained from Pipelines Department, Pipelines Technical Support Division, R-238, Building 3301, NP-II, Dhahran (Tel. 874-1460, Fax 874-1331).

#### LINE IDENTIFICATION (ENTRIES 1-11)

1	Give the official designation of the line, e.g., "Qatif-Ras Tanura Pipeline No. 6" (QRT-6).
2	Show name of start (origin) point, e.g., "Qatif Junction".
3	Show name of end (termination) point, e.g., "Ras Tanura".
4	Indicate the type of fluid handled, e.g., "Arab Light Crude", or "Fuel Gas" or "Water"
5	Show the name of the Valve Operating Diagram of this line, e.g., NACRUDE. If not available, give the P & ID drawing number.
6	Indicate the year in which the line was built.
7	Give the Km. number where the line begins.
8	Give the Km. number of the line where this particular sheet begins.
9	Show number of sheets which cover all major segments of the pipeline to be covered by Form <a href="#">5645-1-ENG</a> , then followed by:
10	The number of the sheet(s) that cover the items which will be covered by Form <a href="#">5645-2-ENG</a> , as identified above.
11	Segments of the pipeline are to be numbered sequentially, i.e., sheet 1 will show segments 1-5, sheet 2 will show segments 6-10, and so on. <b>NOTE:</b> Each segment shall have same diameter, wall thickness, material grade, hydrostatic test pressure, MAOP, area classification, and type of construction. If any of these characteristics change, a new segment is to be generated.

**EQUIPMENT DATA (Entries 12-24)**

12	Enter the nominal diameter of pipe.
13	Enter nominal wall thickness ( $T_n$ ). Fraction of an inch should be express to 3 decimal places, e.g., "0.375 inches".
14	Show the grade of material, i.e., API 5L, Gr.X-50. SAMSS references are not acceptable.
15	Indicate Starting Km. of the segment.
16	Indicate Ending Km. of the segment.
17	Indicate the length of the segment in feet.
18	Indicate the length of the segment in meters.
19	Show process (see mill inspection report) for line pipe: Seamless (S); Longitudinally (straight seam) welded-submerged arc (Electric Fusion Welded) by U-ing, O-ing, Expanding (UOE-EFW); Longitudinally (straight seam) welded-submerged arc (Electric Fusion Welded) by Cage Forming (CF-EFW). Longitudinally (straight seam) welded-electric resistance Welded (UOE-ERW), (CF-ERW); Special welded – Submerged Arc (Spiral-EFW).
20	Indicate the minimum Specified Minimum Yield Strength (SMYS) in psi, shown on the mill certificates for each item of the Purchase Order, e.g., 41,300 psi.
21	Indicate the flange rating per ASME B16.5.
22	Show the type of construction: B: Buried, AGR: restrained above ground, or AGN: nonrestrained above ground.
23	Indicate if the line is externally and/or internally coated and what type of coating as applicable.
24	Include any remarks on pipe material, such as "X-65 pipe in segment 3 is installed on experimental basis to check weldability".

**OPERATING LIMITS (Entries 25-43)**

25	<p>Calculate internal pressure to develop a hoop stress equal to the Design Factor (D.F.) multiplied by the Specified Minimum Yield Strength (SMYS) of the pipe based on OD and corroded wall thickness (<math>T_c</math>), which equals <math>T_n - T_{ca}</math>.</p> $P = (D.F.) * (SMYS) * (2 * T_c) / (OD)$ <p>If other factors are limiting (for example flange rating) indicate the lower MAOP and annotate accordingly.</p>
26	Indicate the limiting factor of the MAOP whether it is the pipe wall or any other factor such as flange rating.
27	Show the design factor of the segment, e.g., 0.5, 0.6, or 0.72.
28	Show the maximum design temperature (°F).
29	Indicate minimum design tie-in temperatures (°F) specified in the project specification or "Scope of Work".
30	Indicate the allowable bending stress ( $S_b$ ) per <a href="#">SAES-L-450</a> .

31	<p>Calculate the required minimum wall thickness (<math>T_m</math>) of the pipe based on the MAOP for the entire pipeline and the design factor (D.F.).</p> $T_m = (\text{MAOP}) * (\text{OD}) / [2 * (\text{D.F.} * \text{SMYS})]$ <p><i>Commentary Note:</i></p> <p><i><math>T_m</math> (retirement wall thickness) shall not be less than the required wall thickness for mechanical strength. Refer to <a href="#">SAES-L-410</a> or piping specialist in the Consulting Services Department for further explanation.</i></p>
32	<p>Show the actual hydrostatic test pressure of that particular segment performed immediately after construction. The test pressure must be calculated in accordance with <a href="#">SAES-L-150</a> "Pressure Testing".</p> <p><i>Commentary Note:</i></p> <p><i>Consideration should be given to the increased head due to elevation differences within the test segment. If this is significant, the low point test pressure must be indicated with a remark.</i></p>
33	<p>Show test date.</p>
34	<p>Indicate the limiting factor of the test pressure, e.g., pipe wall thickness, flange rating, branch connection, etc.</p> <p><i>Commentary Note:</i></p> <p><i>Revalidation hydrostatic tests (Entries 35-37) are to be completed when information is known. The Safety Instruction Sheet (SIS) is to be updated after every revalidation test by the responsible Operations Engineering Unit.</i></p>
35	<p>Indicate the actual test pressure. The test pressure shall be in accordance with <a href="#">SAES-L-150</a>, <a href="#">SAES-A-004</a> and approved by the responsible Saudi Aramco Operations Engineering Unit.</p>
36	<p>Show test date.</p>
37	<p>Indicate the limiting factor of the test pressure.</p>
38	<p>Indicate the date of the baseline run using instrument scraping.</p>
39	<p>Indicate the date of the latest run.</p>
40	<p>Indicate the maximum allowable operating pressure (MAOP) of the entire pipeline as if one system, if applicable. This MAOP will be dictated by the lowest of the MAOP's across the entire pipeline, or the maximum achievable pressure upstream due to, for instance, well head or pump shut off pressure. If the pipeline does not have one system MAOP, indicate so by "N/A" and give a clear explanation in the remarks area, such as 'the line is telescoped'.</p>
41	<p>Show the limiting factor that dictates the system MAOP.</p>
42	<p>List any pertinent remarks which will assist Operations, Inspection or Maintenance. Any safety hazards for line or fluid transported should be mentioned. If the pipeline is constructed such that the pipe, flanges, valves, or fittings will not withstand the shut-off pressure of the pump plus the static head pressure when a downstream valve is closed, then this hazard must be clearly highlighted.</p> <p>Indicate if surge protection systems(s) have been provided. Make reference to any special operating instructions.</p>
43	<p>Include drawing numbers of Schematic Lay-out, P &amp; I Diagram, Process Flow Diagram, Hydrostatic Test Diagram and Hydraulic Profile Drawing.</p>

Saudi Aramco 5645-ENG (12/2001)

SAUDI ARABIAN OIL COMPANY											
SAFETY INSTRUCTION SHEET FOR CROSS COUNTRY PIPELINE - MAIN LINE PIPE											
PMT	OPRNS	1 PIPELINE NAME	2 START POINT	3 END POINT	4 SERVICE	5 VALVE OPER. DIAGRAM	6 YR. BUILT				
CERT											
ENGG		7 THIS LINE BEGINS AT Km.				8 THIS SHEET BEGINS AT Km.					
		9 MAIN PIPELINE, SHEET:	THROUGH:		10 CRITICAL PIPING, SHEET:	THROUGH:					
DESCRIPTION	EQUIPMENT DATA	11	SEGMENTS								
		12	NOMINAL PIPE DIAMETER		in.		in.		in.		
		13	NOM. WALL THICKNESS (T <sub>w</sub> )		in.		in.		in.		
		14	MATERIAL GRADE OF PIPE (eg. GR. B, X 52, etc)								
		15	STARTING AT Km.								
		16	ENDING AT Km.								
		17	LENGTH - (Feet)		ft		ft		ft		
		18	LENGTH - (Meters)		m		m		m		
		19	PROCESS OF MANUFACTURE (ERW, SMLS, SAW, etc.)								
		20	S.M.Y.S. OF PIPE - (PSI)								
		21	FLANGE RATING								
		22	CONSTRUCTION TYPE (B-BURIED, AGR or AGN: ABOVE GROUND)								
		23	COATING TYPE (FBE,TAP, EXTERNAL, INTERNAL)								
		24	REMARKS								
		REV. NO.		25	M.A.O.P. AT DESIGN FACTOR (D.F.) - (PSIG)						
		26	M.A.O.P. LIMITING FACTOR								
DISCIPLINE ENGINEER		27	DESIGN FACTOR (eg., 0.72, 0.5, etc.)								
DATE:		28	DESIGN TEMPERATURE, (°F)								
PROJECT ENGINEER		29	MINIMUM TIE IN TEMPERATURE, (°F)								
DATE:		30	ALLOWABLE BENDING STRESS (S <sub>b</sub> ) - (PSI)								
CERTIFIED		31	CALCULATED WALL THICKNESS @ MAOP & D.F. (T <sub>w</sub> - inch)								
DATE:		32	PRESSURE AT LOW POINT - (PSIG)								
CONSTRUCTION AGENCY		33	TEST DATE								
DATE:		34	LIMITED BY								
OPERATIONS		35	PRESSURE AT LOW POINT - (PSIG)								
DATE:		36	TEST DATE								
		37	LIMITED BY								
		38	BASE LINE RUN DATE								
		39	LATEST RUN DATE								
		40	SYSTEM M.A.O.P.	PSIG	41	LIMITED BY:					
		42	REMARKS								
		43	REFERENCE DWGS.								
EDSD VERIFICATION		CONTROL NUMBER		BY:		DATE:					
REVISION CERTIFICATION		THIS INDICATES THAT REV. NO. _____ OF THIS DRAWING IS COVERED, FOR ALL APPROVAL/CERTIFICATION REQUIREMENTS, BY DRAWING COMPLETION CERTIFICATE (DCC) NO. _____		DWG. TYPE		PLANT NO.	INDEX	DRAWING NO.	SHT. NO.	REV. NO.	
		SAUDI ARAMCO		SIS			A	E-	1 OF 3		
						JO / EWO					

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### Attachment A-3: Completion of SA Form [5645-2-ENG](#), Cross-Country Pipelines – Critical Piping

This form shall be prepared as required per paragraph 6.4 of this Standard.

A blank form with key numbers is included at the end of this attachment, and an electronic file in Excel format is also available in the Forms & Data Sheets section of Saudi Aramco Desktop Standards.

*Commentary Note:*

*Some of the information may not be applicable in cases where the form is used for above ground unrestrained pipelines, such as flowlines.*

#### LINE IDENTIFICATION (ENTRIES 1-10)

1 - 6	Same as corresponding key numbers 1-6 on Form <a href="#">5645-1-ENG</a> .
7	Provide adequate information to clearly identify the equipment, for example, scraper trap, block valve MOV-123, etc.
8	Show the location of the equipment by name and kilometer, e.g., Qatif Junction, Km. 0.0. In the case of flowlines, testlines, or trunklines, show the GOSP name at which these lines terminate.
9	This section number corresponds to a numbering system adopted in the Pipeline Data Book, therefore, this information must be coordinated with the proponent.
10	Indicate Equipment Category, e.g., "Scraper Receiver" or "Jumpover" or "Lateral" or "Crossover", etc.

#### EQUIPMENT DATA (Entries 11-21)

11	Show nominal or outside pipe diameter. List each kind (one diameter, wall thickness and steel grade) of pipe or fitting once in separate columns.
12	Show nominal wall thickness of pipe. Fractions of an inch should be expressed to 3 decimal places, e.g., "0.375 inches".
13	Show material, carbon steel, alloy, etc.
14	Indicate seamless (S) or EFW or ERW or Spiral.
15	Show pipe specification and grade, e.g., API 5L, Gr. B. SAMSS references are not acceptable.
16	Indicate if the line is externally coated and what type of coating as applicable.
17	Indicate flange or fitting rating, e.g., ASME B16.5 for flanges and valves, etc.
18	Enter a two letter abbreviation indicating the type of flange facing, e.g., RF for raised face, RJ for ring joint, etc.

19	Show material, carbon steel or alloy used.
20	ASTM or other specification and grade for flanges or fittings
21	List any special piping components not otherwise covered and include any pertinent remarks.

**OPERATING LIMITS (Entries 22-39)**

22	Calculate maximum allowable operating pressure (MAOP) in accordance with applicable code as limited by flanges or by nominal pipe wall for materials listed under key numbers 10 through 20. Show the item that is limiting the MAOP in key number 21.
23	Show the design factor, and give the basis of the design factor in the remarks area in key number 37.
24	Show the design temperature (°F).
25	Show the actual hydrostatic test pressure of this particular equipment performed immediately after construction. The test pressure must be calculated in accordance with <a href="#">SAES-L-150</a> . The test pressure of this equipment must be equal to or greater than the test pressure in key number 32 on Form <a href="#">5645-1-ENG</a> , for the segment to which this equipment is connected.
26	Show test date.
27	Indicate the item (pipeline segment, flange or special fitting) which limits the test pressure.

**Revalidation Hydrostatic Tests (Entries 28-30)** are to be completed when information is known. The Safety Instruction Sheet (SIS) is to be updated after every revalidation test by the responsible Operations Engineering Unit.

28	Indicate the actual test pressure which must be in accordance with <a href="#">SAES-L-150</a> and approved by the responsible Saudi Aramco Operations Engineering Unit. The test pressure of this equipment must be equal to or greater than the test pressure in key number 35 on Form <a href="#">5645-1-ENG</a> , for the segment to which this equipment is connected.
29	Show test date.
30	Indicate the limiting factor for the test pressure.
31	Indicate the maximum allowable operating pressure (MAOP) of the entire pipeline as if one system. This MAOP is the same as that in key number 40 on Form <a href="#">5645-1-ENG</a> .  <i>Commentary Note:</i>  <i>In the case of flowlines, testlines and trunklines, refer to <a href="#">SAES-L-410</a> for further information.</i>
32	Show the limiting item. In the case where a Saudi Aramco Standard governs, indicate which standard it is and its date.
33	Show the set pressure of safety valve or thermal relief valve or pressure switch or other safety device if included, and if required for routine operation. Show relief device identification number, e.g., "PZV-123", etc. Confirm this information with the P&ID.
34	Show nominal pipe size.

35	<p>Calculate <math>T_m</math> based on the system MAOP shown in key number 31. If not applicable, use the MAOP in key number 22.</p> <p><i>Commentary Note:</i></p> <p><i><math>T_m</math> (retirement wall thickness) shall not be less than the required wall thickness for mechanical strength. Refer to <a href="#">SAES-L-310</a> or <a href="#">SAES-L-410</a> or piping specialist in the Consulting Services Department for further explanation.</i></p>
36	<p>Calculate the available corrosion allowance (<math>T_{ca}</math>) which equals the nominal wall thickness of pipe minus <math>T_m</math> shown in key number 35.</p> <p><i>Commentary Note:</i></p> <p><i>Corrosion allowance (<math>T_{ca}</math>) is the remaining pipe wall thickness above the required <math>T_m</math>. This is NOT a required corrosion allowance. If a corrosion allowance is required, it must be stated (including the referenced standard) in the remarks area under key number 38.</i></p>
37	<p>Indicate On-Stream Inspection Data.</p> <p><i>Commentary Note:</i></p> <p><i>This data is entered into Pipelines Department database by a web application and the program automatically displays the available information. It is not normally entered manually.</i></p>
38	<p>Indicate any special remarks regarding safety hazards in connection with items on subject sheet. See remarks for main line pipe, Form <a href="#">5645-1-ENG</a> key number 42.</p>
39	<p>Indicate specific drawings for the manifolds, cross-overs, branches, scraper traps, road crossings, and any other items covered by this sheet.</p>



Saudi Aramco 5465-ENG (12/2001)

SAUDI ARABIAN OIL COMPANY											
SAFETY INSTRUCTION SHEET FOR CROSS COUNTRY PIPELINE - CRITICAL PIPING											
1	PIPELINE NAME	2	START POINT	3	END POINT	4	SERVICE	5	VALVE OPER. DIAGRAM	6	YR. BUILT
7						EQUIPMENT NAME					
8						LOCATION (@ Km.)					
9						SECTION					
10						EQUIP. CATEGORY					
11						SIZE (in.)					
12						W.T. (in.)					
13						MATERIAL					
14						WELD TYPE					
15						SPEC. / GR.					
16						COATING TYPE					
17						RATING					
18						FACING					
19						MATERIAL					
20						SPEC. / GR.					
21						REMARKS					
22						M.A.O.P. PSIG, LIMITED BY:					
23						DESIGN FACTOR					
24						DESIGN TEMPERATURE: °F					
INITIAL PRESSURE TEST			25 TEST PRESSURE PSIG			INITIAL PRESSURE TEST			TEST PRESSURE PSIG		
			26 TEST DATE						TEST DATE		
			27 LIMITED BY						LIMITED BY		
REVALIDATION			28 TEST PRESSURE PSIG			REVALIDATION			TEST PRESSURE PSIG		
			29 TEST DATE						TEST DATE		
			30 LIMITED BY						LIMITED BY		
31						SYSTEM M.A.O.P. PSIG					
32						LIMITED BY					
33						SAFETY VALVE SET PRESS. PZV					
DES THK @		34 PIPE SIZE		in.		in.		in.		in.	
SYSTEM MAOP		35 PIPE T <sub>m</sub>		in.		in.		in.		in.	
& DES TEMP		36 PIPE T <sub>ca</sub>		in.		in.		in.		in.	
37											
OSI DATA POINTS						OSI DATA POINTS					
SEQ.	DATE	WT (in)	DATE	WT (in)	DATE	WT (in)	SEQ.	DATE	WT (in)	DATE	WT (in)
1							1				
2							2				
3							3				
4							4				
5							5				
6							6				
38						REMARKS					
39						REFERENCE DWGS					
SIS FOR						DWG. TYPE		PLANT NO.		INDEX	
						SIS				A E-	
										2 OF 3	
						SAUDI ARAMCO		JO / EWO			

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### **Attachment A-4: Completion of SA Form [5645-3-ENG](#), Safety Instruction Sheet – Terminal and Bulk Plant Piping**

Complete this form as required in paragraph 6.5 of this standard.

A blank form with key numbers is included at the end of this attachment, and an electronic file in Excel format is also available in the Forms & Data Sheets section of Saudi Aramco Desktop Standards.

#### **LINE IDENTIFICATION (ENTRIES 1-6)**

1	Indicate the complete official name of the line, and, if applicable, followed by an abbreviation of the name in parenthesis, e.g., Fill-Suction Header No. 4 (FSH-4).
2	Show the year in which the line was originally constructed. In cases where Safety Instruction Sheets are being prepared for existing pipelines for which only the approximate date of construction is known, insert "(Approx.)" after the year. If the approximate year the line was constructed is not known, record "unknown".
3	Indicate the official name of the Terminal or Bulk Plant, e.g., Juaymah Tank Farm.
4	Indicate the name of the Department and Location of the facility, e.g., Terminal / Ras Tanura.
5	Indicate the type of fluid handled, e.g., Arab Light Crude Oil, and record the year in which the fluid handled by the line is as stated. Normally this will be the same as the year entered in key number 2.
6	Indicate the approximate total volume of the pipeline (rounded to the nearest 100 barrels). If the line volume is less than 100 barrels, give the volume to the nearest ten barrels. Also, indicate the approximate total length of the pipeline (rounded to the nearest 50 feet). If the line is less than 50 feet long, express the length to the nearest ten feet.

#### **PIPELINE DESIGN INFORMATION, OPERATING DATA & LIMITS (Entries 7-16)**

7	Indicate the applicable ASME piping code; normally B31.4, but in some cases B31.3.
8	If the pipeline is designed according to ASME B31.4, indicate the pipeline's internal design pressure (IDP) as defined in paragraph 401.2.2 of that code. If the pipeline is designed to ASME B31.3, indicate the pipeline's design pressure (DP) as defined in paragraph 301.2 of that code. In addition to the applicable ASME code, the design pressure must comply with <a href="#">SAES-L-310</a> , "Design of Plant Piping".
9	Indicate the design temperature, which must comply with <a href="#">SAES-L-310</a> , "Design of Plant Piping".
10	Indicate whether the line is protected with a surge relief system.
11	If applicable, indicate the set pressure of the surge relief valves. If the line does not have a surge relief system installed, record "N/A".
12	Indicate the maximum allowable surge pressure under the applicable piping code. For piping designed according to ASME B31.4 this will normally be 1.1 times the internal design pressure, and for piping designed according to ASME B31.3 this will normally be 1.33 times the design pressure.

13	Indicate the general location of the surge relief valves, e.g., Inlet Metering Area. If there is no surge relief system installed, record "N/A".
14	Indicate the set pressure of any thermal relief valve(s) installed on the line. If there are no thermal relief valves installed, indicate "N/A".
15	Record the date and pressure of the hydrostatic pressure test performed on the line immediately after construction. The test pressure shall be in accordance with <a href="#">SAES-L-150</a> , "Pressure Testing of Plant Piping and Pipelines". If preparing a Safety Instruction Sheet for an existing line for which this pressure and/or date are not known, record "unknown".
16	Record the date and pressure of the most recent hydrostatic pressure test. For piping designed according to ASME B31.4 this should normally be 1.25 times the internal design pressure, and for piping designed according to ASME B31.3 it should normally be 1.5 times the design pressure. If the line has not been re-tested since the initial hydrostatic pressure test, indicate the proper test pressure as determined by the applicable piping code, and leave the date field blank.  <i>Commentary Note:</i>  <i>The Safety Instruction Sheet (SIS) is to be updated by the responsible Operations Engineering Unit after every hydrostatic pressure test.</i>

**PIPE DATA & MINIMUM THICKNESS REQUIREMENTS (Entries 17-38).** A separate column shall be completed for each unique segment of the line. A single segment shall have same nominal pipe size, wall thickness, material grade, design factor, flange rating, type of construction (buried or above ground), and coating specification.

17	Indicate the starting point for the piping segment covered by that particular column on the SIS. Any appropriate point of reference can be used such as a pipe support or MOV. If the section of piping is at a road crossing, record the applicable road crossing number.
18	Indicate the end point for the segment of piping covered by that particular column on the SIS.
19	Enter the nominal pipe size and pipe outside diameter of the segment of piping covered by that particular column on the SIS.
20	Enter the nominal wall thickness of the segment of piping covered by that particular column on the Safety Instruction Sheet. Fractions of an inch should be expressed to 3 decimal places, e.g., "0.375 inches".  <i>Commentary Note:</i>  <i>Nominal wall thickness is the original wall thickness when the pipe was new, and should not be confused with the actual wall thickness measured later after corrosion may have occurred.</i>
21	Indicate the applicable Saudi Aramco Piping Specification as per <a href="#">SAES-L-105</a> , e.g., -1A1, 3CS9P, etc.  <i>Commentary Note:</i>  <i>This specification should be the Saudi Aramco Piping Specification when the line was originally constructed, even if this specification has since been superseded.</i>
22	Indicate the pipe material specification and grade, e.g., API 5L, Gr. B.
23	Indicate whether the pipe is welded or seamless.

24	For piping designed according to ASME B31.4, indicate the weld joint factor, E, taken from Table 402.4.3 of that code (for most pipe grades this will be 1.00). For piping designed according to ASME B31.3, indicate the longitudinal weld joint quality factor, E <sub>l</sub> , taken from Table 302.3.4 of that code.
25	For piping designed according to ASME B31.4, enter the appropriate design factor, e.g., 0.50, 0.72, etc., in accordance with <a href="#">SAES-L-310</a> or <a href="#">SAES-L-410</a> . If the piping is designed according to ASME B31.3, record "N/A".  <i>Commentary Note:</i>  <i>If preparing a Safety Instruction Sheet for an existing line, record the design factor that was used when the pipeline was designed.</i>
26	If the piping is designed according to ASME B31.4, indicate the specified minimum yield strength (SMYS) of the pipe. If the piping is designed according to ASME B31.3, indicate the allowable stress (S) in accordance with Table A-1 of that code.
27	Indicate the class rating of the pipeline's flanges according to the applicable standard (ASME B16.5, API 605, MSS SP-44, etc.), e.g., Class 150. If any unusual or non-standard flanges are installed on the line, include a note in the Notes & Remarks section providing details.
28	Enter a two letter abbreviation indicating the type of flange facing, e.g., RF for raised face, RJ for ring joint, etc.
29	Enter the material specification of the main line flanges, e.g., ASTM A350 LF2, ASTM 105N, etc. If there is more than one specification, write "see notes" in the space provided, and then list the applicable specifications in a note in the Notes & Remarks section.
30	State whether the segment of piping is buried or above ground.
31	Indicate the Saudi Aramco Coating Specification for the pipeline's external coating, e.g., APCS-4. If the pipe is not externally coated, record "None".
32	Indicate the Saudi Aramco Coating Specification for the pipeline's internal coating, e.g., APCS-102. If the pipe is not internally coated, record "None".
33	Indicate the pipe minimum wall thickness ( $T_{min}$ ), which shall not be less than the greater of the following:  Minimum pressure thickness ( $T_p$ ), which is the minimum wall thickness at which the pipe can withstand an internal pressure equal to the internal design pressure without exceeding the allowable hoop stress based on the pipe's SMYS, applicable piping code, and design factor.  Minimum structural thickness ( $T_s$ ) per Table I in <a href="#">SAES-L-310</a> .  <i>Commentary Note:</i>  <i>In some cases it may be necessary to specify a <math>T_{min}</math> value thicker than both <math>T_p</math> and <math>T_s</math>. This could be necessary due to longer than normal pipe support spacing, presence of external loads, etc. In such cases, a detailed stress analysis is to be performed to establish an appropriate <math>T_{min}</math>.</i>

34	<p>If the piping is designed according to ASME B31.3, record the available corrosion allowance (<math>T_{ca}</math>), which equals the nominal wall thickness of pipe (key number 20) minus <math>T_{min}</math> (key number 33). If the pipe is designed according to ASME B31.4, record "N/A".</p> <p><i>Commentary Note:</i></p> <p><i>Corrosion allowance (<math>T_{ca}</math>) is the remaining pipe wall thickness above the required <math>T_{min}</math>. This is NOT a required corrosion allowance. If a corrosion allowance is required, it must be stated (including the referenced standard) in the remarks area under key number 38.</i></p>
35	<p>Indicate the maximum pipe support spacing for which the <math>T_{min}</math> value entered in key number 33 is valid. This figure is the pipe support spacing at which the longitudinal stress due to the combination of internal pressure and bending moment equals the code allowable limit with the pipeline in the fully corroded condition, i.e., actual wall thickness equals <math>T_{min}</math>.</p> <p><i>Commentary Note:</i></p> <p><i>For piping designed according to ASME B31.4, the maximum pipe support spacing (L) can be calculated using the following equation:</i></p> $L = \sqrt{\frac{(0.75S - PD/4t)(D^4 - d_c^4)}{D[(D^2 - d_o^2)40.6 + 5.2d_o^2]}}$ <p><i>Where:</i></p> <ul style="list-style-type: none"> <li><math>L</math> = Maximum Pipe Support Spacing, feet</li> <li><math>S</math> = Allowable Stress, psi (i.e., SMYS x E x D.F.)</li> <li><math>P</math> = Internal Design Pressure, psi</li> <li><math>D</math> = Pipe OD, inches</li> <li><math>t</math> = <math>T_{min}</math>, inches</li> <li><math>T_n</math> = Pipe nominal wall thickness (before corrosion), inches</li> <li><math>d_o</math> = Pipe ID, before corrosion (Pipe OD minus <math>2T_n</math>), inches</li> <li><math>d_c</math> = Pipe ID after corrosion (Pipe OD minus <math>2t</math>), inches</li> </ul> <p><i>For piping designed according to ASME B31.3, the maximum pipe support spacing (L) can be calculated using the following equation:</i></p> $L = \sqrt{\frac{(S - PD/4t)(D^4 - d_c^4)}{D[(D^2 - d_o^2)40.6 + 5.2d_o^2]}}$ <p><i>Where:</i></p> <ul style="list-style-type: none"> <li><math>L</math> = Maximum Pipe Support Spacing, feet</li> <li><math>S</math> = Allowable Stress, psi</li> <li><math>P</math> = Internal Design Pressure, psi</li> <li><math>D</math> = Pipe OD, inches</li> <li><math>t</math> = <math>T_{min}</math>, inches</li> <li><math>T_n</math> = Pipe nominal wall thickness (before corrosion), inches</li> <li><math>d_o</math> = Pipe ID, before corrosion (Pipe OD minus <math>2T_n</math>), inches</li> <li><math>d_c</math> = Pipe ID after corrosion (Pipe OD minus <math>2t</math>), inches</li> </ul> <p><i>It is also acceptable to specify a maximum pipe support spacing longer than the spacing calculated using this equation provided that a detailed stress analysis is done to show the combined longitudinal stress levels being within the limits of the applicable ASME piping code.</i></p>
36	Enter the drawing number for the Valve Operating Diagram (VOD) for this line.

37	List applicable reference drawings such as isometric piping details (IPDs), Piping & Instrument Diagrams (P&IDs), etc.
38	Include any required notes or remarks regarding entries on the subject Safety Instruction Sheet. This will include explanations of any assumptions made for entries when preparing a SIS for an existing line, and any other information that may be useful for future reference.

Saudi Aramco 5645-ENG (12/2001)

OPRNS	PMT	CERT	ENGG	<b>SAUDI ARABIAN OIL COMPANY</b>																	
				<b>SAFETY INSTRUCTION SHEET - TERMINAL AND BULK PLANT PIPING</b>																	
				1	PIPELINE IDENTIFICATION		4	DEPT. & AREA	/												
				2	YEAR BUILT		5	SERVICE & DATE (YR)	/												
				3	PLANT NAME		6	VOLUME & LENGTH	Barrels		Ft.										
				<b>DESIGN INFORMATION, OPERATING DATA AND LIMITS</b>																	
				7	ASME PIPE CODE		12	MAX. ALLOWABLE SURGE PRESSURE	PSIG												
				8	DESIGN PRESSURE	PSIG	13	SURGE RELIEF VALVE LOCATION													
				9	DESIGN TEMPERATURE	°F	14	THERMAL RELIEF VALVE SET PRESSURE	PSIG												
				10	SURGE PROTECTED (Yes / No)		15	INITIAL HYDROSTATIC TEST DATE & PRESS.	On	@	PSIG										
				11	SURGE VALVE RELIEF PRESS.	PSIG	16	LATEST HYDROSTATIC TEST DATE & PRESS.	On	@	PSIG										
				<b>PIPE DATA AND MINIMUM THICKNESS REQUIREMENTS</b>																	
				17	START POINT (See Sht. 3)																
				18	END POINT (See Sht. 3)																
				19	NOMINAL PIPE SIZE / O.D.	in / in.	in / in.	n . in.	in / in.	in / in.											
				20	NOMINAL WALL THICKNESS	in.															
				21	SAES PIPING SPECIFICATION																
				22	PIPE MAT'L SPEC. & GRADE																
				23	WELDED OR SEAMLESS																
				24	WELD JOINT (QUALITY) FACTOR																
				25	DESIGN FACTOR (B31.4 ONLY)																
				26	S.Y.M.S. OR ALLOWABLE STRESS	PSI	PSI	PSI	PSI	PSI											
				27	FLANGE RATING																
				28	FLANGE FACING																
				29	FLANGE MAT'L SPECIFICATION																
				30	ABOVE GROUND OR BURIED																
				31	EXTERNAL COATING SPEC.																
				32	INTERNAL COATING SPEC.																
				33	PIPE T <sub>min</sub> <sup>(1)(2)</sup>	in.	in.	in.	in.	in.											
				34	CORROSION ALLOW. (B31.3 ONLY)	in.	in.	in.	in.	in.											
				35	MAX. PIPE SUPPORT SPACING <sup>(3)</sup>	Ft.	Ft.	Ft.	Ft.	Ft.											
				<b>DRAWINGS, NOTES and REMARKS</b>																	
				36	VALVE OPERATING DIAGRAM(S):																
				37	REF. DRAWINGS (IPDs, P&IDs, etc.):																
				38	(1) T <sub>min</sub> is only valid for straight runs of pipe with no external loads (valves, branches, road crossings, etc.). For situations where the pipe is not a straight run or external loads are present, consult with Engineering for T <sub>min</sub> . (2) For pipes NPS 20-inch and larger using saddle type supports, T <sub>min</sub> within D/4 of the horn of saddle is to be D/150, where D = pipe OD. (3) For pipe support spans greater than this, consult with Engineering for T <sub>min</sub> .																
				<b>EDSD VERIFICATION</b> CONTROL NUMBER: _____ BY: _____ DATE: _____																	
				<b>REVISION CERTIFICATION</b> THIS INDICATES THAT REV. NO. _____ OF THIS DRAWING IS COVERED FOR ALL APPROVAL/CERTIFICATION REQUIREMENTS. BY DRAWING COMPLETION CERTIFICATE (DCC) NO.: _____																	
				<b>SIS FOR</b>				DWG. TYPE	PLANT NO.	INDEX	DRAWING NO.	SHT. NO.	REV. NO.								
				<b>SIS</b>						<b>E-</b>	<b>3</b>										
				SAUDI ARAMCO				JO / EWO			<b>3</b>										
											<b>OF</b>										
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